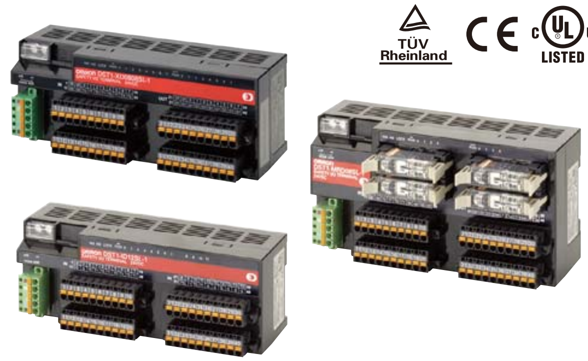
Safety I/O Terminals

DST1 Series

Distributed Safety Terminals That Reduce Wiring.



- ■ Lineup includes four models to accommodate various I/O types and number of I/O points.
- ■ Monitor the safety system from Standard Controllers across the network.
- ■ EN 954-1/ISO13849-1 CAT4 and IEC 61508 SIL3 certification.
- ■ The DST1-XD0808SL-1 also supports logic operation functions for high-speed processing in applications requiring partial stopping of the safety system.

Ordering Information

List of Models

Name	No. of I/O points	Model
Safety I/O Terminals	Safety inputs: 12, test outputs: 4	**DST1-ID12SL-1**
	Safety inputs: 8, safety outputs (semiconductor): 8, test outputs: 4	**DST1-MD16SL-1**
		DST1-XD0808SL-1 *
	Safety inputs: 4, safety outputs (relay): 4, test outputs: 4	**DST1-MRD08SL-1**

Note: The standard DS1T Safety I/O Terminals are equipped with spring-cage terminal blocks, but screw terminal blocks are available if desired, e.g., to replace previous terminals. Refer to DeviceNet Safety Accessories.
* Use the Safety Network Configurator Ver. 2.0 or later to make DST1-XD0808SL-1 settings.

Specifications

Certified Standards

Certification body	Standard
TÜV Rheinland	IEC61508 part1-7/12.98-05.00, EN954-1: 1996, ISO13849-1: 1999, prEN954-2: 1999, ISO13849-2: 2003, EN ISO13849-2: 2003, IEC61131-2: 2003, EN60204-1: 2006, IEC60204-1: 2005, EN61000-6-2: 2001, EN61000-6-4: 2001, EN418: 1993, NFPA 79-2002, ANSI RIA15.06-1999, ANSI B11.19-2003
UL	UL1998, UL508, UL1604 (excluding the DST1-MRD08SL-1), IEC61508 CSA22.2 No. 142, CSA22.2 No. 213 (excluding the DST1-MRD08SL-1)

Specifications

Item / Model		DST1-ID12SL-1	DST1-MD16SL-1	DST1-MRD08SL-1	DST1-XD0808SL-1
Communications power supply voltage		11 to 25 VDC supplied via communications connector			
I/O power supply voltage		20.4 to 26.4 VDC (24 VDC −15%/+10%)			
Current consum-ption	**Commun-ications power supply**	24 VDC 100 mA	24 VDC 110 mA	24 VDC 100 mA	24 VDC 110 mA
Overvoltage category		II			
Noise immunity		Conforms to IEC61131-2.			
Vibration resistance		10 to 57 Hz: 0.35-mm single amplitude, 57 to 150 Hz: 50 m/s²			
Shock resistance		150 m/s², 11 ms		100 m/s², 11 ms	150 m/s², 11 ms
Mounting method		35-mm DIN Track			
Ambient operating temperature		−10 to 55°C			
Ambient operating humidity		10% to 95% (with no condensation)		10% to 85% (with no condensation)	10% to 95% (with no condensation)
Ambient storage temperature		−40 to 70°C			
Degree of protection		IP20			
Weight		420 g		600 g	420 g

Safety Input Specifications

(Common with the DST1 Series)

Input type	Sinking inputs (PNP)
ON voltage	11 VDC min.
OFF voltage	5 VDC max.
OFF current	1 mA max.
Input current	6 mA

Safety Output Specifications (Semiconductor output)

(Common with the DST1-MD16SL-1/XD0808SL-1)

Output type	Sourcing outputs (PNP)
Rated output current	0.5 A max./output
ON residual voltage	1.2 V max.
Leakage current	0.1 mA max.

Test Output Specifications

(Common with the DST1 Series)

Output type	Sourcing outputs (PNP)
Rated output current	0.7 A max./output
ON residual voltage	1.2 V max.
Leakage current	0.1 mA max.

Safety Output Specifications (Relay Output)

(DST1-MRD08SL-1)

Applicable relays		G7SA-2A2B, EN50205 Class A
Failure rate P level * **(Reference value)**		5 VDC, 1 mA
Rated load (resistive)		2 A at 240 VAC, 2 A at 30 VDC
Durability	**Mechanical**	5,000,000 operations min. (at 7,200 operations/h)
	Electrical	100,000 operations min. (at 1,800 operations/h with a resistive load)

* This value is equivalent to 300 operations/minute.

DeviceNet Safety Communications

Safety Slave communications	Max. 4 connections (Max. 2 connections for the DST1-XD0808SL-1)

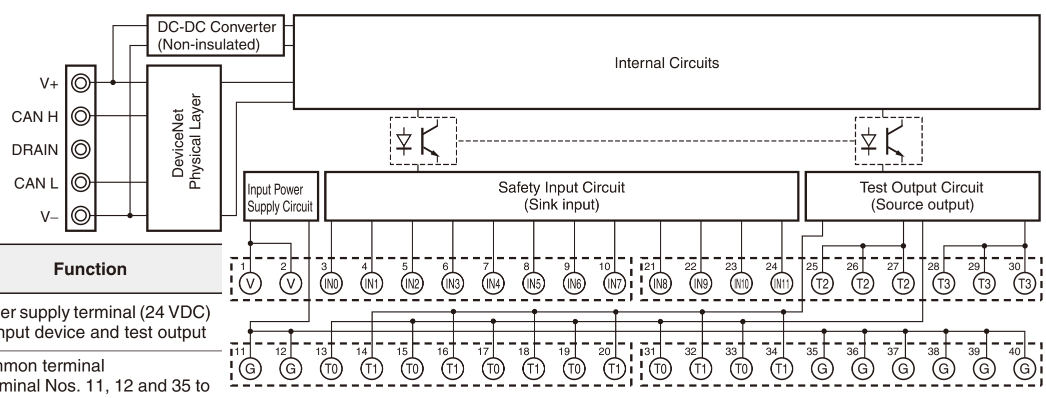
DeviceNet Slave Communications

(Common with the DST1 Series)

Standard Slave communications	Max. 2 connections

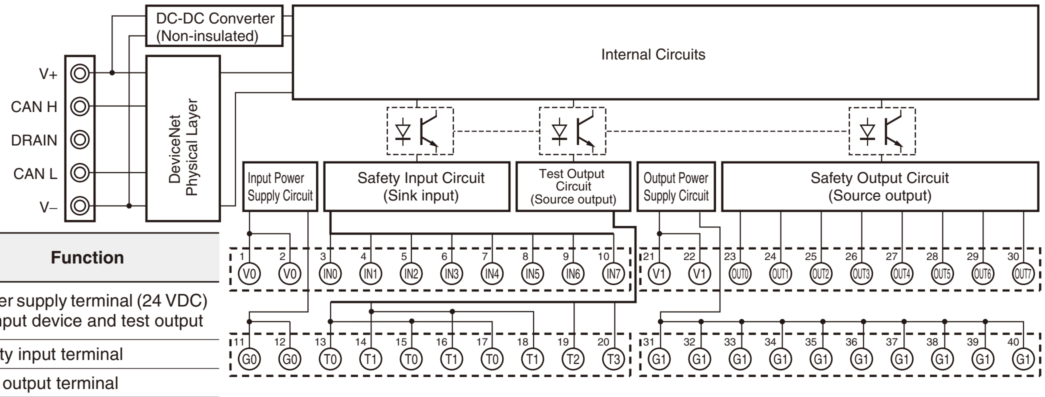
Internal Circuit Configuration

DST1-ID12SL-1



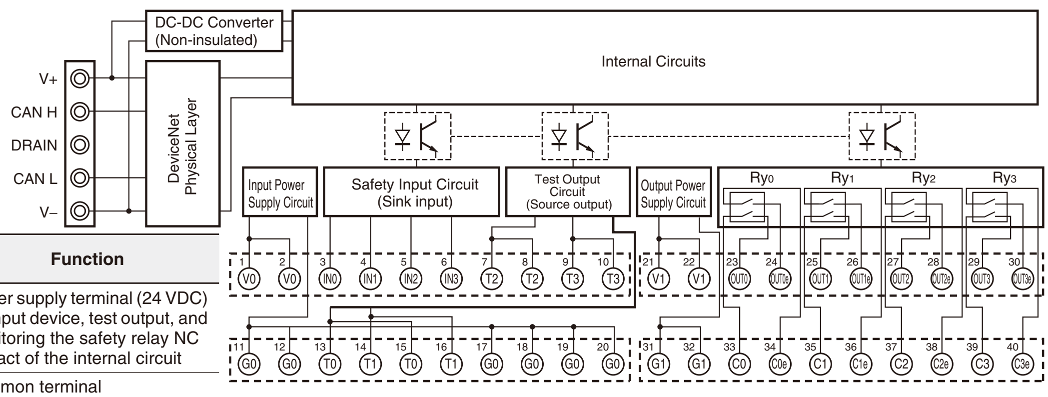
Terminal No.	Name	Function
1, 2	V	Power supply terminal (24 VDC) for input device and test output
11, 12	G	
35 to 40	G	Common terminal (Terminal Nos. 11, 12 and 35 to 40 are internally connected.)
3 to 10 21 to 24	IN0 to IN11	Safety input terminal
13 to 20 25 to 30 31 to 34	T0 to T3	Test output terminal

DST1-MD16SL-1
DST1-XD0808SL-1



Terminal No.	Name	Function
1, 2	V0	Power supply terminal (24 VDC) for input device and test output
11, 12	G0	
3 to 10	IN0 to IN7	Safety input terminal
13 to 20	T0 to T3	Test output terminal
21, 22	V1	Power supply terminal (24 VDC) for output device
31, 32	G1	
23 to 30	OUT0 to OUT7	Safety output terminal
33 to 40	G1	Common terminal (Terminal Nos. 31 to 40 are internally connected.)

DST1-MRD08SL-1



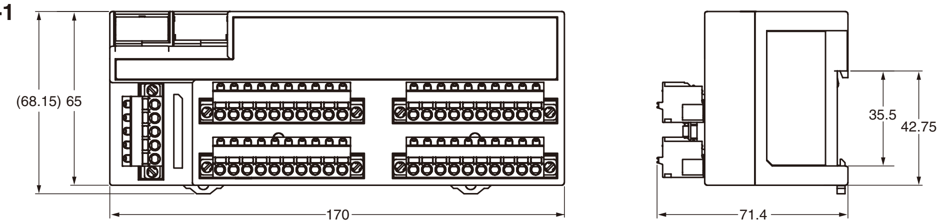
Terminal No.	Name	Function
1, 2	V0	Power supply terminal (24 VDC) for input device, test output, and monitoring the safety relay NC contact of the internal circuit
11, 12	G0	
17 to 20	G0	Common terminal (Terminal Nos. 11, 12 and 17 to 20 are internally connected.)
3 to 6	IN0 to IN3	Safety input terminal
7 to 10 13 to 16	T0 to T3	Test output terminal
21, 22	V1	Power supply terminal (24 VDC) for driving the safety relay of the internal circuit
31, 32	G1	
23 to 30 33 to 40	OUT0 to OUT3 C0 to C3 OUT0e to OUT3e C0e to C3e	Safety output terminal (The outputs of terminal No. 23/33 (OUT0) and 24/34 (OUT0e) are the same.) (The outputs of terminal No. 25/35 (OUT1) and 26/36 (OUT1e) are the same.) (The outputs of terminal No. 27/37 (OUT2) and 28/38 (OUT2e) are the same.) (The outputs of terminal No. 29/39 (OUT3) and 30/40 (OUT3e) are the same.)

Refer to the *DeviceNet Safety DST1-series Safety I/O Terminals Operation Manual* (Cat. No. Z904) for wiring examples.

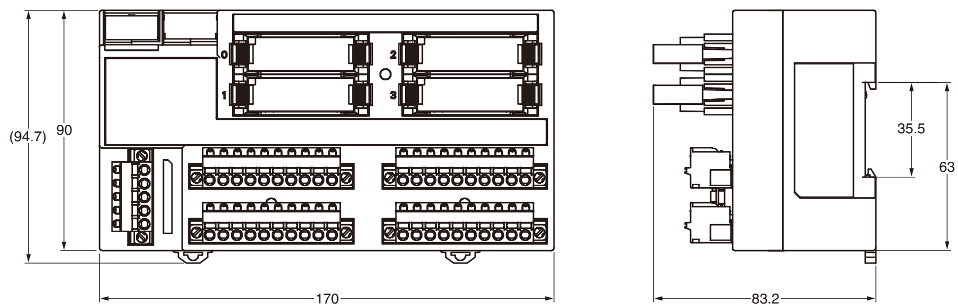
Dimensions

(Unit: mm)

DST1-ID12SL-1
DST1-MD16SL-1
DST1-XD0808SL-1



DST1-MRD08SL-1

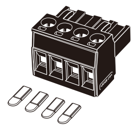
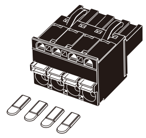


Safety Precautions

Be sure to read the following operation manual for precautions and other details required for correct use of the Safety Network Controller.
DeviceNet Safety DST1-series Safety I/O Terminals Operation Manual **(Cat. No. Z904)**

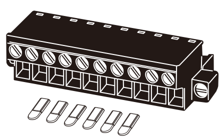
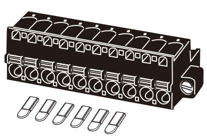
Accessories

Terminal Blocks for the NE1A

Appearance	Specification	Applicable Controllers	Model	Remarks
	Screw terminal blocks (4 pins)	NE1A-SCPU01 NE1A-SCPU01-V1 NE1A-SCPU02 NE1A-EDR01	**Y9S-04T1B-02A**	A set including two screw terminal blocks (black) and six code marks to prevent incorrect insertion
	Spring-cage terminal blocks (4 pins)		**Y9S-04C1B-02A**	A set including two spring-cage terminal blocks (black) and six code marks to prevent incorrect insertion

Note: The standard NE1A Controllers are equipped with spring-cage terminal blocks. Screw terminal blocks can be ordered if desired, e.g., to replace previous terminals.

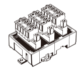
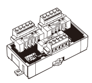
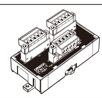
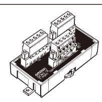
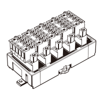
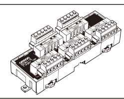
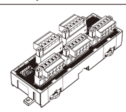
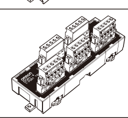
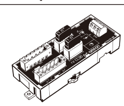
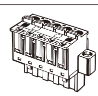
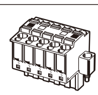
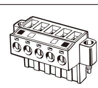
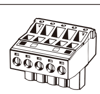
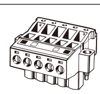
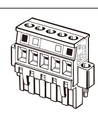
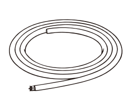
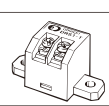
Terminal Blocks for the DST1

Appearance	Specification	Applicable Safety I/O Terminals	Model	Remarks
	Screw terminal blocks (10 pins)	DST1-ID12SL-1 DST1-MD16SL-1 DST1-XD0808SL-1 DST1-MRD08SL-1	**Y9S-10T1B-04B**	A set including four screw terminal blocks (black), six code marks to prevent incorrect insertion, one set of terminal labels *, and code mark instructions
	Spring-cage terminal blocks (10 pins)		**Y9S-10C1B-04B**	A set including four spring-cage terminal blocks (black), six code marks to prevent incorrect insertion, one set of terminal labels *, and code mark instructions

Note: The standard DS1T Safety I/O Terminals are equipped with spring-cage terminal blocks. Screw terminal blocks can be ordered if desired, e.g., to replace previous terminals.

* The set of terminal labels is one sheet containing four sets of labels required for one Terminal Block, i.e., [1, 2 ... 10], [11, 12 ... 20], [21, 22 ... 30] and [31, 32 ... 40].

Peripheral Devices for DeviceNet Communications

Product	Appearance	Model	Specification	
T-branch Tap for 1 branch line		**DCN1-1NC**	Cable wiring direction: Toward top Cable lock direction: From top Connector screw direction: From top	Provided with 3 parallel connectors with clamps (XW4G-05C1-H1-D), standard terminating resistor
		**DCN1-1C**	Cable wiring direction: Toward side Cable screw direction: From top Connector screw direction: From side	Provided with 3 parallel connectors with screws (XW4B-05C1-H1-D), standard terminating resistor
		**DCN1-2C**	Cable wiring direction: Toward top Cable screw direction: From side Connector screw direction: From top	
		**DCN1-2R**	Cable wiring direction: Toward side Cable screw direction: From top Connector screw direction: From top	Provided with 3 orthogonal connectors with screws (XW4B-05C1-VIR-D), standard terminating resistor
T-branch Tap for 3 branch lines		**DCN1-3NC**	Cable wiring direction: Toward top Cable lock direction: From top Connector screw direction: From top	Provided with 5 parallel clamp connectors with screws (XW4G-05C1-H1-D), standard terminating resistor
		**DCN1-3C**	Cable wiring direction: Toward side Cable screw direction: From top Connector screw direction: From side	Provided with 5 parallel connectors with screws (XW4B-05C1-H1-D), standard terminating resistor
		**DCN1-4C**	Cable wiring direction: Toward top Cable screw direction: From side Connector screw direction: From top	
		**DCN1-4R**	Cable wiring direction: Toward side Cable screw direction: From top Connector screw direction: From top	Provided with 5 orthogonal clamp connectors with screws (XW4B-05C1-VIR-D), standard terminating resistor
Power Supply Tap		**DCN1-1P**	One-branch tap provided with 2 connectors, standard terminating resistor, and fuse	
Connectors		**XW4G-05C1-H1-D**	Parallel clamp connector with screws Connector insertion and wiring both performed horizontally.	
		**XW4G-05C4-TF-D**	Parallel multi-branching clamp connector with screws Connector insertion and wiring performed in same direction.	
		**XW4B-05C1-H1-D**	Parallel connector with screws Connector insertion and wiring performed in same direction.	
		**XW4B-05C4-T-D**	Parallel, screw-less, multi-branching connector Connector insertion and wiring performed in same direction.	
		**XW4B-05C4-TF-D**	Parallel, multi-branching connector with screws Connector insertion and wiring performed in same direction.	
		**XW4B-05C1-VIR-D**	Orthogonal connector with screws Connector insertion and wiring performed at a right angle.	
DeviceNet Cables		**DCA1-5C10 (-B)**	Thin cable length: 100 m DCA1-5C10-B: Cable color: Blue DCA1-5C10: Cable color: Gray	
		DCA2-5C10 (-B)	Thick cable length: 100 m DCA2-5C10-B: Cable color: Blue DCA2-5C10: Cable color: Gray	
Terminal-block Terminator		**DRS1-T**	Resistance of 121 Ω	

⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON’s test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company
http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Safety Controllers
F3SX

"Safe" "Simple" "Visible" Safety controller with no need for programming

- Conforms to global safety standards.
- All-in-one constructions for easy multi-input safety circuits.
- Information where you need it: LED indicators, auxiliary outputs, and serial communications.

⚠ Be sure to read the *"Safety Precautions"* on page 21

Features

OMRON believes the fundamentals for building risk-free workplace environments are **safety, simplicity,** and **visibility**.

Design and implementation of safety measures and policies can be readily achieved through proven safety procedures using simple connections.

Peace of mind is attained by communicating safety equipment status information* in a form that is meaningful to the on-site operational and maintenance staff supporting the system.

The F3SX evolves from this philosophy.

* Information:

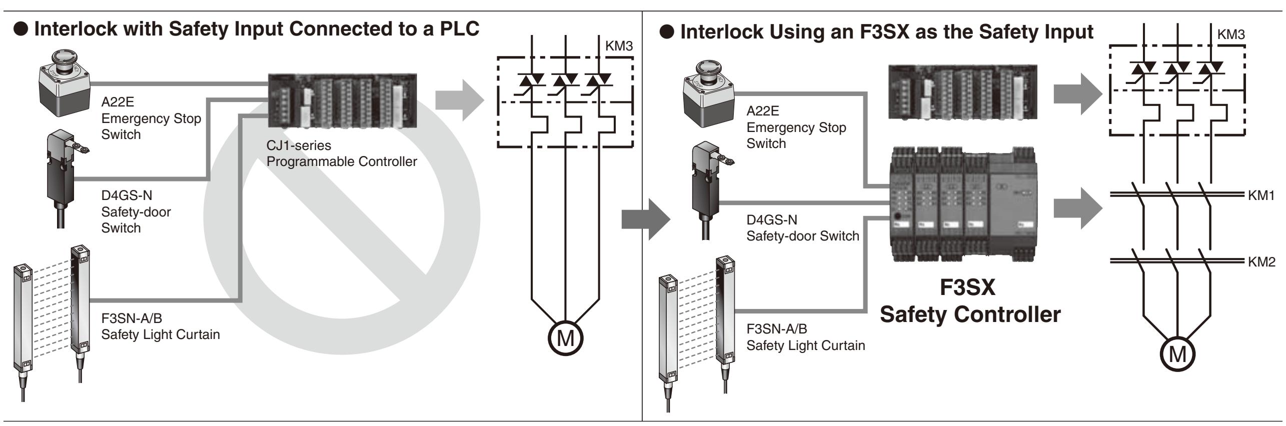
1. Indicator output with self-diagnostic functions clearly communicates proximity warnings and work permission during operation to the operator.
2. The lighting patterns of the Safety Controller's indicators allow the operator to read the ON/OFF status of safety equipment I/O as well as error type information.
3. RS-232 communications can be used to read detailed information for the above status.

What is a Safety Controller?

Are Your Safety Inputs Connected to Your PLC Built with Interlocks?

Generally, safety is jeopardized in PLCs and other programmable control devices due to partial memory loss, CPU runaways, and situations such as on-site overwriting of programs. Using Safety Light Curtains and Safety-door Switches on their own does not necessarily ensure sufficient safety for PLC operation. Nor is safety fully secured through the use of relays in interlocks due to hazardous events that occur as a result of fused relays or short-circuited wiring.

The F3SX offers safe and simple connections for an array of safety equipment, such as Safety Light Curtains and Safety-door Switches, functioning as a central hub to perform integrated monitoring of various safety equipment.



Safe

The Safety Controller Complies with Global Safety Standards

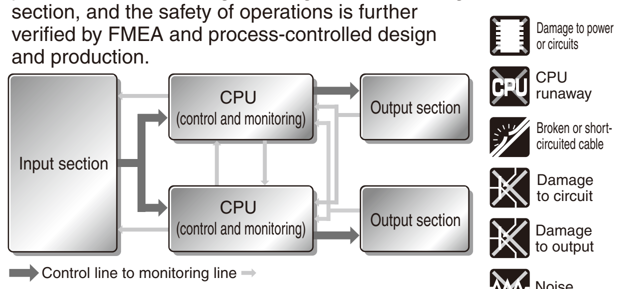
In addition to International standards (IEC), the F3SX also conforms to European (EN), U.S./Canadian (UL) and Korean (KOSHA), safety standards, S-Mark, enabling trouble-free use in machinery for Europe, the U.S., and Canada.

Applicable Standards

- European Machinery Directive 98/37/EC, Low Voltage Directive 73/23/EEC
- IEC 61508 1998 (EN 61508 2001) (SIL 1-3)
- EN 954-1 1996 (Category B 1-4)
- EN 50178 1997, UL 508, UL 1998, etc.

Technology-backed Safety Design

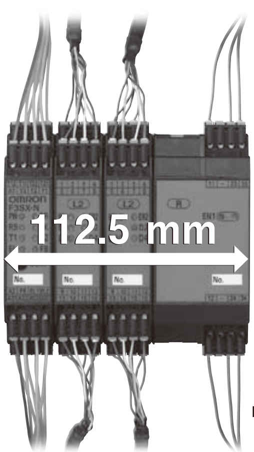
We pursued safety to the limit to deliver safety and reliability backed by the highest level of safety design and FMEA. Two CPU Units perform mutual checking and diagnostic monitoring of each I/O section, and the safety of operations is further verified by FMEA and process-controlled design and production.



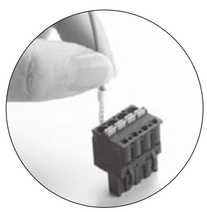
FMEA: Failure Mode & Effects Analysis

Simple

Connection is Easy Using Plug-in Connectors for Even More Readily Accessible Safety



- No unnecessary wiring between Units allows considerable cuts in the cost of evaluating design safety.
- Reduced wiring, post terminals, and connector connections enable substantial reductions in the cost of maintenance labor.
- Width has been reduced by approximately 50% from 225 mm to 112.5 mm max. (compared to previous OMRON products; connecting F3SN (4 sets), F3SP-B1P, and G9SB-301).
- Post terminals aid in preventing unintentional neglect to tighten terminal screws.

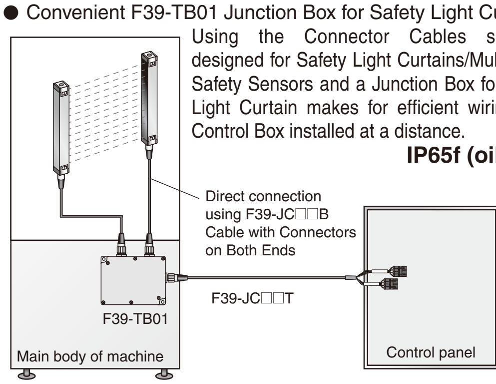


Note: The wire colors are for reference purposes only. Refer to individual international standards for details.

- Convenient F39-TB01 Junction Box for Safety Light Curtain.

Using the Connector Cables specially designed for Safety Light Curtains/Multi-beam Safety Sensors and a Junction Box for Safety Light Curtain makes for efficient wiring to a Control Box installed at a distance.

IP65f (oil-resistant)



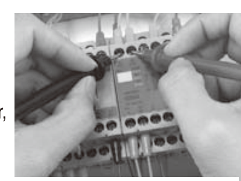
F39-TB01
Junction Box for Safety Light Curtain

F39-JC□□T
Connector Cable for Safety Light Curtains

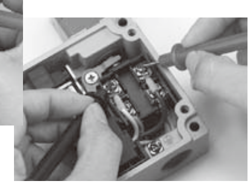
Visible

Providing Meaningful Safety Equipment Information that Satisfies Needs for Safety and Peace of Mind

Previously Majority of time lost due to failures is from investigating the causes. In particular, most time is spent in determining the location of broken lines or faulty contacts.



Safety Relay Unit

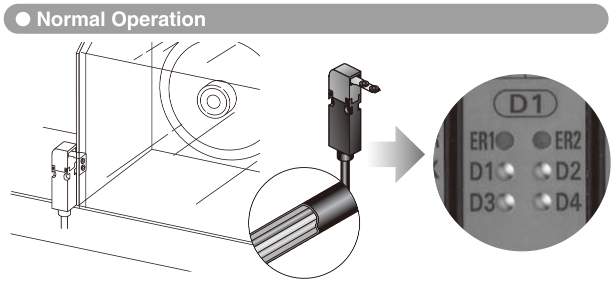


Electromagnetic Locking Door Switch

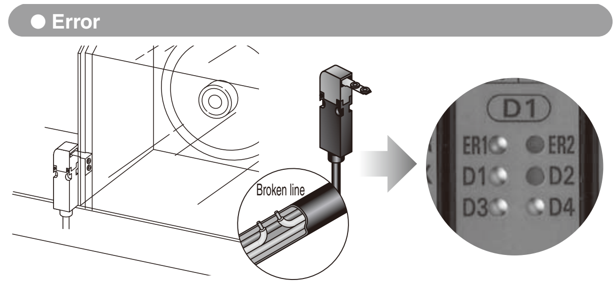
Indicator Displays Are Easy to Understand and More Convenient

F3SX Shorter Downtimes! The F3SX uses indicators to show the status of each I/O, contributing to less time (downtime) spent investigating the cause.

● Normal Operation



● Error



Note: Refer to pages 14 and 15 for details on indicator patterns.

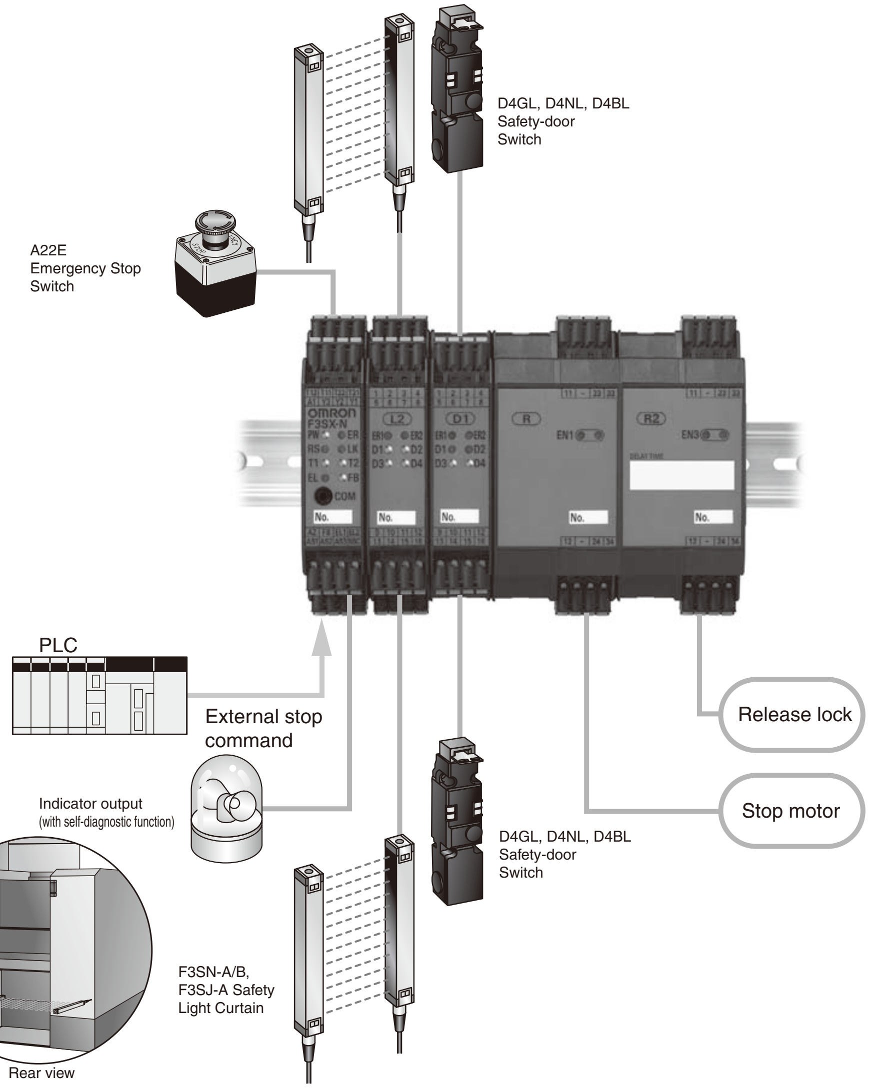
Applications Using Electromagnetic Lock Switches and Safety Light Curtains for Detecting Workers

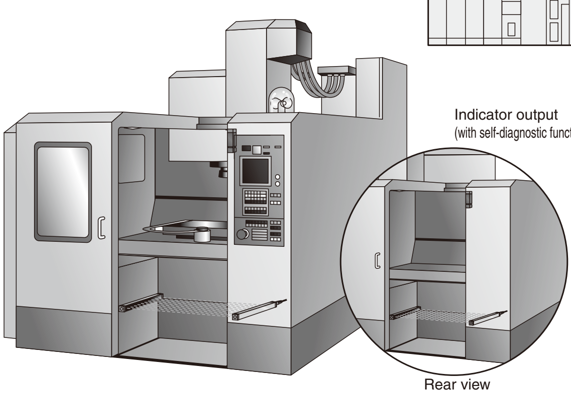
Simple External Stop Input Connection

When an electromagnetic lock and Safety Light Curtain (worker detection) are used, as shown in the diagram, an external stop command input is required in addition to the Emergency Stop Switch.
Inputting a PLC operation command to the SSC input allows easy connection and control. Causes of failures can be determined from detailed communications data, which safeguards against any problem that may occur.

Indicator Lighting Pattern Shows Lock Release Timing to Operator

External indicator output lighting patterns can be utilized as work permission indicators. When equipment stops, the indicator turns ON. During OFF delays, indicator flashing gradually increases speed as the remaining time shortens to notify the operator of release timing. This contributes to increased productivity and dispels agitation due to unknown waiting times.





Selection Method

Choose stop method. → Choose output type. → Choose the input type and number of Modules.

Non-delay (Instant-breaking) — For induction motors or valves
- Relay output/external indicator output → F3SX-NR/F3SX-N-□□□R page 6
- DC solid-state safety output → F3SX-E□/F3SX-E-□□□□ page 6

OFF-delay — For servomotors/inverters or electromagnetic locks
- Relay output/external indicator output
  - OFF-delay time setting type → F3SX-N-□□RR2 page 8
- Relay output/DC solid-state safety output
  - OFF-delay time setting type → F3SX-ER2/F3SX-E-□□□R2 page 8
  - OFF-delay time fixed type → F3SX-ER2-T□□□ page 8

ON-delay — For warning before startup
- Relay output/DC solid-state safety output
  - ON-delay time fixed type → F3SX-ER1-T□□□ page 9

Model Number Structure and Product Configuration

Model Number Legend

F3SX-□□□(-T□□□)*
1 2 3

Number	Symbol	Description
1	E	Emergency Stop Controller with DC solid-state safety outputs
	NR	Emergency Stop Controller with safety relay output and external indicator output
	ER	Emergency Stop Controller with safety relay output and DC solid-state safety output
	EL1	Emergency Stop/Safety Light Curtain/Two-hand Control Switch Input Controller with DC solid-state safety outputs
	EL2	Emergency Stop/Safety Light Curtain Controller with DC solid-state safety outputs
	EB1	Emergency Stop/Single-beam Safety Sensor Controller with DC solid-state safety outputs
	ED1	Emergency Stop/Door Switch Input Controller with DC solid-state safety outputs
2	H	Delay time: 0.5 s × value indicated at 3. (odd numbers from TH01 to TH59)
	N	Delay time: 1.0 s × value indicated at 3. (integers from TN01 to TN60)
	W	Delay time: 10 s × value indicated at 3. (integers from TW07 to TW60)

* "-T□□□" is specified only in model numbers for Controllers with fixed delay times.

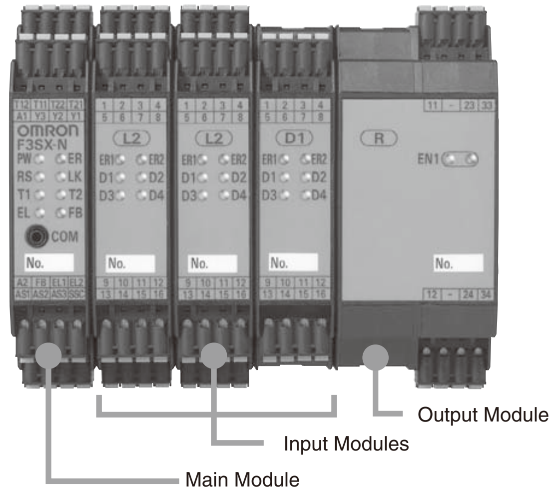
F3SX-□-□□(-T□□□)*
1 2 3 4

Number	Symbol	Description
1	N	Main Module with external indicator output
	E	Main Module with DC solid-state safety outputs
2	L1	Safety Light Curtain/Two-hand Control Switch Input Module
	L2	Safety Light Curtain Input Module
	B1	Single-beam Safety Sensor Input Module
	D1	Door Switch Input Module
	R	Relay Output Module (DPST-NO, SPST-NC): Non-delay (instant breaking) outputs (delay time cannot be set)
	R1	Relay Output Module (DPST-NO, SPST-NC): ON-delay outputs
	R2	Relay Output Module (DPST-NO, SPST-NC): OFF-delay outputs
3	H	Delay time: 0.5 s × value indicated at 4. (odd numbers from TH01 to TH59)
	N	Delay time: 1.0 s × value indicated at 4. (integers from TN01 to TN60)
	W	Delay time: 10 s × value indicated at 4. (integers from TW07 to TW60)

Note: "-T□□□" is specified only in model numbers for Controllers with fixed delay times.

* In -T□□□ models, all parameters, such as delay time and auxiliary solid-state outputs, are set at the factory. Therefore, these parameters cannot be changed using the Function Setup Software (F3SX-CD100-E) for the F3SX.

Product Configuration



The Controller has a modular configuration comprised of a combination of Main Modules, Input Modules, and Output Modules, as shown in the diagram above.
For information on non-standard I/O combinations, contact your OMRON sales representative.

Ordering Information

Main Modules

Non-delay (Instant Breaking) Models

Output type	Non-delay (instant breaking) outputs		Model
	Solid-state outputs	Contact outputs	
Indicator output + contact output	None	Main contact (DPST-NO) Auxiliary contact (SPST-NC)	**F3SX-NR**
			F3SX-N-□□□R
Solid-state output	2 safety outputs 1 auxiliary output	None	**F3SX-E□**
			F3SX-E-□□□□

Note: Models with multiple contact outputs are also available (RR/RRR).

OFF-delay Time Setting Models

Output type	Non-delay (instant breaking) outputs		OFF-delay outputs	Model
	Solid-state outputs	Contact outputs	Contact outputs	
Indicator output + contact output	None	Main contact (DPST-NO) Auxiliary contact (SPST-NC)	Main contact (DPST-NO) Auxiliary contact (SPST-NC)	**F3SX-N-□□RR2**
Solid-state output + contact output	2 safety outputs 1 auxiliary output	None	Main contact (DPST-NO) Auxiliary contact (SPST-NC)	**F3SX-ER2**
				F3SX-E-□□□R2

Note: The OFF-delay time for R2 models is factory-set to 0.0 s (non-delay (instant breaking)).

OFF-delay Time Fixed Models

Output type	Non-delay (instant breaking) outputs	OFF-delay outputs	OFF-delay time	Model
	Solid-state outputs	Contact outputs		
Solid-state output + contact output	2 safety outputs 1 auxiliary output	Main contact (DPST-NO) Auxiliary contact (SPST-NC)	0.5 s to 29.5 s (0.5-s intervals)	**F3SX-ER2-TH□□**
			1 s to 60 s (1-s intervals)	**F3SX-ER2-TN□□**
			70 s to 600 s (10-s intervals)	**F3SX-ER2-TW□□**

Note: The Function Setup Software for the F3SX cannot be used to change the settings for the above OFF-delay time fixed models.

ON-delay Time Fixed Models

Output type	Non-delay (instant breaking) outputs	ON-delay outputs	ON-delay time	Model
	Solid-state outputs	Contact outputs		
Solid-state output + contact output	2 safety outputs 1 auxiliary output	Main contact (DPST-NO) Auxiliary contact (SPST-NC)	1 to 60 s (1-s intervals)	**F3SX-ER1-TN□□**

Note: The Function Setup Software for the F3SX cannot be used to change the settings for the above ON-delay time fixed models.
All models:
For details on models with □□ shown in the model numbers, refer to *"List of Models"* on page 6.

List of Models

Non-delay (Instant Breaking) Models

F3SX-NR, F3SX-N-□□□R (with External Indicator Output)

Input type					Model	Width *	Weight (Main Module only)
Emergency Stop	F3SN/F3SH/F3SJ Safety Light Curtain/ Multi-beam Safety Sensor	Single-beam Safety Sensor E3ZS/E3FS	Two-hand Control Switch	Door Switch			
1 set	---	---	---	---	**F3SX-NR**	45.0 mm	Approx. 0.3 kg
1 set	---	---	---	2 sets	**F3SX-N-D1R**	90.0 mm	Approx. 0.5 kg
1 set	---	---	---	4 sets	**F3SX-N-D1D1R**	112.5 mm	Approx. 0.6 kg
1 set	---	---	---	6 sets	**F3SX-N-D1D1D1R**	135.0 mm	Approx. 0.7 kg
1 set	2 sets	---	---	---	**F3SX-N-L2R**	90.0 mm	Approx. 0.5 kg
1 set	4 sets	---	---	---	**F3SX-N-L2L2R**	112.5 mm	Approx. 0.6 kg
1 set	2 sets	---	---	2 sets	**F3SX-N-L2D1R**	112.5 mm	Approx. 0.6 kg
1 set	4 sets	---	---	2 sets	**F3SX-N-L2L2D1R**	135.0 mm	Approx. 0.7 kg
1 set	2 sets	---	---	4 sets	**F3SX-N-L2D1D1R**	135.0 mm	Approx. 0.7 kg
1 set	1 set	---	1 set	---	**F3SX-N-L1R**	90.0 mm	Approx. 0.5 kg
1 set	1 set	---	1 set	2 sets	**F3SX-N-L1D1R**	112.5 mm	Approx. 0.6 kg
1 set	1 set	---	1 set	4 sets	**F3SX-N-L1D1D1R**	135.0 mm	Approx. 0.7 kg
1 set	---	4 sets	---	---	**F3SX-N-B1R**	90.0 mm	Approx. 0.5 kg
1 set	---	4 sets	---	2 sets	**F3SX-N-B1D1R**	112.5 mm	Approx. 0.6 kg
1 set	---	4 sets	---	4 sets	**F3SX-N-B1D1D1R**	135.0 mm	Approx. 0.7 kg
1 set	2 sets	4 sets	---	---	**F3SX-N-L2B1R**	112.5 mm	Approx. 0.6 kg

* For details on the width, refer to *"Dimensions"* on page 19.

F3SX-E□/F3SX-E-□□□□ (with DC Solid-state Safety Output)

Input type					Model	Width *	Weight (Main Module only)
Emergency Stop	F3SN/F3SH/F3SJ Safety Light Curtain/ Multi-beam Safety Sensor	Single-beam Safety Sensor E3ZS/E3FS	Two-hand Control Switch	Door Switch			
1 set	---	---	---	---	**F3SX-E**	22.5 mm	Approx. 0.3 kg
1 set	---	---	---	2 sets	**F3SX-ED1**	45.0 mm	Approx. 0.3 kg
1 set	---	---	---	4 sets	**F3SX-E-D1D1**	67.5 mm	Approx. 0.4 kg
1 set	---	---	---	6 sets	**F3SX-E-D1D1D1**	90.0 mm	Approx. 0.5 kg
1 set	---	---	---	8 sets	**F3SX-E-D1D1D1D1**	112.5 mm	Approx. 0.6 kg
1 set	2 sets	---	---	---	**F3SX-EL2**	45.0 mm	Approx. 0.3 kg
1 set	2 sets	---	---	2 sets	**F3SX-E-L2D1**	67.5 mm	Approx. 0.4 kg
1 set	2 sets	---	---	4 sets	**F3SX-E-L2D1D1**	90.0 mm	Approx. 0.5 kg
1 set	2 sets	---	---	6 sets	**F3SX-E-L2D1D1D1**	112.5 mm	Approx. 0.6 kg
1 set	4 sets	---	---	---	**F3SX-E-L2L2**	67.5 mm	Approx. 0.4 kg
1 set	4 sets	---	---	2 sets	**F3SX-E-L2L2D1**	90.0 mm	Approx. 0.5 kg
1 set	4 sets	---	---	4 sets	**F3SX-E-L2L2D1D1**	112.5 mm	Approx. 0.6 kg
1 set	1 set	---	1 set	---	**F3SX-EL1**	45.0 mm	Approx. 0.3 kg
1 set	1 set	---	1 set	2 sets	**F3SX-E-L1D1**	67.5 mm	Approx. 0.4 kg
1 set	1 set	---	1 set	4 sets	**F3SX-E-L1D1D1**	90.0 mm	Approx. 0.5 kg
1 set	1 set	---	1 set	6 sets	**F3SX-E-L1D1D1D1**	112.5 mm	Approx. 0.6 kg
1 set	---	4 sets	---	---	**F3SX-EB1**	45.0 mm	Approx. 0.3 kg
1 set	---	8 sets	---	---	**F3SX-E-B1B1**	67.5 mm	Approx. 0.4 kg
1 set	---	4 sets	---	2 sets	**F3SX-E-B1D1**	67.5 mm	Approx. 0.4 kg
1 set	2 sets	4 sets	---	---	**F3SX-L2B1**	67.5 mm	Approx. 0.4 kg
1 set	---	4 sets	---	---	**F3SX-B1R**	90.0 mm	Approx. 0.5 kg

* For details on the width, refer to *"Dimensions"* on page 19.

Korean S-mark Certified Instant Breaking Models

F3SX-NR-S/F3SX-N-□□□R-S (with External Indicator Output)

Input type				Model	Width *	Weight (Main Module only)
Emergency Stop	F3SN/F3SH/F3SJ Safety Light Curtain/ Multi-beam Safety Sensor	Two-hand Control Switch	Door Switch			
1 set	---	---	---	**F3SX-NR-S**	45.0 mm	Approx. 0.3 kg
1 set	---	---	2 sets	**F3SX-N-D1R-S**	90.0 mm	Approx. 0.5 kg
1 set	---	---	4 sets	**F3SX-N-D1D1R-S**	112.5 mm	Approx. 0.6 kg
1 set	---	---	6 sets	**F3SX-N-D1D1D1R-S**	135.0 mm	Approx. 0.7 kg
1 set	2 sets	---	---	**F3SX-N-L2R-S**	90.0 mm	Approx. 0.5 kg
1 set	4 sets	---	---	**F3SX-N-L2L2R-S**	112.5 mm	Approx. 0.6 kg
1 set	2 sets	---	2 sets	**F3SX-N-L2D1R-S**	112.5 mm	Approx. 0.6 kg
1 set	4 sets	---	2 sets	**F3SX-N-L2L2D1R-S**	135.0 mm	Approx. 0.7 kg
1 set	2 sets	---	4 sets	**F3SX-N-L2D1D1R-S**	135.0 mm	Approx. 0.7 kg
1 set	1 set	1 set	---	**F3SX-N-L1R-S**	90.0 mm	Approx. 0.5 kg
1 set	1 set	1 set	2 sets	**F3SX-N-L1D1R-S**	112.5 mm	Approx. 0.6 kg
1 set	1 set	1 set	4 sets	**F3SX-N-L1D1D1R-S**	135.0 mm	Approx. 0.7 kg

Note: 1. Use a cable of 10 m maximum to connect the Safety-mark Compliant Safety Controller and DC Power Supply.
2. The English, Japanese, and Korean versions of the operation manual for Safety-mark Compliant Safety Controllers is provided on CD.
* For details on the width, refer to *"Dimensions"* on page 19.

F3SX-E-S/F3SX-E-□□□□-S (with DC Solid-state Safety Output)

Input type				Model	Width *	Weight (Main Module only)
Emergency Stop	F3SN/F3SH/F3SJ Safety Light Curtain/ Multi-beam Safety Sensor	Two-hand Control Switch	Door Switch			
1 set	---	---	---	**F3SX-E-S**	22.5 mm	Approx. 0.3 kg
1 set	---	---	2 sets	**F3SX-ED1-S**	45.0 mm	Approx. 0.3 kg
1 set	---	---	4 sets	**F3SX-E-D1D1-S**	67.5 mm	Approx. 0.4 kg
1 set	---	---	6 sets	**F3SX-E-D1D1D1-S**	90.0 mm	Approx. 0.5 kg
1 set	---	---	8 sets	**F3SX-E-D1D1D1D1-S**	112.5 mm	Approx. 0.6 kg
1 set	2 sets	---	---	**F3SX-EL2-S**	45.0 mm	Approx. 0.3 kg
1 set	2 sets	---	2 sets	**F3SX-E-L2D1-S**	67.5 mm	Approx. 0.4 kg
1 set	2 sets	---	4 sets	**F3SX-E-L2D1D1-S**	90.0 mm	Approx. 0.5 kg
1 set	2 sets	---	6 sets	**F3SX-E-L2D1D1D1-S**	112.5 mm	Approx. 0.6 kg
1 set	4 sets	---	---	**F3SX-E-L2L2-S**	67.5 mm	Approx. 0.4 kg
1 set	4 sets	---	2 sets	**F3SX-E-L2L2D1-S**	90.0 mm	Approx. 0.5 kg
1 set	4 sets	---	4 sets	**F3SX-E-L2L2D1D1-S**	112.5 mm	Approx. 0.6 kg
1 set	1 set	1 set	---	**F3SX-EL1-S**	45.0 mm	Approx. 0.3 kg
1 set	1 set	1 set	2 sets	**F3SX-E-L1D1-S**	67.5 mm	Approx. 0.4 kg
1 set	1 set	1 set	4 sets	**F3SX-E-L1D1D1-S**	90.0 mm	Approx. 0.5 kg
1 set	1 set	1 set	6 sets	**F3SX-E-L1D1D1D1-S**	112.5 mm	Approx. 0.6 kg

Note: 1. Use a cable of 10 m maximum to connect the Safety-mark Compliant Safety Controller and DC Power Supply.
2. The English, Japanese, and Korean versions of the operation manual for Safety-mark Compliant Safety Controllers is provided on CD.
* For details on the width, refer to *"Dimensions"* on page 19.

OFF-delay Time Setting Models (Using Function Setup Software for the F3SX)

F3SX-N-□□RR2

Input type				Model	Width *	Weight (Main Module only)
Emergency Stop	F3SN/F3SH/F3SJ Safety Light Curtain/ Multi-beam Safety Sensor	Two-hand Control Switch	Door Switch			
1 set	---	---	---	**F3SX-N-RR2**	112.5 mm	Approx. 0.5 kg
1 set	---	---	2 sets	**F3SX-N-D1RR2**	135.0 mm	Approx. 0.6 kg
1 set	---	---	4 sets	**F3SX-N-D1D1RR2**	157.5 mm	Approx. 0.7 kg
1 set	2 sets	---	---	**F3SX-N-L2RR2**	135.0 mm	Approx. 0.6 kg
1 set	2 sets	---	2 sets	**F3SX-N-L2D1RR2**	157.5 mm	Approx. 0.7 kg
1 set	4 sets	---	---	**F3SX-N-L2L2RR2**	157.5 mm	Approx. 0.7 kg
1 set	1 set	1 set	---	**F3SX-N-L1RR2**	135.0 mm	Approx. 0.6 kg
1 set	1 set	1 set	2 sets	**F3SX-N-L1D1RR2**	157.5 mm	Approx. 0.7 kg

Note: 1. The factory setting for the OFF-delay time is 0 s (non-delay (instant breaking)).
2. By using the Function Setup Software for the F3SX (F3SX-CD100-E, sold separately), the time can be set in 0.1-second units.
* For details on the width, refer to *"Dimensions"* on page 19.

F3SX-ER2/F3SX-E-□□□R2

Input type				Model	Width *	Weight (Main Module only)
Emergency Stop	F3SN/F3SH/F3SJ Safety Light Curtain/ Multi-beam Safety Sensor	Two-hand Control Switch	Door Switch			
1 set	---	---	---	**F3SX-ER2**	45.0 mm	Approx. 0.3 kg
1 set	---	---	2 sets	**F3SX-E-D1R2**	90.0 mm	Approx. 0.5 kg
1 set	---	---	4 sets	**F3SX-E-D1D1R2**	112.5 mm	Approx. 0.6 kg
1 set	---	---	6 sets	**F3SX-E-D1D1D1R2**	135.0 mm	Approx. 0.7 kg
1 set	2 sets	---	---	**F3SX-E-L2R2**	90.0 mm	Approx. 0.5 kg
1 set	2 sets	---	2 sets	**F3SX-E-L2D1R2**	112.5 mm	Approx. 0.6 kg
1 set	2 sets	---	4 sets	**F3SX-E-L2D1D1R2**	135.0 mm	Approx. 0.7 kg
1 set	4 sets	---	---	**F3SX-E-L2L2R2**	112.5 mm	Approx. 0.6 kg
1 set	4 sets	---	2 sets	**F3SX-E-L2L2D1R2**	135.0 mm	Approx. 0.7 kg
1 set	1 set	1 set	---	**F3SX-E-L1R2**	90.0 mm	Approx. 0.5 kg
1 set	1 set	1 set	2 sets	**F3SX-E-L1D1R2**	112.5 mm	Approx. 0.6 kg
1 set	1 set	1 set	4 sets	**F3SX-E-L1D1D1R2**	135.0 mm	Approx. 0.7 kg

Note: 1. The factory setting for the OFF-delay time is 0 s (non-delay (instant breaking)).
2. By using the Function Setup Software for the F3SX (F3SX-CD100-E, sold separately), the time can be set in 0.1-second units.
* For details on the width, refer to *"Dimensions"* on page 19.

OFF-delay Time Fixed Models

F3SX-ER2-T□□□

-TH01 to -TH59 (odd model numbers only) (0.5-second units)		-TN01 to -TN60 (1.0-second units)				-TW07 to -TW60 (10-second units)	
Model suffix -T□□□	Set time	Model suffix -T□□□	Set time	Model suffix -T□□□	Set time	Model suffix -T□□□	Set time
-TH01	0.5 s	-TN01	1 s	-TN10	10 s	-TW07	70 s
-TH03	1.5 s	-TN02	2 s	-TN20	20 s	-TW08	80 s
-TH05	2.5 s	-TN03	3 s	-TN30	30 s	-TW09	90 s
-TH07	3.5 s	-TN04	4 s	-TN40	40 s	-TW10	100 s
-TH09	4.5 s	-TN05	5 s	-TN50	50 s	-TW20	200 s
-TH11	5.5 s	-TN06	6 s	-TN60	60 s	-TW30	300 s
-TH13	6.5 s	-TN07	7 s	---	---	-TW40	400 s
-TH15	7.5 s	-TN08	8 s	---	---	-TW50	500 s
-TH17	8.5 s	-TN09	9 s	---	---	-TW60	600 s

Note: 1. It is not possible to change the factory settings for delay time or any other parameters.
2. The set time can be customized at the factory to a user-preferred time, provided that it is within the model standards. Contact your OMRON representative for details.

ON-delay Time Fixed Models

F3SX-ER1-T□□□

1 to 5 s (1.0-second units) *	
Model suffix -T□□□	**Set time**
-TN01	1 s
-TN02	2 s
-TN03	3 s
-TN04	4 s
-TN05	5 s

Note: It is not possible to change the factory settings for delay time or any other parameters.
* In addition to the models listed in this table, ON-delay Time Fixed models of up to 60 s max (1.0-second units) are also available.

Function Setup Software for the F3SX (English Version)

Appearance	Supported OS	Model
	Windows 98SE or higher *, Windows 2000 SP4 or higher, or Windows XP SP1 or higher	**F3SX-CD100-E**

Note: The F3SX-CD100-E Function Setup Software is not included and must be purchased separately. Contact your OMRON representative for details.
* IE4.0 or higher must be installed.

Setting Functions

- Delay time settings (ON-delay/OFF-delay)
- Monitoring time settings
- Indicator lighting pattern settings (F3SX-N only)
- Auxiliary outputs (AS1/AS2/AS3)
- Log read (feedback time for past 16 operations)
- Intersystem monitoring time (for past 16 operations), error log
- I/O monitor
- An RS-232C cable (F39-JC2X1, sold separately) is required to use the Function Setup Software for the F3SX.

Accessories (Sold Separately)

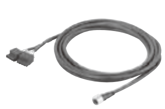
Junction Box for Safety Light Curtain

Appearance	Connecting devices	Model
	F3SN-A/-B, F3SJ ↕ F3SX Series	**F39-TB01**

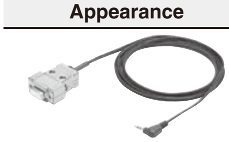
Junction Connector for F3SX

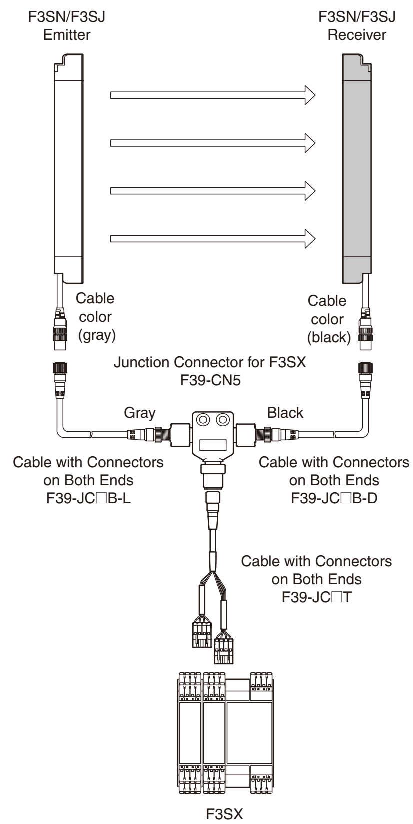
Appearance	Connecting devices	Model
	F3SN-A/-B, F3SJ ↕ F3SX Series	**F39-CN5**

Cable with Connectors on Both Ends

Appearance	Connecting devices	Model	Cable length
	F39-TB01, F39-CN5 ↕ F3SX Series	**F39-JC1T**	1 m
		F39-JC3T	3 m
		F39-JC5T	5 m
		F39-JC10T	10 m

RS-232C Cable (9-pin D-Sub Connector)

Appearance	Connecting devices	Model	Cable length
	RS-232C cable for connecting F3SX to personal computer	**F39-JC2X1**	2 m
	RS-232C cable for connecting F3SX to OMRON PLC	**F39-JC2X2**	



Specifications

General Specifications

Common Specifications

Item	Ratings and Specifications
Safety category (EN954-1)	Category 4
Safety standards (IEC61508)	SIL3
Rated supply voltage	24 VDC ±10% (ripple p-p 10% max.)
Startup time	5 s max.
Control circuit protection	Output short-circuit protection, power supply reverse polarity protection *
Overvoltage category (IEC60664-1)	II
Insulation resistance	100 MΩ (500 VDC) between all lead wires and outer case
Dielectric strength	2,200 VAC, 50/60 Hz for 1 min between all lead wires and outer case
Ambient temperature	Operating: −10 to 50°C (with no icing or condensation) Storage: −30 to 70°C (with no icing or condensation)
Ambient humidity	Operating and storage: 35% to 85% (with no icing or condensation)
Vibration resistance	10 to 55 Hz, double amplitude: 0.7 mm, X, Y and Z directions, 20 sweeps (power ON)
Shock resistance	100 m/s^2, X, Y and Z directions, 1,000 times (power ON)
Case material	Glass fiber-reinforced polyamide 66 (PA-66-FR)
Degree of protection	Terminal block: IP20 Main body: IP40 (IEC60529)

* If the protective function operates, turn ON the power again to recover.

Main Modules with External Indicator Output (N Modules)

I/O		Ratings and Specifications
Input	**Emergency stop input**	ON: 15 to 24 VDC ±10% OFF: Open or 0 to 5 VDC max. Internal impedance: Approx. 5 kΩ
	Reset input	
	Feedback input	
	Auxiliary input	
DC solid-state output	**External indicator output *1 *2 *3**	Connectable indicators: Filament types (incandescent lamp) 24 VDC, 3 to 7 W
	Auxiliary solid-state output	PNP transistor output Load current: 25 mA max. Residual voltage: 2 V max. *4

*1. When external indicators are not connected, connect resistance (1/4 W, 4.7 kΩ) between the EL1 terminal and EL2 terminal. The lead wire resistance (without polarity) shown in the following diagram is included with the product.

*2. LED indicators (ratings: 24 VDC, 0.7 to 7 W) can also be connected. Diagnostic checks, however, cannot be performed if LED indicators are connected.

*3. OMRON recommends the following indicators (both have a power consumption of 5 W).

- PS-24-Y B0568: Manufactured by PATLITE Corporation (Always use an incandescent lamp as a replacement indicator. The malfunction monitoring using current detection will not function if LED indicators are used.)
- ASSC-24: Manufactured by ARROW ELECTRONICS IND. CO., LTD.

PS-24-Y-B0568
(by PATLITE Corporation)

ASSC-24
(by ARROW ELECTRONICS IND. CO., LTD.)

*4. Except for voltage drop due to cable extension.

Main Modules with DC Solid-state Safety Output (E Modules)

Item		Ratings and Specifications
Input	Emergency stop input	ON: DC15 to 24 V±10% OFF: Open or 0 to 5 VDC max. Internal impedance: Approx. 5 kΩ
	Reset input	
	Feedback input	
	Auxiliary input	
DC solid-state output	DC solid-state safety output	PNP transistor output Load current: 300 mA max. (resistance load/inductive load) *1 Residual voltage (when ON): 2 V max. *2 Residual voltage (when OFF): 0.1 V max. Leakage current (when OFF): 0.1 mA max. Allowable capacitive load: 1 μF max. Allowable wire resistance between output terminals and load: 4 Ω max.
	Auxiliary solid-state output	PNP transistor output Load current: 25 mA max; Residual voltage: 2 V max. *2

Note: 1. With an inductive load, connect a diode or other surge absorber parallel to the load.
2. Except for voltage drop due to cable extension.

Relay Output Modules

R Modules: Delay time cannot be set.
R1 Modules: ON-delay can be set.
R2 Modules: OFF-delay can be set.

Item				Ratings and Specifications
Relay contact outputs	Number of main contacts (safety outputs)			DPST-NO
	Number of auxiliary contacts (auxiliary outputs)			SPST-NC
	Rated load	Resistive load	Terminals 11/12 (Auxiliary contact: Auxiliary output)	250 VAC, 50/60Hz, 30 VDC at 5A
			Terminals 23/24 Terminals 33/34 (Main contacts: Safety outputs)	250 VAC, 50/60Hz, 30 VDC at 3.15 A (5 A) *1
		Inductive load		AC15: 240 VAC at 2 A cosϕ = 0.3 DC13: 24 VDC at 1 A L/R = 48 ms
	Minimum permissible load *2			24 VDC at 5 mA (reference value) *3
	Electrical durability *2			100,000 operations min. (switching frequency: 1,800 times/hr)
	Mechanical durability *2			10,000,000 operations min. (switching frequency: 36,000 times/hr)

*1. An external fuse must be connected to the safety relay output. The safety category depends on the fuse rating:
1)Safety Category 4 (EN954-1)
A fuse rated at 3.15 A max. must be connected externally to protect the safety relay output from contact welding. The current that can be applied to the relay contacts is limited by the fuse rating to 3.15 A max. (resistive load).
2) Safety Category 3 (EN954-1) or lower
A fuse rated at 5 A max. must be connected externally to protect the safety relay output from contact welding. The current that can be applied to the relay contacts is limited by the fuse rating to 5 A max. (resistive load). For details, refer to section 10.4.3.4 of prEN50156-1.
*2. This rating is for Modules with built-in relays. The durability conditions are an ambient temperature of 15 to 35°C and an ambient humidity of 25% to 75%.
*3. This value is a reference value. The Modules are not designed to be used below this value. If a large load is applied even once, switching may not be possible for microloads.

Rated Current

The rated current depends on the type and number of Modules used, as shown below.

Module type	Rated current
Main Module (E, N)	150 mA
Input Module (L1, L2, B1, D1)	150 mA
Relay Output Module (R, R1, R2)	100 mA

Example:
F3SX-N-L2L2R: 150 (N Module) + 150 (L2 Module) + 150 (L2 Module) + 100 (R Module) = 550 mA

Response Time

Non-delay (Instant Breaking) Models

Model (N Modules)	Relay outputs		Auxiliary output (AS1)	
	ON → OFF	OFF → ON	ON → OFF	OFF → ON
F3SX-NR(-S)	35 ms	135 ms	25 ms	105 ms
F3SX-N-□R(-S)	35 ms	135 ms	25 ms	105 ms
F3SX-N-□□R(-S)	40 ms	156 ms	30 ms	126 ms
F3SX-N-□□□R(-S)	45 ms	177 ms	35 ms	147 ms

ON-delay/OFF-delay Time Setting Models

Model (N Modules)	Relay outputs		Auxiliary output (AS1)	
	ON → OFF *2	OFF → ON *1	ON → OFF	OFF → ON
F3SX-N-RR1 *1 F3SX-N-RR2 *2	35 ms	135 ms	25 ms	105 ms
F3SX-N-□RR1 *1 F3SX-N-□RR2 *2	40 ms	156 ms	30 ms	126 ms
F3SX-N-□□RR1 *1 F3SX-N-□□RR2 *2	45 ms	177 ms	35 ms	147 ms

Note: The actual ON-delay time (time from interlock reset until output occurs) and OFF-delay time (time from when input turns OFF until output turns OFF) is calculated by adding the applicable times shown in the above table to the user-set time.
Example: If the OFF-delay for an F3SX-N-RR2 is set to 0.5 s (500 ms), the actual OFF-delay is 500 + 35 = 535 ms.

*1. R1 Modules (terminals 23/24, 33/34) support an ON-delay time setting using the Function Setup Software for the F3SX (F3SX-CD100-E)
The ON-delay time is factory-set to 0 s (non-delay (instant breaking)).

*2. R2 Modules (terminals 23/24, 33/34) support an OFF-delay time setting using the Function Setup Software for the F3SX (F3SX-CD100-E)
The OFF-delay time is factory-set to 0 s (non-delay (instant breaking)).

Non-delay (Instant Breaking) Models

Model (E Modules)	Relay outputs		DC solid-state safety output, auxiliary output	
	ON → OFF	OFF → ON	ON → OFF	OFF → ON
F3SX-E(-S)	---	---	25 ms	105 ms
F3SX-E□(-S)	35 ms	135 ms	25 ms	105 ms
F3SX-E-□□(-S)	35 ms	135 ms	25 ms	105 ms
F3SX-E-□□□(-S)	40 ms	156 ms	30 ms	126 ms
F3SX-E-□□□□(-S)	45 ms	177 ms	35 ms	147 ms

ON-delay/OFF-delay Time Setting Models

Model (E Modules)	Relay outputs		DC solid-state safety output, auxiliary output	
	ON → OFF *2	OFF → ON *1	ON → OFF	OFF → ON
F3SX-ER1 *1 F3SX-ER2 *2	35 ms	135 ms	25 ms	105 ms
F3SX-E-□R1 *1 F3SX-E-□R2 *2	35 ms	135 ms	25 ms	105 ms
F3SX-E-□□R1 *1 F3SX-E-□□R2 *2	40 ms	156 ms	30 ms	126 ms
F3SX-E-□□□R1 *1 F3SX-E-□□□R2 *2	45 ms	177 ms	35 ms	147 ms

Note: The actual ON-delay time (time from interlock reset until output occurs) and OFF-delay time (time from when input turns OFF until output turns OFF) is calculated by adding the applicable times shown in the above table to the user-set time.
Example: If the OFF-delay for an F3SX-E-D1D1D1R2 is set to 1 s (1,000 ms), the actual OFF-delay is 1,000 + 45 = 1,045 ms.

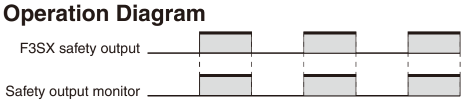
*1. R1 Modules (terminals 23/24, 33/34) support an ON-delay time setting using the Function Setup Software for the F3SX (F3SX-CD100-E)
The ON-delay time is factory-set to 0 s (non-delay (instant breaking)).

*2. R2 Modules (terminals 23/24, 33/34) support an OFF-delay time setting using the Function Setup Software for the F3SX (F3SX-CD100-E).
The OFF-delay time is factory-set to 0 s (non-delay (instant breaking)).

Safety Output Monitor (AS1 Terminal: N/E Modules)

The safety output monitor outputs synchronously with the safety outputs (non-delay (instant breaking)).

Operation Diagram

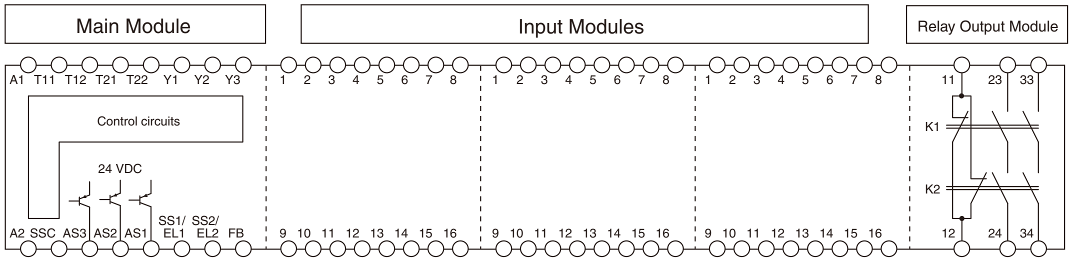


⚠ WARNING

AS1, AS2, and AS3 are not safety outputs and cannot be used to configure a safety system. Doing so may result in serious injury if the F3SX or peripheral devices malfunction.

Connections

Terminal Arrangement



Main Modules

Item	Terminal No.	Function F3SX-N	Function F3SX-E
Power supply inputs	A1	24-VDC input	
	A2	GND (0 V) input	
Emergency stop inputs *1	T11	Emergency Stop Switch inputs	
	T12		
	T21		
	T22		
Reset inputs	Y1	Reset inputs: Auto/manual reset selection, system reset	
	Y2		
	Y3		
Feedback input	FB	Feedback time monitor (500 ms max.)	
Auxiliary solid-state outputs *2	AS1	Safety output monitor (standard setting: Outputs synchronously with the safety output)	
	AS2	Information trigger (Standard setting: Outputs error information, information on excessive output switching, and information on excessive ON time)	Ready output (Standard setting: Outputs when safety inputs are all ON.)
	AS3	Standby output (Standard setting: Outputs after power is turned ON, the F3SX has been initialization, and I/O can be normally controlled.)	
Auxiliary input *3	SSC	Start command input (soft-start circuit)	
External indicator outputs *4	EL1	Indicator input with diagnostic functions (+: sourcing)	---
	EL2	Indicator input with diagnostic functions (–: sinking)	---
DC solid-state safety outputs	SS1	---	DC solid-state safety output 1
	SS2	---	DC solid-state safety output 2
RS-232C port	COM	RS-232C port for connecting communications cable	

*1. If the emergency stop switch is not necessary, directly connect terminal T11 to T12, and terminal T21 to T22.
*2. The Function Setup Software for the F3SX (F3SX-CD100-E, sold separately) can be used to change function settings for the auxiliary solid-state output terminals (AS1, AS2, and AS3), and the external indicator output. For details refer to the *Help* menu in the F3SX-CD100-E.
*3. When the start command input (SSC) is not necessary, directly connect the SSC terminal to the 24 VDC input terminal (A1 terminal).
*4. When an external indicator is not necessary, connect resistance (1/4 W, 4.7 kΩ) between the terminals EL1 and EL2.

Indicator Display, Lighting Patterns, and Meanings

ER indicator	Meaning	Cause	Remedy
● Lit	Emergency stop switch input sync error	Emergency stop switch contact is faulty or emergency stop switch wiring is incorrect.	Check the wiring to the emergency stop switch.
1-time flashing	Short-circuit/wiring error between emergency stop switch inputs	The wiring to the emergency stop switch has short-circuited.	Check the emergency stop switch and wiring.
2-time flashing	Emergency stop switch input terminal circuit error	The emergency stop switch input terminal is faulty.	Replace the F3SX.
		Excessive noise is affecting the F3SX.	Check the noise conditions around the F3SX.
3-time flashing	Reset input terminal error	The wiring to the reset input terminal is incorrect.	Check the wiring to the reset input terminal.
		The wiring to the reset input terminal is broken or short-circuited.	Check the wiring to the reset input terminal.
		The reset input terminal circuit is faulty.	Replace the F3SX.
4-time flashing	External indicator output terminal error (F3SX-N)	The external indicator output circuit is faulty.	Replace the external indicator.
		The wiring to the external indicator output circuit is incorrect	Check the wiring to the external indicator.
		An error has occurred in the external indicator output circuit.	Replace the F3SX.
	DC solid-state safety output terminal error (F3SX-E)	The load (external device) is faulty.	Replace the load (external device).
		The wiring to the load (external device) is incorrect.	Check the wiring to the load (external device).
		An error has occurred in the DC solid-state safety output circuit.	Replace the F3SX.
5-time flashing	Relay output terminal error *	The relay output is faulty.	Replace the F3SX.
		Excessive noise is affecting the F3SX.	Check the noise conditions around the F3SX.
6-time flashing	Feedback input terminal error	The wiring to the contactor or other external device is incorrect.	Check the wiring to the contactor or other external devices.
		The contactor or other external device is faulty.	Replace the contactor or other external device.
Continuously flashing	Noise or F3SX malfunction	Excessive noise is affecting the F3SX.	Check the noise conditions around the F3SX.
		The F3SX's internal circuits are faulty.	Replace the F3SX.

* This error does not occur in F3SX Safety Controllers configured without a Relay Output Module.

Input Modules

L1

Terminal No.	Connection	
1	Not used.	Two-hand Control Switch
2	2hand-SW S32 NC contact	
3	Not used.	
4	2hand-SW S31 NC contact	
5	2hand-SW S32 NO contact	
6	2hand-SW S32 COMMON	
7	2hand-SW S31 NO contact	
8	2hand-SW S31 COMMON	
9	Test input	F3SN/F3SJ Safety Light Curtain or F3SH Multi-beam Safety Sensor
10	Control output 2	
11	Reset input	
12	Control output 1	
13	RS-485 (B)	
14	RS-485 (A)	
15	0 V	
16	+24 V	

Note: For details on the signals and wiring of Two-hand Control Switches, refer to *"F3SX-N-L1D1R Auto-reset Circuit Example"* on page 17.

L2

Terminal No.	Connection	
1	+24 V	F3SN/F3SJ Safety Light Curtain or F3SH Multi-beam Safety Sensor (first set)
2	0 V	
3	RS-485 (A)	
4	RS-485 (B)	
5	Control output 1	
6	Reset input	
7	Control output 2	
8	Test input	
9	Test input	F3SN/F3SJ Safety Light Curtain or F3SH Multi-beam Safety Sensor (second set)
10	Control output 2	
11	Reset input	
12	Control output 1	
13	RS-485 (B)	
14	RS-485 (A)	
15	0 V	
16	+24 V	

D1

Terminal No.	Connection	
1	Not used.	
2		
3		
4		
5	Contact such as Safety Limit Switch or Safety Door Switch	First set
6		
7	Contact such as Safety Limit Switch or Safety Door Switch	
8		
9	Contact such as Safety Limit Switch or Safety Door Switch	Second set
10		
11	Contact such as Safety Limit Switch or Safety Door Switch	
12		
13	Not used.	
14		
15		
16		

B1

Terminal No.	Connection	
1	+24 V	E3FS/E3ZS Single-beam Safety Sensor (first set)
2	0 V	
3	Control output	
4	Test input	
5	+24 V	E3FS/E3ZS Single-beam Safety Sensor (second set)
6	0 V	
7	Control output	
8	Test input	
9	Test input	E3FS/E3ZS Single-beam Safety Sensor (third set)
10	Control output	
11	0 V	
12	+24 V	
13	Test input	E3FS/E3ZS Single-beam Safety Sensor (fourth set)
14	Control output	
15	0 V	
16	+24 V	

Relay Output Modules

Terminal No.	Function
11/12	Auxiliary relay output (N.C.)
23/24	Safety relay output (N.O.)
33/34	Safety relay output (N.O.)

Indicator Display, Lighting Patterns, and Meaning for L1/L2/D1 Modules

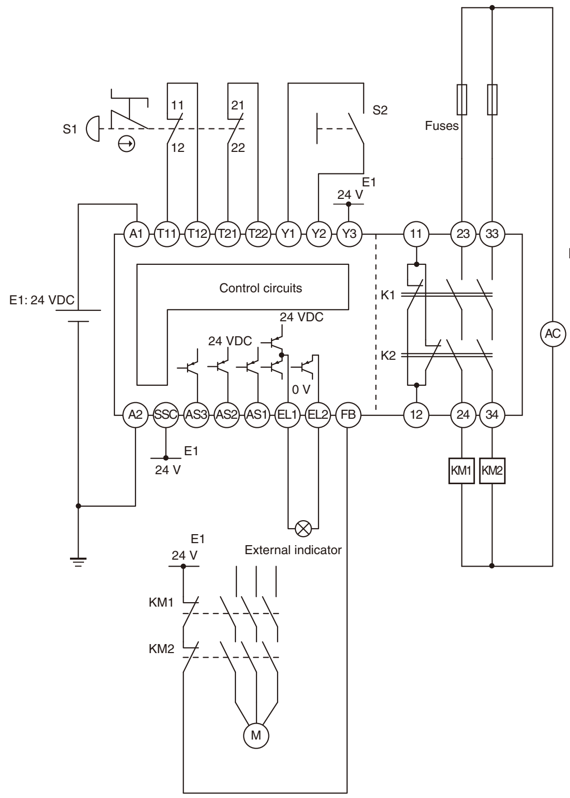
The ER1 indicator display indicates errors in Modules in the first set, and the ER2 indicator display indicates errors in Modules in the second set.

ER1/ER2 indicator	Meaning	Cause	Remedy
● Lit	Input sync error in input device	The input device contacts are faulty or the input device wiring is incorrect.	Check the input device and wiring.
1-time flashing	Short-circuit or wiring error between inputs of input device.	The input device wiring is short-circuited.	Check the wiring to the input device.
2-time flashing	Error in input terminal circuit of input device.	Excessive noise is affecting the F3SX.	Check the noise environment around the F3SX.
		The input device input circuits are faulty.	Replace the F3SX.

Note: Refer to the *F3SX User's Manual* for LED lighting patterns on B1 Models.

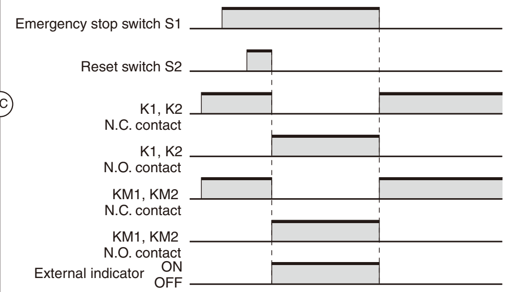
Application Examples

F3SX-NR (Manual Reset) Circuit Example



Stop category	IEC60204-1	0
Safety category	EN954-1	4

Timing Chart



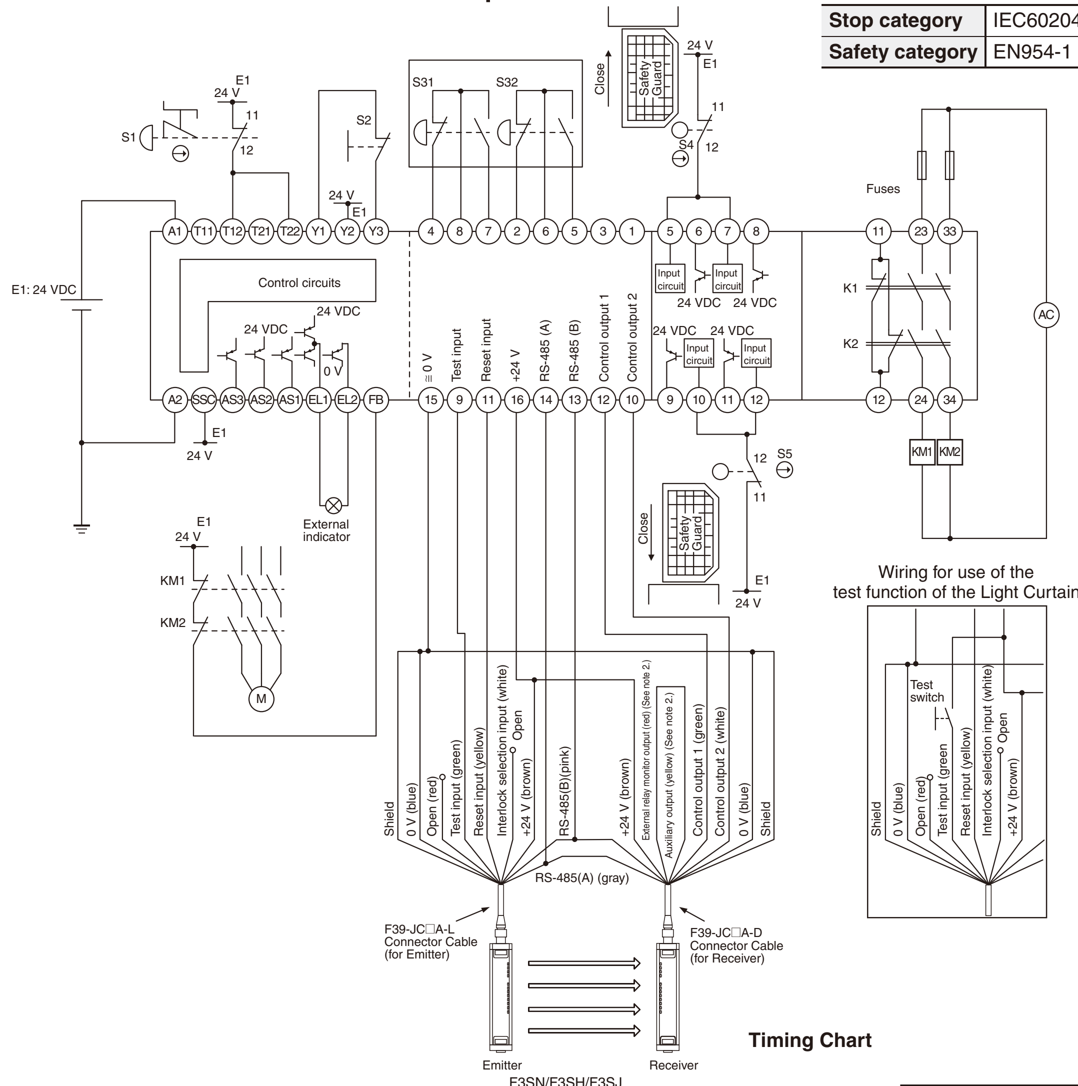
S1: Emergency stop switch (positive opening mechanism) (A165E, A22E) ⊖
S2: Reset switch
KM1, KM2: Magnetic contactor
M: Three-phase motor
E1: 24-VDC power supply (S82K)
External indicator: Filament-type indicator
(When an external indicator is not necessary, connect resistance of 1/4 W, 4.7 kΩ.)

AS1: Auxiliary control output (synchronized with K1, K2 N.O. contacts)
AS2: Information trigger
AS3: Standby output
SSC: Start command input (Not connected in the above circuit diagram. When this input is not necessary, connect it to terminal A1.)

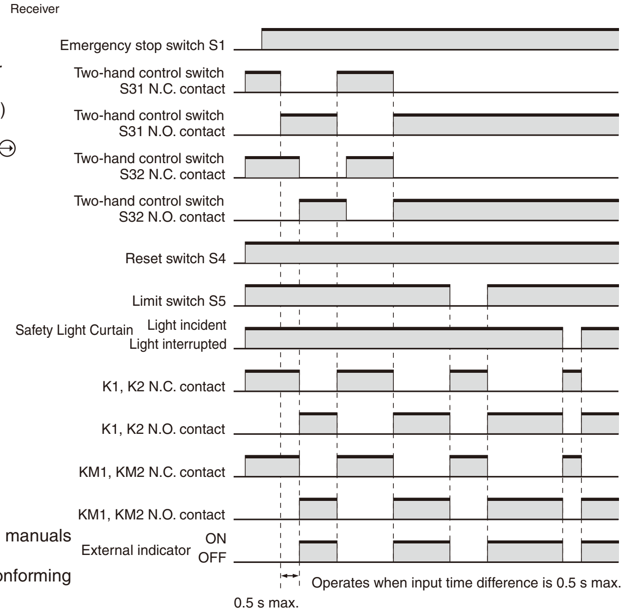
Note: The above circuit diagram conforms to Category 4.

F3SX-N-L1D1R Auto-reset Circuit Example

Stop category	IEC60204-1	0
Safety category	EN954-1	2



Timing Chart

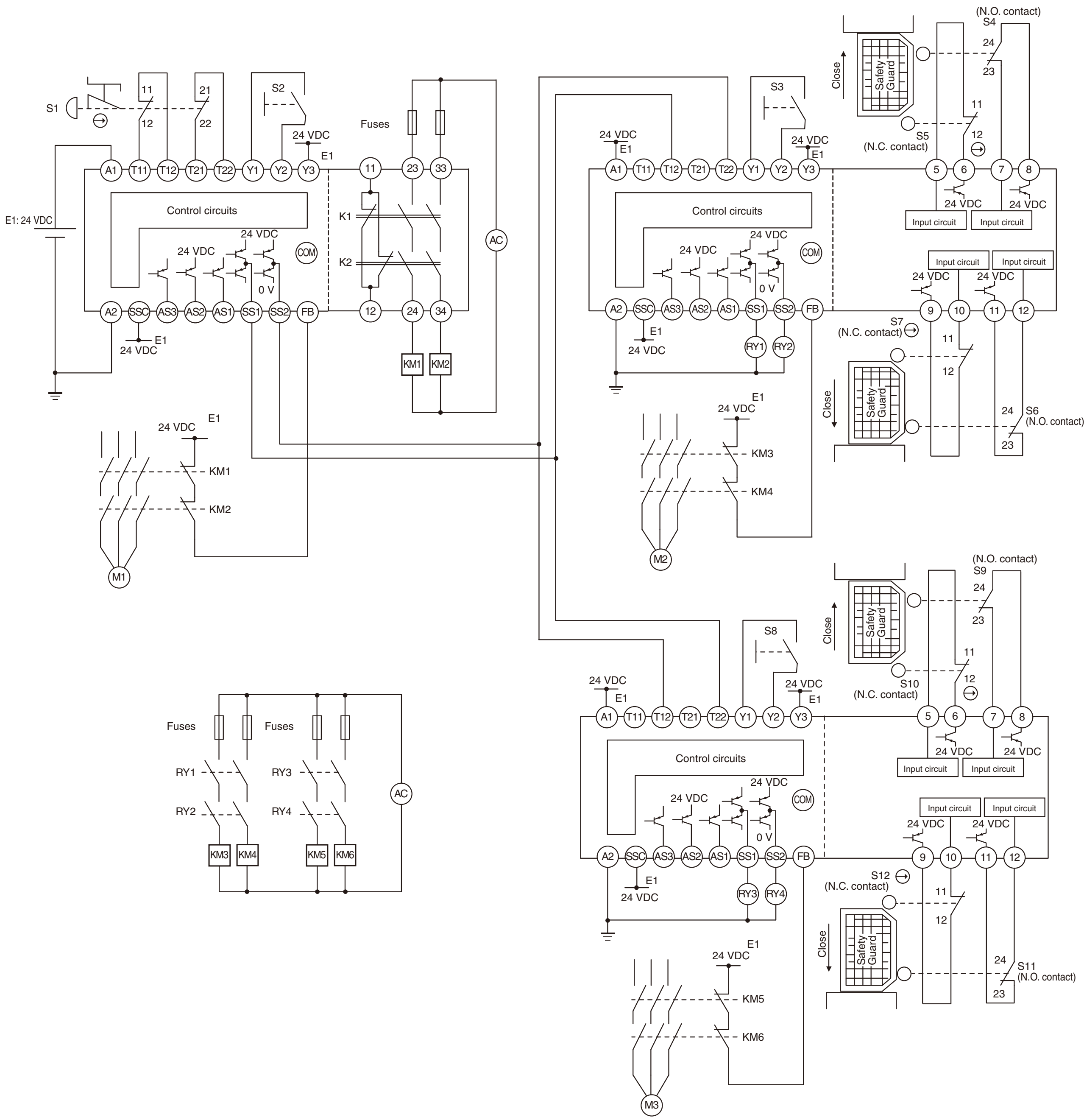


S1:	Emergency stop switch with positive opening mechanism A165E or A22E) ⊖
S2:	Reset switch (switch is reset by keeping pressed down for 3 s min.)
S31, S32:	Two-hand control switch
S4, S5:	Safety limit switch with positive opening mechanism (D4N or D4B) ⊖
KM1, KM2:	Magnetic contactor
M:	Three-phase motor
E1:	24-VDC power supply (S82K)
External indicator:	Filament-type indicator (When an external indicator is not necessary, connect resistance of 1/4 W, 4.7 kΩ.)
S6 :	External test switch
AS1:	Auxiliary control output (synchronized with K1, K2 N.O. contacts)
AS2:	Information trigger
AS3:	Standby output
SSC:	Start command input (Not connected in the above circuit diagram. When this input is not necessary, connect it to terminal A1.) Use switches that can be used with microloads (24 VDC, 5 mA).

Note:
1. The above circuit diagram example conforms to Category 2.
2. In this connection example, the auxiliary output is set to the standard setting (Dark-ON operation). To operate using non-standard settings, refer to the catalog or operation manuals for the F3SN/F3SH.
3. Two-hand Control Switches are available as 1 N.O. and 1 N.C. types, conforming to IEC/EN60947-5-1. Use compliant products. Make sure the wiring arrangement satisfies EN574. Use switches that can be used with microloads (24 VDC, 5 mA).

Wiring Example: F3SX-ER + F3SX-ED1 + F3SX-ED1 (Manual Reset)

Stop category	IEC60204-1	0
Safety category	EN954-1	4



S1: Emergency stop switch with positive opening mechanism (A165E or A22E)
S2,S3, S8: Reset switch
S4, S6, S9, S11: Limit switch
S5, S7, S10, S12: Safety limit switch with positive opening mechanism (D4N or D4B)
KM1 to KM6: Magnetic contactor
M1 to M3: Three-phase motor
E1: 24-VDC power supply (S82K)

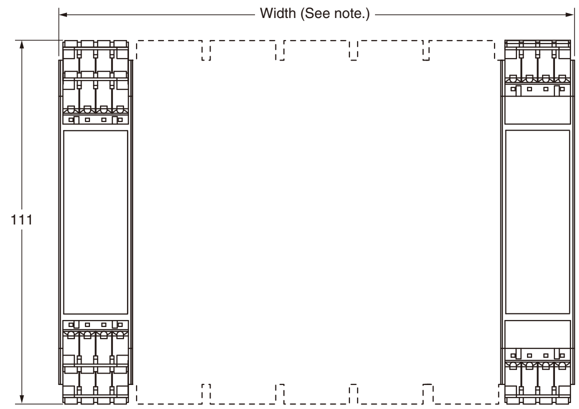
Note 1. The above circuit diagram example conforms to Category 4.
2. In the above circuit diagram example, the stop category (EN60204-1) is 0.

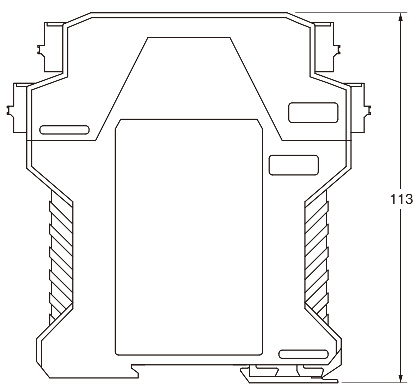
Dimensions

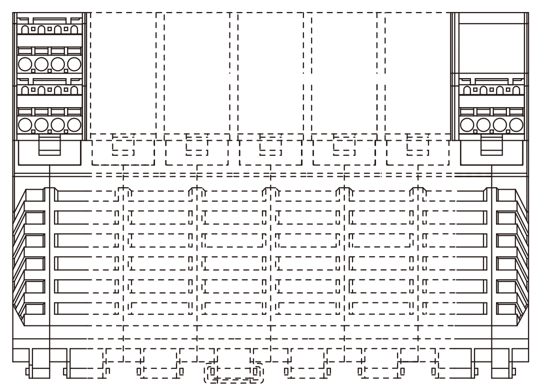
(Unit: mm)

Safety Controller

F3SX



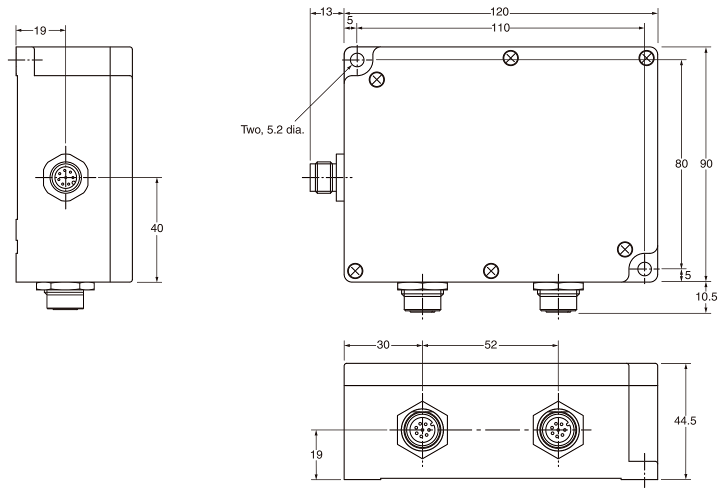




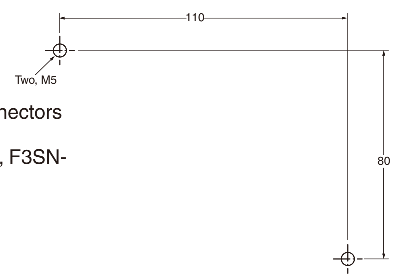
Note: For details on the width, refer to *"List of Models"* on page 6 to 9.

Junction Box for Safety Light Curtain

F39-TB01



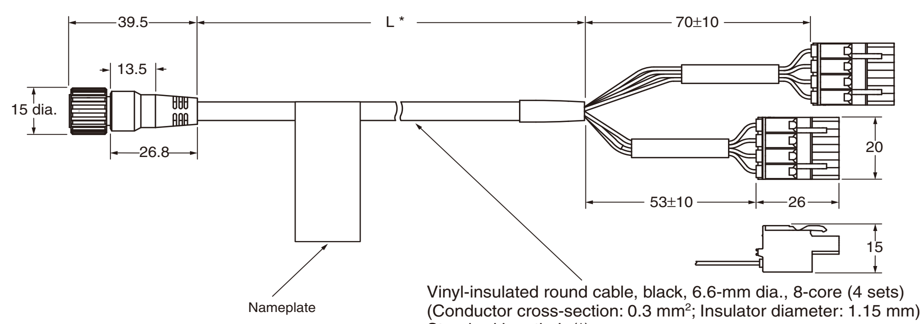
Mounting Hole Dimensions



Note: Use F39-JC□B or F39-JC□T Cable with Connectors on Both Ends to connect the Junction Box.
For details on F39-JC□B, refer to F3SJ Ver.2, F3SN-A/F3SN-B/F3SH-A, and F3SN-A□SS.

Cable with Connectors on Both Ends

F39-JC□□T



Vinyl-insulated round cable, black, 6.6-mm dia., 8-core (4 sets)
(Conductor cross-section: 0.3 mm^2; Insulator diameter: 1.15 mm)
Standard length: L (*)

*The length depends on the model number, as shown below.

Model	L (mm)
F39-JC1T	$1,000^{+150}_{0}$
F39-JC3T	$3,000^{+150}_{0}$
F39-JC5T	$5,000^{+300}_{0}$
F39-JC10T	$10,000^{+300}_{0}$

Wire color	Signal name	F3SX terminal No.
Brown	+24 V	1 or 16
Blue/shield	0 V	2 or 15
Gray	RS-485 (A)	3 or 14
Pink	RS-485 (B)	4 or 13
Green	Control output 1	5 or 12
Yellow	Reset output	6 or 11
White	Control output 2	7 or 10
Red	Test input	8 or 9

Safety Precautions

The following information is intended as a guide for selecting the F3SX Safety Controller.
Be sure to read the User's Manual for the product (SCHG-705) before use.

Overview

- The F3SX is designed for use by authorized personnel who thoroughly understand the installed machinery.
- The use of "authorized personnel" in the User's Manual (SCHG-705) refers to personnel qualified and authorized to secure safety across all phases of the safety life cycle from machinery design through, installation, operation, maintenance, and disposal.
- The specified installation environment and machinery performance characteristics of the F3SX are applicable under correct usage conditions. Have a related organization perform risk assessment before selecting, installing, or setting the F3SX.
- Be sure to thoroughly read and understand the User's Manual for the product (SCHG-705) before use and always use the product correctly according to the manual.

Regulations and Standards

- "Type Approval" specified in Chapter 44.2 of the Industrial Safety and Health Law in Japan does not apply to independent Controllers. This law applies to systems incorporated with the F3SX Controllers. Therefore, when using the F3SX Controllers in Japan as "safety devices for presses or shearing machines" as specified in Chapter 42 of the same law, apply for approval as a system.
- The F3SX is electro-sensitive protective equipment (ESPE) in accordance with European Union (EU) Machinery Directive Annex IV, B, Safety Components, Item 1 and Item 2.
- The F3SX received the following approvals from TÜV-Product Service.

1. EU Regulations
- Machinery Directive: Directive 98/37/EC
- Low Voltage Directive: Directive 73/23/EEC
- EMC Directive: Directive 89/336/EEC

2. European Standards
- EN61508 (SIL1-3), EN954-1 (Category 4, 3, 2, 1, B), EN61496-1 (TYPE 4 ESPE), EN50178, EN55011, EN60204-1, EN61000-6-2, EN61000-6-4, EN1760, EN574 (Type III C), EN1088

3. International Standards
- IEC61508 (SIL1-3), IEC61496-1 (Type 4 ESPE), IEC60204-1
- The F3SX received the following approvals from the Third Party Assessment Body UL:
- Certificate of UL listing for US and Canadian safety standards: UL508, UL1998, UL61496-1 (Type 4 ESPE), CSA C22.2 No. 14, CSA C22.2 No.0.8

⚠ WARNING

- Install the reset switch in a location from which the entire hazardous area is visible and where the switch cannot be operated from within the hazardous area.
- Connect control devices that are suitable for the required safety functions. Using unsuitable external devices may result in the F3SX not being capable of performing safety functions fully.
- The DC Power Supply Unit must satisfy all of the following conditions for the F3SX to meet EN60204-1, IEC61496-1, and UL508 standards.
  - The power supply voltage is within the rating (24 VDC ± 10%).
  - The power supply is used to supply the F3SX and its connected Sensors only, and is not connected to any other devices or equipment. When connecting multiple devices, make sure the total rated current is not exceeded.
  - The power supply conforms to the EMC Directive (industrial environment).
  - The power supply uses double or reinforced insulation between the primary and secondary circuits.
  - The power supply automatically resets overcurrent protection characteristics (voltage drop).
  - The power supply maintains an output holding time of at least 20 ms.
  - The power supply must have output characteristics of Class 2 Circuit or Limited Voltage-Current Circuit as defined in UL508.
  - The power supply must conform to regulatory requirements and standards regarding EMC and electrical equipment safety of the country where the F3SX is installed.
    Example: The EMC Directive (industrial environment) and the Low Voltage Directive in EU.
- When using a commercially available switching regulator, make sure FG (frame ground terminal) is connected. Faulty operation caused by switching noise may result if the terminal is not connected.
- Do not connect a DC or AC power supply output that exceeds the rated value to the power supply input of the F3SX.
- Connect a fuse serially to the output contact of the relay output.
- Do not use a load that exceeds the switching capacity. Doing so may result in damage to the output circuits and the F3SX may not be capable of turning OFF.
- Take measures to prevent common malfunctions that would disable all redundant safety circuits at the same time.
- Do not use the F3SX's PLC communications functions to configure a safety system. Doing so may result in serious injury due to faulty wiring or PLC malfunction.
- Do not attempt to disassemble, repair, or modify the F3SX. Otherwise, the F3SX may not be capable of performing its safety functions.
- Wire the I/O terminals correctly. Incorrect wiring may result in electric shock or the safety functions may be damaged.
- Do not use the auxiliary outputs to configure a safety system. Using the auxiliary outputs as safety outputs may result in serious injury if the F3SX or peripheral devices malfunction.
- Do not connect input devices to the auxiliary input terminal (start command input) to configure a safety system. Doing so may result in serious injury if the F3SX or peripheral devices malfunction.

⚠ CAUTION

- The applicable safety category is determined from the whole safety control system. Consultation with a third party assessment body is recommended to make sure that the whole safety control system meets requirements.
- The service life greatly depends on factors such as the switching conditions and load. Be sure to test the F3SX under actual application conditions, and make sure that the number of switching operations is within the permissible range.
- Use the F3SX within a protective structure that complies with IP54 or higher.
- Secure the F3SX to the DIN track using Mounting Brackets if the DIN track is short or if securing is otherwise required. Not doing so may result in the F3SX falling off the DIN track due to vibration.
- Provide a space of at least 5 mm beside and at least 50 mm above and below the F3SX for ventilation.

Terminology

IEC61508: 1998 (EN61508: 2001)

This standard specifies detailed provisions for the procedures to be followed (including design and evaluation methods) covering all phases of the safety life cycle from design through installation, maintenance, and disposal when a product has safety functions that use electrical, electronic, or programmable systems.

DC Solid-state Safety Output Waveform

In the F3SX, the output periodically turns OFF for a short time to check that the function for turning OFF output is operating normally. If the output signal turns OFF during this time the output circuit is determined to be operating normally. Conversely, if the output does not turn OFF, an output circuit or wiring error is detected, and the Controller is put in lockout status. Set the input response time of connected devices such that the devices connected to terminals SS1 and SS2 do not malfunction due to the OFF pulse signal.

SIL (Safety Integrity Level)

SIL refers to a numeric value that indicates the safety integrity requirements of the safety system in the same way as they were previously indicated by EN954-1 Safety Categories B, and 1 through 4. The level is obtained by calculating the ratio of dangerous malfunctions that can occur and assigning a level that corresponds to the frequency of use. This Controller is SIL3, which indicates a safety level equivalent to EN954-1 Safety Category 4.

Diagnostic Functions

Intersystem Synchronous Monitoring

The time difference in the rise time of inputs between systems (between channels 1 and 2) is monitored. This prevents safety equipment from being disabled.

Intersystem Short-circuit Monitoring

Short-circuits of inputs between systems (between channels 1 and 2) are monitored. This allows detection of damage to safety equipment. If a short-circuit occurs, the Controller is locked out, and the OFF status is maintained. (Fuse replacement is not required.)

Control Functions

Monitoring Feedback Timing (FB)

The N.C. contact of the external relay that controls the source of danger in the machine is input to the F3SX as a feedback signal, thereby detecting welding contacts and other operating faults, and can also monitor whether the feedback signal is returned within a fixed time (factory setting: 500 ms).
When this function is not used, perform function settings using the F3SX-CD100-E Function Setup Software for the F3SX.

Standby Output (AS3 Terminal)

The standby output is output after the F3SX CPU Unit is initialized and I/O control can be performed normally. Use this output as part of the operation standby signals for the entire system.

⚠ The standby output is not a safety output. Do not use the standby output to configure safety systems. Doing so may result in serious injury if a malfunction occurs.

Ready Output (AS2 Terminal: E Modules)

The ready output is output when the F3SX is in a standby state and all the safety inputs are ON.

Information Trigger (AS2 Terminal: N Modules)

The information trigger is output when damage or a timeout occurs during Controller diagnosis or monitoring. The trigger signal can be used as a command request signal to a host (e.g., Programmable Controller or personal computer).

⚠ The information trigger output is not a safety output. Do not use the information trigger to configure safety systems. Doing so may result in serious injury if a malfunction occurs.

Start Command Input (SSC Terminal)

The start command input is used to operate a safety relay when it receives a start command from the machine in addition to an input condition from the safety device. (If the SSC terminal is not required, connect it to the 24-VDC terminal.)

⚠ Do not connect the start command input to an input device, or otherwise use it to configure safety systems. Doing so may result in serious injury if a malfunction occurs.

Precautions for Correct Use

1. Do not use the F3SX in atmospheres or environments that exceed product ratings.
2. Safety Application Controller's Relay durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
   When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay or the Safety Application Controller immediately.
   If the Relay or the Safety Application Controller is used continuously without replacing, then it can lead to loss of safety function.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON’s test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.1

OMRON Corporation
Industrial Automation Company

In the interest of product improvement, specifications are subject to change without notice.

http://www.ia.omron.com/

Safety Relay Unit

G9S

Ideal for Safety Door and Emergency Stop Switch Circuits

- ■ Two-pole, three-pole, and five-pole models are available.
- ■ Basic Models and OFF-delay models are available
- ■ Incorporates LED indicators for monitoring built-in relays.
- ■ Finger-protection construction.
- ■ Conforms to EN standards and certified by BIA.
- ■ Both DIN track mounting and screw mounting possible (two-pole models)

⚠ Be sure to read the *"Safety Precautions"* on page 9.

Model Number Structure

Model Number Legend

G9S-□□□□-□□□
1 2 3 4 5

1. Contact Configuration (Safety Output)
2: DPST-NO
3: 3PST-NO
5: 5PST-NO

2. Contact Configuration (OFF-delay Output)
0: None
2: DPST-NO

3. Contact Configuration (Auxiliary Output)
0: None
1: SPST-NC

4. Input Configuration
None: 1-channel or 2-channel input possible
1: 1-channel input
2: 2-channel input

5. OFF-delay Time
None: No OFF-delay
T01: 1 second
T015: 1.5 seconds
T03: 3 seconds
T04: 4 seconds
T05: 5 seconds
T06: 6 seconds
T10: 10 seconds
T30: 30 seconds

Ordering Information

Basic Models

Number of poles	Rated voltage	Main contact form	Number of input channels	Model
2	24 VDC	DPST-NO	2 channels	**G9S-2002**
3 *	24 VDC	3PST-NO	1 channel or 2 channels possible	**G9S-301**
	24 VAC 100 VAC 120 VAC			
	200 VAC 240 VAC			
5 *	24 VDC	5PST-NO		**G9S-501**
	24 VAC 100 VAC 120 VAC			
	200 VAC 240 VAC			

* Auxiliary contact is SPST-NC.

OFF-delay Models

Number of poles	Rated voltage	Main contact form	OFF-delay form	Number of input channels	OFF-delay time	Model
3	24 VDC 24 VAC 100 VAC 120 VAC 200 VAC 240 VAC	3PST-NO	DPST-NO	1 channel or 2 channels possible	1 s 1.5 s 3 s 4 s 5 s 6 s 10 s 30 s	**G9S-321-T01** **G9S-321-T015** **G9S-321-T03** **G9S-321-T04** **G9S-321-T05** **G9S-321-T06** **G9S-321-T10** **G9S-321-T30**

Note: Each model has an SPST-NC auxiliary contact.

Specifications

Ratings

Controller Block

Model	Rated voltage	Rated current	Rated power consumption
G9S-2002	24 VDC	66 mA±20%	Approx. 1.6 W
G9S-301	24 VDC	62.5 mA±20%	Approx. 1.5 W
	24 VAC	125 mA±20%	Approx. 3 VA (60 Hz)
	100 VAC	30 mA±20%	
	120 VAC	25 mA±20%	
	200 VAC	15 mA±20%	
	240 VAC	12.5 mA±20%	
G9S-501	24 VDC	127 mA±20%	Approx. 3 W
	24 VAC	229 mA±20%	Approx. 5.5 VA (60 Hz)
	100 VAC	55 mA±20%	
	120 VAC	45.8 mA±20%	
	200 VAC	27.5 mA±20%	
	240 VAC	22.9 mA±20%	
G9S-321-T□	24 VDC	150 mA±20%	Approx. 3.6 W
	24 VAC	254 mA±20%	Approx. 6.1 VA (60 Hz)
	100 VAC	61 mA±20%	
	120 VAC	50.8 mA±20%	
	200 VAC	30.5 mA±20%	
	240 VAC	25.4 mA±20%	

Note: The above ratings are at an ambient temperature of 23°C.

Contact

Item / Model / Load	G9S-301, G9S-501, G9S-321-T□		G9S-2002	
	Resistive load	Inductive load	Resistive load	Inductive load
Rated load	240 VAC, 3 A * 24 VDC, 3 A	240 VAC, 3 A (cosϕ = 0.3) 24 VDC, 1 A (L/R=100 ms)	240 VAC, 5 A 24 VDC, 5 A	240 VAC, 3 A (cosϕ = 0.3) 24 VDC, 1 A (L/R=100 ms)
Rated carry current	5 A			

* If the load is 5 A at 240 VAC, the durability will be 40,000 operations.

Characteristics

Item	Model	G9S-2002	G9S-301	G9S-501	G9S-321-T□
Operating time *1		50 ms max.	300 ms max.		
Response time *2		50 ms max.	100 ms max.		
Control circuit power supply voltage allowance		–15% to +10%			
Insulation resistance (at 500 VDC)	Between control circuits and safety/auxiliary circuits	100 Ω min.			
	Between safety circuits and auxiliary circuits	100 Ω min.			
	Safety circuits	100 Ω min.			
Dielectric strength	Between control circuits and safety/auxiliary circuits	2,500 VAC (50/60 Hz, 1 min.)			
	Between safety circuits and auxiliary circuits	2,500 VAC (50/60 Hz, 1 min.)			
	Safety circuits	2,500 VAC (50/60 Hz, 1 min.)			
Vibration resistance	Destruction	10 to 55 to 10 Hz, 0.375-mm single amplitude (0.75-mm double amplitude)			
	Malfunction	10 to 55 to 10 Hz, 0.25-mm single amplitude (0.5-mm double amplitude)			
Shock resistance	Destruction	300 m/s^2			
	Malfunction	50 m/s^2			
Min. permissible load (P level) (reference value)		24 VDC, 50 mA			
Ambient operating temperature		–25 to 55°C (with no icing or condensation)			
Ambient operating humidity		35% to 85%			
Terminal tightening torque		0.98 N·m			
Weight *3		Approx. 180 g	Approx. 365 g	Approx. 550 g	Approx. 580 g

*1. Not including bounce time.
*2. The response time is the time it takes for the main contact to open after the input is turned OFF. Includes bounce time.
*3. These weights are for DC models. AC models are 200 g heavier.

Durability

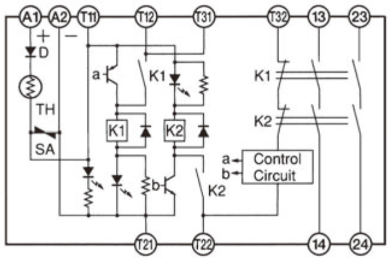
Mechanical durability	1,000,000 operations min. with a switching frequency of approx. 1,800 operations/h
Electrical durability	100,000 operations min. at the rated load with a switching frequency of approx. 1,800 operations/h

Note: The durability is for an ambient temperature of 15 to 35°C and an ambient humidity of 25% to 75%.

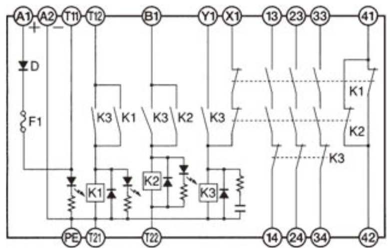
Connections

Internal Connections

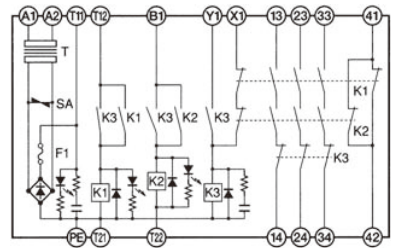
G9S-2002



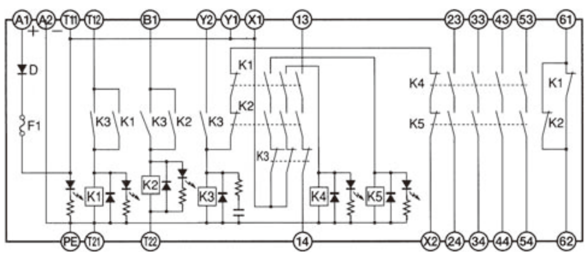
G9S-301 (24 VDC)



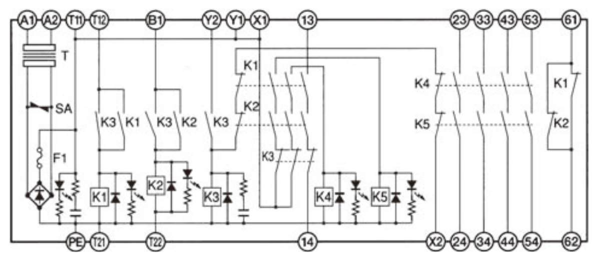
G9S-301 (AC Model)



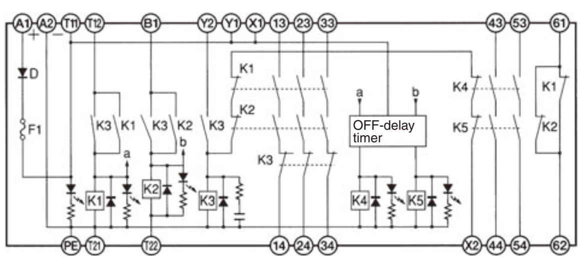
G9S-501 (24 VDC)



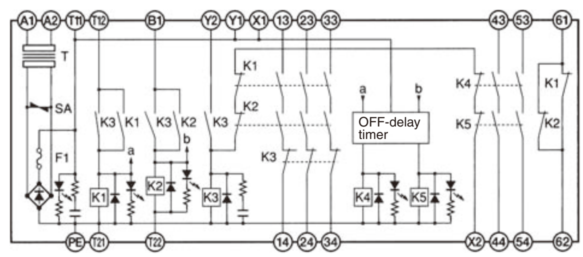
G9S-501 (AC Model)



G9S-321-T□ (24 VDC)



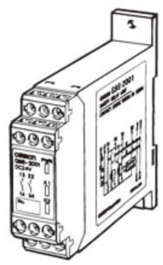
G9S-321-T□ (AC Model)

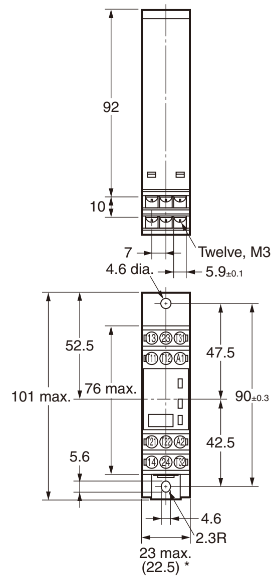


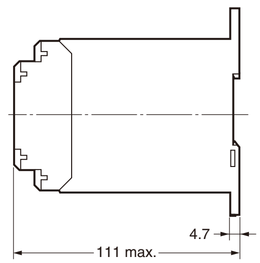
Dimensions

(Unit: mm)

G9S-2002

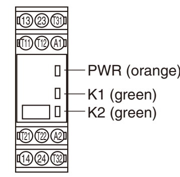






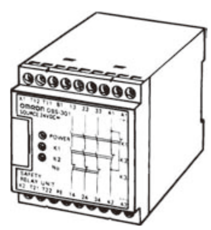
Terminal Arrangement

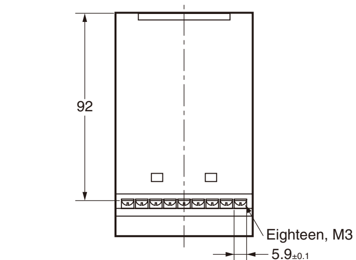
G9S-2002

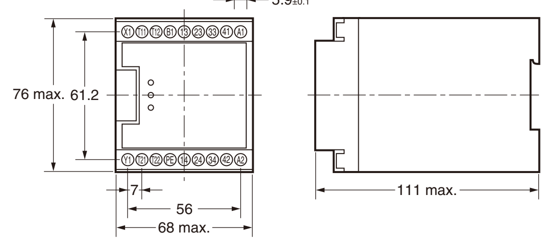


* This is an average value.

G9S-301

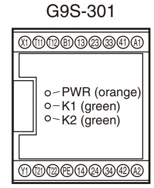




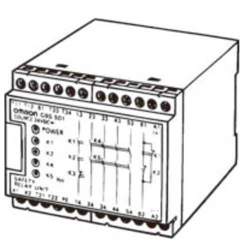


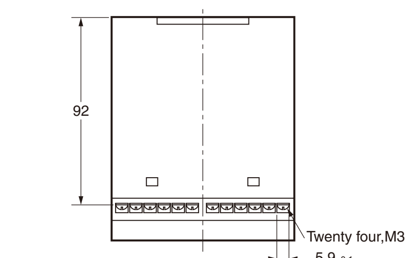
Terminal Arrangement

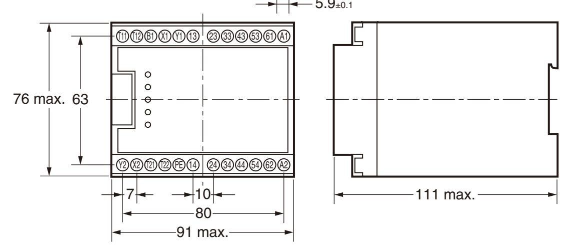
G9S-301



G9S-501
G9S-321-T□

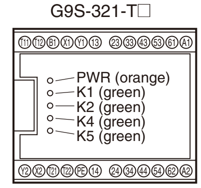






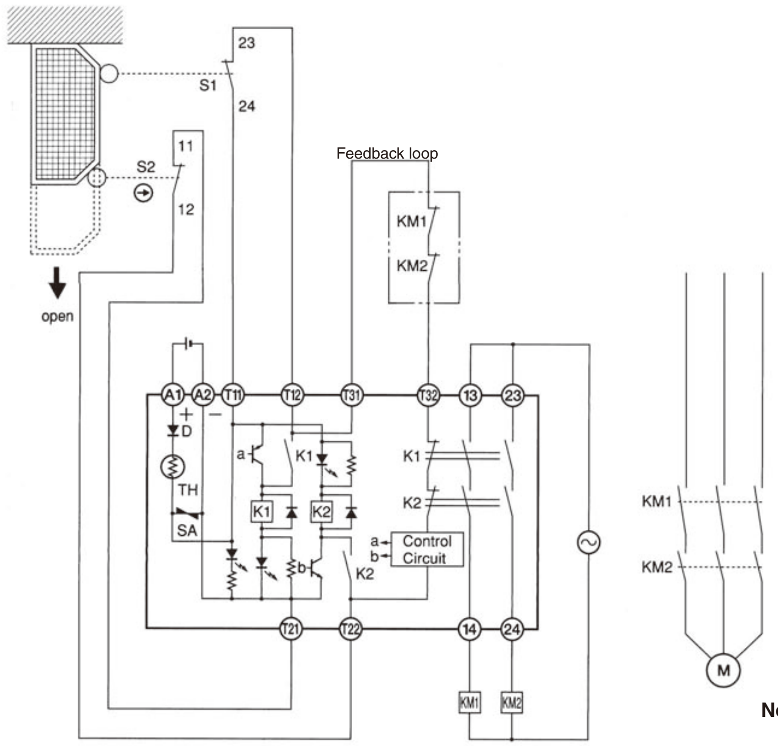
Terminal Arrangement

G9S-501
G9S-321-T□

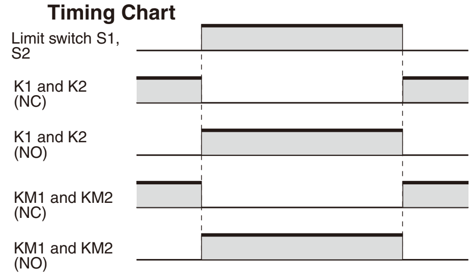


Application Examples

G9S-2002 with 2-channel Limit Switch Input/Auto-reset



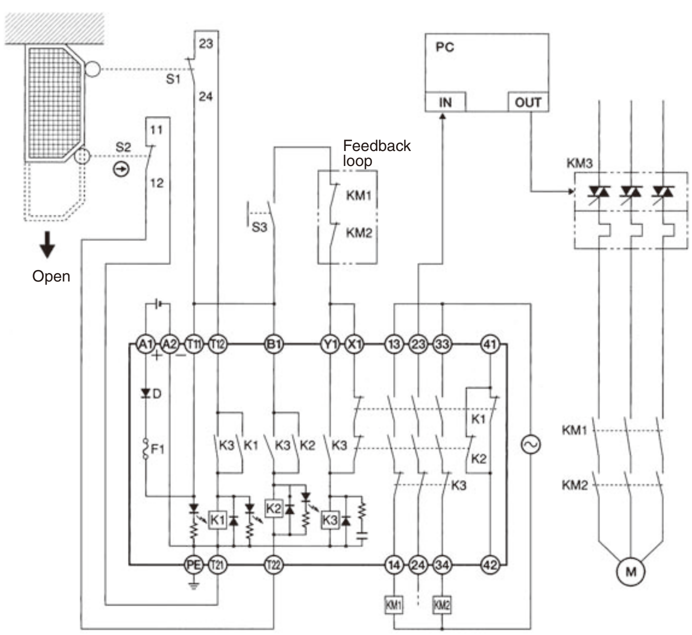
Timing Chart



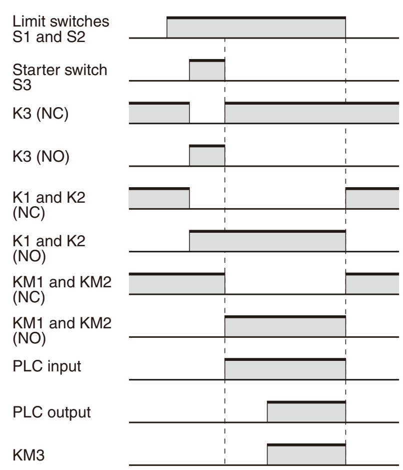
S1:	Limit switch (NO)
S2:	Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
KM1 and KM2:	Magnet Contactor
M:	3-phase motor

Note: This circuit conforms to Safety Category 4.

G9S-301 (24 VDC) with 2-channel Limit Switch Input/Manual Reset



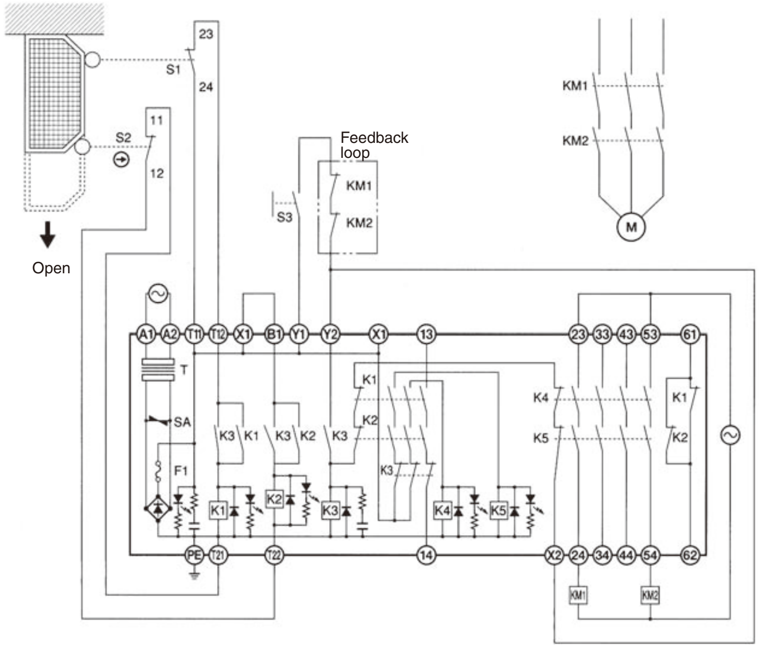
Timing Chart



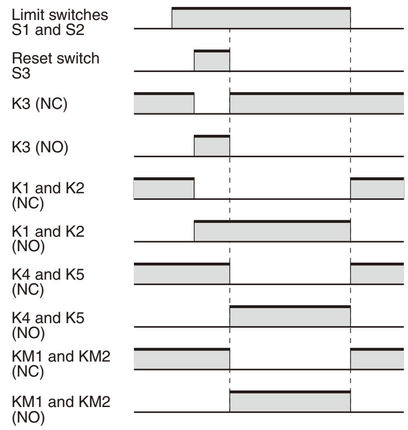
S1:	Limit switch (NO)
S2:	Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S3:	Reset switch (momentary operation)
KM1 and KM2:	Magnet Contactor
KM3:	G3J Solid-state Contactor
M:	3-phase motor

Note: This circuit conforms to Safety Category 4.

G9S-501 (AC Model) with 2-channel Limit Switch Input/Manual Reset



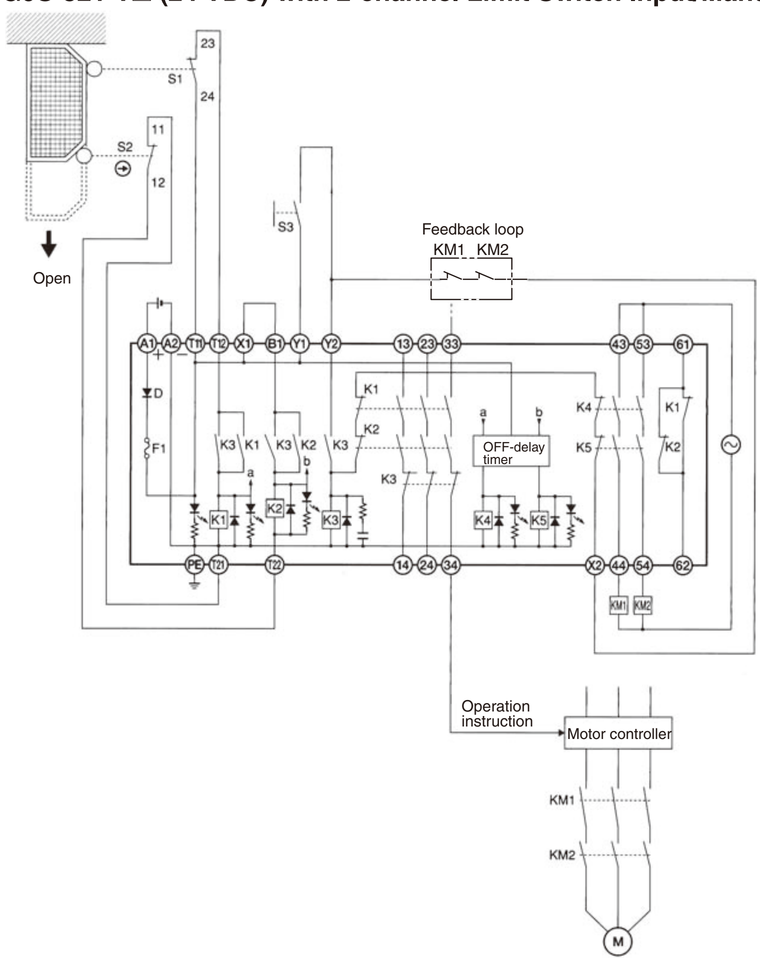
Timing Chart



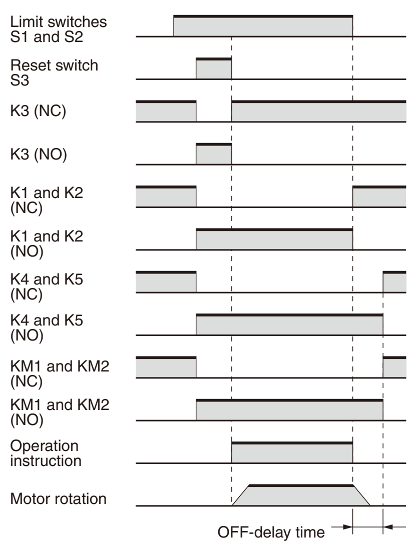
S1: Limit switch (NO)
S2: Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S3: Reset switch (momentary operation)
KM1 and KM2: Magnet Contactor
M: 3-phase motor

Note: This circuit conforms to Safety Category 4.

G9S-321-T□ (24 VDC) with 2-channel Limit Switch Input/Manual Reset



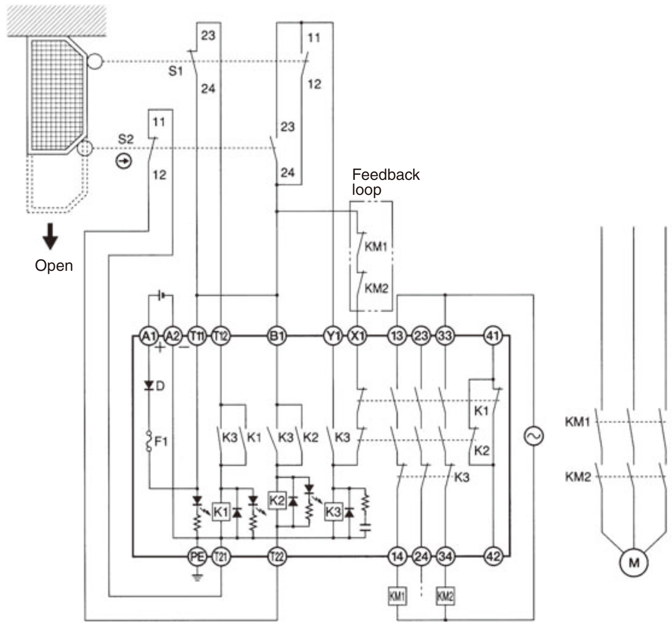
Timing Chart



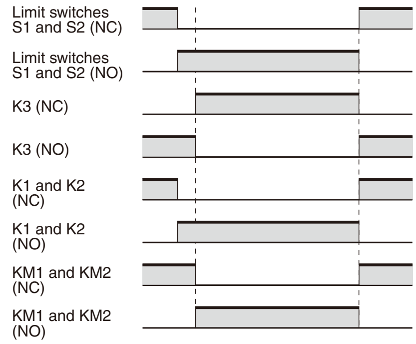
S1: Limit switch (NO)
S2: Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S3: Reset switch (momentary operation)
KM1 and KM2: Magnet Contactor
M: 3-phase motor

Note: This circuit conforms to Safety Category 4 except for the OFF-delay output sections, which conforms to Category 3.

G9S-301 (24 VDC) with 2-channel Limit Switch Input/Auto-reset



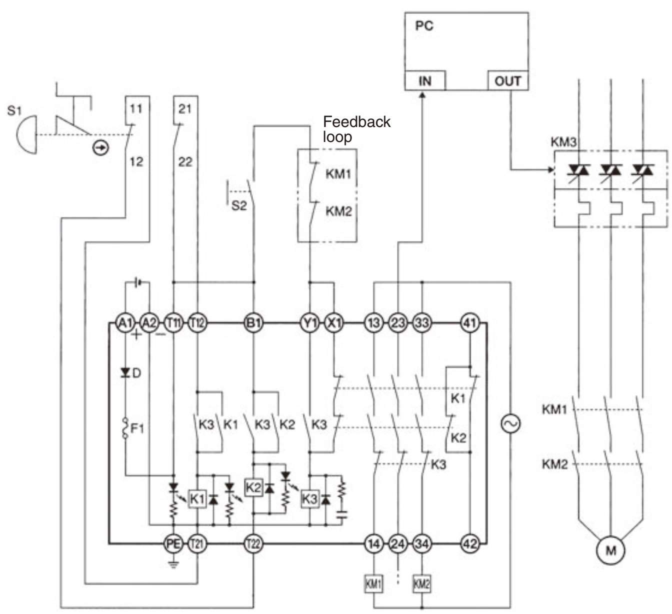
Timing Chart



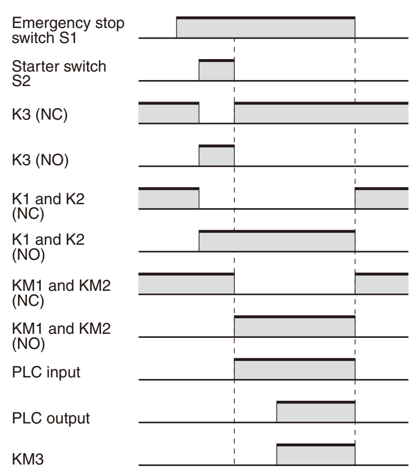
S1:	Limit switch (NO)
S2:	Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
KM1 and KM2:	Magnet Contactor
M:	3-phase motor

Note: This circuit conforms to Safety Category 4.

G9S-301 (24 VDC) with 2-channel Emergency Stop Switch Input/Manual Reset



Timing Chart



S1:	Emergency stop switch
S2:	Reset switch (momentary operation)
KM1 and KM2:	Magnet Contactor
KM3:	G3J Solid-state Contactor
M:	3-phase motor

Note: This circuit conforms to Safety Category 4.

Safety Precautions

Refer to the *"Precautions for All Relays"* and *"Precautions for All Relays with Forcibly Guided Contacts"*.

⚠ CAUTION

Turn OFF the G9S before wiring the G9S. Do not touch the terminals of the G9S while the power is turned ON, because the terminals are charged and may cause an electric shock.

Precautions for Correct Use

Installation

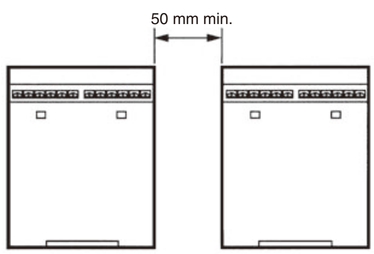
- The G9S should be installed perpendicular on a vertical surface (i.e., vertically so that the markings can be read).

Wiring

- Use the following to wire the G9S.
  Stranded wire: 0.75 to 1.5 mm^2
  Steel wire: 1.0 to 1.5 mm^2
- Make sure that each screw is tightened to a torque of 0.78 to 1.18 N·m, or the G9S may malfunction or generate heat.
- External inputs connected to T11 and T12 or T21 and T22 of the G9S-301 must be no-voltage contact inputs.
- PE is a ground terminal.
  When a machine is grounded at the positive, the PE terminal should not be grounded.

Mounting Multiple Units

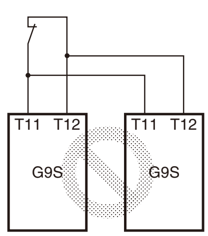
- If the output current is 3 A or more, make sure that there is a minimum distance of 50 mm each between all adjacent G9S Units. (24-VDC models do not require this spacing.)



Connecting Inputs

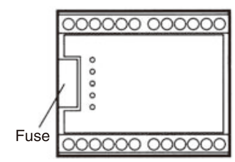
- When using more than one G9S Unit, do not connect the same switch to more than one G9S Unit. This applies to all input terminals.

Incorrect



Fuse Replacement (Three- and Five-pole Models)

- The power input circuit of the G9S includes a fuse to protect the G9S from damage that may be caused by short-circuiting. The fuse is mounted to the side panel. Use the following type of fuse as a replacement. Using a non-specified fuse can cause malfunction or burning.
- Littel Fuse 218.4 (rated current 0.4 A), IEC127 approval.
- Use a flat-blade screwdriver to remove the fuse cover.
- Be sure to turn OFF the G9S before replacing the fuse.



Resetting Inputs

- When only channel 1 of the 2-channel input turns OFF, the safety output is interrupted. In order to restart when this happens, it is necessary to turn OFF and ON both input channels. It is not possible to restart by resetting only channel 1.

Resetting Inputs During OFF Delay Time

The G9S-321-T☐ operates as follows according to the reset mode when the inputs are to be re-entered during the OFF delay time of the G9S-321-T☐:
For auto reset, after the OFF delay time has ended, the outputs will turn OFF, and then the outputs will turn ON again.
For manual reset, after the OFF delay time has ended, the outputs will turn OFF, and then the outputs will turn ON again when the reset is input.

Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

Applicable Safety Category (EN954-1)

All G9S-series Relays fall under Safety Category 4 of EN954-1 except the G9S-321-T. The G9S-321-T has an OFF-delay output block falling under Safety Category 3.
The above is provided according to circuit examples presented by OMRON. Therefore, the above may not apply to all operating environments.
The applicable safety category is determined from the whole safety control system. Make sure that the whole safety control system meets EN954-1 requirements.
Wire the G9S-2002 for auto-reset. If either one of them is connected to a manual reset switch, EN954-1 requirements will not apply.

Safety Category 4 of EN954-1

- Wire the G9S-2002 for auto-reset. If it is connected to a manual reset switch, EN954-1 requirements will not apply.
- Apply 2-channel external input to the T11 and T12 terminals and T21 and T22 terminals through switches each incorporating a force-separation mechanism. If limit switches are used, make sure that at least one of them incorporates a force-separation mechanism.
  Refer to *Application Examples* and input a signal for the normally-closed contact of the contactor (i.e., input to X1 of the G9S-301, X2 of the G9S-501, or X2 of the G9S-321-T).
- Be sure to ground the PE terminal. If the relay is operating with DC, the power supply may be grounded instead.

Certified Standards

The G9S-301, G9S-501, G9S-321-T and G9S-2002 conform to the following standards.

- EN standards, certified by BIA:
  EN954-1
  EN60204-1
- Conformance to EMC (Electromagnetic Compatibility), certified by TÜV Product Service:
  EMI (Emission): EN55011 Group 1 Class A
  EMS (Immunity): EN61000-6-2
- UL standards: UL508 (Industrial Control Equipment)
- CSA standards: CSA C22.2 No. 14 (Industrial Control Equipment)

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)
To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).
Refer to the *Safety Components Technical Guide* (Cat No. Y107). The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

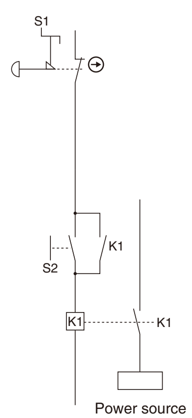
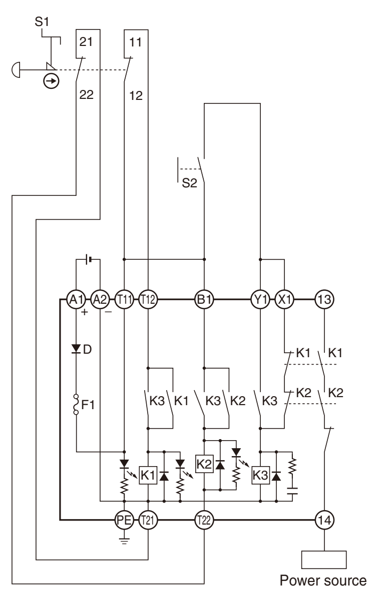


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)
The G7SA, G7S and G7S-□-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-□-E, however, do not display the CE Marking according to the concepts in the guidelines.
VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-□-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

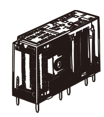
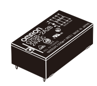
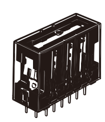
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	**Flux protection**	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

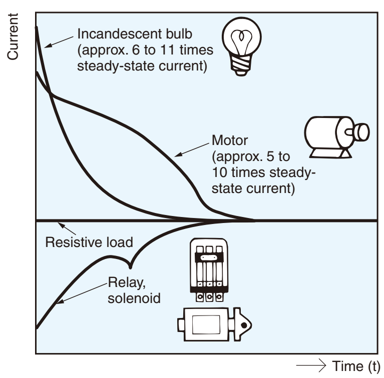
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

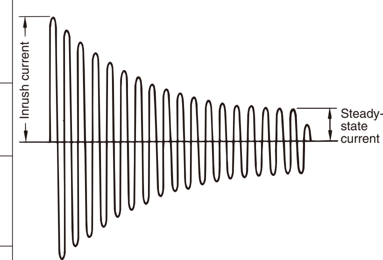
Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	

❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

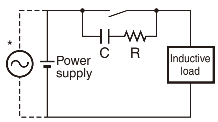
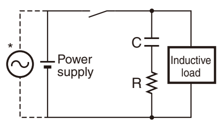
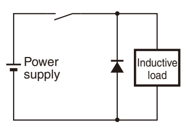
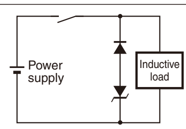
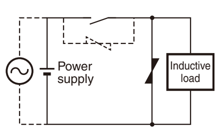
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

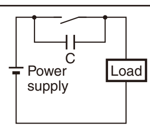
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

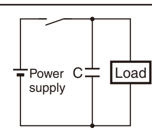
Typical Examples of Contact Protection Circuits

Circuit example		Applicable current		Features and remarks	Element selection
		AC	DC		
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.



This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.



This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

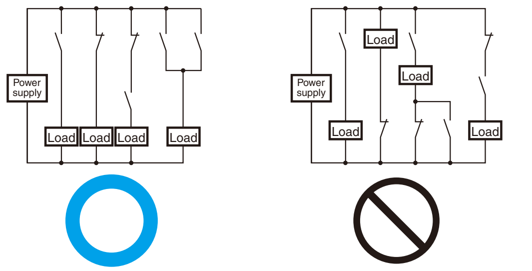
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

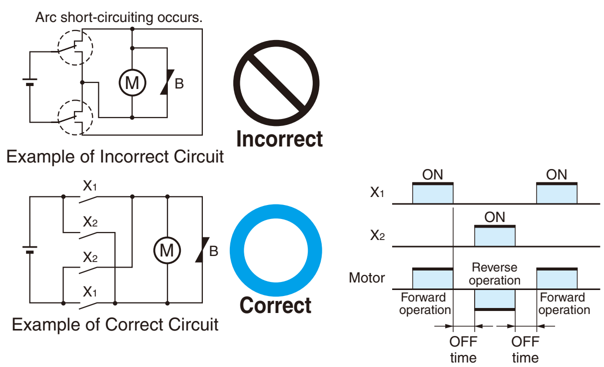
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



a. Correct Connection b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.

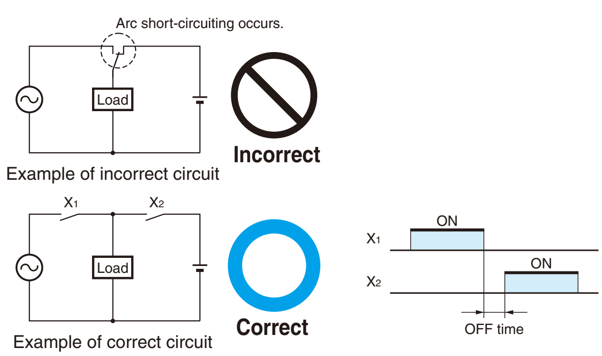


❸-①-8 Power Supply Double Break with Multi-pole Relays

If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

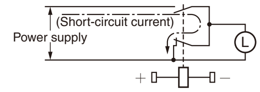
❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.
Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.
Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.
The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.
Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.
This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).
This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

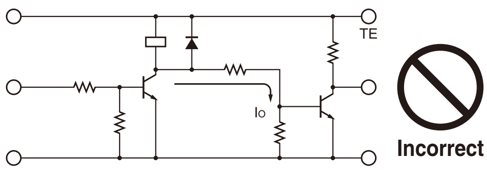
❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.
As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.
Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

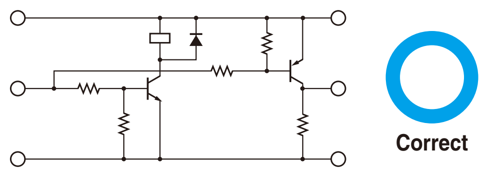
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

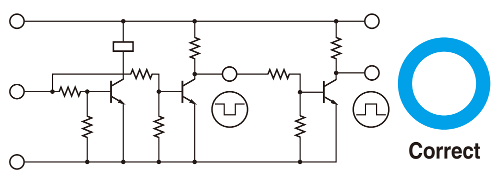
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value

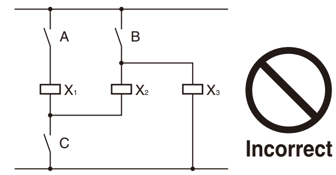


❸-②-7 Using with Infrequent Switching

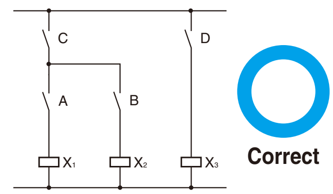
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.
The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.
The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



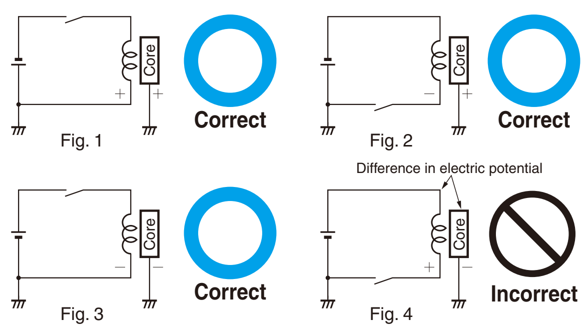
❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)

(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)

(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

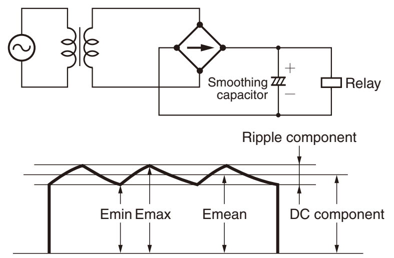


❸-②-10 Individual Specifications for Must-operate/release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



$$\text{Ripple percentage } \% = \frac{E_{max} - E_{min}}{E_{mean}} \times 100\%$$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON.
Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil

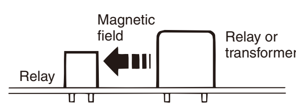
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock

Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields

Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads

Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust

Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

❺ Relay Mounting Operations

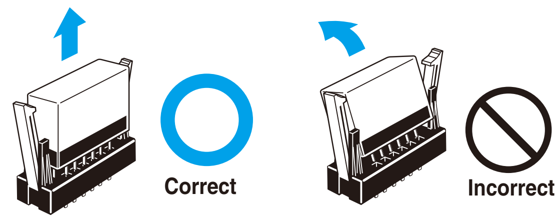
① Plug-in Relays

❺-①-1 Panel-mounting Sockets

1. Socket Mounting Screws
   When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
   If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach.
   Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.
2. Lead Wire Screw Connections
   Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
   If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
   Conversely, excessive tightening can strip the threads.

❺-①-2 Relay Removal Direction

Insert and remove Relays from the socket perpendicular to the socket surface.

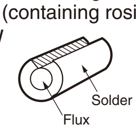


If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering

Solder General-purpose Relays manually following the precautions described below.

1. Smooth the tip of the solder gun and then begin the soldering.
   - Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
   For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.
3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning

Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals

Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals

Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations

Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing

G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

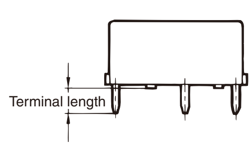
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material	Epoxy		Phenol
Item	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

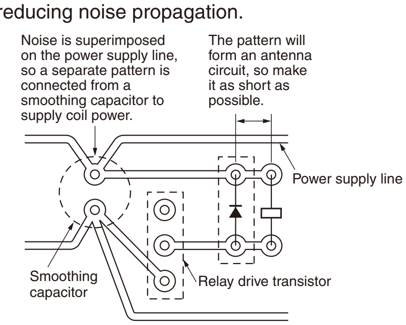
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② Noise from Contacts

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ High-frequency Patterns

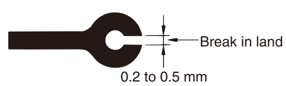
As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

Correct Examples	
Incorrect Examples	

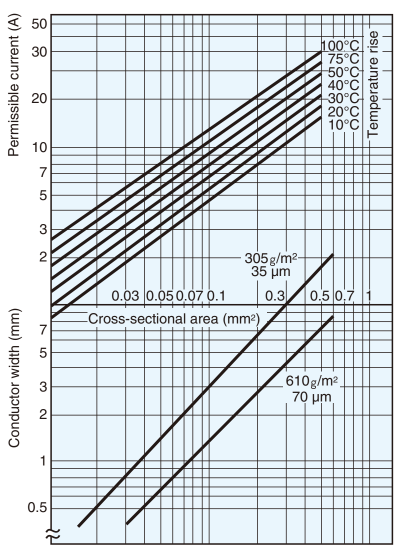
2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.



❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 µm and 70 µm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

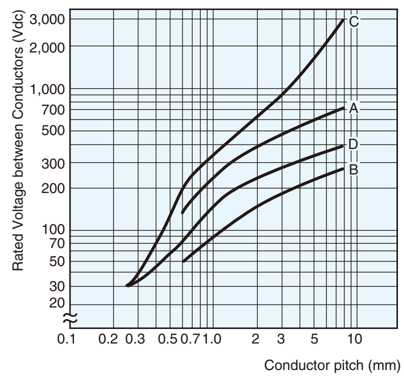
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

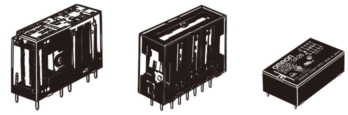
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

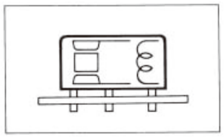
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

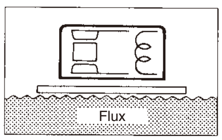
Placement



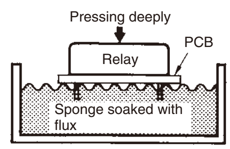
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay. The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials.
   For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.
   Apply the flux sparingly and evenly to prevent penetration into the Relay.
   When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



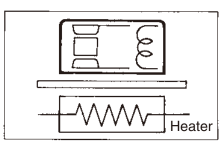
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

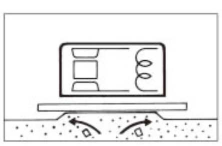
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

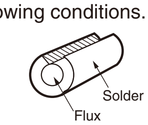
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

Applicability of Manual Soldering

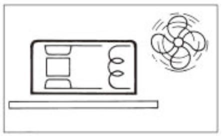
G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5

Cooling



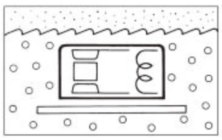
1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6

Cleaning



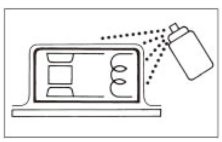
Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7

Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed. Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

In the interest of product improvement, specifications are subject to change without notice.

OMRON Corporation
Industrial Automation Company
http://www.ia.omron.com/

Safety Relay Unit (Sensor Connector Type)

G9SA-300-SC

Less Wiring Required with Safety Light Curtain

- Sensor connector allows direct connection to OMRON F3SN-A/F3SN-B/F3SH-A Safety Light Curtains with PNP outputs.
- Reduces wiring and prevents incorrect connection.
- Connection to emergency stop switch also supported.
- Conforms to EN standards (TÜV approval).
- DIN track mounting possible.

Be sure to read the *"Safety Precautions"* on page 8.

Model Number Structure

Model Number Legend

G9SA-□□□□□□-□□
1 2 3 4 5 6

1. Function
None: Emergency stop

2. Contact Configuration (Safety Output)
3: 3PST-NO

3. Contact Configuration (OFF-delay Output)
0: None

4. Contact Configuration (Auxiliary Output)
0: None

5. Input Configuration
None: 1-channel or 2-channel input possible

6. Terminal
SC: Connector terminals

Ordering Information

Safety Relay Unit

Emergency-stop Unit with Sensor Connector

Main contact	Auxiliary contact	Number of input channels	Rated voltage	Model
3PST-NO	None	2 channels	24 VDC	**G9SA-300-SC**

Note: 1. Connect to the sensor connector using a special OMRON F3SN-A/F3SN-B/F3SH-A Safety Light Curtain Connecting Cable. For details, refer to the information on accessories below.
2. The Safety Light Curtain and Connecting Cable are sold separately.

Accessories (Order Separately)

Connecting Cables (for F3SN-A/F3SN-B/F3SH-A)

Appearance	Cable length	Model
	0.2 m	**F39-JCR2C**
	1 m	**F39-JC1C**
	3 m	**F39-JC3C**
	7 m	**F39-JC7C**
	10 m	**F39-JC10C**
	15 m	**F39-JC15C**

Note: The model numbers given in the table are for sets of two Cables, one for the emitter and one for the receiver.

Specifications

Ratings

Power Input

Item / Model	G9SA-300-SC
Power supply voltage	24 VDC
Operating voltage range	85% to 110% of rated power supply voltage
Power consumption	24 VDC: 0.7 W max.

Contacts

Item / Model	G9SA-300-SC
Item / Load	Resistive load
Rated load	250 VAC, 5 A 30 VDC, 5 A
Rated carry current	5 A

Inputs

Item / Model	G9SA-300-SC
Input current	40 mA max.

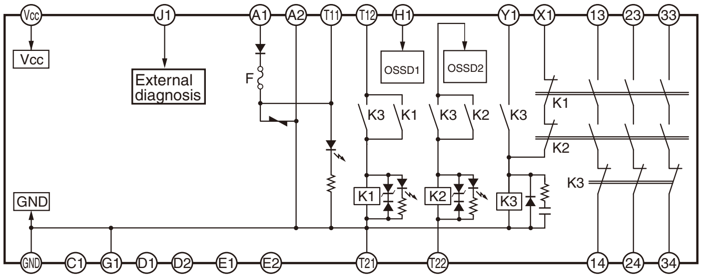
Characteristics

Item	Model	G9SA-300-SC
Contact resistance *1		100 mΩ
Operating time *2		300 ms max.
Response time *3		10 ms max.
Insulation resistance *4		100 MΩ min. (at 500 VDC)
Dielectric strength	Between different outputs	2,500 VAC, 50/60 Hz for 1 min
	Between inputs and outputs	
	Between power inputs and outputs	
Vibration resistance		10 to 55 to 10 Hz, 0.375-mm single amplitude (0.75-mm double amplitude)
Shock resistance	Destruction	300 m/s^2
	Malfunction	100 m/s^2
Durability	Mechanical	5,000,000 operations min. (at approx. 7,200 operations/h)
	Electrical	100,000 operations min. (at approx. 1,800 operations/h, rated load)
Failure rate (P level) (reference value)		5 VDC, 1 mA
Ambient operating temperature		–25 to 55°C (with no icing or condensation)
Ambient operating humidity		35% to 85%
Terminal tightening torque		0.98 N·m
Weight		Approx. 300 g

*1. The contact resistance was measured with 1 A at 5 VDC using the voltage-drop method.
*2. Not including bounce time.
*3. The response time is the time it takes for the main contact to turn OFF after the input is turned OFF. Includes bounce time.
*4. The insulation resistance was measured with 500 VDC at the same places that the dielectric strength was checked.

Connections

Internal Connections

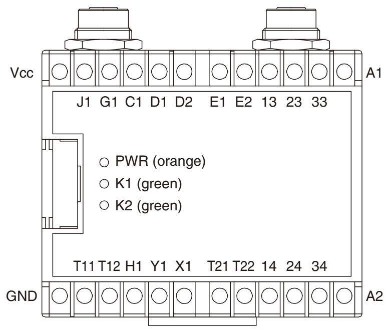


Note: Do not connect anything to terminals C1, D1, D2, E1, and E2.

Terminal Arrangement

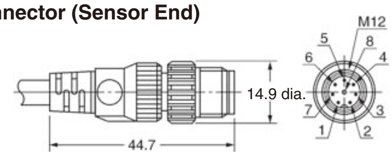
Emitter Connector
F3SN-A□□□□P□□-L,
F3SN-B□□□□P□□-L,
F3SH-A□□□□P□□-L

Receiver Connector
F3SN-A□□□□P□□-D,
F3SN-B□□□□P□□-D,
F3SH-A□□□□P□□-D



The pin arrangement at the Sensor is shown below.

Connector (Sensor End)

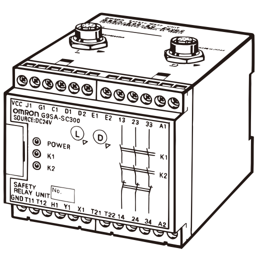


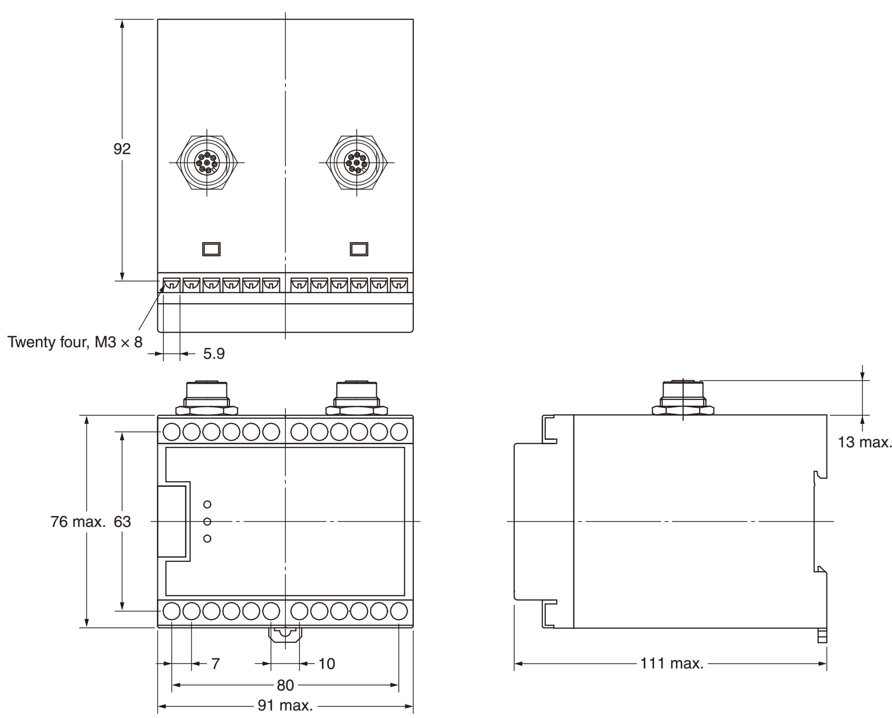
Pin number	Signal name	
	Receiver	Emitter
1	Control output 2 (OSSD2)	Interlock selection input (INTERLOCK)
2	+24V (24 VDC)	+24V (24 VDC)
3	Control output 1 (OSSD1)	Test input (TEST)
4	Auxiliary output (AUXILIARY)	Reset input (RESET)
5	RS-485 (A)	RS-485 (A)
6	RS-485 (B)	RS-485 (B)
7	0V	0V
8	External relay monitor input (EDM)	N.C.

Dimensions

(Unit: mm)

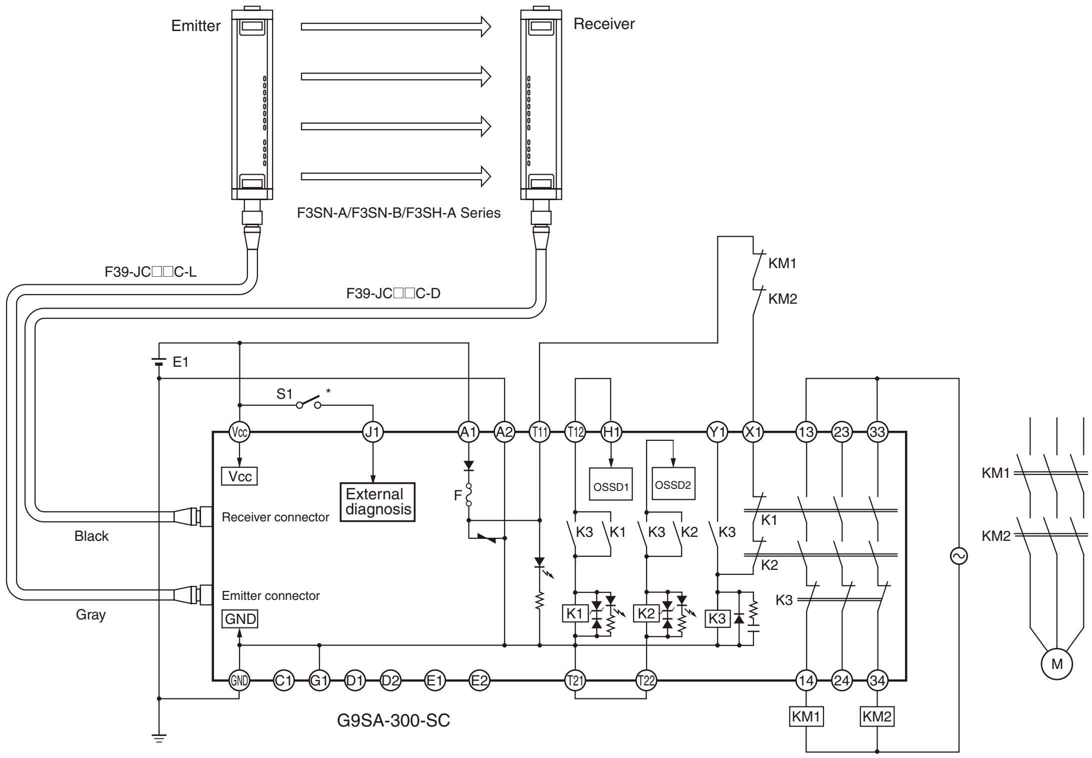
G9SA-300-SC





Application Examples

Connection to Safety Light Curtain Only (Auto-reset)



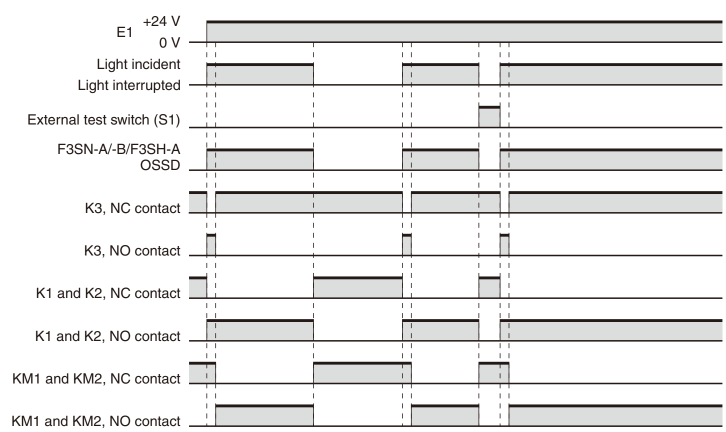
S1:	External test switch
KM1 and KM2:	Magnetic Contactors
M:	3-phase motor
E1:	24-VDC Power Supply (S82K)

Note: 1. The F3SN-A's EDM function and auxiliary outputs cannot be used.

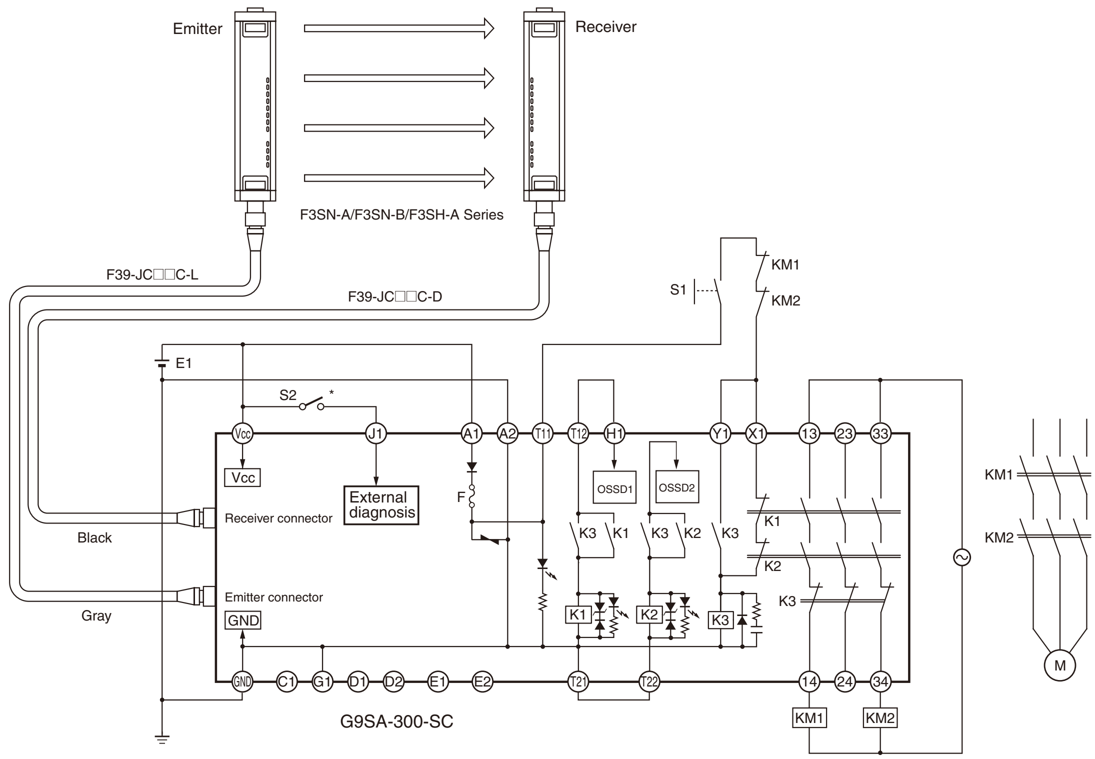
2. Do not connect anything to terminals C1, D1, D2, E1, and E2.

* The Unit performs normal operation when S1 is open and external diagnosis when it is closed.

Timing Chart



Connection to Safety Light Curtain Only (Manual Reset)



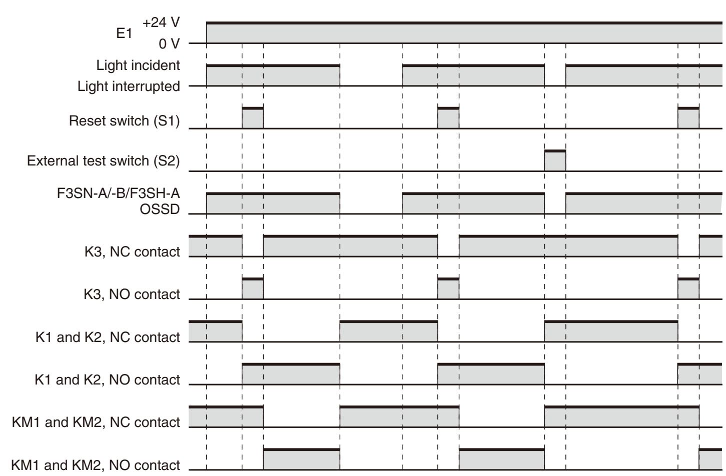
S1:	Reset switch (momentary action switch)
S2:	External test switch
KM1 and KM2:	Magnetic Contactors
M:	3-phase motor
E1:	24-VDC Power Supply (S82K)

Note: 1. The F3SN-A's EDM function and auxiliary outputs cannot be used.

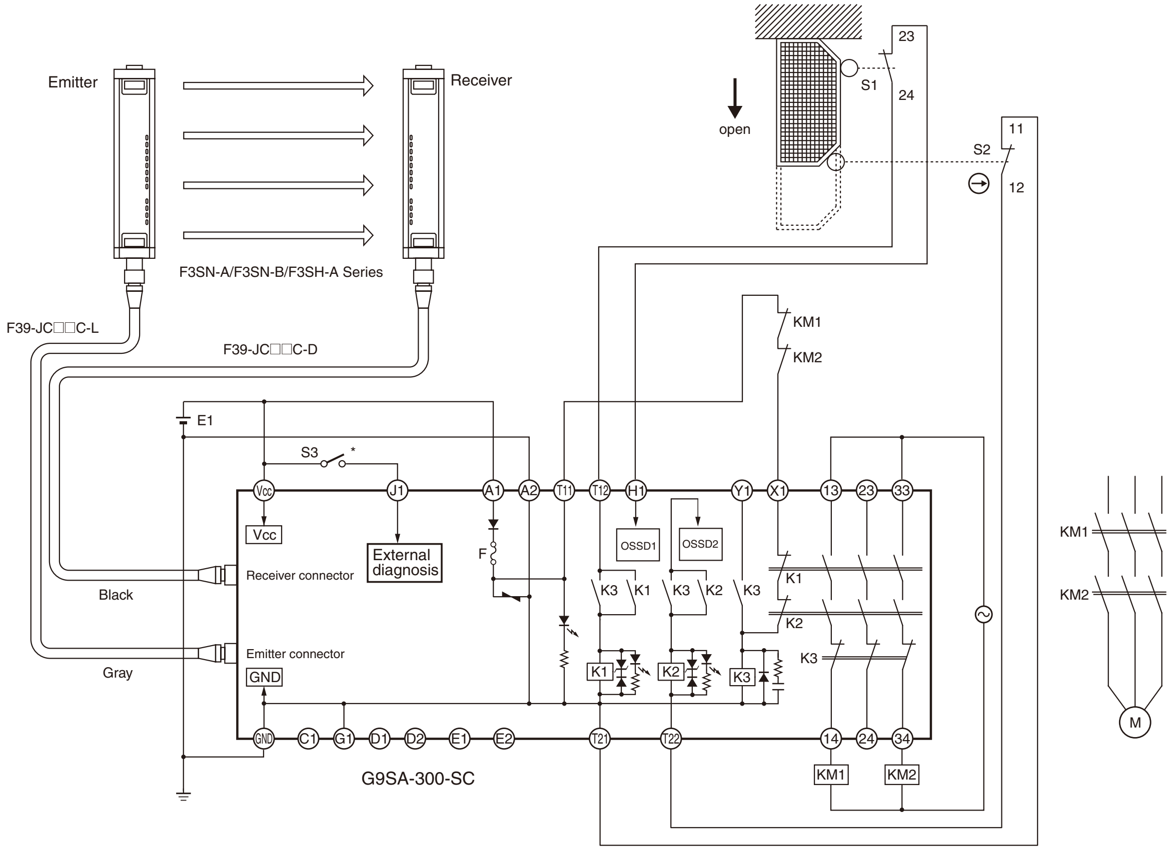
2. Do not connect anything to terminals C1, D1, D2, E1, and E2.

* The Unit performs normal operation when S2 is open and external diagnosis when it is closed.

Timing Chart



Connection to Safety Light Curtain and Two Channels of Limit Switch Input (Auto-reset)

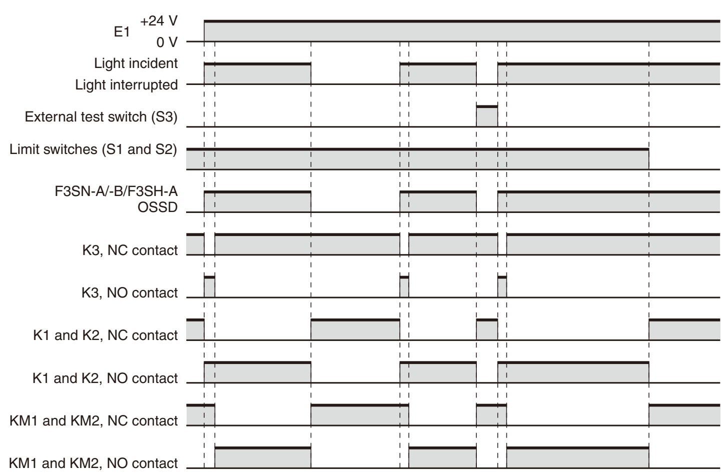


S1: Limit switch (NO)
S2: Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S3: External test switch
KM1 and KM2: Magnetic Contactors
M: 3-phase motor
E1: 24-VDC Power Supply (S82K)

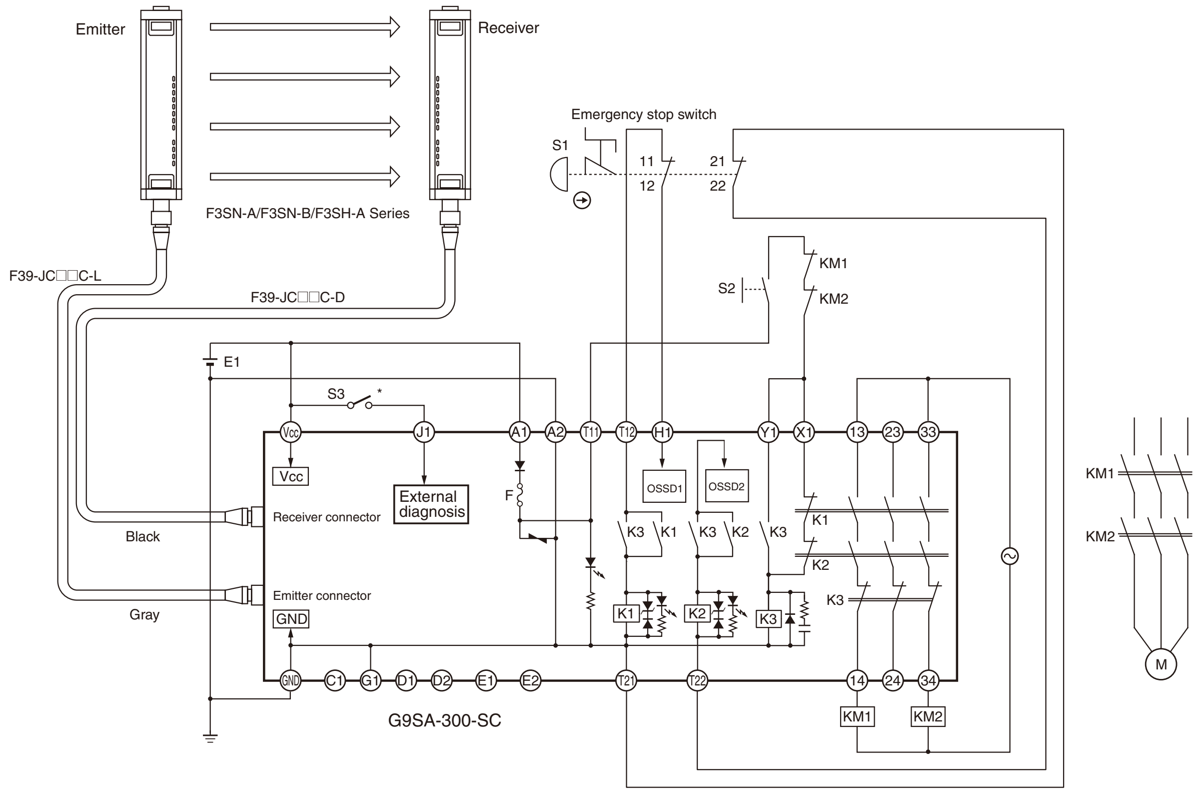
Note: 1. The F3SN-A's EDM function and auxiliary outputs cannot be used.
2. Do not connect anything to terminals C1, D1, D2, E1, and E2.

* The Unit performs normal operation when S3 is open and external diagnosis when it is closed.

Timing Chart

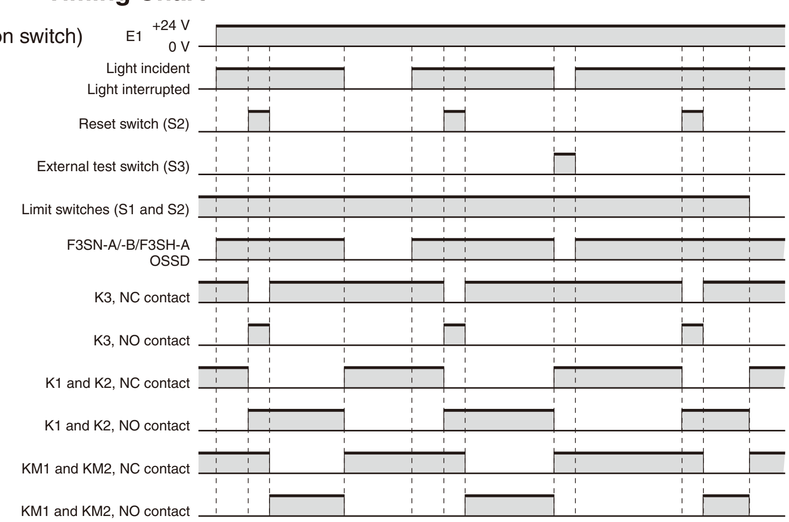


Connection to Safety Light Curtain and Two Channels of Emergency Stop Switch Input (Manual Reset)



Timing Chart

S1:	Emergency stop switch
S2:	Reset switch (momentary action switch)
S3:	External test switch
KM1 and KM2:	Magnetic Contactors
M:	3-phase motor
E1:	24-VDC Power Supply (S82K)



Note: 1. The F3SN-A's EDM function and auxiliary outputs cannot be used.
2. Do not connect anything to terminals C1, D1, D2, E1, and E2.

* The Unit performs normal operation when S3 is open and external diagnosis when it is closed.

Safety Precautions

Refer to the *"Precautions for All Relays"* and *"Precautions for All Relays with Forcibly Guided Contacts"*.

Precautions for Safe Use

- Turn OFF the G9SA-300-SC before wiring the G9SA-300-SC. Do not touch the terminals of the G9SA-300-SC while the power is turned ON, because the terminals are charged and may cause an electric shock.
- To conform to IEC61496-1 and UL508 when using the F3SN-A, F3SN-B, or F3SH-A, ensure that the DC power supply satisfies all the conditions below.
  - The voltage is within the rated power supply voltage range (24 VDC ±10%).
  - The power supply is connected only to the F3SN-A or devices with a direct bearing on the F3SN-A's electrical detection protective function, such as Safety Controllers or Muting Sensors. Do not connect it to any other devices or equipment. When connecting more than one device, ensure that the capacity is easily sufficient for the total rated current.
  - The power supply conforms to the EMC Directive (industrial environment).
  - The power supply uses double or reinforced insulation between the primary and secondary circuits.
  - The power supply automatically resets overcurrent protection characteristics (voltage drop).
  - The power supply maintains an output holding time of at least 20 ms.
  - The power supply satisfies the output characteristic requirements of limited voltage/current circuits and Class 2 circuits as defined by UL508.
  - The power supply satisfies laws, regulations, and standards concerning EMC and the safety of electrical devices for the country or region in which it is used. (In the EU, for example, the power supply must conform to the EMC Directive and Low Voltage Directive.)
- Recommended Power Supplies: S82K, S82J, S82F, or S82F-P made by OMRON. For details, refer to the *Power Supply Selection Guide* (Cat. No. Y102).
- Do not connect any device other than the F3SN-A, F3SN-B, or F3SH-A with PNP outputs.
- Be sure to mount both the emitter and the receiver in the correct position. (The Sensor will not operate it they are mounting in reverse.)
- For further details on using the F3SN-A, F3SN-B, or F3SH-A, refer to F3SN-A/F3SN-B, or F3SH-A.

Precautions for Correct Use

Installation

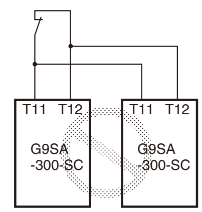
The G9SA-300-SC can be installed in any direction.

Wiring

- Use the following to wire the Unit.
  Stranded wire: 0.75 to 1.5 mm^2
  Solid wire: 1.0 to 1.5 mm^2
- Tighten each screw to a torque of 0.78 to 1.18 N·m, or the Unit may malfunction or generate heat.
- External inputs connected to H1 and T12 or T21 and T22 of the Unit must be no-voltage contact inputs.
- GND is a ground terminal. When a machine is grounded at the positive, the GND terminal cannot be grounded.

Connecting Inputs

When using more than one G9SA300-SC Unit, do not connect the same switch to more than one G9SA300-SC Unit. This applies to all input terminals.



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

Appricable Safety Category (EN954-1)

G9SA-300-SC Safety Relay Units fall under Safety Category 4.
The above is provided according to circuit examples presented by OMRON. Therefore, the above may not apply to all operating environments.
The applicable safety category is determined from the whole safety control system. Make sure that the whole safety control system meets EN954-1 requirements.

Certified Standards

The G9SA-300-SC conforms to the following standards.

- EN standards, certified by TÜV Rheinland
  EN954-1
  EN60204-1
- Conformance to EMC (Electromagnetic Compatibility), certified by TÜV Rheinland:
  EMI (Emission): EN55011 Group 1 Class A
  EMS (Immunity): EN61000-6-2
- UL standards: UL508 (Industrial Control Equipment)
- CSA standards: CSA C22.2 No. 14 (Industrial Control Equipment)

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)
To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).
Refer to the *Safety Components Technical Guide* (Cat No. Y107). The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

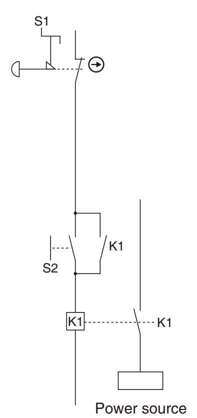
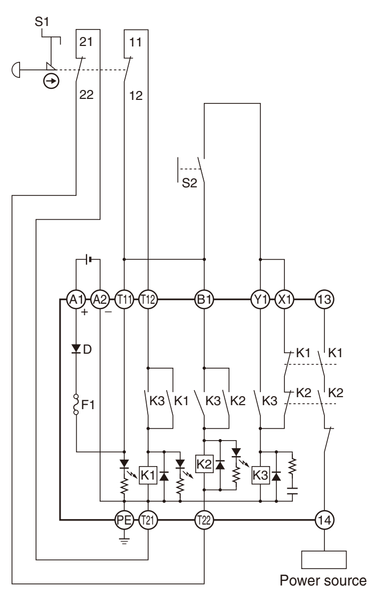


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)
The G7SA, G7S and G7S-□-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-□-E, however, do not display the CE Marking according to the concepts in the guidelines.
VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-□-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

No.	Area	No.	Classification	No.	Item	Page
❹	Operating and Storage Environments			1 2 3 4 5 6 7 8	Operating, Storage, and Transport Operating Atmosphere Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas) Adhesion of Water, Chemicals, Solvent, and Oil Vibration and Shock External Magnetic Fields External Loads Adhesion of Magnetic Dust	C-9 to C-10
❺	Relay Mounting Operations	①	Plug-in Relays	1 2 3	Panel-mounting Sockets Relay Removal Direction Terminal Soldering	C-10
		②	Printed Circuit Board Relays	1	Ultrasonic Cleaning	
		③	Common Items	1 2 3 4	Removing the Case and Cutting Terminals Deformed Terminals Replacing Relays and Performing Wiring Operations Coating and Packing	
❻	Handling Relays			1 2	Vibration and Shock Dropped Products	C-11
❼	Relays for Printed Circuit Boards (PCBs)			1 2 3 4 5 6 7 8 9 10	Selecting PCBs, (1) PCB Materials Selecting PCBs, (2) PCB Thickness Selecting PCBs, (3) Terminal Hole and Land Diameters Mounting Space ① Ambient Temperature ② Mutual Magnetic Interference Pattern Design for Noise Countermeasures ① Noise from Coils ② Noise from Contacts ③ High-frequency Patterns Shape of Lands Pattern Conductor Width and Thickness Conductor Pitch Securing the PCB Automatic Mounting of PCB Relays	C-11 to C-14
❽	Troubleshooting					C-15

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

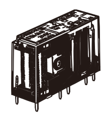
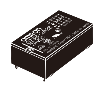
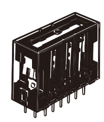
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	**Flux protection**	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

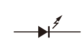
② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED 	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

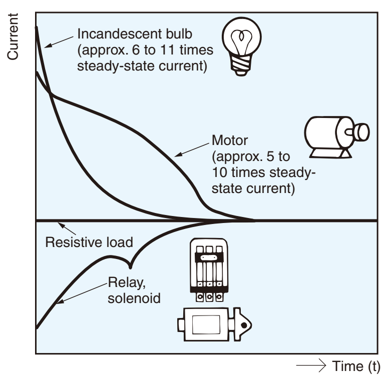
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

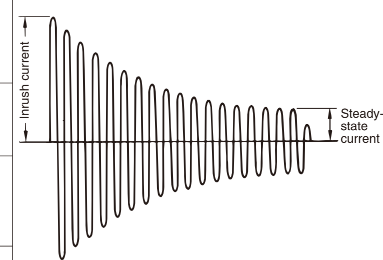
Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	

❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

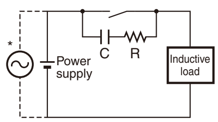
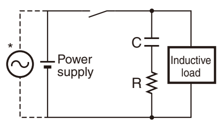
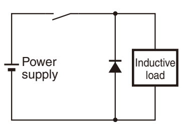
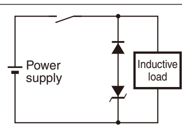
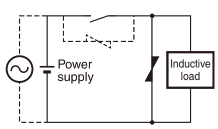
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

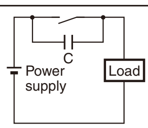
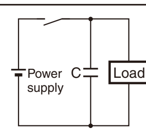
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current		Features and remarks	Element selection
		AC	DC		
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

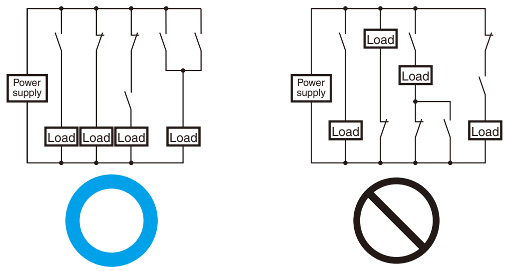
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

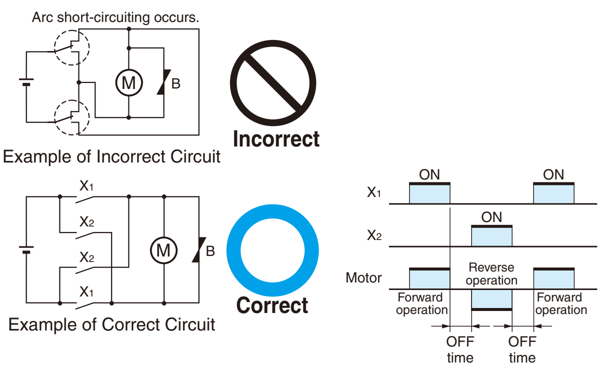
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



a. Correct Connection   b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



Example of Incorrect Circuit

Example of Correct Circuit

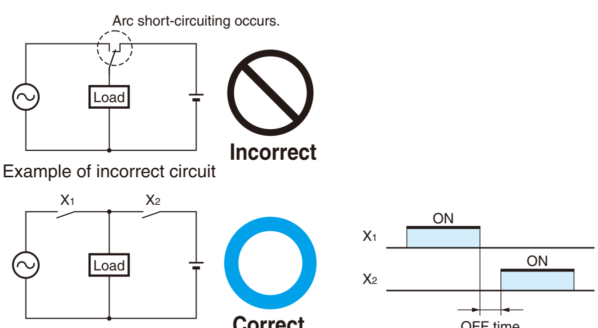
❸-①-8 Power Supply Double Break with Multi-pole Relays

If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.

Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



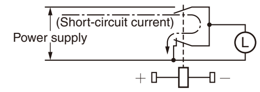
Example of incorrect circuit

Example of correct circuit

❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.

Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.

The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.

Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.

This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).

This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.

As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.

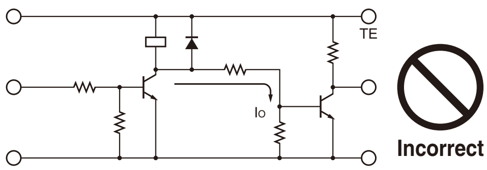
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.

Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

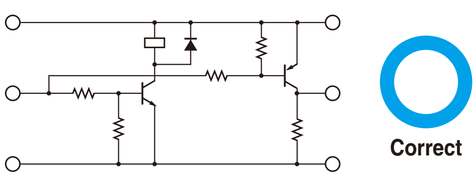
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

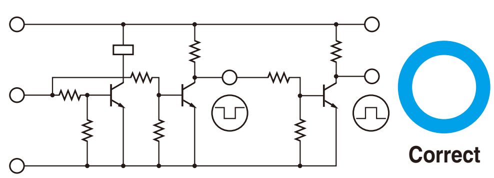
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value



❸-②-7 Using with Infrequent Switching

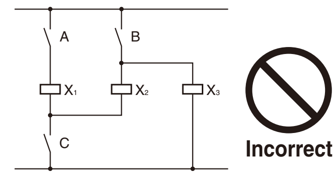
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.

The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

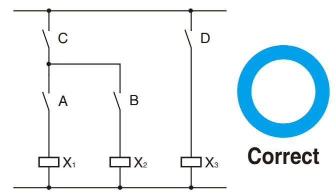
❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.

The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



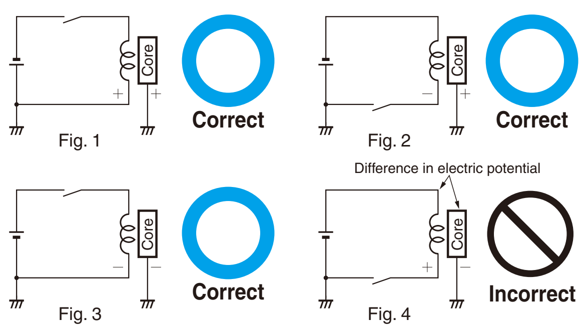
❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)

(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)

(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

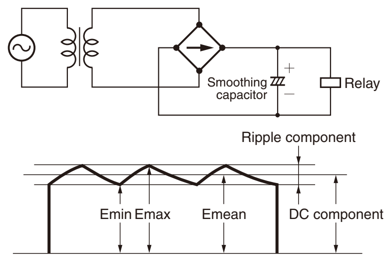


❸-②-10 Individual Specifications for Must-operate/ release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



Ripple percentage %= $\frac{\text{Emax}-\text{Emin}}{\text{Emean}} \times 100\%$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON. Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil

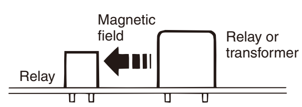
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock

Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields

Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads

Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust

Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

❺ Relay Mounting Operations

① Plug-in Relays

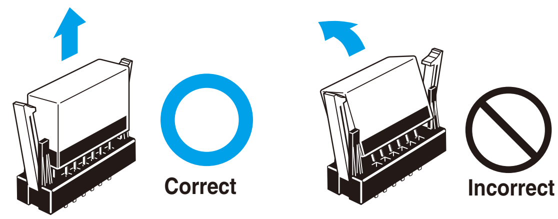
❺-①-1 Panel-mounting Sockets

1. Socket Mounting Screws
When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach. Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.

2. Lead Wire Screw Connections
Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure. Conversely, excessive tightening can strip the threads.

❺-①-2 Relay Removal Direction

Insert and remove Relays from the socket perpendicular to the socket surface.

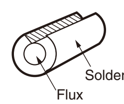


If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering

Solder General-purpose Relays manually following the precautions described below.

1. Smooth the tip of the solder gun and then begin the soldering.
- Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
- Soldering iron: Rated at 30 to 60 W
- Tip temperature: 280 to 300°C
- Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.

3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning

Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals

Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals

Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations

Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing

G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

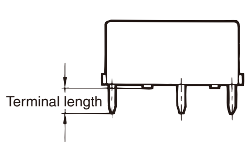
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material	Epoxy		Phenol
Item	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

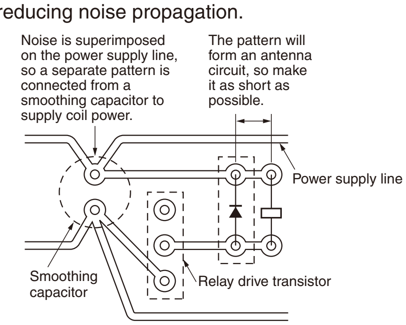
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② **Noise from Contacts**

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ **High-frequency Patterns**

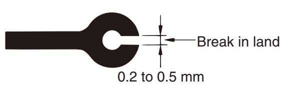
As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

Correct Examples	
Incorrect Examples	

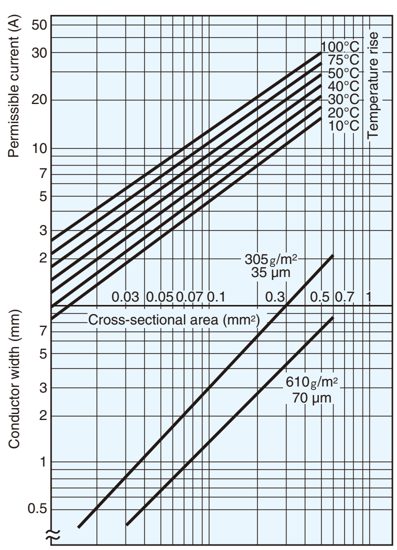
2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.



❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 μm and 70 μm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

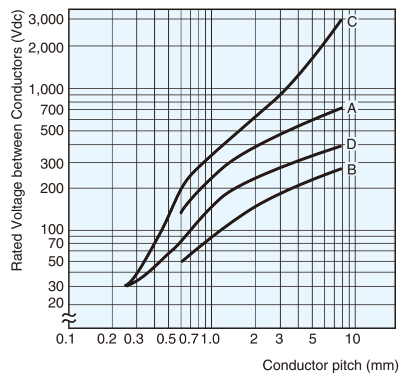
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

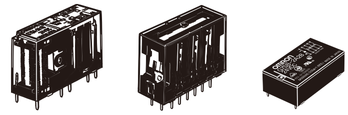
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

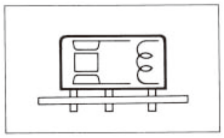
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

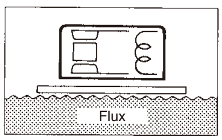
Placement



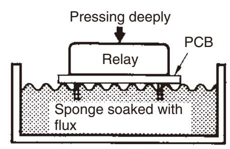
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay.
   The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials.
   For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.
   Apply the flux sparingly and evenly to prevent penetration into the Relay.
   When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



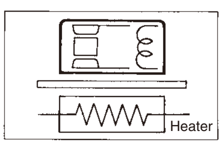
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

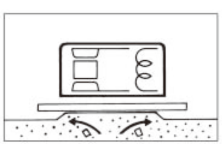
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

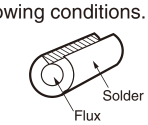
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

Applicability of Manual Soldering

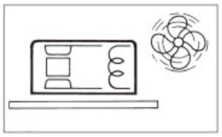
G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5

Cooling



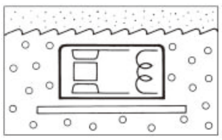
1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6

Cleaning



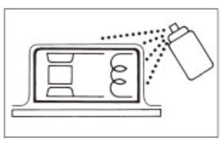
Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7

Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed.
   Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

In the interest of product improvement, specifications are subject to change without notice.

OMRON Corporation
Industrial Automation Company
http://www.ia.omron.com/

Safety Relay Unit

G9SA

The G9SA Series Offers a Complete Line-up of Compact Units.

- ■ Four kinds of 45-mm wide Units are available:
  A 3-pole model, a 5-pole model, and models with 3 poles and 2 OFF-delay poles, as well as a Two-hand Controller. Also available are 17.5-mm wide Expansion Units with 3 poles and 3 OFF-delay poles.
- ■ Simple expansion connection.
- ■ OFF-delay models have 15-step OFF-delay settings.
- ■ Conforms to EN standards. (BG approval)
- ■ Both DIN track mounting and screw mounting are possible.

⚠ Be sure to read the *"Safety Precautions"* on page 13

Model Number Structure

Model Number Legend

G9SA-□□□□□□-□□□□
1 2 3 4 5 6

1. Function
None: Emergency stop
EX: Expansion Unit
TH: Two-hand Controller

2. Contact Configuration (Safety Output)
0: None
3: 3PST-NO
5: 5PST-NO

3. Contact Configuration (OFF-delay Output)
0: None
2: DPST-NO
3: 3PST-NO

4. Contact Configuration (Auxiliary Output)
0: None
1: SPST-NC

5. Input Configuration
None: 1-channel or 2-channel input possible

6. OFF-delay Time (Max. setting time)
None: No OFF-delay
T075: 7.5 seconds
T15: 15 seconds
T30: 30 seconds

Ordering Information

Emergency-stop Units

Main contacts	Auxiliary contact	Number of input channels	Rated voltage	Model
3PST-NO	SPST-NC	1 channel or 2 channels possible	24 VAC/VDC	**G9SA-301**
			100 to 240 VAC	
5PST-NO			24 VAC/VDC	**G9SA-501**
			100 to 240 VAC	

Emergency-stop OFF-delay Units

Main contacts	OFF-delay contacts	Auxiliary contact	Number of input channels	OFF-delay time	Rated voltage	Model
3PST-NO	DPST-NO	SPST-NC	1 channel or 2 channels possible	7.5 s	24 VAC/VDC	**G9SA-321-T075**
					100 to 240 VAC	
				15 s	24 VAC/VDC	**G9SA-321-T15**
					100 to 240 VAC	
				30 s	24 VAC/VDC	**G9SA-321-T30**
					100 to 240 VAC	

Note: The following 15-step OFF-delay time settings are available:
T075: 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, and 7.5 s
T15: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 s
T30: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, and 30 s

Two-hand Controller

Main contacts	Auxiliary contact	Number of input channels	Rated voltage	Model
3PST-NO	SPST-NC	2 channels	24 VAC/VDC	**G9SA-TH301**
			100 to 240 VAC	

Expansion Unit

The Expansion Unit connects to a G9SA-301, G9SA-501, G9SA-321, or G9SA-TH301.

Main contacts	Auxiliary contact	Model
3PST-NO	SPST-NC	**G9SA-EX301**

Expansion Units with OFF-delay Outputs

The Expansion Unit connects to a G9SA-301, G9SA-501, G9SA-321, or G9SA-TH301.

Main contact form	Auxiliary contact	OFF-delay time	Model
3PST-NO	SPST-NC	7.5 s	**G9SA-EX031-T075**
		15 s	**G9SA-EX031-T15**
		30 s	**G9SA-EX031-T30**

Note: The following 15-step OFF-delay time settings are available:
T075: 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, and 7.5 s
T15: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 s
T30: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, and 30 s

Specifications

Ratings

Power Input

Item / Model	G9SA-301/TH301	G9SA-501	G9SA-321-T□
Power supply voltage	24 VAC/VDC:24 VAC, 50/60 Hz, or 24 VDC 100 to 240 VAC:100 to 240 VAC, 50/60 Hz		
Operating voltage range	85% to 110% of rated power supply voltage		
Power consumption *	24 VAC/VDC: 1.8 VA/1.7 W max. 100 to 240 VAC: 9 VA max.	24 VAC/VDC: 2.8 VA/2.6 W max. 100 to 240 VAC: 11 VA max.	24 VAC/VDC: 3.5 VA/3.3 W max. 100 to 240 VAC: 12.5 VA max.

* When an Expansion Unit is connected, the power consumption is increased by 2 VA/2 W max.

Inputs

Item / Model	G9SA-301/321-T□/TH301	G9SA-501
Input current *	40 mA max.	60 mA max.

* When an Expansion Unit is connected, the input current is increased by 30 mA max.

Contacts

Model	G9SA-301/501/321-T□/TH301/EX301/EX031-T□
Item / Load	Resistive load
Rated load	250 VAC, 5 A 30 VDC, 5 A
Rated carry current	5 A

Characteristics

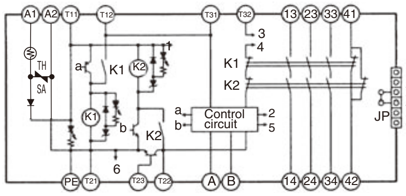
Item		G9SA-301/TH301	G9SA-501/321-T□	G9SA-EX301/EX031-T□
Contact resistance *1		100 mΩ		
Operating time *2		30 ms max.		
Response time *3		10 ms max.		
Insulation resistance *4		100 MΩ min. (at 500 VDC)		
Dielectric strength	Between different outputs	2,500 VAC, 50/60 Hz for 1 min		
	Between inputs and outputs			
	Between power inputs and outputs			
	Between power inputs and other inputs (only for 100 to 240-V models)			
Vibration resistance		10 to 55 to 10 Hz, 0.375-mm single amplitude (0.75-mm double amplitude)		
Shock resistance	Destruction	300 m/s^2		
	Malfunction	100 m/s^2		
Durability *5	Mechanical	5,000,000 operations min. (at approx. 7,200 operations/hr)		
	Electrical	100,000 operations min. (at approx. 1,800 operations/hr)		
Failure rate (P Level) (reference value)		5 VDC, 1 mA		
Ambient operating temperature		–25 to 55°C (with no icing or condensation)		
Ambient operating humidity		35% to 85%		
Terminal tightening torque		0.98 N·m		
Weight *6		Approx. 210 g	Approx. 270 g	Approx. 130 g

*1. The contact resistance was measured with 1 A at 5 VDC using the voltage-drop method.
*2. Not Including bounce time.
*3. The response time is the time it takes for the main contact to open after the input is turned OFF. Includes bounce time.
*4. The insulation resistance was measured with 500 VDC at the same places that the dielectric strength was checked.
*5. The durability is for an ambient temperature of 15 to 35°C and an ambient humidity of 25% to 75%.
*6. Weight shown is for 24-VAC/VDC type. For 100 to 240-VAC type, add approximately 20 g.

Connections

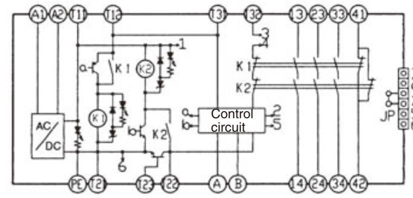
Internal Connections

G9SA-301 (24 VAC/VDC)



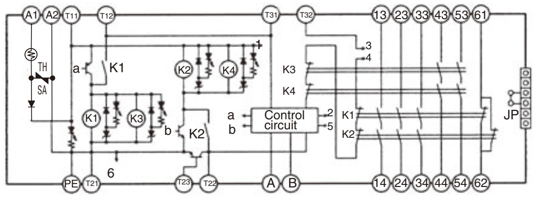
*2 *1

G9SA-301 (100 to 240 VAC)



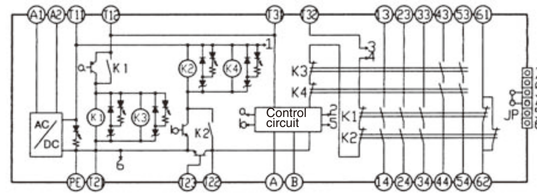
*2 *1

G9SA-501 (24 VAC/VDC)



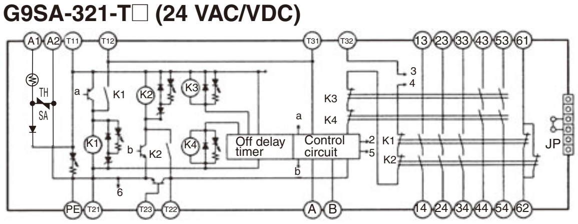
*2 *1

G9SA-501 (100 to 240 VAC)



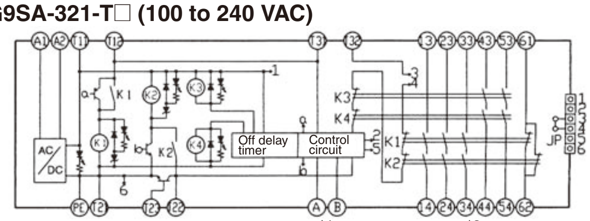
*2 *1

G9SA-321-T□ (24 VAC/VDC)



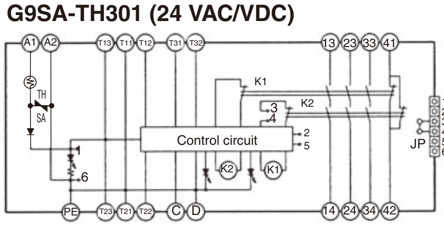
*2 *1 *3

G9SA-321-T□ (100 to 240 VAC)

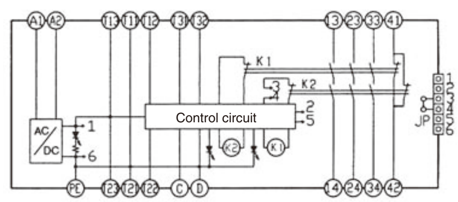


*2 *1 *3

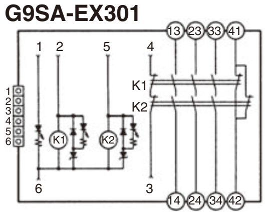
G9SA-TH301 (24 VAC/VDC)



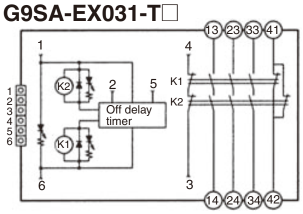
G9SA-TH301 (100 to 240 VAC)



G9SA-EX301



G9SA-EX031-T□



Note: 1. With 100 to 240-VAC type, be sure to connect PE to a protective ground. With 24-VAC/VDC type, if the power supply is not connected to a protective ground, be sure to connect PE to a protective ground.

2. With 24-VAC/VDC type, the power supply terminals A1 and A2 have polarities. A2 is the negative pole.

*1. Use terminals A and B to switch reset mode.
A to B open: Manual reset
A to B closed: Auto-reset

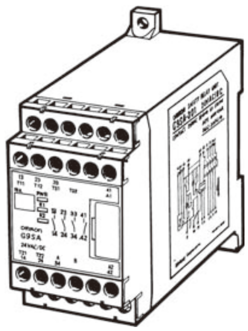
*2. Use terminal T23 with + common 2-channel input.
When using T23, make sure that T21 and T22 are open.
For 1-channel input, make sure that T12 and T23 are shorted.

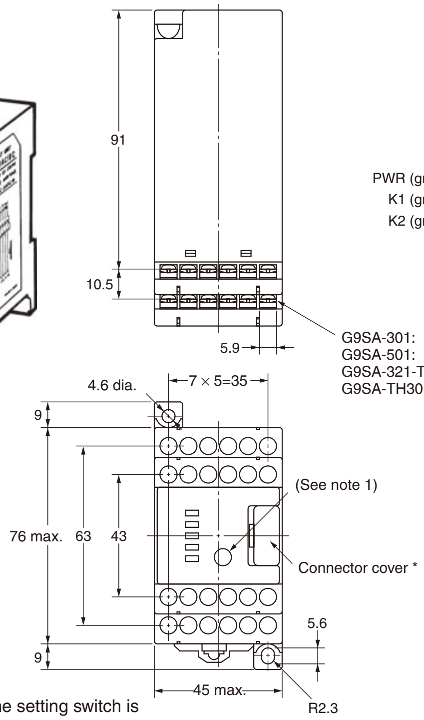
*3. Terminals 43-44 and terminals 53-54 are OFF-delayed outputs.

Dimensions and Terminal Arrangement

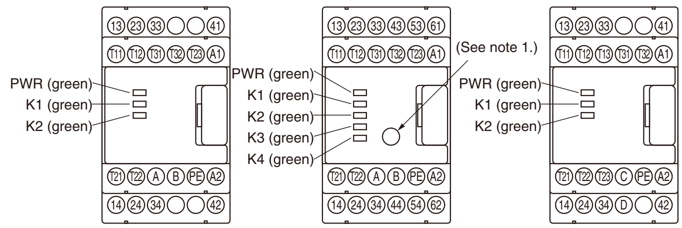
(Unit: mm)

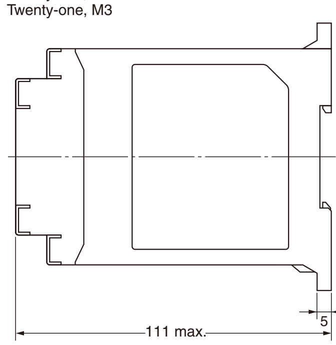
G9SA-301
G9SA-501
G9SA-321-T□
G9SA-TH301



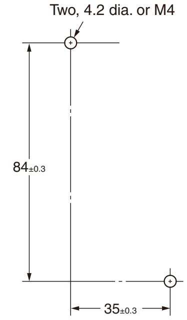


Terminal Arrangement



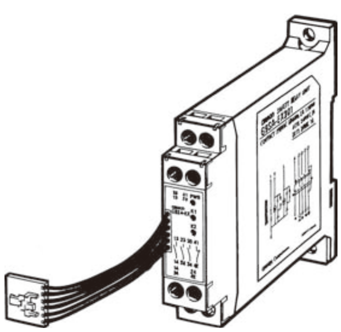


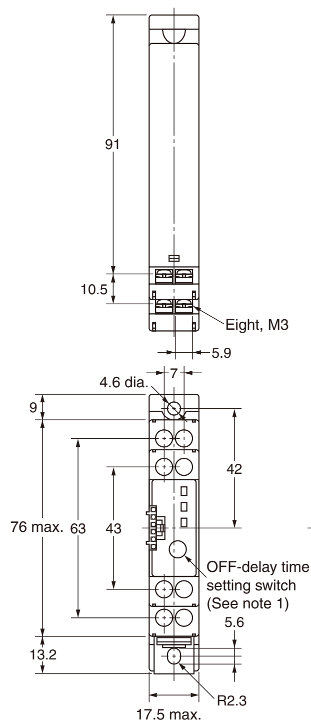
Mounting Holes



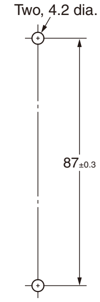
Note 1: The OFF-delay time setting switch is found on the G9SA-321-T□ only.
2: The K1 to K4 indicators light when the NO contacts of internal relays K1 to K4 close.
* Do not remove unless an Expansion Unit is being used.

G9SA-EX301
G9SA-EX031-T□

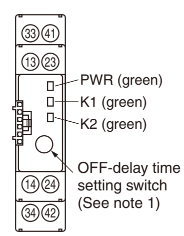


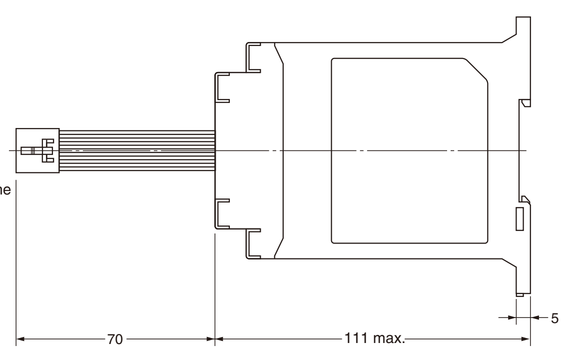


Mounting Holes



Terminal Arrangement

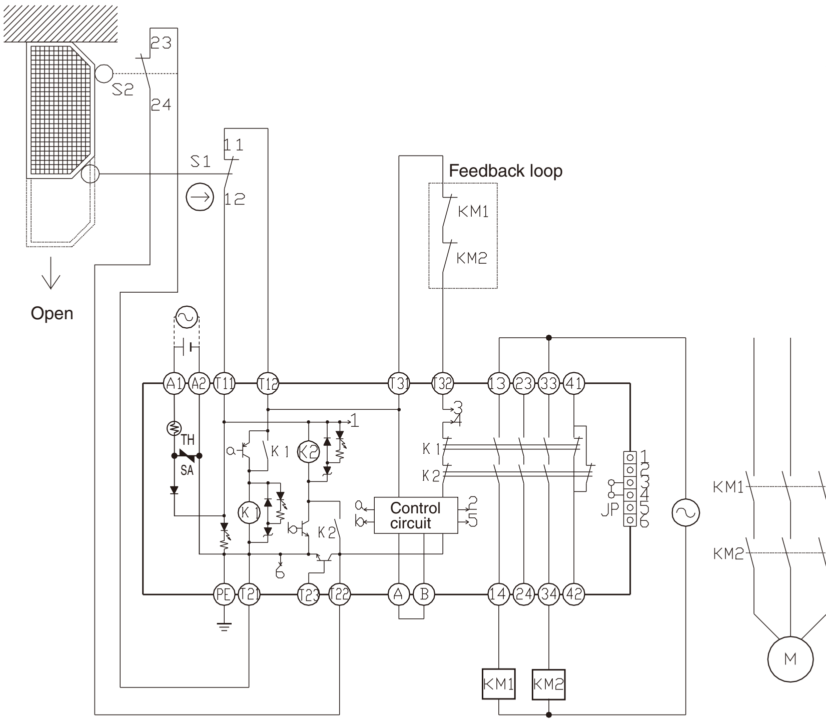


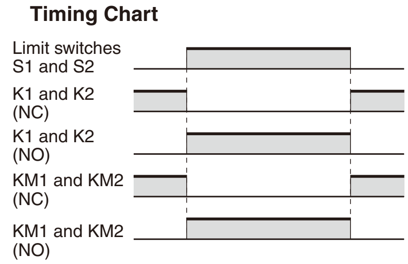


Note 1: The OFF-delay time setting switch is found on the G9SA-EX031-T□ only.
2: The K1 and K2 indicators light when the NO contacts of internal relays K1 and K2 close.

Application Examples

G9SA-301 (24 VAC/VDC) with 2-channel Limit Switch Input/Auto-reset

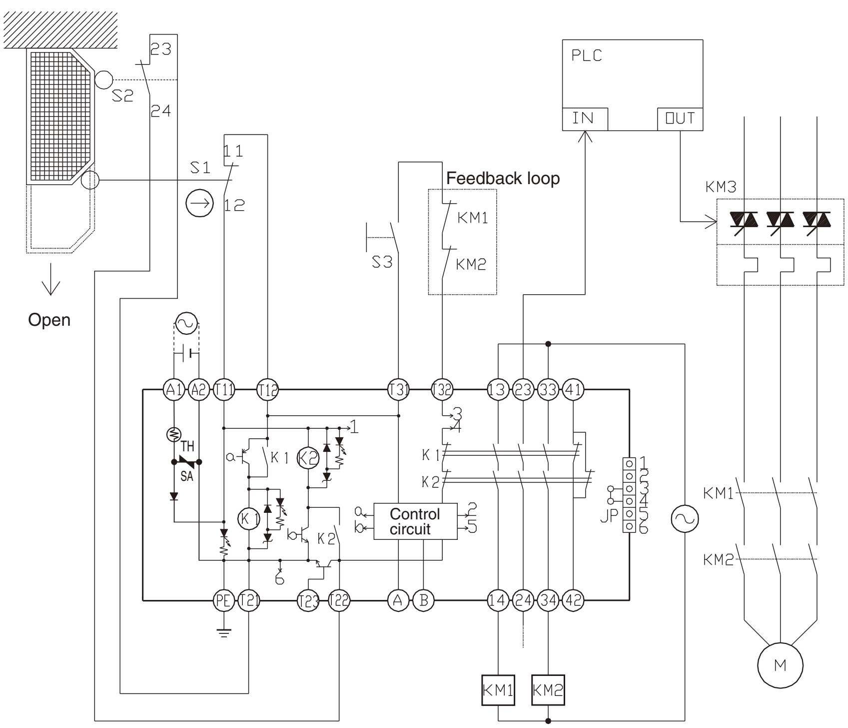


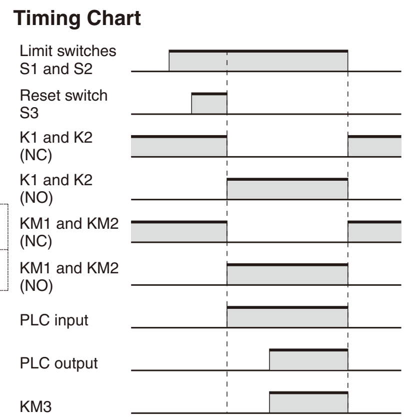


S1: Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S2: Limit switch (NO)
S3: Reset switch
KM1 and KM2: Magnetic Contactor
M: 3-phase motor

Note: This circuit achieves Safety Category 4.

G9SA-301 (24 VAC/VDC) with 2-channel Limit Switch Input/Manual Reset

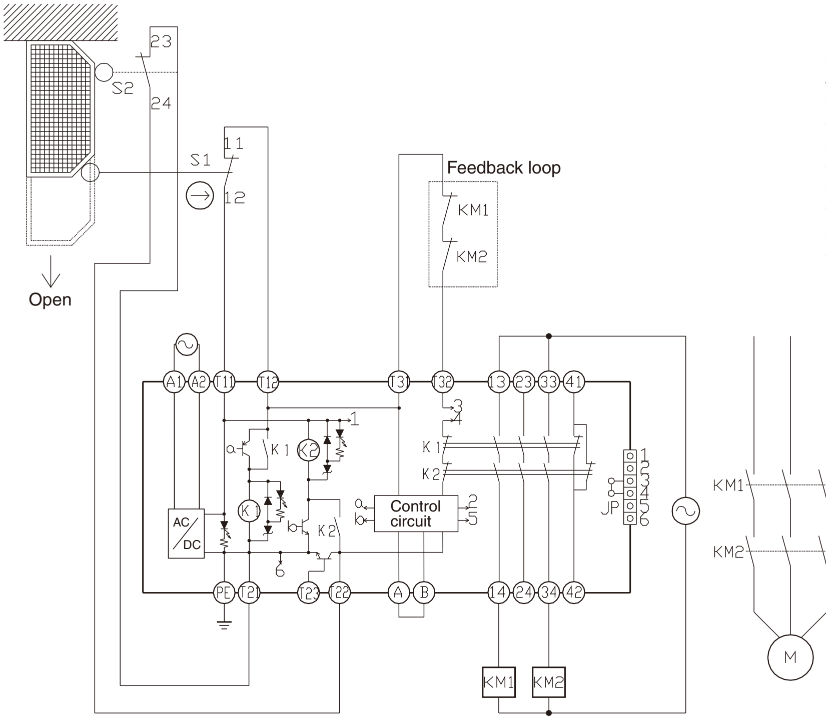




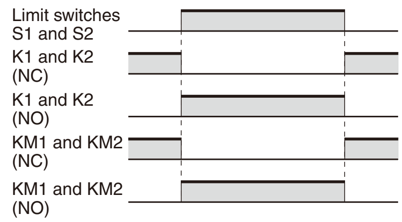
S1: Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S2: Limit switch (NO)
S3: Reset switch
KM1 and KM2: Magnetic Contactor
KM3: G3J Solid-state Contactor (G3J)
M: 3-phase motor

Note: This circuit achieves Safety Category 4.

G9SA-301 (100 to 240 VAC) with 2-channel Limit Switch Input/Auto-reset



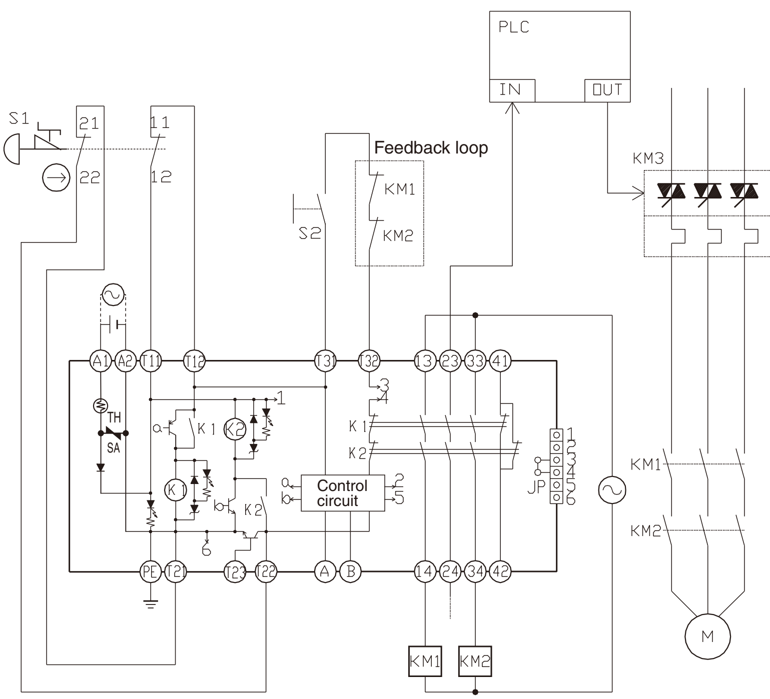
Timing Chart



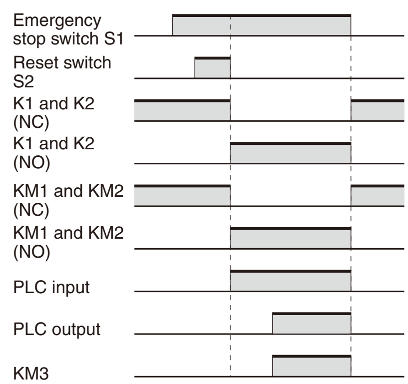
S1: Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F) ⊖
S2: Limit switch (NO)
KM1 and KM2: Magnetic Contactor
M: 3-phase motor

Note: This circuit achieves Safety Category 4.

G9SA-301 (24 VAC/VDC) with 2-channel Emergency Stop Switch Input/Manual Reset



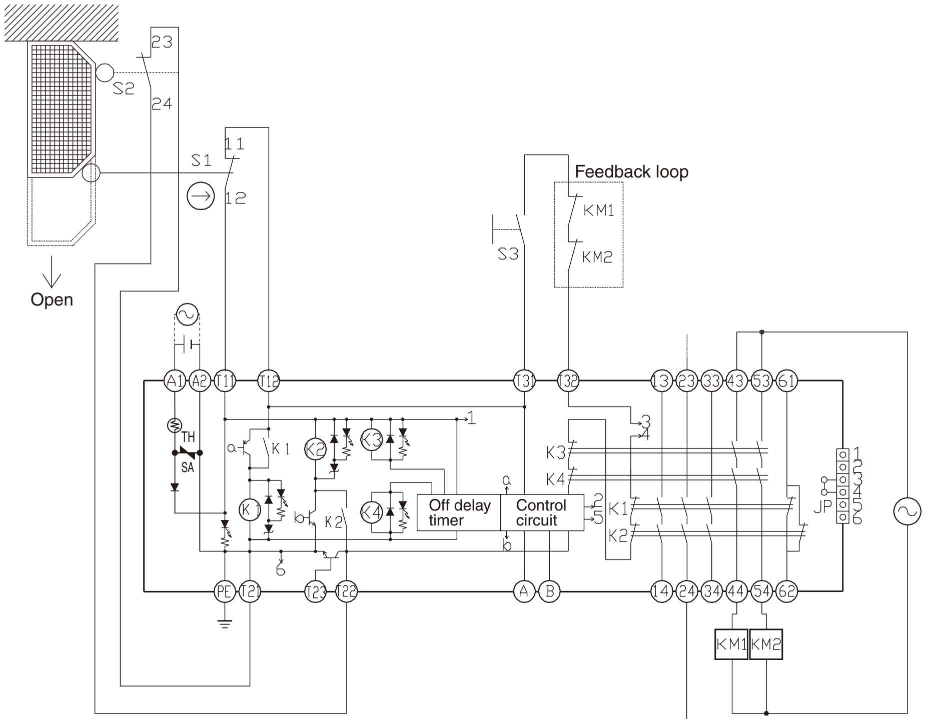
Timing Chart

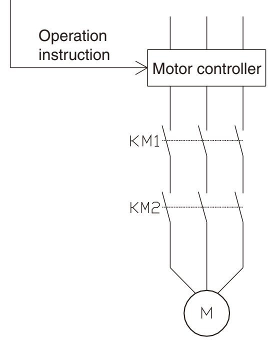


S1: Emergency stop switch with direct opening mechanism (A165E or A22E) ⊖
S2: Reset switch
KM1 and KM2: Magnetic Contactor
KM3: G3J Solid-state Contactor (G3J)
M: 3-phase motor

Note: This circuit achieves Safety Category 4.

G9SA-321-T□ (24 VAC/VDC) with 2-channel Limit Switch Input/Manual Reset

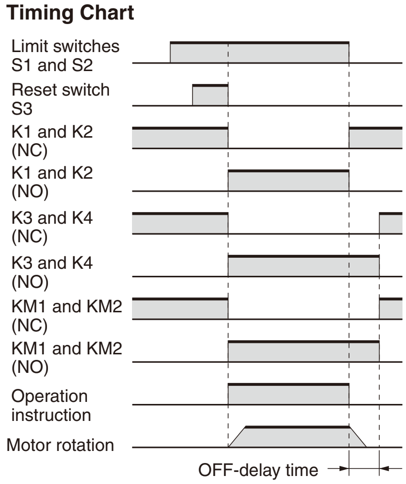




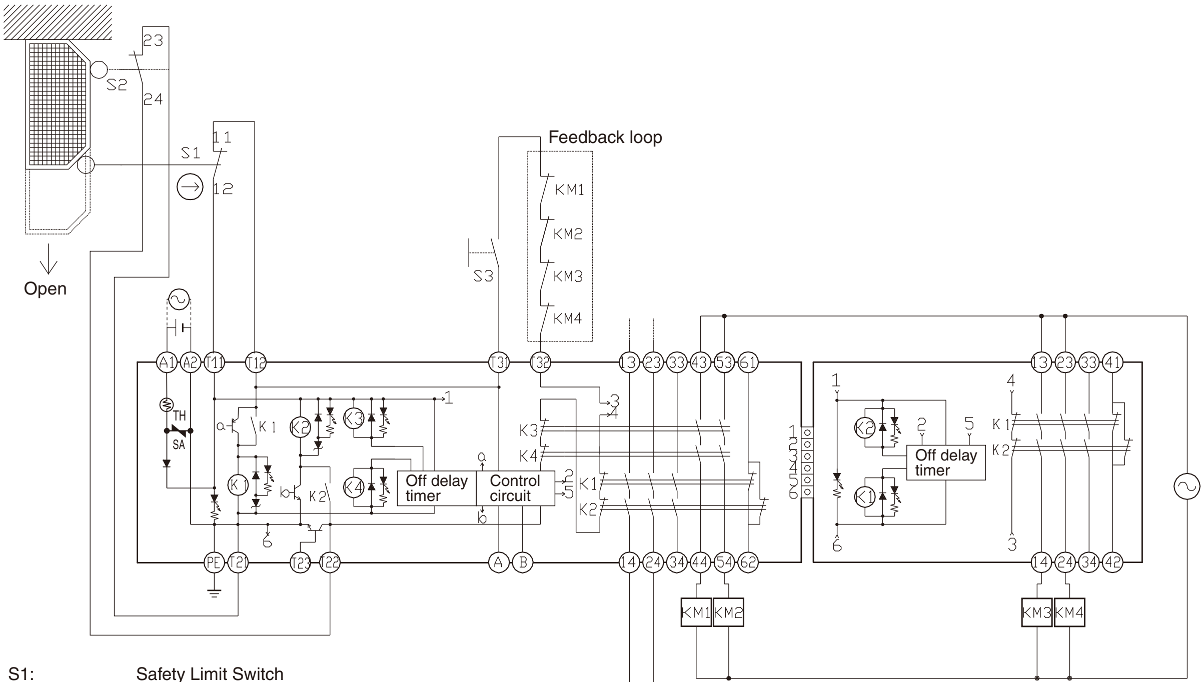
S1:	Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S2:	Limit switch (NO)
S3:	Reset switch
KM1 and KM2:	Magnetic Contactor
M:	3-phase motor

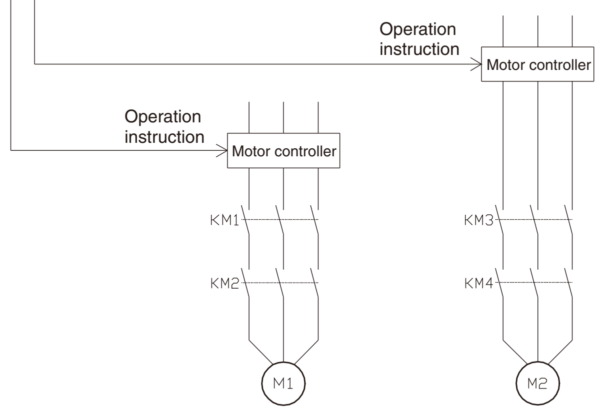
Note: This circuit achieves Safety Category 4. The OFF-delay output, however, achieves Safety Category 3.

Timing Chart



G9SA-321-T□ (24 VAC/VDC) + G9SA-EX031-T□ with 2-channel Limit Switch Input/Manual Reset

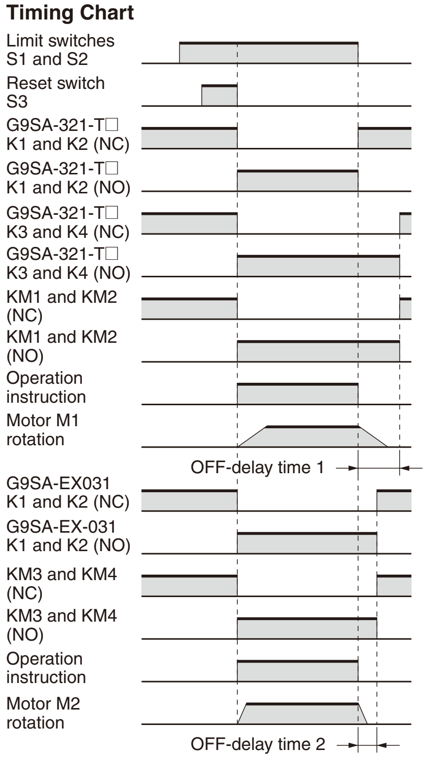




S1: Safety Limit Switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)⊖
S2: Limit switch (NO)
S3: Reset switch
KM1, KM2, KM3, and KM4: Magnetic Contactor
M1, M2: 3-phase motor

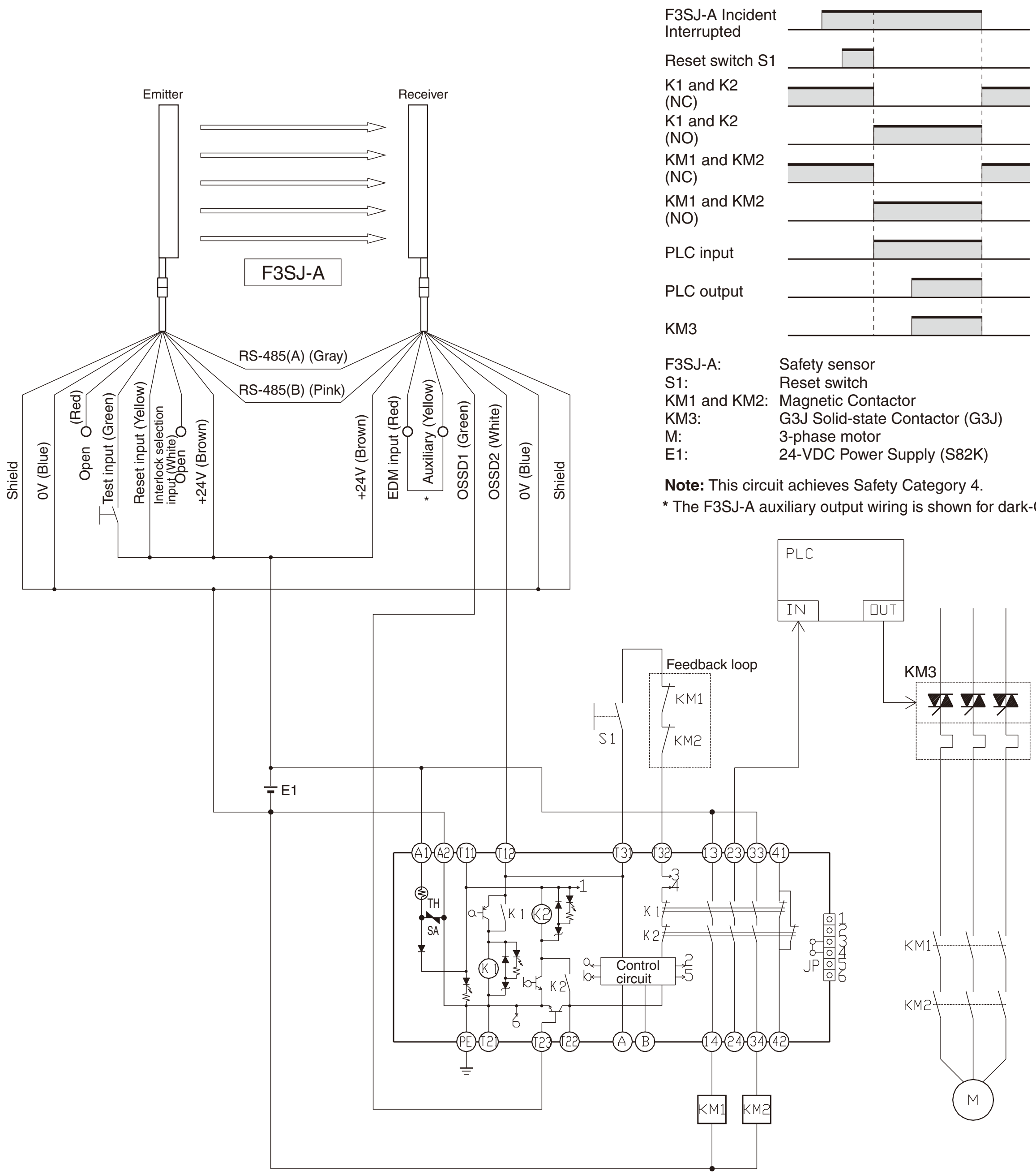
Note: This circuit achieves Safety Category 4. The OFF-delay output, however, achieves Safety Category 3.

Timing Chart



G9SA-301 (24 VAC/VDC) with 2-channel Safety Sensor/Manual Reset

Timing Chart

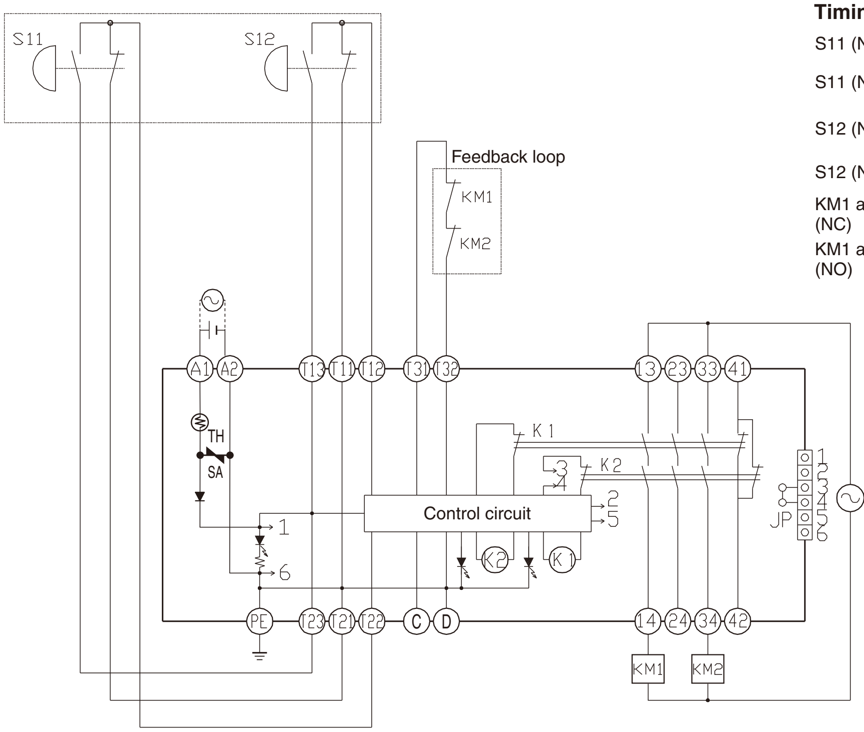


F3SJ-A:	Safety sensor
S1:	Reset switch
KM1 and KM2:	Magnetic Contactor
KM3:	G3J Solid-state Contactor (G3J)
M:	3-phase motor
E1:	24-VDC Power Supply (S82K)

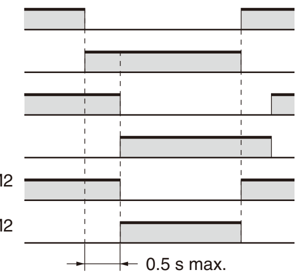
Note: This circuit achieves Safety Category 4.

* The F3SJ-A auxiliary output wiring is shown for dark-ON operation.

G9SA-TH301 (24 VDC) with 2-hand Inputs



Timing Chart



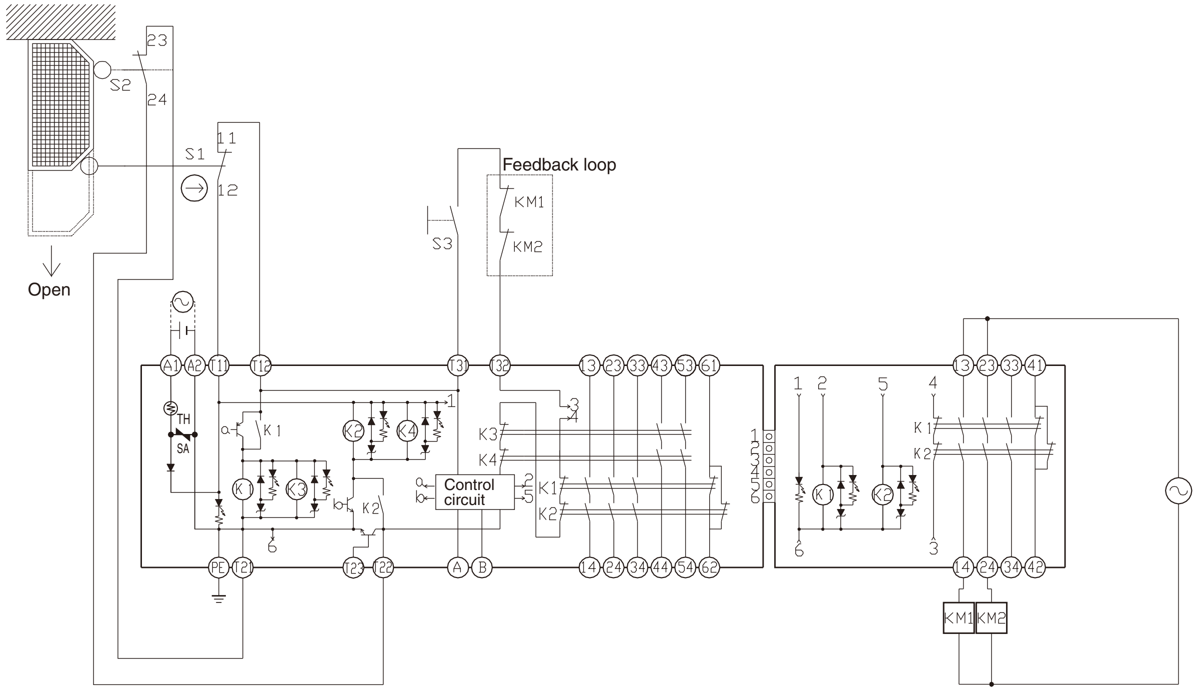
Input time difference operates only when the difference is 0.5 s max.

S11, S12: Two-hand pushbutton switches
KM1 and KM2: Magnetic Contactor

Note: 1. Use a 1NC+1NO switch for S11 and S12.

2. This circuit achieves Safety Category 4.

G9SA-501 (24 VAC/VDC) and G9SA-EX301 with 2-channel Limit Switch Input/Manual Reset



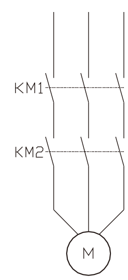
S1: Safety Limit Switch
with direct opening mechanism (NC)
(D4B-N, D4N, D4F)

S2: Limit switch (NO)

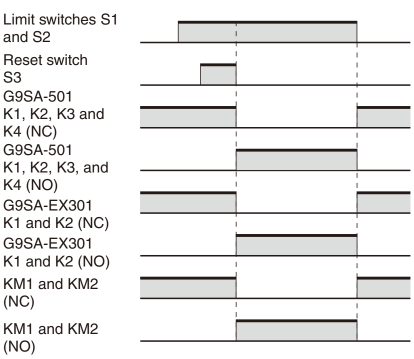
S3: Reset switch

KM1 and KM2: Magnetic Contactor

M: 3-phase motor



Timing Chart



Note: This circuit achieves Safety Category 4.

Safety Precautions

Refer to the *"Precautions for All Relays"* and *"Precautions for All Relays with Forcibly Guided Contacts"*.

⚠ CAUTION

Turn OFF the G9SA before wiring the G9SA. Do not touch the terminals of the G9SA while the power is turned ON, because the terminals are charged and may cause an electric shock.

Precautions for Correct Use

Installation

- The G9SA can be installed in any direction.

Wiring

- Use the following to wire the G9SA.
  Stranded wire: 0.75 to 1.5 mm^2
  Solid wire: 1.0 to 1.5 mm^2
- Tighten each screw to a torque of 0.78 to 1.18 N·m, or the G9SA may malfunction or generate heat.
- External inputs connected to T11 and T12 or T21 and T22 must be no-voltage contact inputs.
- PE is a ground terminal.
  When a machine is grounded at the positive, the PE terminal should not be grounded.

Connector Cover

- Do not remove the connector cover of the G9SA-301, G9SA-501, G9SA-321-T□, or G9SA-TH301 unless an Expansion Unit is being used.

Mounting Expansion Units

- Turn OFF the G9SA before connecting the Expansion Unit.
- When an Expansion Unit is being used, remove the connector cover from the G9SA Safety Relay Unit (G9SA-301, G9SA-501, G9SA-321-T□, or G9SA-TH301) and insert the connector of the Expansion Unit's connector cable.

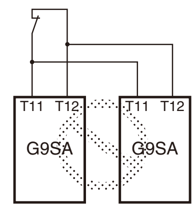
Mounting Multiple Units

- When mounting multiple Units close to each other, the rated current will be 3 A. Do not apply a current higher than 3 A.

Connecting Inputs

- If using multiple G9SA models, inputs cannot be made using the same switch. This is also true for other input terminals.

Incorrect



Ground Shorts

- A positive thermistor (TH) is built into the G9SA internal circuit to detect ground shorts and shorts between channels 1 and 2. When such faults are detected, the safety outputs are interrupted. If the short breakdown is repaired, the G9SA automatically recovers.

Resetting Inputs

- When only channel 1 of the 2-channel input turns OFF, the safety output is interrupted. In order to restart when this happens, it is necessary to turn OFF and ON both input channels. It is not possible to restart by resetting only channel 1.

Resetting Inputs During OFF Delay Time

The G9SA-321-T□ operates as follows according to the reset mode when the inputs are to be re-entered during the OFF delay time of the G9SA-321-T□:
For auto reset, after the OFF delay time has ended, the outputs will turn OFF, and then the outputs will turn ON again.
For manual reset, after the OFF delay time has ended, the outputs will turn OFF, and then the outputs will turn ON again when the reset is input.

Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

Applicable Safety Category (EN954-1)

G9SA-series Relays meet the requirements of Safety Category 4 of the EN954-1 standards when they are used as shown in the examples provided by OMRON. The Relays may not meet the standards in some operating conditions. The OFF-delay output of models G9SA-321-T□ and EX031-T□, however, conform to Safety Category 3.
The applicable safety category is determined from the whole safety control system. Make sure that the whole safety control system meets EN954-1 requirements.

Certified Standards

The G9SA-301/501/321-T□/TH301/EX301/EX031-T□ conform to the following standards.

- EN standards, certified by BG:
  EN954-1
  EN60204-1
  EN574 (G9SA-TH301 only)
- Conformance to EMC (Electromagnetic Compatibility)
  Certified by TÜV Product Service: G9SA (-TH301) 24 VAC/VDC
  G9SA-EX301/EX031-T□
  Certified by TÜV Rheinland: G9SA (-TH301) 100-240 VAC
  EMI (Emission): EN55011 Group 1 Class A
  EMS (Immunity): EN61000-6-2
- UL standards: UL508 (Industrial Control Equipment)
- CSA standards: CSA C22.2 No. 14 (Industrial Control Equipment)

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions"* section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)

To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).

Refer to the *Safety Components Technical Guide* (Cat No. Y107). The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

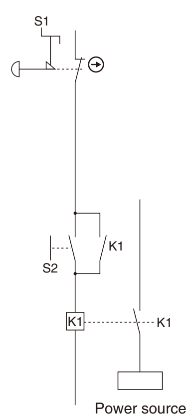
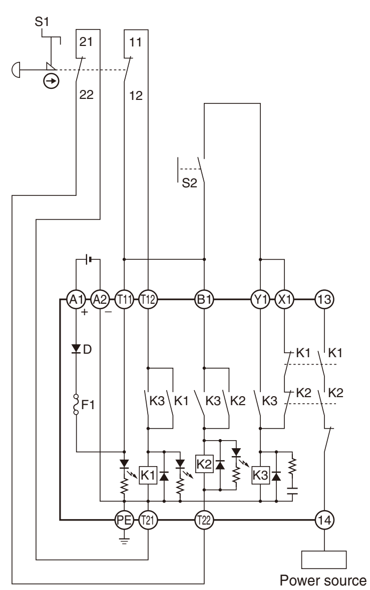


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.

When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)

The G7SA, G7S and G7S-☐-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-☐-E, however, do not display the CE Marking according to the concepts in the guidelines.

VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-☐-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

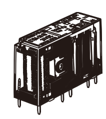
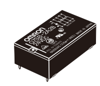
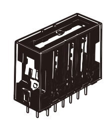
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	**Flux protection**	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

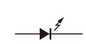
② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED 	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

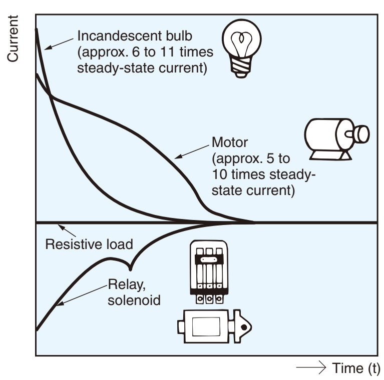
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

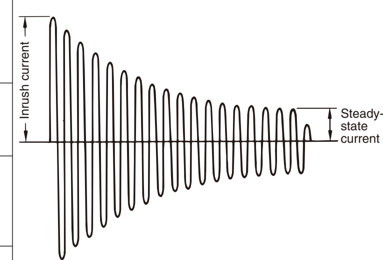
If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	



❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

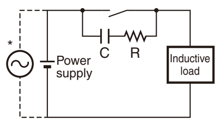
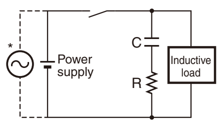
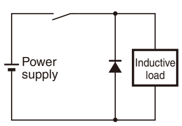
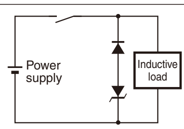
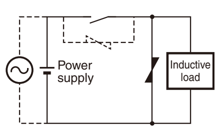
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

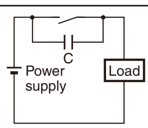
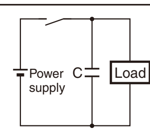
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current		Features and remarks	Element selection
		AC	DC		
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

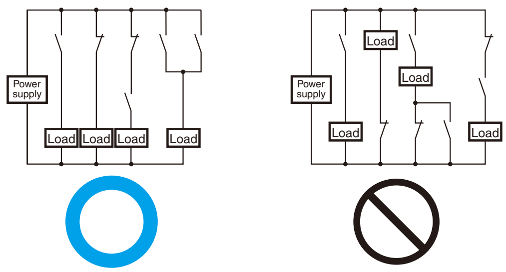
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

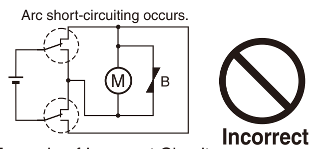
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



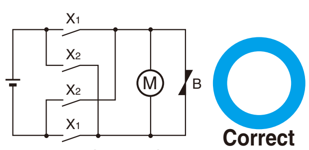
a. Correct Connection   b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

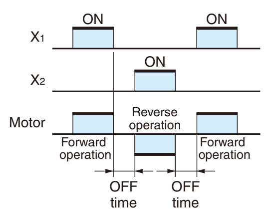
Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



Example of Incorrect Circuit



Example of Correct Circuit

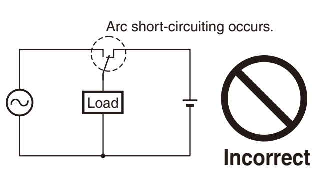


❸-①-8 Power Supply Double Break with Multi-pole Relays

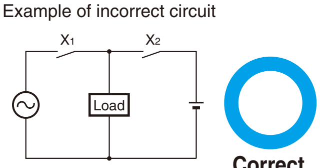
If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

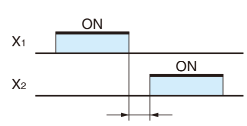
With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.
Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



Example of incorrect circuit

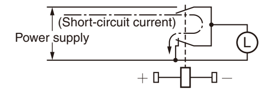


Example of correct circuit



❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.
Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.
The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.
Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.
This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).
This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

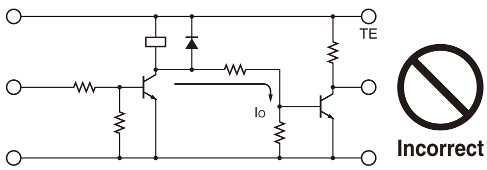
❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.
As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.
Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

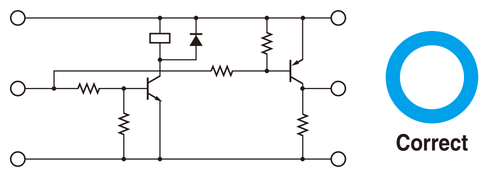
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

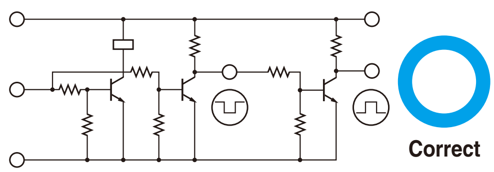
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value

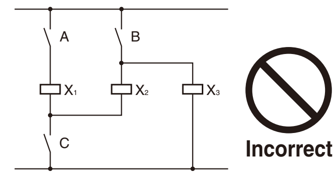


❸-②-7 Using with Infrequent Switching

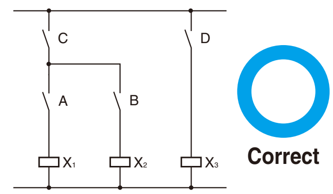
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.
The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.
The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



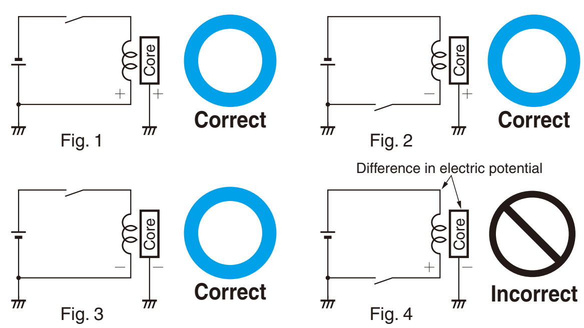
❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)

(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)

(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

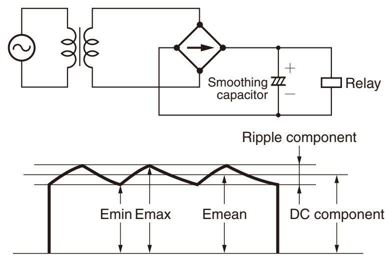


❸-②-10 Individual Specifications for Must-operate/ release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



Ripple percentage %= $\frac{Emax-Emin}{Emean} \times 100\%$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON.
Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

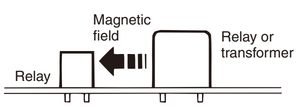
Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock
Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields
Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads
Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust
Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

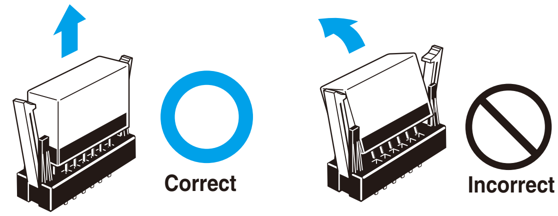
❺ Relay Mounting Operations

① Plug-in Relays

❺-①-1 Panel-mounting Sockets
1. Socket Mounting Screws
When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach.
Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.

2. Lead Wire Screw Connections
Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
Conversely, excessive tightening can strip the threads.

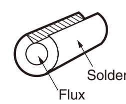
❺-①-2 Relay Removal Direction
Insert and remove Relays from the socket perpendicular to the socket surface.



If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering
Solder General-purpose Relays manually following the precautions described below.

1. Smooth the tip of the solder gun and then begin the soldering.
- Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
- Soldering iron: Rated at 30 to 60 W
- Tip temperature: 280 to 300°C
- Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.

3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning
Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals
Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals
Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations
Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing
G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

❼-1 Selecting PCBs

(1) PCB Materials

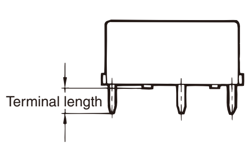
PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material	Epoxy		Phenol
Item	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs

(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs

(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

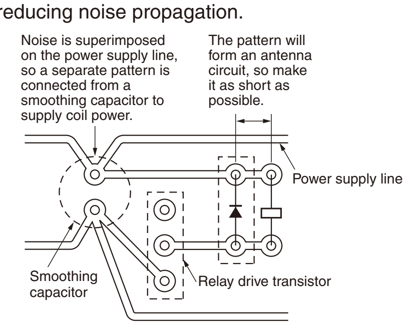
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② Noise from Contacts

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ High-frequency Patterns

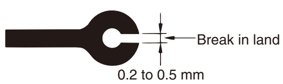
As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

Correct Examples	
Incorrect Examples	

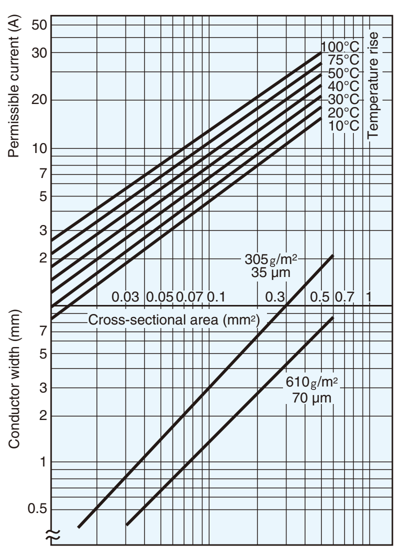
2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.



❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 µm and 70 µm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

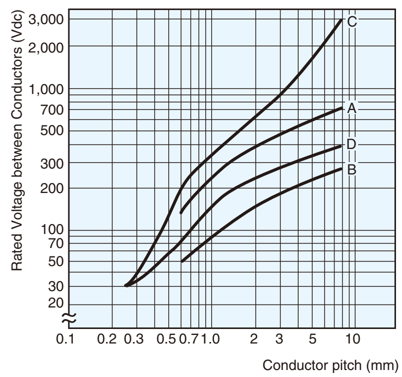
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

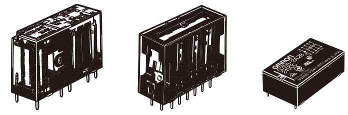
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

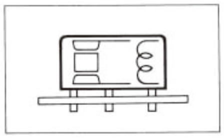
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

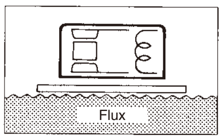
Placement



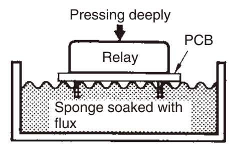
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay. The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials. For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive. Apply the flux sparingly and evenly to prevent penetration into the Relay. When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



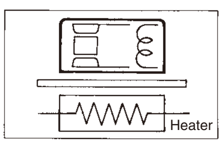
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

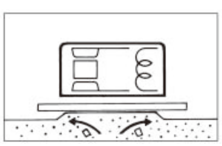
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

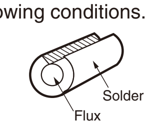
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

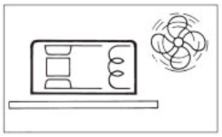
Applicability of Manual Soldering

G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5
Cooling

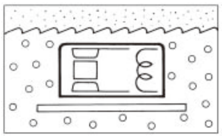


1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6
Cleaning

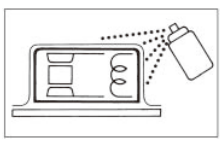


Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7
Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed.
   Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company
http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Safety Relay Unit

G9SB

Ultra Slim Safety Relay Unit

- Models of width 17.5 mm available with 2 or 3 poles. Models of width 22.5 mm with 3 poles also available.
- Conforms to EN standards. (TÜV approval)
- DIN track mounting possible.

TÜV Rheinland

⚠ Be sure to read the *"Safety Precautions"* on page 8.

Model Number Structure

Model Number Legend

G9SB-□□□□□-□
1 2 3 4 5 6

1. Function
None: Emergency stop

2. Contact Configuration (Safety Output)
2: DPST-NO
3: 3PST-NO

3. Contact Configuration (OFF-delay Output)
0: None

4. Contact Configuration (Auxiliary Output)
0: None
1: SPST-NC

5. Input Configuration
None: 1-channel or 2-channel input possible
0: None (direct breaking)
2: 2-channel input

6. Miscellaneous
A: Auto-reset, inverse input
B: Auto-reset, + common input
C: Manual reset, inverse input
D: Manual reset, + common input

Ordering Information

Main contacts	Auxiliary contact	Number of input channels	Reset mode	Input type	Rated voltage	Model
DPST-NO	None	2 channels	Auto-reset	Inverse	24 VAC/VDC	**G9SB-2002-A**
		1 channel or 2 channels		+ common		**G9SB-200-B**
		2 channels	Manual reset	Inverse		**G9SB-2002-C**
		1 channel or 2 channels		+ common		**G9SB-200-D**
3PST-NO	SPST-NC	None (direct breaking)	Auto-reset	---	24 VDC	**G9SB-3010 ***
		2 channels		Inverse	24 VAC/VDC	**G9SB-3012-A**
		1 channel or 2 channels		+ common		**G9SB-301-B**
		2 channels	Manual reset	Inverse		**G9SB-3012-C**
		1 channel or 2 channels		+ common		**G9SB-301-D**

Note: 1. Relays with inverse inputs are used mainly when inputting signals from two mechanical switches.
2. Relays with positive commons are used mainly when inputting signals from a safety sensor or from one mechanical switch.
* The G9SB-3010 can be applied to Safety Category 3 of the EN954-1 if double breaking is used.

Specifications

Ratings

Power Input

Item / Model	G9SB-200□-□	G9SB-3010	G9SB-301□-□
Power supply voltage	24 VAC/VDC: 24 VAC, 50/60 Hz, or 24VDC 24 VDC: 24 VDC		
Operating voltage range	85% to 110% of rated power supply voltage		
Power consumption	1.6 VA/1.4 W max.	1.7 W max.	2.0 VA/1.7 W max.

Inputs

Item / Model	G9SB-200□-□	G9SB-3010	G9SB-301□-□
Input current	25 mA max.	60 mA max. *	30 mA max.

* Indicates the current between terminals A1 and A2.

Contacts

Model	G9SB-200□-□	G9SB-3010	G9SB-301□-□
Item / Load	Resistive load		
Rated load	250 VAC, 5 A 30 VDC, 5 A		
Rated carry current	5 A		

Characteristics

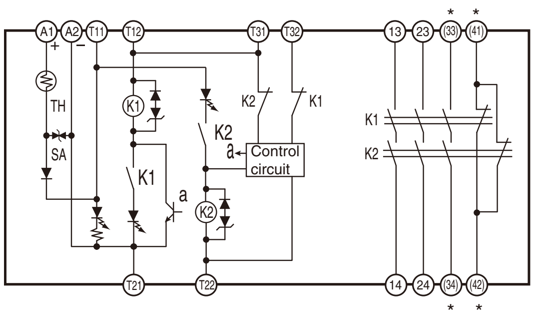
Item	Model	G9SB-200□-□	G9SB-3010	G9SB-301□-□
Contact resistance *1		100 mΩ		
Operating time *2		30 ms max.		
Response time *3		10 ms max.		
Insulation resistance *4		100 MΩ min. (at 500 VDC)		
Dielectric strength	Between different outputs	2,500 VAC, 50/60 Hz for 1 min		
	Between inputs and outputs			
	Between power inputs and outputs			
Vibration resistance		10 to 55 to 10 Hz, 0.375-mm single amplitude (0.75-mm double amplitude)		
Shock resistance	Destruction	300 m/s^2		
	Malfunction	100 m/s^2		
Durability *5	Mechanical	5,000,000 operations min. (at approx. 7,200 operations/hr)		
	Electrical	100,000 operations min. (at approx. 1,800 operations/hr)		
Failure rate (P level) (reference value)		5 VDC, 1 mA		
Ambient operating temperature		–25 to 55°C (with no icing or condensation)		
Ambient operating humidity		35% to 85%		
Terminal tightening torque		0.5 N·m		
Weight		Approx. 115 g	Approx. 135 g	Approx. 120 g

*1. The contact resistance was measured with 1 A at 5 VDC using the voltage-drop method.
*2. Not including bounce time.
*3. The response time is the time it takes for the main contact to open after the input is turned OFF. Includes bounce time.
*4. The insulation resistance was measured with 500 VDC at the same places that the dielectric strength was checked.
*5. The durability is for an ambient temperature of 15 to 35°C and an ambient humidity of 25% to 75%.

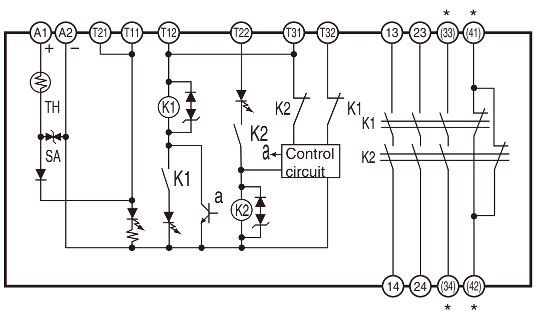
Connections

Internal Connections

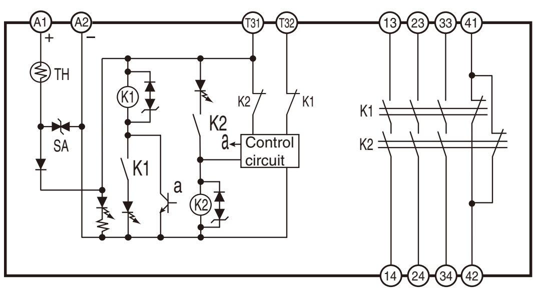
G9SB-2002-A/C (24 VAC/VDC)
G9SB-3012-A/C (24 VAC/VDC)



G9SB-200-B/D (24 VAC/VDC)
G9SB-301-B/D (24 VAC/VDC)



G9SB-3010 (24 VDC)



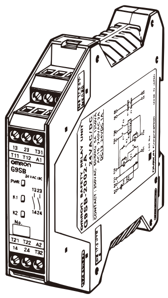
Note: 1. For 1-channel input with G9SB-□□□-B/D models, short terminals T12 and T22. It is not possible to wire G9SB-□□□2-A/C models for 1-channel input.
2. Always provide a protective ground externally, e.g., on the power supply.

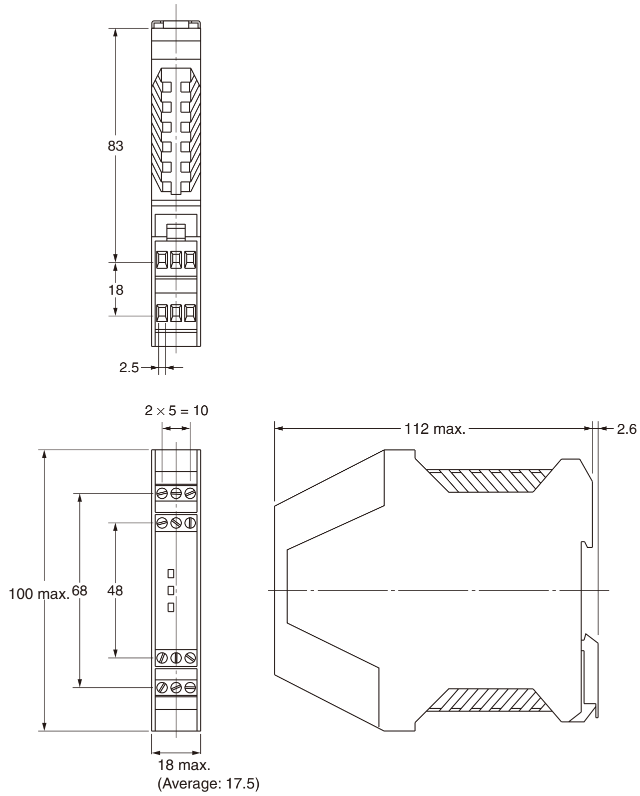
*Only G9SB-301□-□ models have terminals 33-34 and 41-42.

Dimensions and Terminal Arrangement

(Unit: mm)

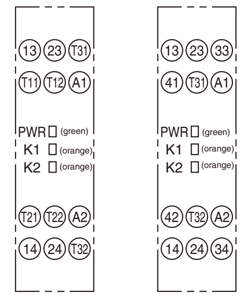
G9SB-200□-□
G9SB-3010



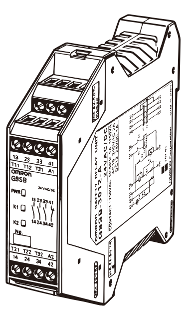


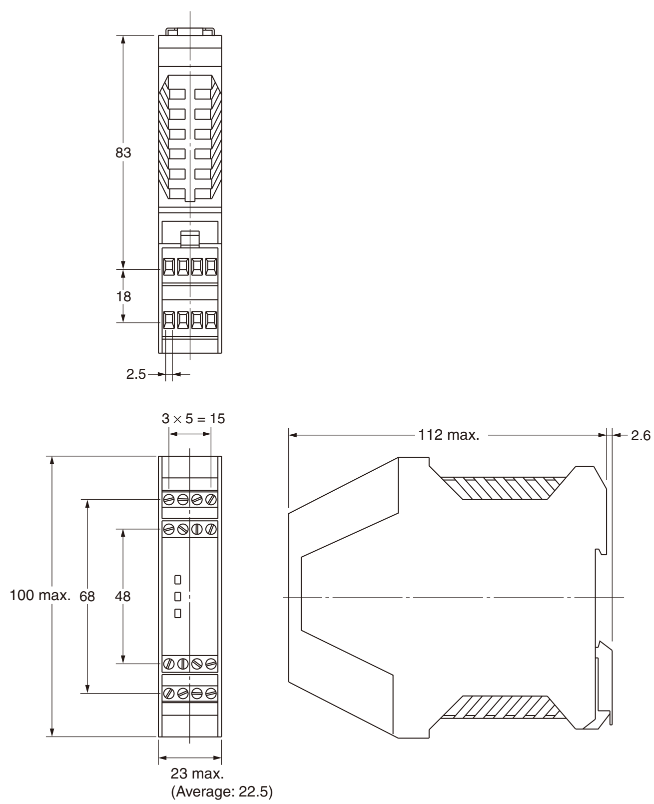
Terminal Arrangement

G9SB-200□-□ **G9SB-3010**



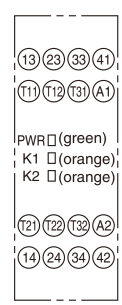
G9SB-301-□-□





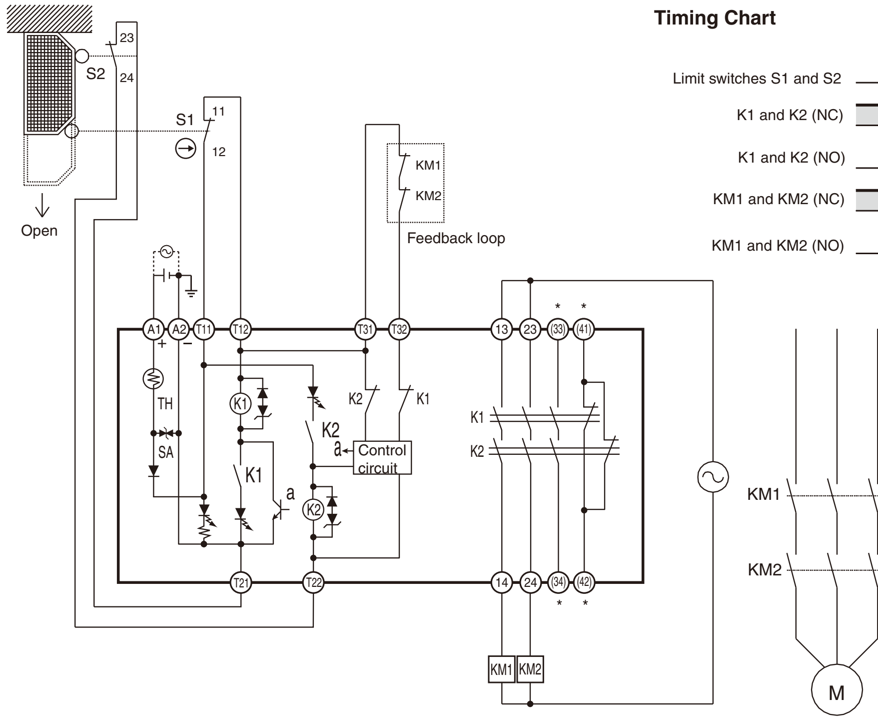
Terminal Arrangement

G9SB-301-□-□

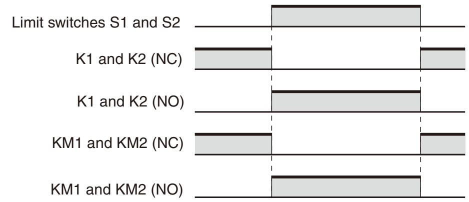


Application Examples

G9SB-2002-A (24 VAC/VDC) or G9SB-3012-A (24 VAC/VDC) with 2-channel Limit Switch Input/Auto-reset



Timing Chart



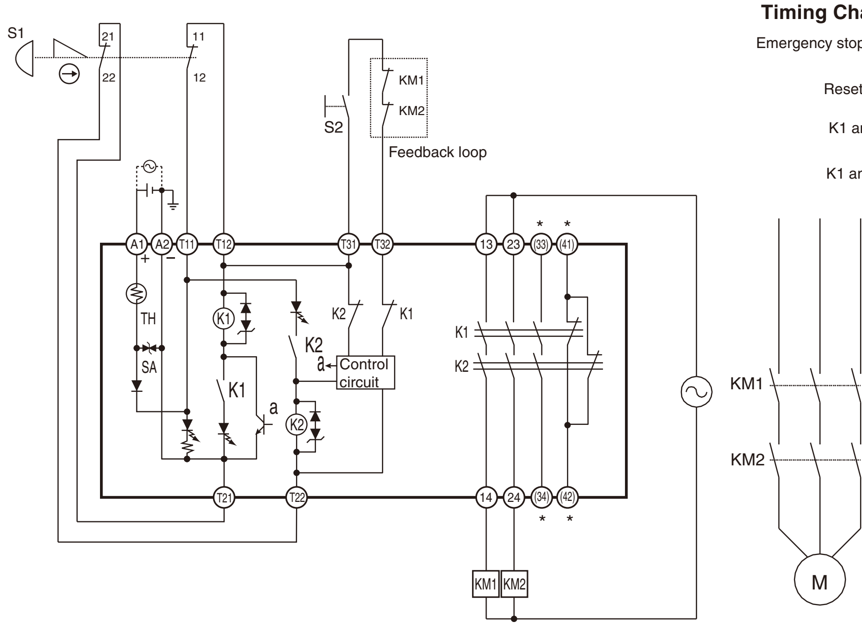
S1:	Safety limit switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S2:	Limit switch (NO)
KM1 and KM2:	Magnetic Contactor
M:	3-phase motor

Note: 1. External connections and timing charts for G9SB-200-B/301-B models are the same as those for G9SB-2002-A/3012-A models.

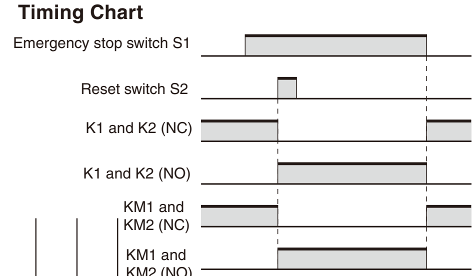
2. This circuit conforms to Safety Category 4.

* Only the G9SB-3012-A model has terminals 33-34 and 41-42.

G9SB-2002-C (24 VAC/VDC) or G9SB-3012-C (24 VAC/VDC) with 2-channel Emergency Stop Switch Input/Manual Reset



Timing Chart



Note: Output turns ON with the rising edge of reset switch S2, but will not operate if there is a short breakdown in S2.

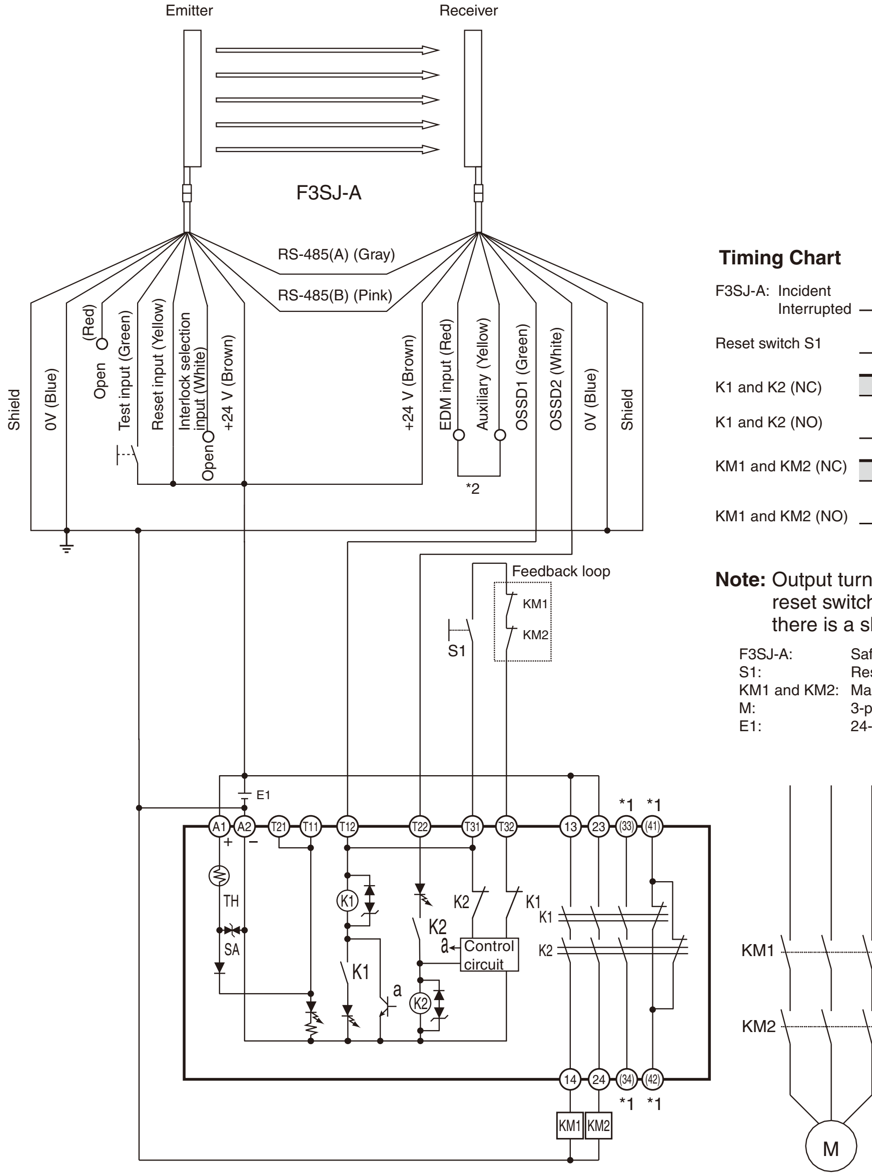
S1:	Emergency stop switch with direct opening mechanism (A165E, A22E)
S2:	Reset switch
KM1 and KM2:	Magnetic Contactor
M:	3-phase motor

Note: 1. External connections and timing charts for G9SB-200-D/301-D models are the same as those for G9SB-2002-C/3012-C models.

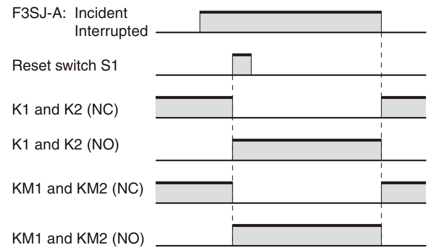
2. This circuit conforms to Safety Category 4.

* Only the G9SB-3012-C model has terminals 33-34 and 41-42.

G9SB-200-D (24 VAC/VDC) or G9SB-301-D (24 VAC/VDC) with 2-channel Safety Sensor/Manual Reset



Timing Chart

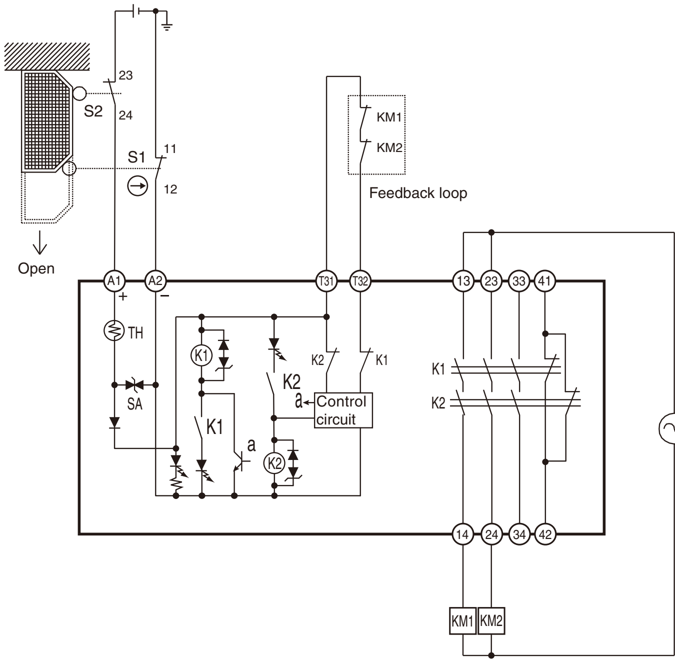


Note: Output turns ON with the rising edge of reset switch S1, but will not operate if there is a short breakdown in S1.

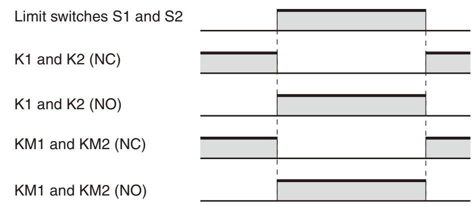
F3SJ-A:	Safety Sensor
S1:	Reset switch
KM1 and KM2:	Magnetic Contactor
M:	3-phase motor
E1:	24-VDC power supply (S82K)

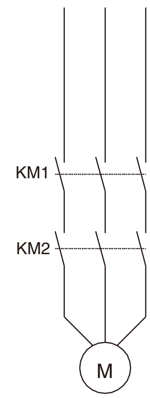
Note: This circuit conforms to Safety Category 4.
*1. Only the G9SB-301-D model has terminals 33-34 and 41-42.
*2. Wiring is shown for when the F3SJ-A auxiliary output turns ON for light interruption.

G9SB-3010 (24 VDC) with 2-channel Limit Switch Input/Auto-reset



Timing Chart





S1:	Safety limit switch with direct opening mechanism (NC) (D4B-N, D4N, D4F)
S2:	Limit switch (NO)
KM1 and KM2:	Magnetic Contactor
M:	3-phase motor

Note: This circuit conforms to Safety Category 3.

Safety Precautions

Refer to the *"Precautions for All Relays"* and *"Precautions for All Relays with Forcibly Guided Contacts".*

⚠ CAUTION

Turn OFF the G9SB before wiring the G9SB. Do not touch the terminals of the G9SB while the power is turned ON, because the terminals are charged and may cause an electric shock.

Precautions for Correct Use

Installation

- The G9SB can be installed in any direction.

Wiring

- Use the following to wire the G9SB.
  Stranded wire: 0.2 to 2.5 mm^2
  Solid wire: 0.2 to 2.5 mm^2
- Tighten each screw to a torque of 0.5 to 0.6 N·m, or the G9SB may malfunction or generate heat.
- External inputs connected to T11 and T12 or T21 and T22 of the G9SB must be no-voltage contact inputs.
- Strip the wires by 7 mm max.

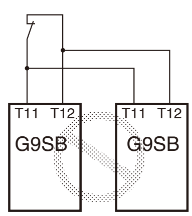
Mounting Multiple Units

- When mounting multiple Units close to each other, the rated current will be 3 A. Do not apply a current higher than 3 A.

Connecting Inputs

- If using multiple G9SB models, inputs cannot be made using the same switch. This is also true for other input terminals.

Incorrect



Ground Shorts

- A positive thermistor (TH) is built into the G9SB internal circuit to detect ground shorts and shorts between channels 1 and 2. When such faults are detected, the safety outputs are interrupted. (Only G9SB-2002-□/3012-□ is able to detect shorts between channels 1 and 2.)
  If the short breakdown is repaired, the G9SB automatically recovers.

Note: In order to detect earth short breakdowns, connect the minus side of the power supply to ground.

Resetting Inputs

- When only channel 1 of the 2-channel input turns OFF, the safety output is interrupted. In order to restart when this happens, it is necessary to turn OFF and ON both input channels. It is not possible to restart by resetting only channel 1.

Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

Applicable Safety Category (EN954-1)

G9SB-200□-□/301□-□ meet the requirements of Safety Category 4 of the EN954-1 standards when they are used as shown in the examples provided by OMRON. Relays may not meet the standards in some operating conditions. The G9SB-3010 can be applied to Safety Category 3 of the EN954-1 using double breaking.
The applicable safety category is determined from the whole safety control system. Make sure that the whole safety control system meets EN954-1 requirements.

Certified Standards

The G9SB-200□-□/3010/301□-□ conforms to the following standards.

- EN standards, certified by TÜV Rheinland:
  EN954-1
  EN60204-1
- Conformance to EMC (Electromagnetic Compatibility), certified by TÜV Rheinland
  EMI (Emission): EN55011 Group 1 Class A
  EMS (Immunity): EN61000-6-2
- UL standards: UL508 (Industrial Control Equipment)
- CSA standards: CSA C22.2 No. 14 (Industrial Control Equipment)

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)
To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).
Refer to the *Safety Components Technical Guide* (Cat No. Y107).
The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

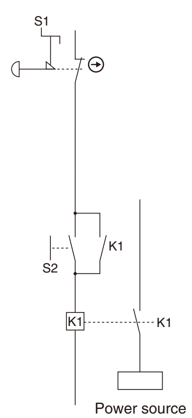
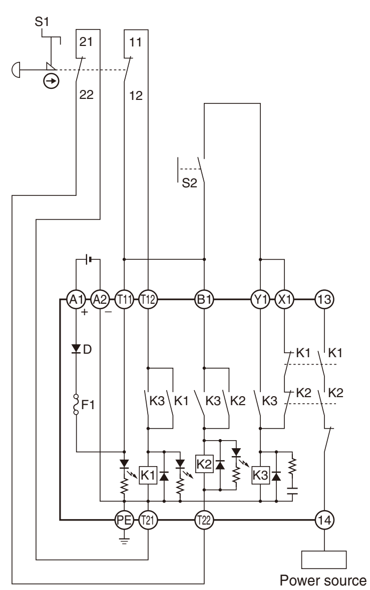


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)
The G7SA, G7S and G7S-☐-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-☐-E, however, do not display the CE Marking according to the concepts in the guidelines.
VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-☐-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

No.	Area	No.	Classification	No.	Item	Page
❹	Operating and Storage Environments			1 2 3 4 5 6 7 8	Operating, Storage, and Transport Operating Atmosphere Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas) Adhesion of Water, Chemicals, Solvent, and Oil Vibration and Shock External Magnetic Fields External Loads Adhesion of Magnetic Dust	C-9 to C-10
❺	Relay Mounting Operations	①	Plug-in Relays	1 2 3	Panel-mounting Sockets Relay Removal Direction Terminal Soldering	C-10
		②	Printed Circuit Board Relays	1	Ultrasonic Cleaning	
		③	Common Items	1 2 3 4	Removing the Case and Cutting Terminals Deformed Terminals Replacing Relays and Performing Wiring Operations Coating and Packing	
❻	Handling Relays			1 2	Vibration and Shock Dropped Products	C-11
❼	Relays for Printed Circuit Boards (PCBs)			1 2 3 4 5 6 7 8 9 10	Selecting PCBs, (1) PCB Materials Selecting PCBs, (2) PCB Thickness Selecting PCBs, (3) Terminal Hole and Land Diameters Mounting Space ① Ambient Temperature ② Mutual Magnetic Interference Pattern Design for Noise Countermeasures ① Noise from Coils ② Noise from Contacts ③ High-frequency Patterns Shape of Lands Pattern Conductor Width and Thickness Conductor Pitch Securing the PCB Automatic Mounting of PCB Relays	C-11 to C-14
❽	Troubleshooting					C-15

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

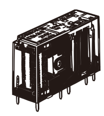
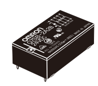
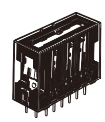
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	Flux protection	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

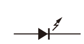
② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED 	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

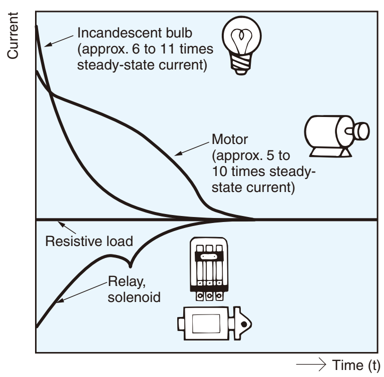
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

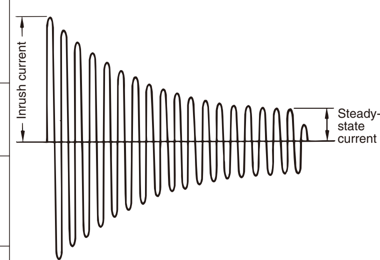
Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	

❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

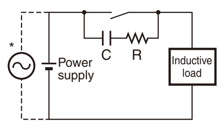
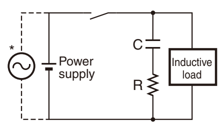
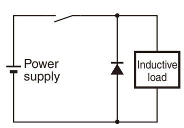
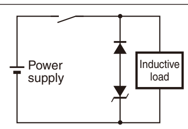
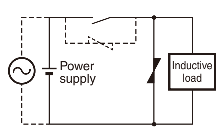
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

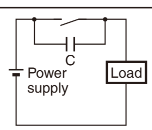
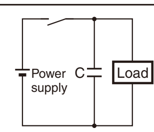
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

	Circuit example	Applicable current		Features and remarks	Element selection
		AC	**DC**		
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

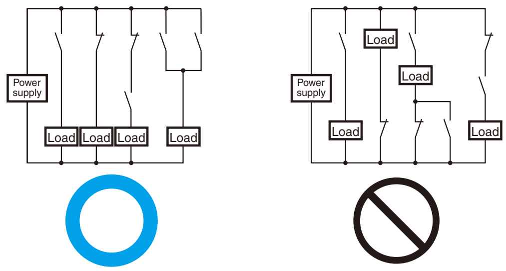
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

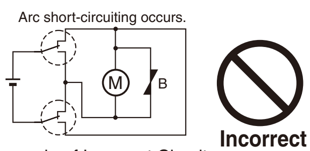
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



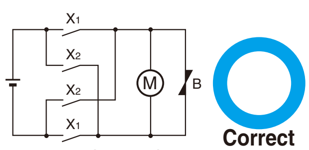
a. Correct Connection   b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

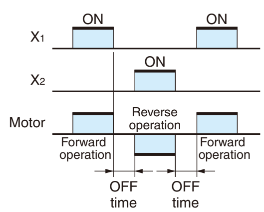
Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



Example of Incorrect Circuit



Example of Correct Circuit

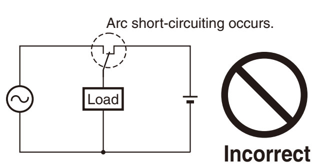


❸-①-8 Power Supply Double Break with Multi-pole Relays

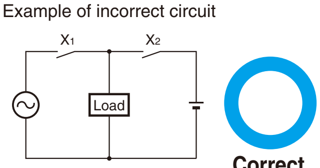
If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

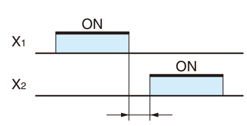
With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.
Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



Example of incorrect circuit

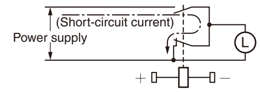


Example of correct circuit



❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.
Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.
The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.
Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.
This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).
This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.

As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.

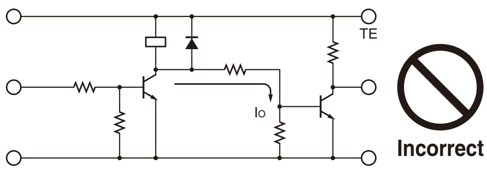
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.

Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

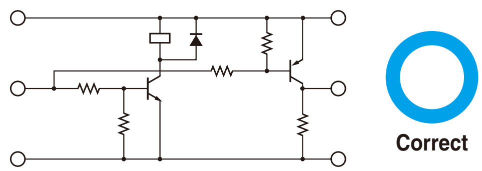
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

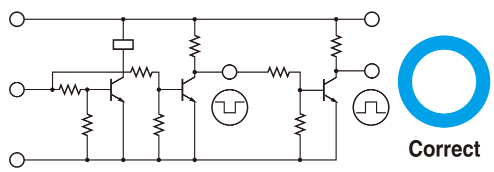
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value



❸-②-7 Using with Infrequent Switching

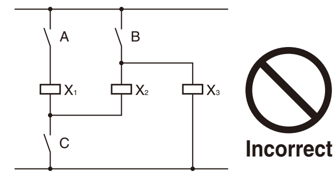
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.

The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

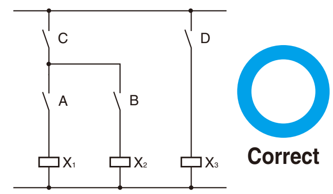
❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.

The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



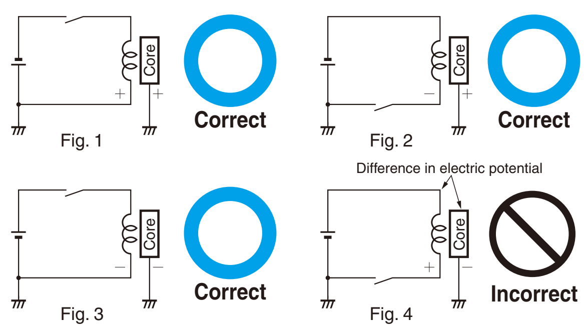
❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)

(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)

(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

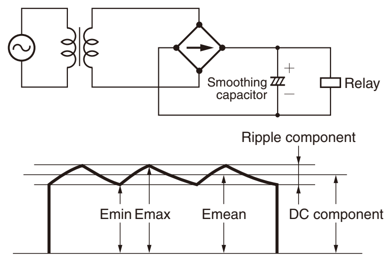


❸-②-10 Individual Specifications for Must-operate/ release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



$$\text{Ripple percentage } \% = \frac{E\max - E\min}{E\text{mean}} \times 100\%$$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON.
Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil

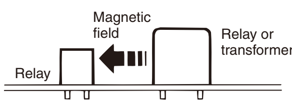
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock

Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields

Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads

Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust

Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

❺ Relay Mounting Operations

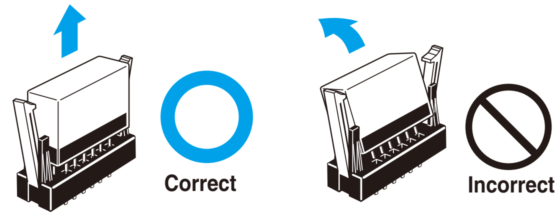
① Plug-in Relays

❺-①-1 Panel-mounting Sockets

1. Socket Mounting Screws
   When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
   If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach.
   Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.
2. Lead Wire Screw Connections
   Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
   If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
   Conversely, excessive tightening can strip the threads.

❺-①-2 Relay Removal Direction

Insert and remove Relays from the socket perpendicular to the socket surface.

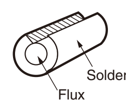


If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering

Solder General-purpose Relays manually following the precautions described below.

1. Smooth the tip of the solder gun and then begin the soldering.
   - Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
   For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.
3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning

Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals

Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals

Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations

Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing

G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

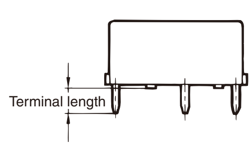
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material	Epoxy		Phenol
Item	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

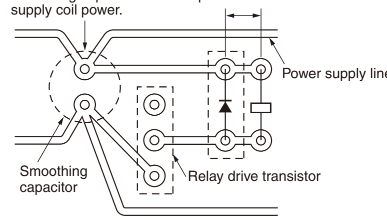
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② **Noise from Contacts**

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ **High-frequency Patterns**

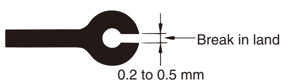
As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

Correct Examples	
Incorrect Examples	

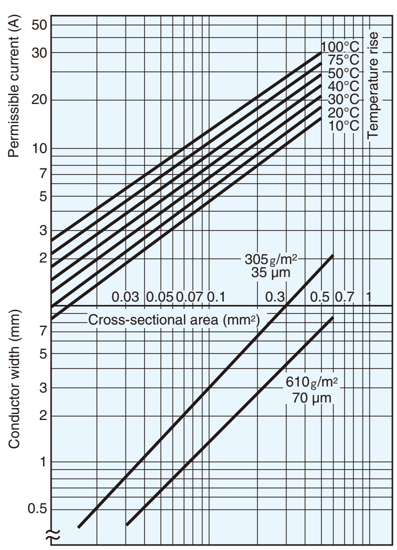
2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.



❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 µm and 70 µm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

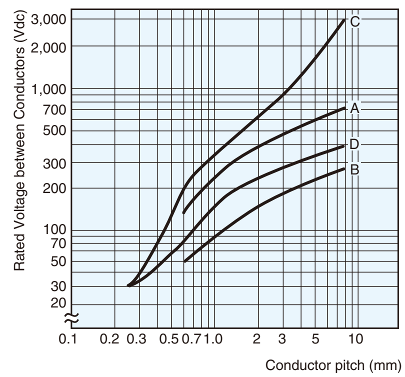
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

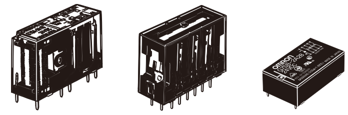
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

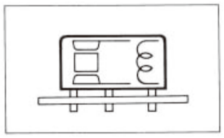
❼-10 Automatic Mounting of PCB Relays

① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.

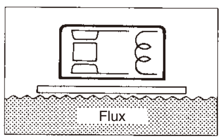


Process 1
Placement

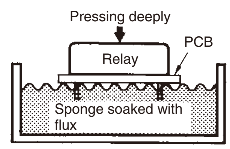


1. Do not bend any terminals of the Relay to use it as a self-clinching Relay. The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2
Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials. For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive. Apply the flux sparingly and evenly to prevent penetration into the Relay. When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.

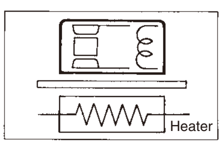


Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3
Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

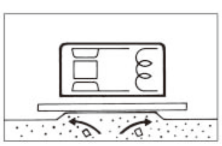
Temperature	100°C max.
Time	1 min max.

3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4
Soldering



Automatic soldering

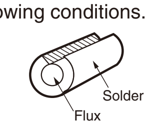
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

Applicability of Manual Soldering

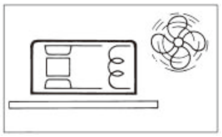
G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5

Cooling



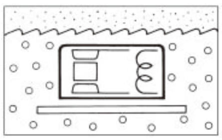
1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6

Cleaning



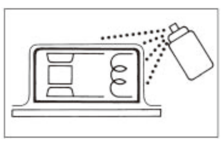
Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7

Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed.
   Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Flexible Safety Unit

G9SX

Logical AND Function Adds Flexibility to I/O Expansion

- Facilitates partial or complete control system setup.
- Solid-state outputs (excluding Expansion Units).
- Detailed LED indications enable easy diagnosis.
- TÜV Product Service certification for compliance with IEC/EN61508 (SIL3) and EN954-1 (Cat. 4).
- Approved by UL and CSA.
- New unit joins the Series with the following two additional features:
  -OFF-delay time of up to 150 seconds
   (The OFF-delay output also complies with Cat. 4.)
  -Two logical AND connection inputs

⚠ Be sure to read the "*Safety Precautions*" on page 24.

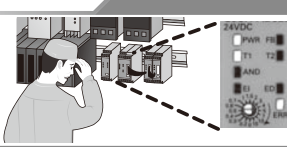
Features

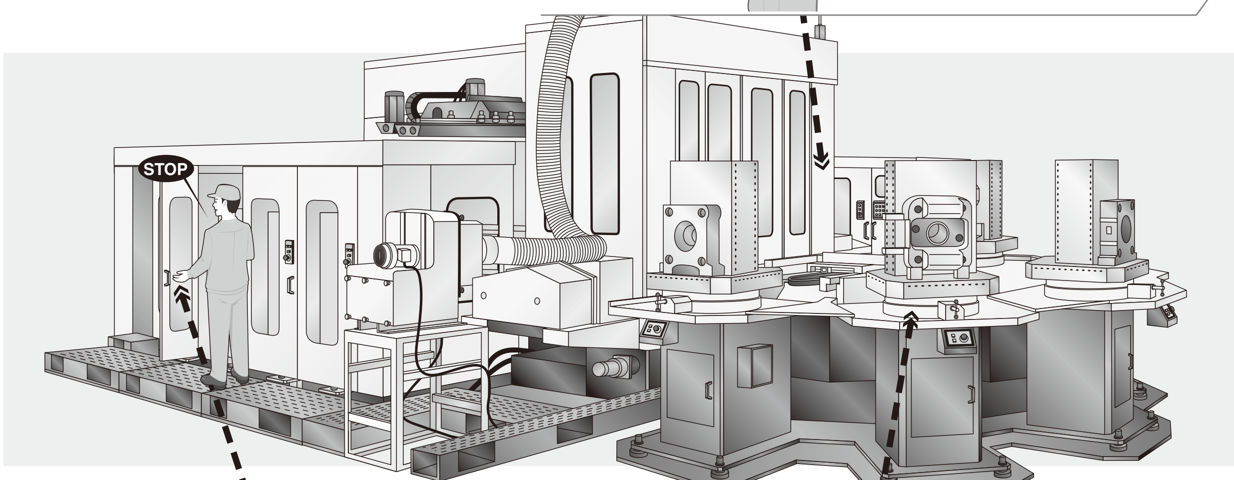
Maintainability

Easily isolate the cause when the equipment stops.

Detailed status displays minimize downtime.

Detailed status displays help locate the cause.





Productivity

Door opened to check the equipment when a problem occurs.

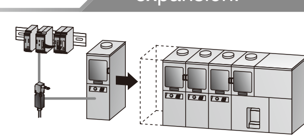
Only the process where the problem has occurred stops, cutting production losses to a minimum.

Expandability

Safety circuits must be rebuilt when equipment is modified.

Simplified safety circuits enable easier system expansion.

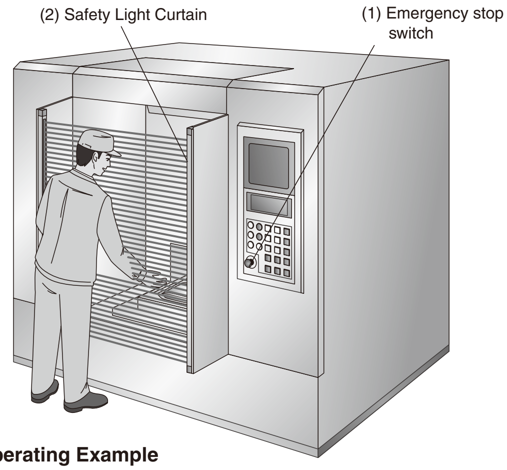
Logical AND connections simplify adding safety switch inputs.

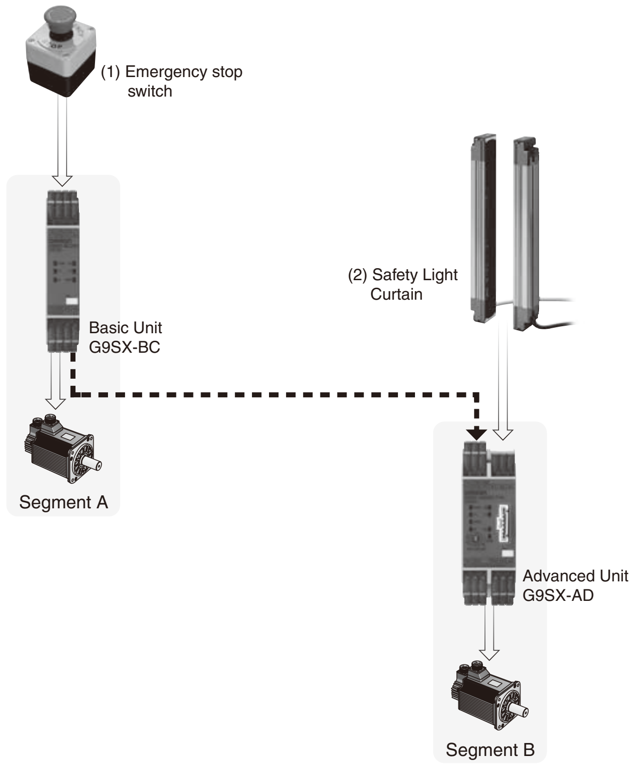


Applications

Parts Processing Machine

- The entire device stops when the emergency stop switch is pressed.
- Only the processing section stops when the Safety Light Curtain is interrupted.





Operating Example

(1) The emergency stop switch is pressed.

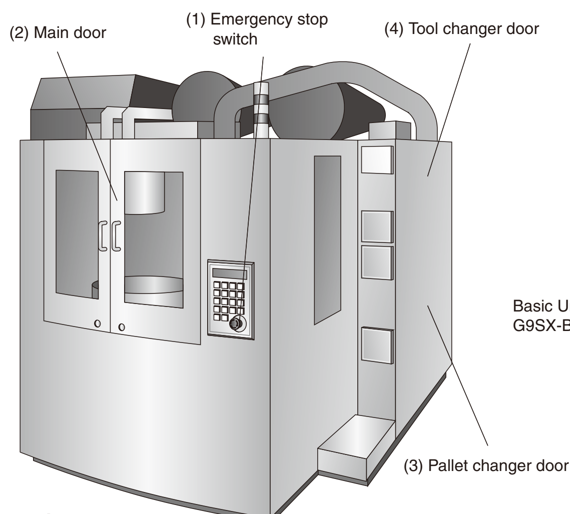
Segment A	Segment B
Stop	Stop

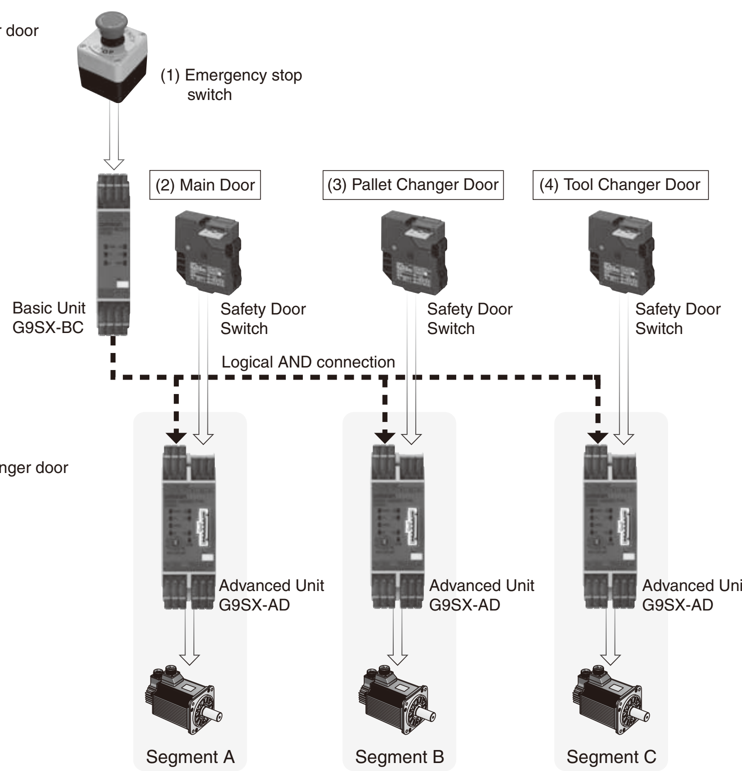
(2) Safety Light Curtain is interrupted.

Segment A	Segment B
	Stop

Machining Center

- When the Emergency Stop Switch is pressed, the entire machine will stop.
- When a door is open, the corresponding part will not be activated.





Operating Example

(1) The emergency stop switch is pressed.

Segment A	Segment B	Segment C
Stop	Stop	Stop

(2) The main door is opened.

Segment A	Segment B	Segment C
Stop		

(3) The pallet changer door is opened.

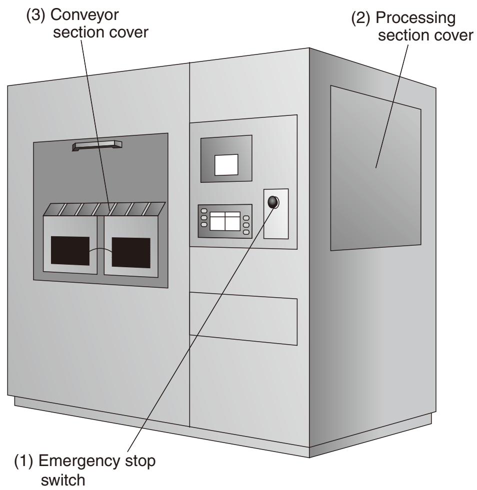
Segment A	Segment B	Segment C
	Stop	

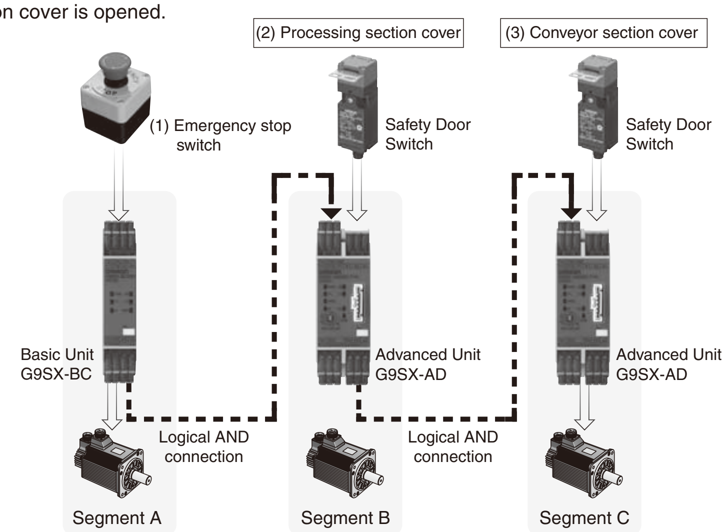
(4) The tool changer door is opened.

Segment A	Segment B	Segment C
		Stop

Semiconductor Manufacturing Equipment

- All of the equipment stops when the emergency stop switch is pressed.
- The processing section and conveyor section stop when the processing section cover is opened.
- Only the conveyor section stops when the conveyor section cover is opened.



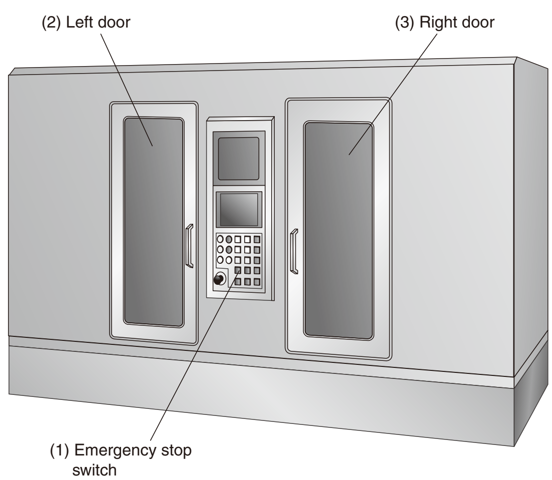


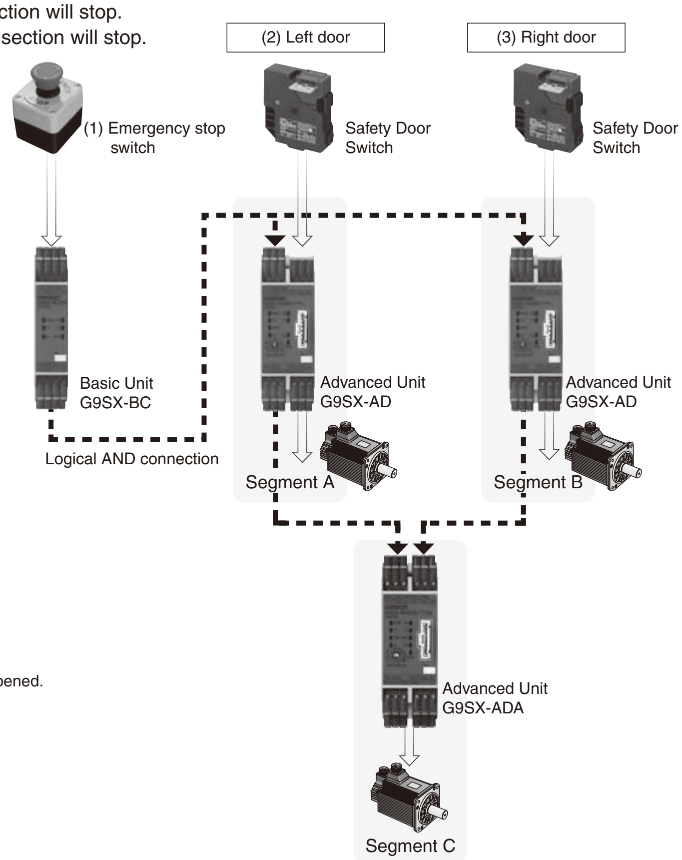
Operating Example

(1) The emergency stop switch is pressed.	(2) The processing section cover is opened.	(3) The conveyor section cover is opened.
Stop (Segment A), Stop (Segment B), Stop (Segment C)	Segment A, Stop (Segment B), Stop (Segment C)	Segment A, Segment B, Stop (Segment C)

Machine Tool

- When the Emergency Stop Switch is pressed, the entire machine will stop.
- If the left door is opened, the left drive section and transport section will stop.
- If the right door is opened, the right drive section and transport section will stop.



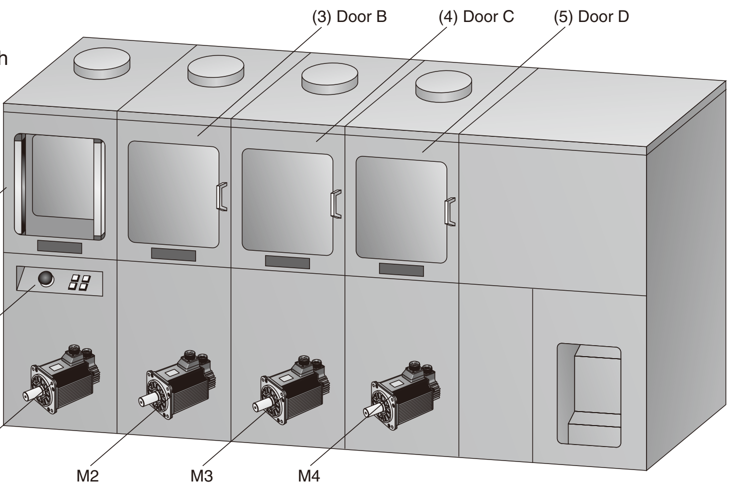


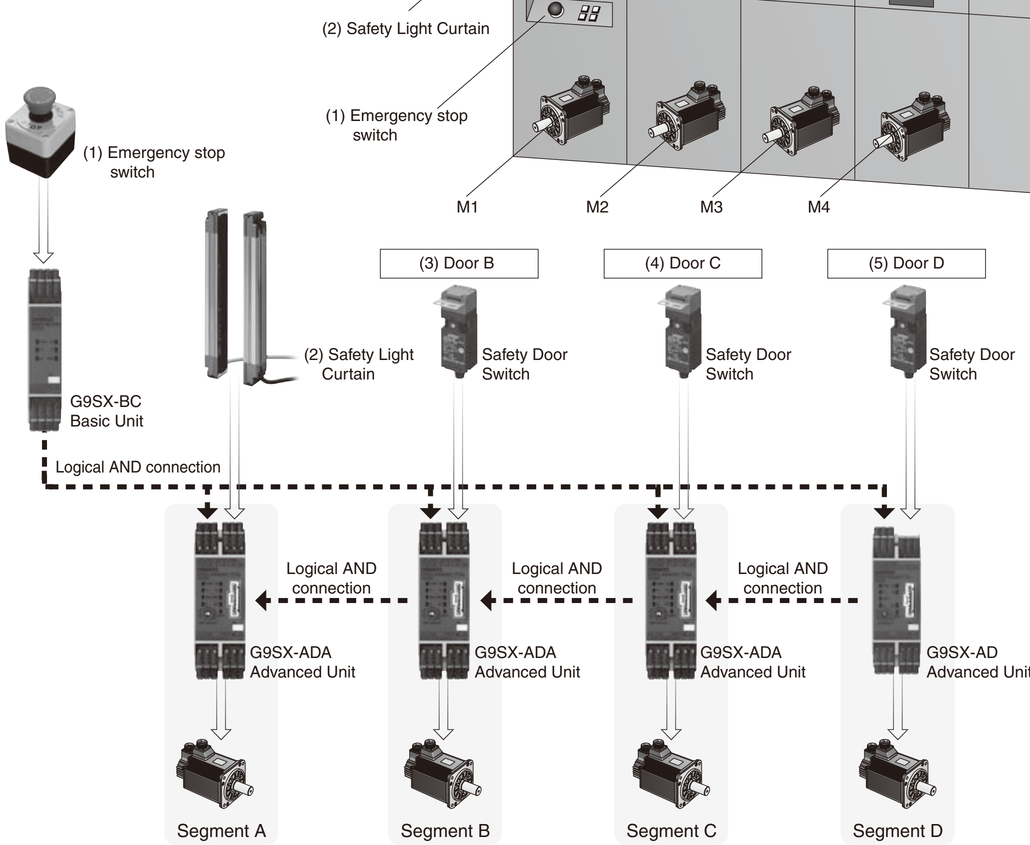
Operating Example

(1) The emergency stop switch is pressed.	(2) The left door is opened.	(3) The right door is opened.
Stop (Segment A), Stop (Segment B), Stop (Segment C)	Stop (Segment A), Segment B, Stop (Segment C)	Segment A, Stop (Segment B), Stop (Segment C)

Semiconductor Testing Equipment

- All of the equipment stops when the emergency stop switch is pressed.
- M1 stops when the Safety Light Curtain is interrupted.
- M1 and M2 stop when door B is opened.
- M1, M2, and M3 stop when door C is opened.
- M1, M2, M3, and M4 stop when door D is opened.





Operating Example

(1) The emergency stop switch is pressed.

Segment A	Segment B	Segment C	Segment D
Stop	Stop	Stop	Stop

(2) Safety Light Curtain is interrupted.

Segment A	Segment B	Segment C	Segment D
Stop			

(3) Door B is opened.

Segment A	Segment B	Segment C	Segment D
Stop	Stop		

(4) Door C is opened.

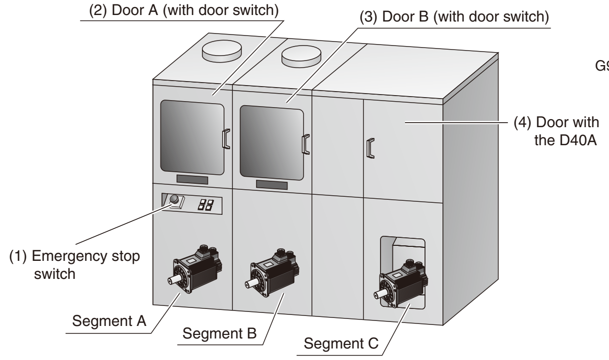
Segment A	Segment B	Segment C	Segment D
Stop	Stop	Stop	

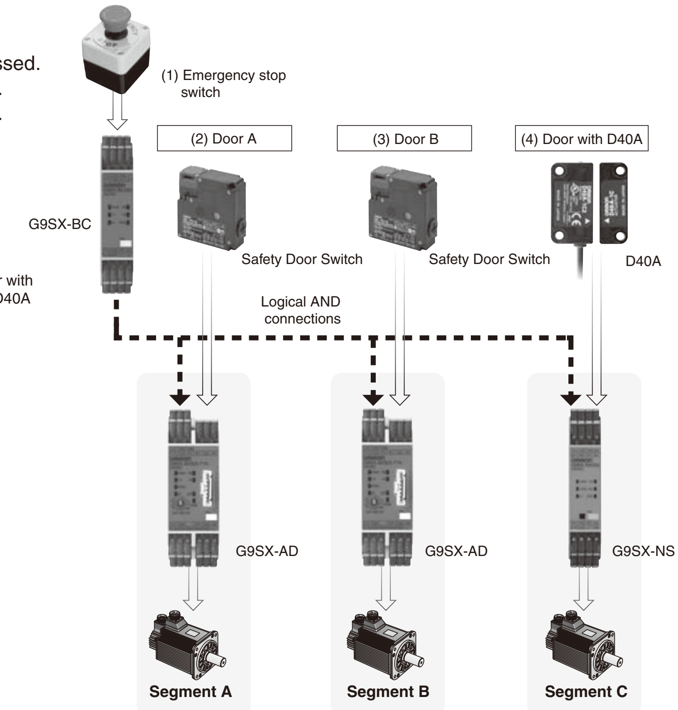
(5) Door D is opened.

Segment A	Segment B	Segment C	Segment D
Stop	Stop	Stop	Stop

Semiconductor Inspection System (Using Non-contact Door Switches)

- The entire system will stop if the emergency stop switch is pressed.
- Only segment A will stop if door A (with door switch) is opened.
- Only segment B will stop if door B (with door switch) is opened.
- Only segment C will stop if the door with the D40A is opened.





Operation Examples

(1) Emergency stop is switch pressed.

Segment A	Segment B	Segment C
Stop	Stop	Stop

(2) Door A is opened.

Segment A	Segment B	Segment C
Stop		

(3) Door B is opened.

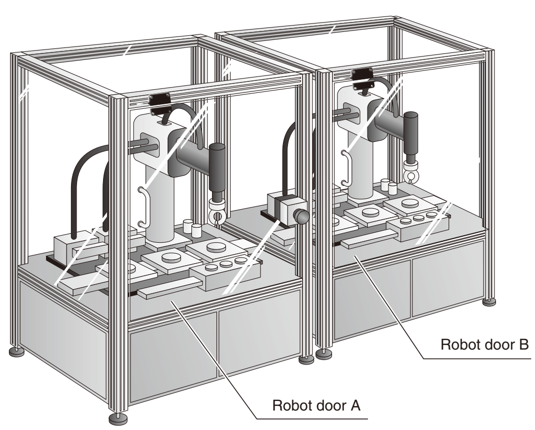
Segment A	Segment B	Segment C
	Stop	

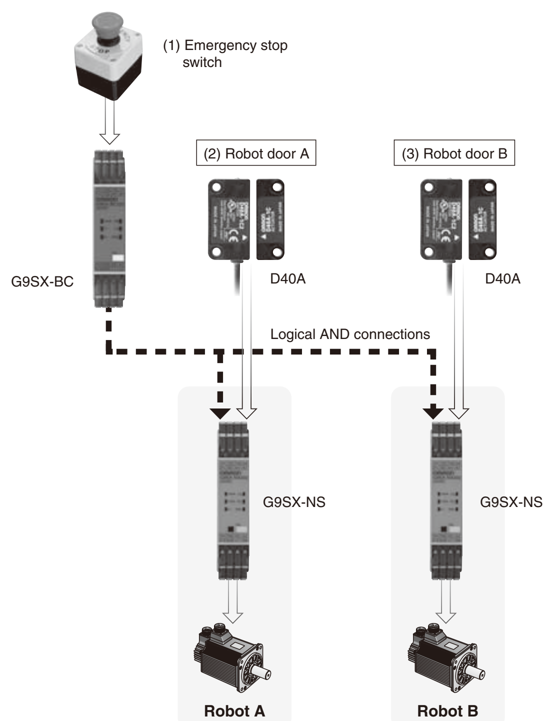
(4) Door with D40A is opened.

Segment A	Segment B	Segment C
		Stop

Small Assembly System (Using Non-contact Door Switches)

- Both robots will stop when the emergency stop switch is pressed.
- Robot A will stop when robot door A is opened.
- Robot B will stop when robot door B is opened





Operation Examples

(1) Emergency stop is switch pressed.

Robot A	Robot B
Stop	Stop

(2) Robot door A is opened.

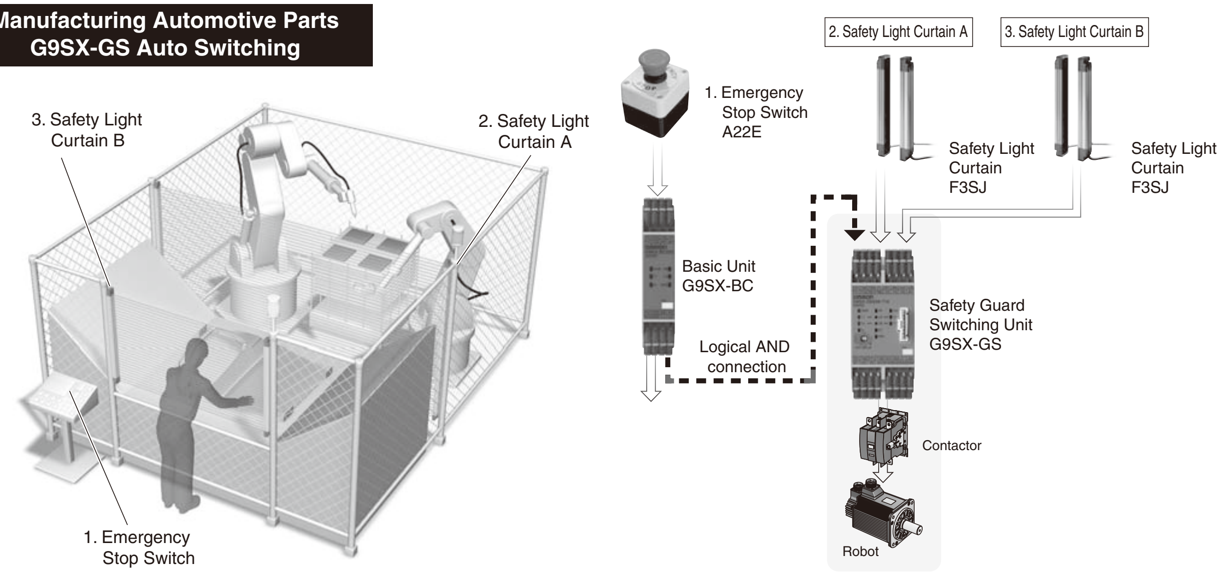
Robot A	Robot B
Stop	

(3) Robot door B is opened.

Robot A	Robot B
	Stop

Refer to D40A/G9SX-NS when using the D40A Compact Non-contact Door Switch and the G9SX-NS Flexible Safety Unit.

Manufacturing Automotive Parts
G9SX-GS Auto Switching

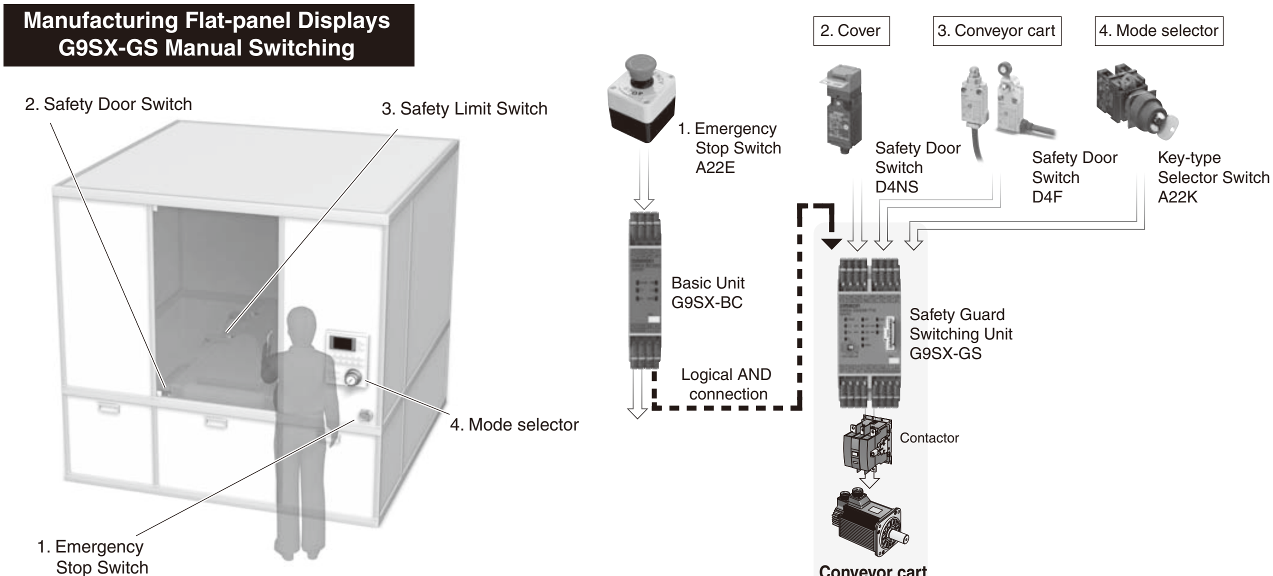


Auto switching

Emergency Stop Switch — When pressed, processing will stop.

Safety Light Curtain A
Safety Light Curtain B — When both are interrupted simultaneously, processing will stop.

Manufacturing Flat-panel Displays
G9SX-GS Manual Switching



Normal operating mode

Manual switching

Emergency Stop Switch — When pressed, processing will stop.

Cover — When the cover is opened, processing will stop.

Conveyor cart — Processing will continue regardless of the conveyor cart position.

Maintenance mode

Manual switching

Emergency Stop Switch — When pressed, processing will stop.

Cover — Processing will continue regardless of whether the cover is opened or closed.

Conveyor cart — When the conveyor cart moves away from its safe position, processing will stop.

Refer to G9SX-GS for information on the G9SX-GS Safety Guard Switching Unit.

Model Number Structure

Model Number Legend

G9SX-□□□□□□-□□□-□□
1 2 3 4 5 6

1. Functions
AD/ADA: Advanced Unit
BC: Basic Unit
EX: Expansion Unit

2. Output Configuration (Instantaneous Safety Outputs)
0: None
2: 2 outputs
3: 3 outputs
4: 4 outputs

3. Output Configuration (OFF-delayed Safety Outputs)
0: None
2: 2 outputs
4: 4 outputs

4. Output Configuration (Auxiliary Outputs)
1: 1 output
2: 2 outputs

5. Max. OFF-delay Time
Advanced Unit
T15: 15 s
T150: 150 s
Basic Unit
No indicator: No OFF delay
Expansion Unit
No indicator: No OFF delay
T: OFF delay

6. Terminal Block Type
RT: Screw terminals
RC: Spring-cage terminals

Ordering Information

List of Models

Advanced Unit

Safety outputs *3		Auxiliary outputs *4	Logical AND connection		No. of input channels	Max. OFF-delay time *1	Rated voltage	Terminal block type	Model
Instantaneous	OFF-delayed *2		Inputs	Outputs					
3 (Semiconductor)	2 (Semiconductor)	2 (Semiconductor)	1 (Semi-conductor)	1 (Semi-conductor)	1 or 2 channels	15 s	24 VDC	Screw terminals	**G9SX-AD322-T15-RT**
								Spring-cage terminals	**G9SX-AD322-T15-RC**
						150 s		Screw terminals	**G9SX-AD322-T150-RT**
								Spring-cage terminals	**G9SX-AD322-T150-RC**
2 (Semiconductor)			2 (Semi-conductor)	2 (Semi-conductor)		15 s		Screw terminals	**G9SX-ADA222-T15-RT**
								Spring-cage terminals	**G9SX-ADA222-T15-RC**
						150 s		Screw terminals	**G9SX-ADA222-T150-RT**
								Spring-cage terminals	**G9SX-ADA222-T150-RC**

*1. The OFF-delay time can be set in 16 steps as follows:
T15: 0/0.2/0.3/0.4/0.5/0.6/0.7/1/1.5/2/3/4/5/7/10/15 s
T150: 0/10/20/30/40/50/60/70/80/90/100/110/120/130/140/150 s
*2. The OFF-delayed output becomes an instantaneous output by setting the OFF-delay time to 0 s.
*3. P channel MOS FET transistor output
*4. PNP transistor output

Basic Unit

Safety outputs *1		Auxiliary outputs *2	No. of input channels	Rated voltage	Terminal block type	Model
Instantaneous	OFF-delayed					
2	---	2 (Semiconductor)	1 or 2 channels	24 VDC	Screw terminals	**G9SX-BC202-RT**
					Spring-cage terminals	**G9SX-BC202-RC**

*1. P channel MOS FET transistor output
*2. PNP transistor output

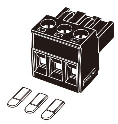
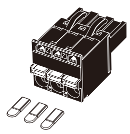
Expansion Unit

Safety outputs		Auxiliary outputs *1	OFF-delay time	Rated voltage	Terminal block type	Model
Instantaneous	OFF-delayed					
4 PST-NO	---	1 (Semiconductor)	---	24 VDC	Screw terminals	**G9SX-EX401-RT**
					Spring-cage terminals	**G9SX-EX401-RC**
---	4 PST-NO		*2		Screw terminals	**G9SX-EX041-T-RT**
					Spring-cage terminals	**G9SX-EX041-T-RC**

*1. PNP transistor output
*2. The OFF-delay time is synchronized to the OFF-delay time setting in the connected Advanced Unit (G9SX-AD-□/G9SX-ADA-□).

Accessories

Terminal Block

Appearance *	Specifications	Applicable units	Model	Remarks
	Terminal Block with screw terminals (3-pin)	G9SX-AD-□ G9SX-ADA-□	**Y9S-03T1B-02A**	Two Terminal Blocks (black) with screw terminals, and a set of six code marks to prevent erroneous insertion.
	Terminal Block with screw terminals (4-pin)	G9SX-BC-□ G9SX-EX-□	**Y9S-04T1B-02A**	Two Terminal Blocks (black) with screw terminals, and a set of six code marks to prevent erroneous insertion.
	Terminal Block with spring-cage terminals (3-pin)	G9SX-AD-□ G9SX-ADA-□	**Y9S-03C1B-02A**	Two Terminal Blocks (black) with spring-cage terminals, and a set of six code marks to prevent erroneous insertion.
	Terminal Block with spring-cage terminals (4-pin)	G9SX-BC-□ G9SX-EX-□	**Y9S-04C1B-02A**	Two Terminal Blocks (black) with spring-cage terminals, and a set of six code marks to prevent erroneous insertion.

Note: The G9SX main unit comes with a terminal block as standard equipment. The accessories shown here can be ordered as a replacement.
* The illustrations show 3-pin types

Specifications

Ratings

Power input

Item Model	G9SX-AD322-□/ADA222-□	G9SX-BC202-□	G9SX-EX-□
Rated supply voltage	24 VDC		
Operating voltage range	–15% to 10% of rated supply voltage		
Rated power consumption *	4 W max.	3 W max.	2 W max.

* Power consumption of loads not included.

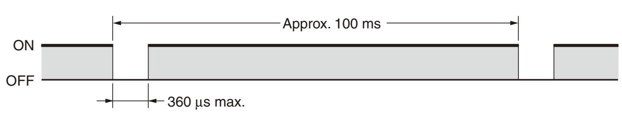
Inputs

Item Model	G9SX-AD322-□/ADA222-□	G9SX-BC202-□
Safety input	Operating voltage: 20.4 VDC to 26.4 VDC, internal impedance: approx. 2.8 kΩ	
Feedback/reset input		

Outputs

Item Model	G9SX-AD322-□/ADA222-□	G9SX-BC202-□
Instantaneous safety output *1 **OFF-delayed safety output *1**	P channel MOS FET transistor output Load current: Using 2 outputs or less: 1 A DC max. *2 Using 3 outputs or more: 0.8 A DC max.	P channel MOS FET transistor output Load current: Using 1 output: 1 A DC max. *2 Using 2 outputs: 0.8 A DC max.
Auxiliary output	PNP transistor output Load current: 100 mA max.	

*1. While safety outputs are in the ON state, the following signal sequence is output continuously for diagnosis. When using the safety outputs as input signals to control devices (i.e. Programmable Controllers), consider the OFF pulse shown below.



*2. The following derating is required when Units are mounted side-by-side.
G9SX-AD322-□/G9SX-ADA222-□/G9SX-BC202-□: 0.4 A max. load current

Expansion Unit Ratings

Item Model	G9SX-EX-□
Rated load	250 VAC, 3A/30 VDC, 3A (resistive load)
Rated carry current	3 A
Maximum switching voltage	250 VAC, 125 VDC

Characteristics

Item	Model	G9SX-AD322-□/ADA222-□	G9SX-BC202-□	G9SX-EX-□
Overvoltage category (IEC/EN 60664-1)		II		II (Safety relay outputs 13 to 43 and 14 to 44: III)
Operating time (OFF to ON state) *1		50 ms max. (Safety input: ON) *2 100 ms max. (Logical AND connection input: ON) *3	50 ms max. (Safety input: ON)	30 ms max. *4
Response time (ON to OFF state) *1		15 ms max.		10 ms max. *4
ON-state residual voltage		3.0 V max. (safety output, auxiliary output)		
OFF-state leakage current		0.1 mA max. (safety output, auxiliary output)		
Maximum wiring length of safety input and logic AND input		100 m max. (External connection impedance: 100 Ω max. and 10 nF max.)		
Reset input time (Reset button pressing time)		100 ms min.		
Accuracy of OFF-delay time *5		Within ± 5% of the set value	---	Within ± 5% of the set value
Insulation resistance	**Between logical AND connection terminals, and power supply input terminals and other input and output terminals connected together**	20 MΩ min. (at 100 VDC)	---	---
	Between all terminals connected together and DIN track		20 MΩ min. (at 100 VDC)	100 MΩ min. (at 500 VDC)
Dielectric strength	**Between logical AND connection terminals, and power supply input terminals and other input and output terminals connected together**	500 VAC for 1 min	---	---
	Between all terminals connected together and DIN track		500 VAC for 1 min	1,200 VAC for 1 min
	Between different poles of outputs	---	---	
	Between safety relay outputs connected together and other terminals connected together			2,200 VAC for 1 min
Vibration resistance		Frequency: 10 to 55 to 10 Hz, 0.375-mm single amplitude (0.75-mm double amplitude)		
Shock resistance	**Destruction**	300 m/s^2		
	Malfunction	100 m/s^2		
Durability	**Electrical**	---		100,000 cycles min. (rated load, switching frequency: 1,800 cycles/hour)
	Mechanical	---		5,000,000 cycles min. (switching frequency: 7,200 cycles/hour)
Ambient operating temperature		−10 to 55°C (with no icing or condensation)		
Ambient operating humidity		25% to 85%		
Terminal tightening torque *6		0.5 N·m		
Weight		Approx. 200 g	Approx. 125 g	Approx. 165 g

*1. When two or more Units are connected by logical AND, the operating time and response time are the sum total of the operating times and response times, respectively, of all the Units connected by logical AND.
*2. Represents the operating time when the safety input turns ON with all other conditions set.
*3. Represents the operating time when the logical AND input turns ON with all other conditions set.
*4. This does not include the operating time or response time of Advanced Units that are connected.
*5. This does not include the operating time or response time of internal relays in the G9SX-EX-□.
*6. For the G9SX-□-RT (with screw terminals) only.

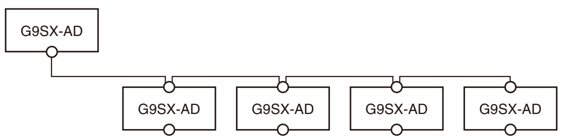
Logical AND Connection

Item / Model	G9SX-AD322-□/ADA222-□	G9SX-BC202-□	G9SX-EX-□
Number of Units connected per logical AND output	4 Units max.		---
Total number of Units connected by logical AND *1	20 Units max.		---
Number of Units connected in series by logical AND	5 Units max.		---
Max. number of Expansion Units connected *2	---		5 Units max.
Maximum cable length for logical AND input	100 m max.		---

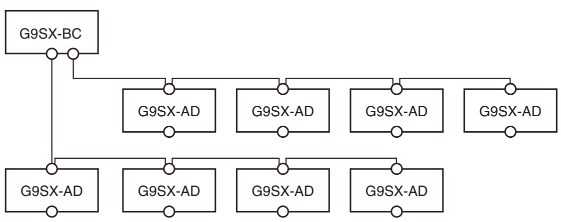
Note: See Logical AND Connection Combinations below for details.
*1. The number of G9SX-EX401-□ Expansion Units or G9SX-EX041-T-□ Expansion Units (OFF-delayed Model) not included.
*2. G9SX-EX401-□ Expansion Units and G9SX-EX041-T-□ Expansion Units (OFF-delayed Model) can be mixed.

Logical AND Connection Combinations

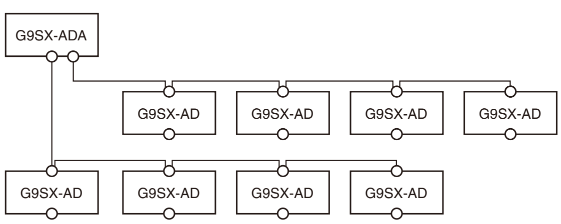
1. One logical AND connection output from an Advanced Unit G9SX-AD can be logical AND connected to up to four Advanced Units.



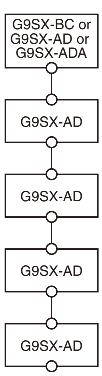
2. Two logical AND outputs from a Basic Unit G9SX-BC can be logical AND connected to up to eight Advanced Units.



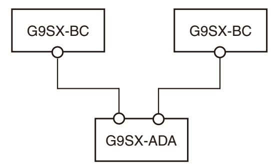
3. Two logical AND outputs from an Advanced Unit G9SX-ADA can be logical AND connected to up to eight Advanced Units.



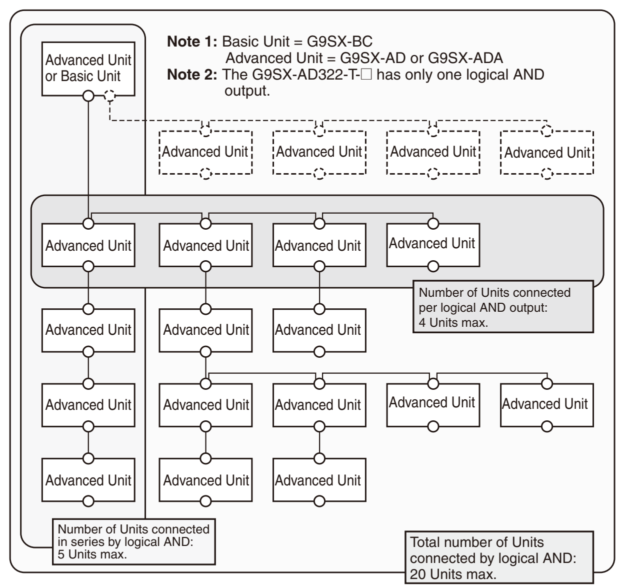
4. Any Advanced Unit with logical AND input can be logical AND connected to Advanced Units on up to five tiers.



5. Two logical AND connection outputs, each from different Advanced/Basic Units, can be logical AND connected to a single G9SX-ADA Unit.



6. The largest possible system configuration contains a total of 20 Advanced and Basic Units. In this configuration, each Advanced Unit can have up to five Expansion Units.



Response Time and Operating Time

The following table shows the response time for two or more Units that are logical AND connected.

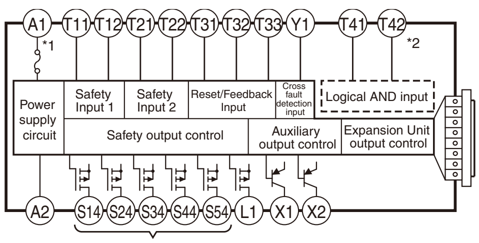
Item / Tier	Block flow diagram	Max. response time *1 (not including Expansion Units)	Max. response time *2 (including Expansion Units)	Max. operating time *3 (not including Expansion Units)	Max. operating time *4 (including Expansion Units)
First tier	 ↓ Advanced Unit or Basic Unit	15 ms	25 ms	50 ms	80 ms
Second tier	↓ Advanced Unit	30 ms	40 ms	150 ms	180 ms
Third tier	↓ Advanced Unit	45 ms	55 ms	250 ms	280 ms
Fourth tier	↓ Advanced Unit	60 ms	70 ms	350 ms	380 ms
Fifth tier	↓ Advanced Unit ↓ 	75 ms	85 ms	450 ms	480 ms

*1. The maximum response time (not including Expansion Units) in this block flow diagram is the time it takes the output from the Unit on the lowest tier to switch from ON to OFF after the input to the Unit on the highest tier switches from ON to OFF.
*2. The maximum response time (including Expansion Units) in this block flow diagram is the time it takes the output from the Expansion Unit connected to the Unit on the lowest tier to switch from ON to OFF after the input to the Unit on the highest tier switches from ON to OFF.
*3. The maximum operating time (not including Expansion Units) in this block flow diagram is the time it takes the output from the Unit on the lowest tier to switch from OFF to ON after the input to the Unit on the highest tier switches from OFF to ON.
*4. The maximum operating time (including Expansion Units) in this block flow diagram is the time it takes the output from the Expansion Unit connected to the Unit on the lowest tier to switch from OFF to ON after the input to the Unit on the highest tier switches from OFF to ON.

Connections

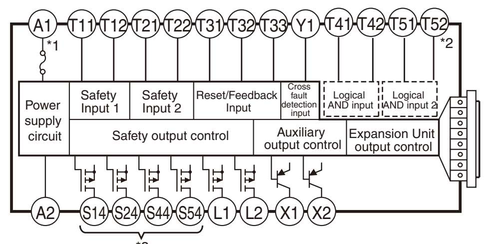
Internal Connection

G9SX-AD322-□ (Advanced Unit)



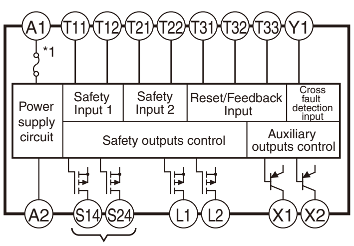
*1. Internal power supply circuit is not isolated.
*2. Logical AND input is isolated.
*3. Outputs S14 to S54 are internally redundant.

G9SX-ADA222-□ (Advanced Unit)



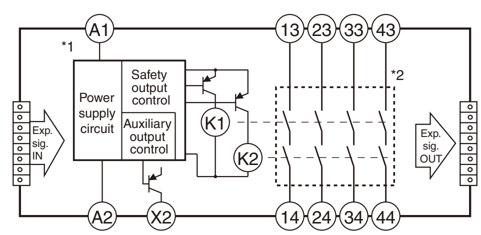
*1. Internal power supply circuit is not isolated.
*2. Logical AND inputs are isolated.
*3. Outputs S14 to S54 are internally redundant.

G9SX-BC202-□ (Basic Unit)



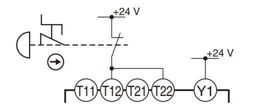
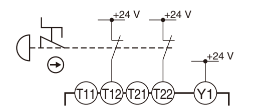
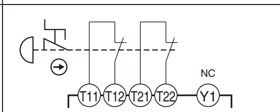
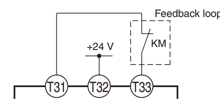
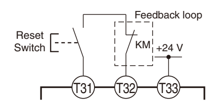
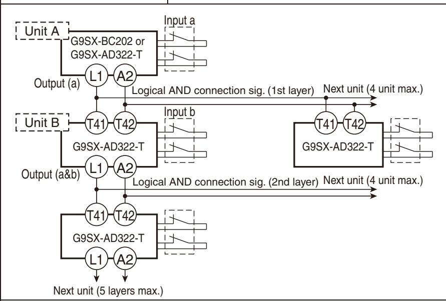
*1. Internal power supply circuit is not isolated.
*2. Outputs S14 and S24 are internally redundant.

G9SX-EX401-□/G9SX-EX041-T-□ (Expansion Unit / Expansion Unit OFF-delayed model)



*1. Internal power supply circuit is not isolated.
*2. Relay outputs are isolated.

Wiring of Inputs and Outputs

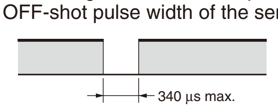
Signal name	Terminal name	Description of operation	Wiring	
Power supply input	A1, A2	The input terminals for power supply. Connect the power source to the A1 and A2 terminals.	Connect the power supply plus (24 VDC) to the A1 terminal. Connect the power supply minus (GND) to the A2 terminal.	
Safety input 1	T11, T12	To set the safety outputs in the ON state, the ON state signals must be input to both safety input 1 and safety input 2. Otherwise the safety outputs cannot be in the ON state.	Corresponds to Safety Category 2	
Safety input 2	T21, T22		Corresponds to Safety Category 3	
			Corresponds to Safety Category 4	
Feedback/reset input	T31, T32, T33	To set the safety outputs in the ON state, the ON state signal must be input to T33. Otherwise the safety outputs cannot be in the ON state.	Auto reset	
		To set the safety outputs in the ON state, the signal input to T32 must change from the OFF state to the ON state, and then to the OFF state. Otherwise the safety outputs cannot be in the ON state.	Manual reset	
Logical AND connection input	T41, T42, T51, T52	A logical AND connection means that one unit (Unit A) outputs a safety signal “a” to a subsequent unit (Unit B) and Unit B calculates the logical multiplication (AND) (i.e., outputs the AND) of the signal “a” and safety signal “b”, which is input to Unit B. Thereby the logic of the safety output of Unit B is “a” AND “b”. (An AND of inputs “a” and “b” is output.) To set the safety outputs of the subsequent Unit in the ON state, its logical AND connection preset switch must be set to AND (enable) and the HIGH state signal must be input to T41 of the subsequent unit.		
Cross fault detection input	Y1	Selects the mode for the failure detecting (cross fault detecting) function for the safety inputs of G9SX corresponding to the connection of the cross fault detection input.	Keep Y1 open when using T11, T21. (Wiring corresponding to category 4) Connect Y1 to 24 VDC when not using T11, T21. (Wiring corresponding to category 2 or 3, or when connecting safety sensors)	
Instantaneous safety output	S14, S24, S34	Turns ON/OFF according to the state of the safety inputs, feedback/reset inputs, and logical AND connection inputs. During OFF-delay state, the Instantaneous safety outputs are not able to turn ON.	Keep these outputs open when not used.	
OFF-delayed safety output	S44, S54	OFF-delayed safety outputs. The OFF-delay time is set by the OFF-delay preset switch. When the delay time is set to zero, these outputs can be used as instantaneous safety outputs.	Keep these outputs open when not used.	
Logical AND connection output	L1, L2	Outputs a signal of the same logic as the instantaneous safety outputs.	Keep these outputs open when not used.	
Auxiliary monitor output	X1	Outputs a signal of the same logic as the instantaneous safety outputs	Keep these outputs open when not used.	
Auxiliary error output	X2	Outputs when the error indicator is lit or blinking.	Keep these outputs open when not used.	

Connecting Safety Sensors and the G9SX

1. When connecting safety sensors to the G9SX, the Y1 terminal must be connected to 24 VDC.
The G9SX will detect a connection error, if the Y1 terminal is open.

2. In many cases, safety sensor outputs include an OFF-shot pulse for self diagnosis.
The following condition of test pulse is applicable as safety inputs for the G9SX.

- OFF-shot pulse width of the sensor, during the ON-state: 340 µs max.



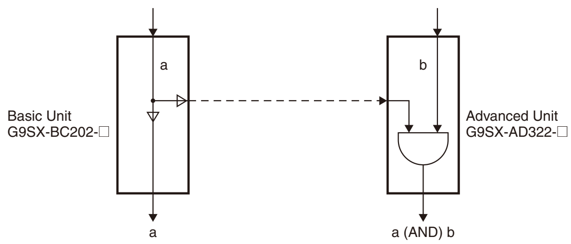
Operation

Functions

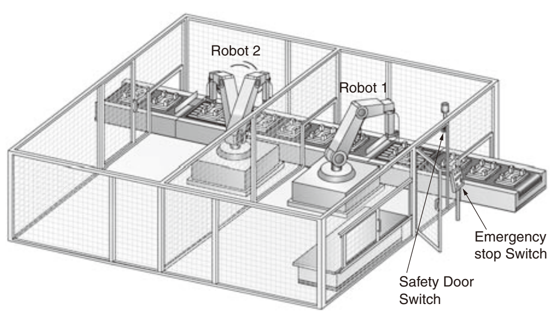
Logical AND Connection

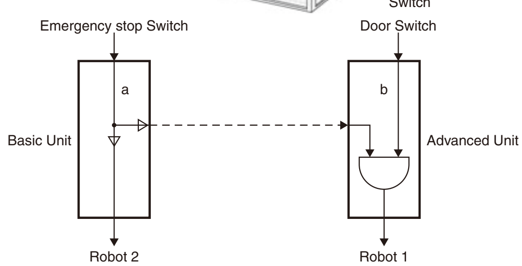
● Example with G9SX-AD322-□

The logical AND connection means that the Basic Unit (or Advanced Unit) outputs a safety signal “a” to an Advanced Unit, and the Advanced Unit calculates the logical multiplication (AND) of the safety signal “a” and safety signal “b.” The safety output of an Advanced Unit with the logical AND connection shown in the following diagram is “a” AND “b”.



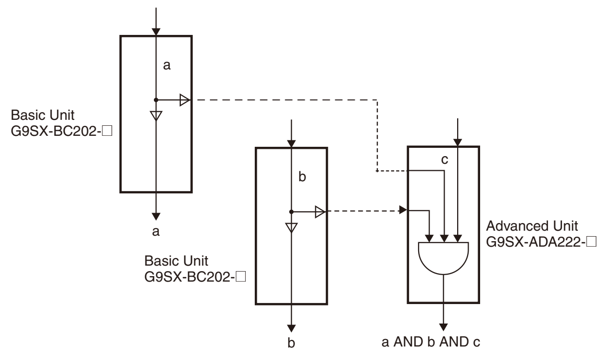
This is illustrated using the application in the following diagram as an example. The equipment here has two hazards identified as Robot 1 and Robot 2, and it is equipped with a safety door switch and an emergency stop button. You may have overall control where both Robot 1 and Robot 2 are stopped every time the emergency stop button is pressed. You may also have partial control where only Robot 1, which is closest to the door, is stopped when the door is opened. In that case, Robot 2 will continue to operate.
The actual situation using a G9SX for this application is shown in this example.
(Note: The logical AND setting on the Advanced Unit must be set to AND (enabled).)





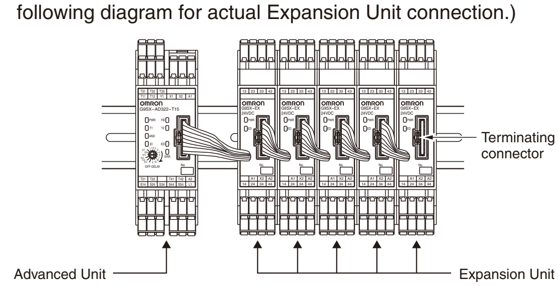
● Example with G9SX-ADA222-□

The Advanced Unit G9SX-ADA222-□ is equipped with two logical AND connection inputs. Therefore, it is capable of receiving two safety signals, each from different Advanced or Basic Units. As shown in the diagram below, the output of Advanced Unit G9SX-ADA222-□ will be “a” AND “b” AND “c”.



Connecting Expansion Units

- The G9SX-EX and G9SX-EX-T Expansion Units can be connected to an Advanced Unit (G9SX-AD322-□/G9SX-ADA222-□) to increase the number of safety outputs. (They cannot be connected to a Basic Unit.)
- A maximum of five Expansion Units can be connected to one Advanced Unit. This may be a combination of G9SX-EX Instantaneous types and G9SX-EX-T OFF-delayed types.
- Remove the terminating connector from the receptacle on the Advanced Unit and insert the Expansion Unit cable connector into the receptacle. Insert the terminating connector into the receptacle on the Expansion Unit at the very end (rightmost).
- When Expansion Units are connected to an Advanced Unit, make sure that power is supplied to every Expansion Unit. (Refer to the following diagram for actual Expansion Unit connection.)

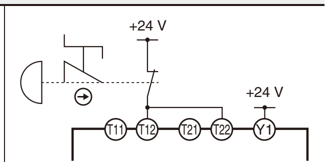
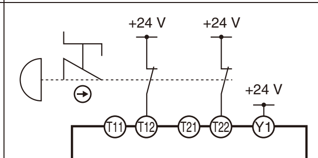
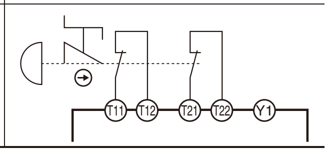


Setting Procedure

1.Cross Fault Detection (Advanced Unit/Basic Unit)

Set the cross fault detection mode for safety inputs by shorting Y1 to 24 V or leaving it open. When cross fault detection is set to ON, short-circuit failures are detected between safety inputs T11-T12 and T21-22. When a cross fault is detected, the following will occur.

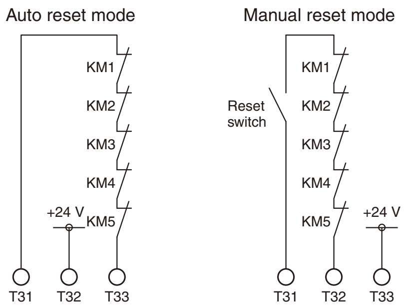
1. The safety outputs and logical AND outputs lock out.
2. The LED error indicator is lit.
3. The error output (auxiliary output) turns ON.

Cross fault detection	Wiring	
OFF	Corresponds to Safety Category 2	
	Corresponds to Safety Category 3	
ON	Corresponds to Safety Category 4	

2.Reset Mode (Advanced Unit/Basic Unit)

Set the reset mode using feedback/reset input terminals T31, T32, and T33.

Auto reset mode is selected when terminal T32 is shorted to 24 V and manual reset mode is selected when terminal T33 is shorted to 24 V.

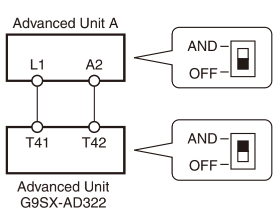


3.Setting Logical AND Connection (Advanced Unit)

When connecting two or more Advanced Units (or Basic Units) by logical AND connection, set the logical AND connection preset switch on the Advanced Unit that is on the input side (Advanced Unit G9SX-AD322 in the following diagram) to AND.

The default setting of the logical AND connection preset switch is set to OFF.

(1) Using G9SX-AD322 on the Input Side

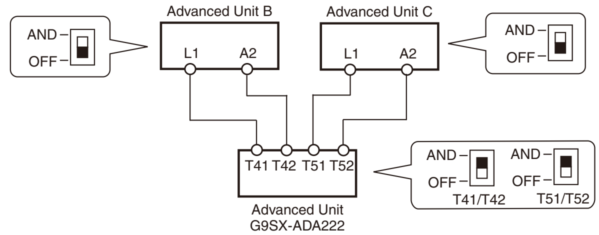


Note: 1. A setting error will occur and Advanced Unit G9SX-AD322 will lock out if the logical AND setting switch on the Unit is set to OFF.

2. Set the logical AND setting switch on Advanced Unit A to OFF or an error will occur.

3. A logical AND input cannot be sent to a Basic Unit.

(2) Using G9SX-ADA222 on the Input Side



Note: 1. When not connecting Advanced Unit B, leave terminals T41 and T42 of the G9SX-ADA222 Advanced Unit open, and set the logical AND setting switch T41/T42 to OFF.

2. When not connecting Advanced Unit C, leave terminals T51 and T52 of the G9SX-ADA222 Advanced Unit open, and set the logical AND setting switch T51/T52 to OFF.

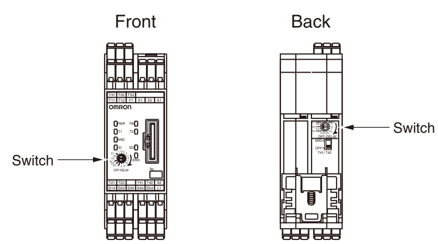
The following table shows the relationship between the logical ON setting switches and the conditions for safety outputs turning ON.

Logical AND connection preset switch		Conditions for safety outputs turning ON		
T41/T42	T51/T52	Safety input	Logic input 1	Logic input 2
OFF	OFF	ON	OFF	OFF
AND	OFF	ON	ON	OFF
OFF	AND	ON	OFF	ON
AND	AND	ON	ON	ON

4.Setting the OFF-delay Time (Advanced Unit)

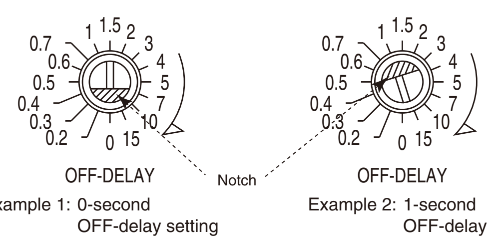
The OFF-delay preset time on an Advanced Unit is set from the OFF-delay time preset switch (1 each on the front and back of the Unit). Normal operation will only occur if both switches are identically set. An error will occur if the switches are not identically set.

The default setting of the OFF-delay time preset switch is set to 0 s.



Refer to the following illustration for details on setting switch positions.

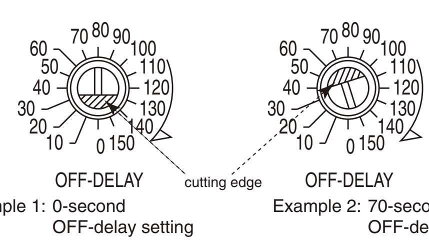
G9SX-AD322-T15/G9SX-ADA222-T15



Example 1: 0-second OFF-delay setting

Example 2: 1-second OFF-delay setting

G9SX-AD322-T150/G9SX-ADA222-T150



Example 1: 0-second OFF-delay setting

Example 2: 70-second OFF-delay setting

LED Indicators

Marking	Color	Name	G9SX-AD	G9SX-ADA	G9SX-BC	G9SX-EX	G9SX-EX-T	Function	Reference
PWR	**Green**	**Power supply indicator**	❍	❍	❍	❍	❍	Lights up while power is supplied.	---
T1	**Orange**	**Safety input 1 indicator**	❍	❍	❍	---	---	Lights up while a HIGH state signal is input to T12. Blinks when an error relating to safety input 1 occurs.	*
T2	**Orange**	**Safety input 2 indicator**	❍	❍	❍	---	---	Lights up while a HIGH state signal is input to T22. Blinks when an error relating to safety input 2 occurs.	
FB	**Orange**	**Feedback/ reset input indicator**	❍	❍	❍	---	---	Lights up in the following cases: • With automatic reset while a HIGH state signal is input to T33. • With manual reset while a HIGH state signal is input to T32. Blinks when an error relating to feedback/reset input occurs.	
AND	**Orange**	**Logical AND input indicator**	❍	---	---	---	---	Lights up while a HIGH state signal is input to T41. Blinks when an error relating to logical AND connection input occurs.	
AND1	**Orange**	**Logical AND input indicator**	---	❍	---	---	---	Lights up while a HIGH state signal is input to T41. Blinks when an error relating to logical AND connection input occurs.	
AND2	**Orange**	**Logical AND input indicator**	---	❍	---	---	---	Lights up while a HIGH state signal is input to T51. Blinks when an error relating to logical AND connection input occurs.	
EI	**Orange**	**Safety output indicator**	❍	❍	❍	❍	---	Lights up while the Instantaneous safety outputs (S14, S24, S34) are in the ON-state. Blinks when an error relating to the instantaneous safety output occurs.	
ED	**Orange**	**OFF-delayed safety output indicator**	❍	❍	---	---	❍	Lights up while OFF-delayed safety outputs (S44, S54) are in the ON-state. Blinks when an error relating to OFF-delayed safety output occurs.	
ERR	**Red**	**Error indicator**	❍	❍	❍	❍	❍	Lights up or blinks when an error occurs.	

* Refer to *Fault Detection* on the next page for details.

Settings Indication (at Power ON)

Settings for the G9SX can be checked by the orange indicators for approx. 3 seconds after the power is turned ON. During this settings indication period, the ERR indicator will light, however the auxiliary error output will remain OFF

Indicator	Item	Setting position	Indicator status	Setting mode	Setting status
T1	**Cross fault detection mode**	Y1 terminal	Lit	Cross fault detection mode: ON	Y1 = open
			Not lit	Cross fault detection mode: OFF	Y1 = 24 VDC
FB	**Reset mode**	T32 or T33 terminal	Lit	Manual reset mode	T33 = 24 VDC
			Not lit	Auto reset mode	T32 = 24 VDC
AND (AND1, AND2)	**Logical AND connection input mode**	Logical AND connection preset switch	Lit	Enable logical AND input	“AND”
			Not lit	Disable logical AND input	“OFF”

Fault Detection

When the G9SX detects a fault, the ERR indicator and/or other indicators light up or blink to inform the user about the fault.

Check and take necessary measures referring to the following table, and then re-supply power to the G9SX.

(Advanced Unit/Basic Unit)

ERR indicator	Other indicator	Fault	Expected causes of the fault	Check points and measures to take
Blinks	---	Fault due to electro-magnetic disturbance or of internal circuits.	1) Excessive electro-magnetic disturbance 2) Failure of the internal circuit	1) Check the disturbance level around the G9SX and the related system. 2) Replace with a new product.
● Lights up	T1 blinks	Fault involved with safety input 1	1) Failure involving the wiring of safety input 1 2) Incorrect setting of cross fault detection input 3) Failure of the circuit of safety input 1	1) Check the wiring to T11 and T12. 2) Check the wiring to Y1. 3) Replace with a new product.
	T2 blinks	Fault involved with safety input 2	1) Failure involving the wiring of safety input 2 2) Incorrect setting of cross fault detection input 3) Failure of circuits of safety input 2	1) Check the wiring to T21 and T22. 2) Check the wiring to Y1. 3) Replace with a new product.
	FB blinks	Faults involved with feedback/reset input	1) Failures involving the wiring of feedback/ reset input. 2) Failures of the circuit of feedback/reset input	1) Check the wiring to T31, T32 and T33. 2) Replace with a new product.
		Fault in Expansion Unit	1) Improper feedback signals from Expansion Unit 2) Abnormal supply voltage to Expansion Unit 3) Failure of the circuit of safety relay contact outputs	1) Check the connecting cable of Expansion Unit and the connection of the termination socket. 2) Check the supply voltage to Expansion Unit. **Note:** Make sure that all Expansion units' PWR indicators are lit. 3) Replace the Expansion Unit with a new one.
	EI blinks	Fault involved with instantaneous safety outputs or logical AND connection outputs or auxiliary monitor output	1) Failure involving the wiring of instantaneous safety outputs 2) Failure of the circuit of Instantaneous safety outputs 3) Failure involving the wiring of the logical AND connection output 4) Failure of the circuit of the logical AND connection output 5) Failure involving the wiring of the auxiliary monitor output 6) Impermissible high ambient temperature	1) Check the wiring to S14, S24, and S34. 2) Replace with a new product. 3) Check the wiring to L1 and L2. 4) Replace with a new product. 5) Check the wiring to X1. 6) Check the ambient temperature and spacing around the G9SX.
	ED blinks	Fault involved with OFF-delayed safety outputs	1) Failure involving the wiring of OFF-delayed safety relay contact outputs 2) Incorrect set values for OFF-delay time 3) Failure of the circuit of OFF-delayed safety relay contact outputs 4) Impermissible high ambient temperature	1) Check the wiring to S44 and S54. 2) Confirm the set values of the two OFF-delay time preset switches. 3) Replace with a new product. 4) Check the ambient temperature and spacing around the G9SX.
	AND blinks (AND1, AND2)	Fault involved with logical AND connection input	1) Failure involving the wiring of the logical AND connection input 2) Incorrect setting for the logical AND connection input 3) Failure of the circuit of the logical AND connection input	1) Check the wiring to T41 and T42 (T51 and T52). **Note:** Make sure that the wiring length for the T41, T42, T51, T52 terminal is less than 100 meters. **Note:** Make sure that the logical AND connection signal is branched for less than 4 units. 2) Confirm the set value of the logical AND connection preset switch. 3) Replace with a new product.
	All indicators except PWR blink	Supply voltage outside the rated value	1) Supply voltage outside the rated value	1) Check the supply voltage to the Units.

When indicators other than the ERR indicator blink, check and take necessary actions referring to the following table.

ERR indicator	Other indicators		Fault	Expected cause of the fault	Check points and measures to take
○ Off	T1	Blink	Mismatch between input 1 and input 2.	The input status between input 1 and input 2 is different, due to contact failure or a short circuit of safety input device(s) or a wiring fault.	Check the wiring from safety input devices to the G9SX. Or check the input sequence of safety input devices. After removing the fault, turn both safety inputs to the OFF state.
	T2				

(Expansion Unit)

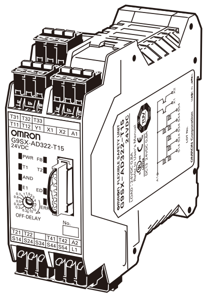
ERR indicator	Other indicators	Fault	Expected cause of the faults	Check points and measures to take
● Lights	---	Fault involved with safety relay outputs of Expansion Units	1)Welding of relay contacts 2)Failure of the internal circuit	Replace with a new product.

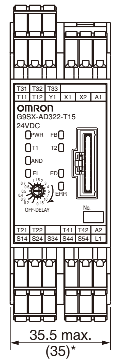
Dimensions

(Unit: mm)

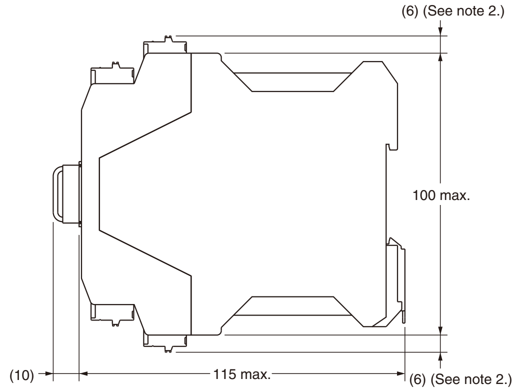
Advanced Unit

G9SX-AD322-□



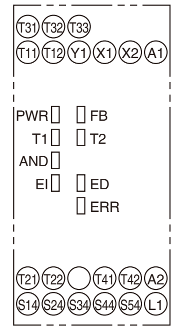


* Typical dimension



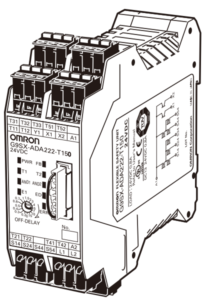
Note: 1. Above outline drawing is for -RC terminal type.
2. For -RC terminal type only.

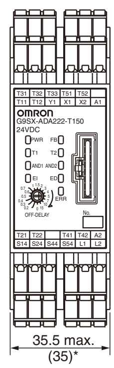
Terminal arrangement



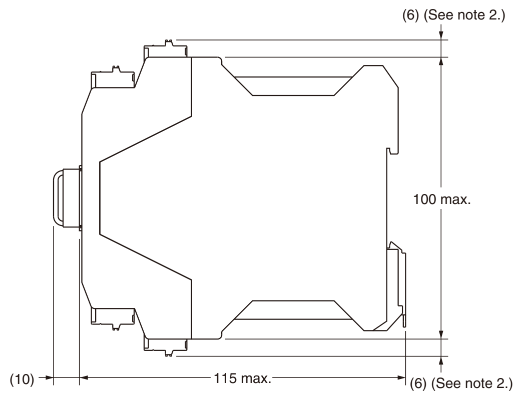
Advanced Unit

G9SX-ADA222-□



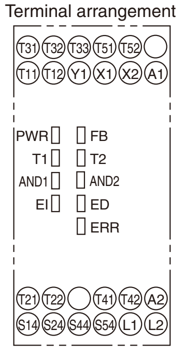


* Typical dimension



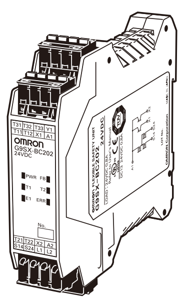
Note: 1. Above outline drawing is for -RC terminal type.
2. For -RC terminal type only.

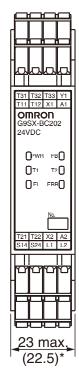
Terminal arrangement



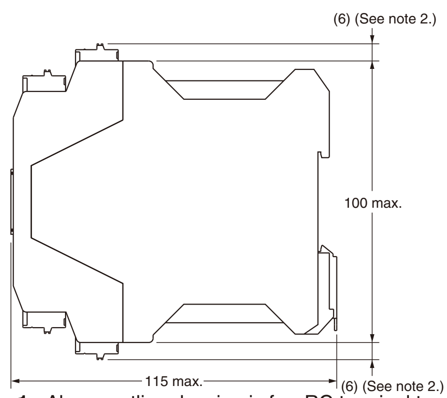
Basic Unit

G9SX-BC202-□



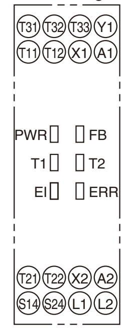


* Typical dimension



Note: 1. Above outline drawing is for -RC terminal type.
2. For -RC terminal type only.

Terminal arrangement

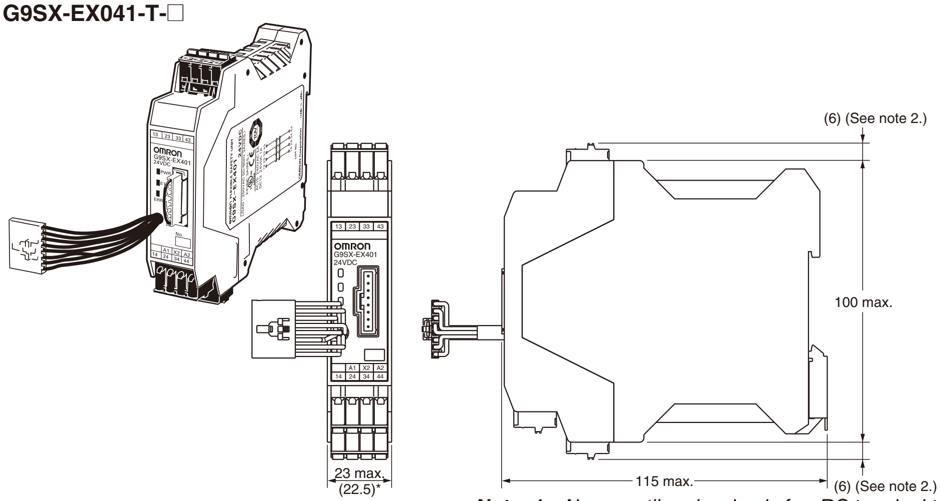


Expansion Unit

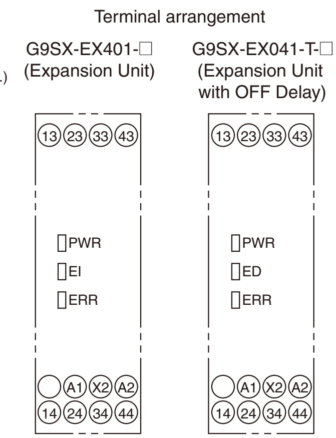
G9SX-EX401-□

Expansion Unit (OFF-delayed Model)

G9SX-EX041-T-□



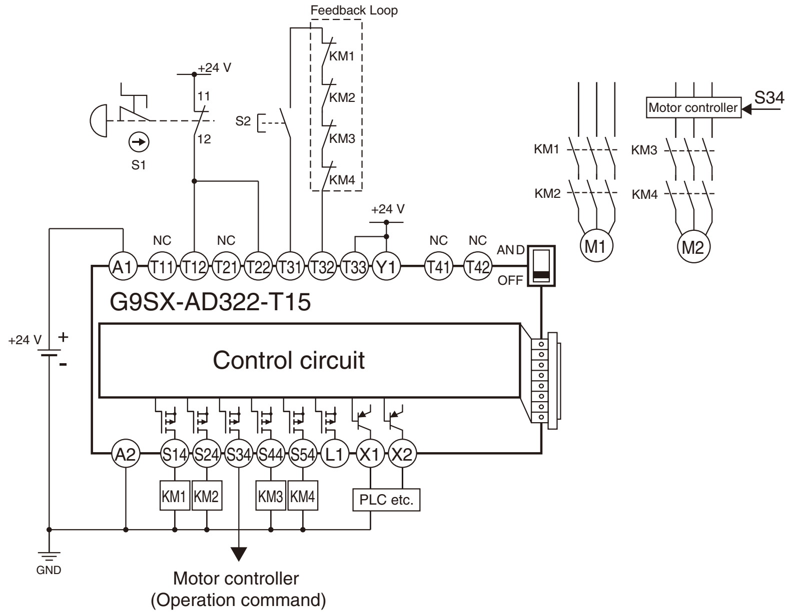
* Typical dimension

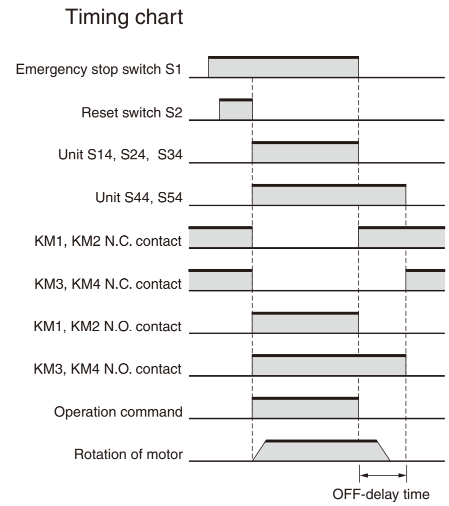


Note: 1. Above outline drawing is for -RC terminal type.
2. For -RC terminal type only.

Application Examples

G9SX-AD322-T15 (24 VDC) (1-channel Emergency Stop Switch Input / Manual Reset)

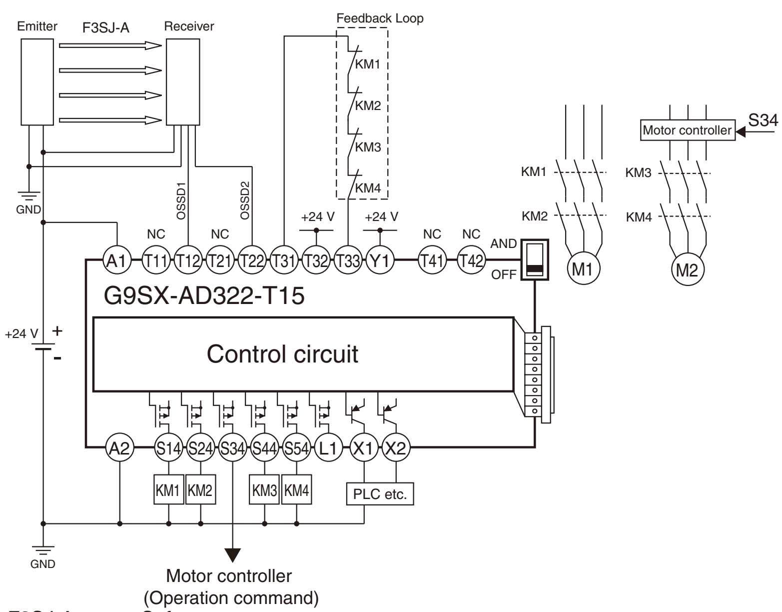


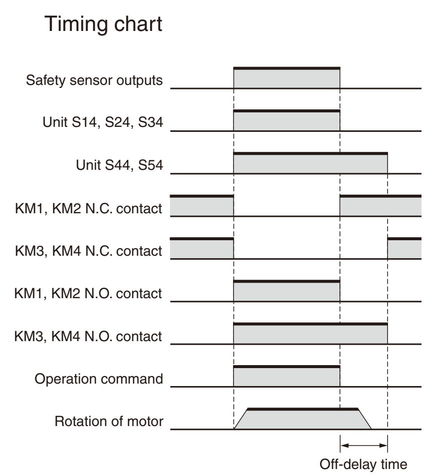


S1: Emergency Stop Switch
S2: Reset Switch S2
KM1 to KM4: Contactor
M1, M2: 3-phase motor

Note: This example corresponds to category 2.

G9SX-AD322-T15 (24 VDC) (2-channel Safety Sensor / Auto Reset)

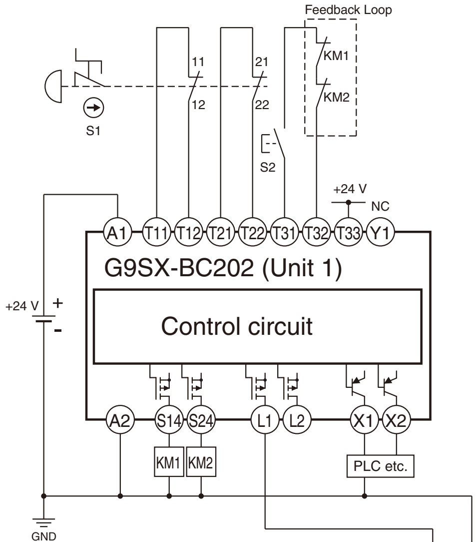


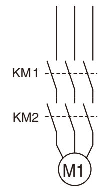


F3SJ-A: Safety sensor
KM1 to KM4: Contactor
M1, M2: 3-phase motor

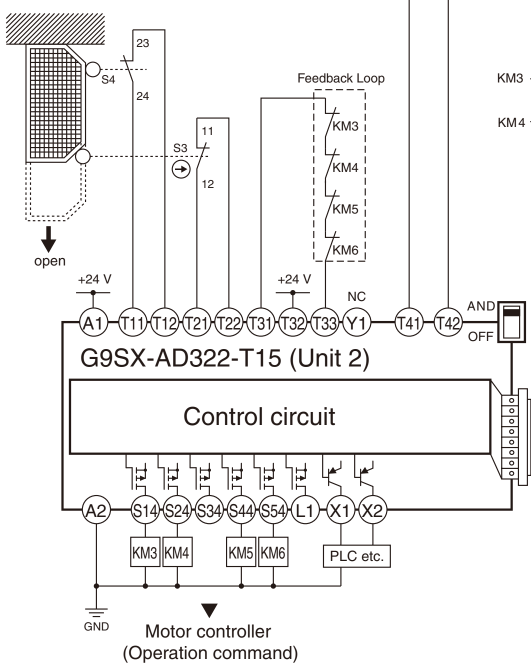
Note: 1. This example corresponds to category 4.
2. For further information of settings and wiring, refer to the catalog or instruction manual of the connected sensor.
3. Use safety sensors with PNP outputs.

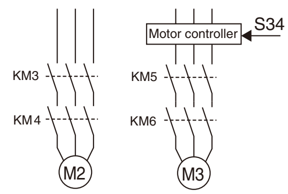
G9SX-BC202 (24 VDC) (2-channel Emergency Stop Switch Input / Manual Reset) + G9SX-AD322-T15 (24 VDC) (2-channel Safety Limit Switch Input / Auto Reset)



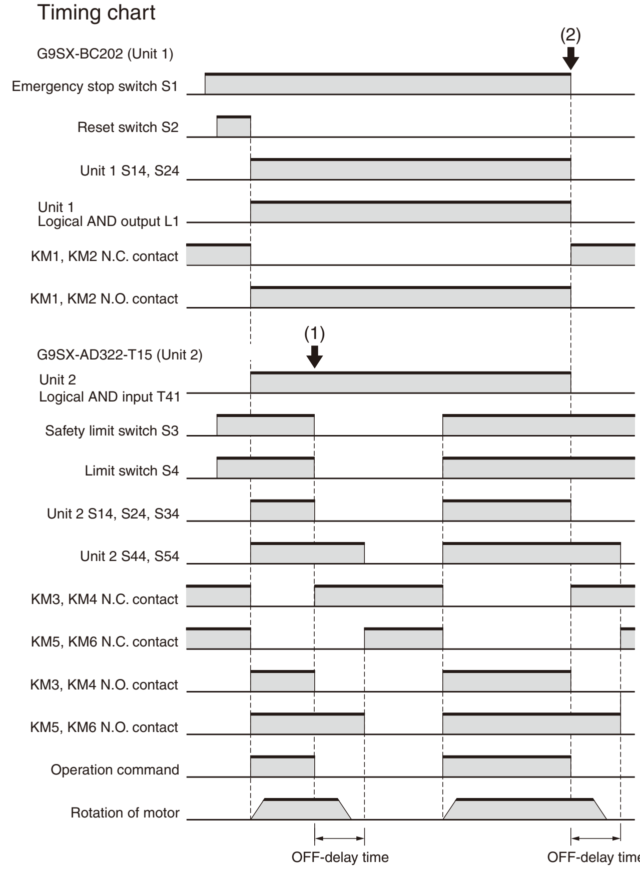


S1: Emergency Stop Switch
S2: Reset Switch
S3: Safety Limit Switch
S4: Limit Switch
KM1 to KM6: Contactor
M1 to M3: 3-phase motor





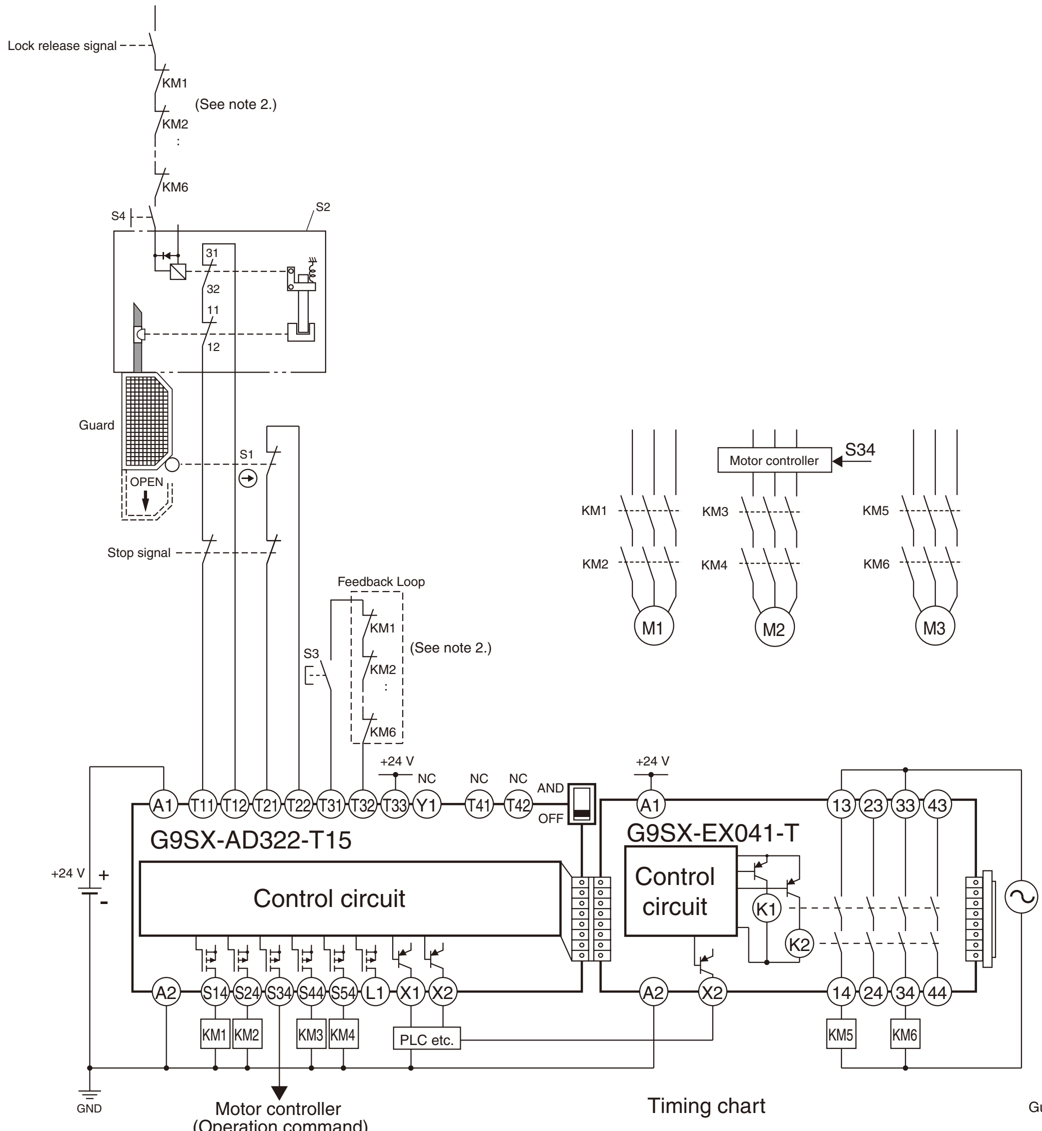
Timing chart



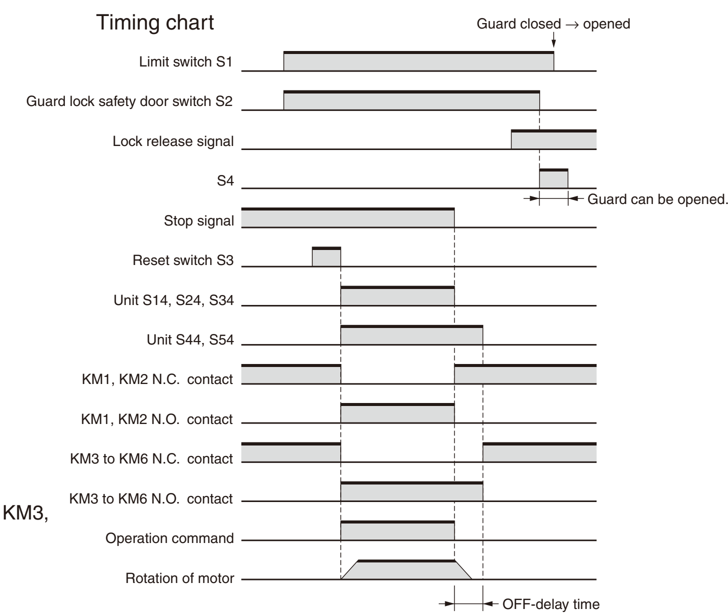
(1) Door opened: Only the Unit 2 stops.
(2) Emergency stop button pressed: Both the Unit 1 and 2 stop.

Note: This example corresponds to category 4.

G9SX-AD322-T15 (24 VDC) + G9SX-EX041-T (24 VDC)
(Guard Lock Safety Door Switch (Mechanical Lock), 2-channel Safety Limit Switch Inputs / Manual Reset)

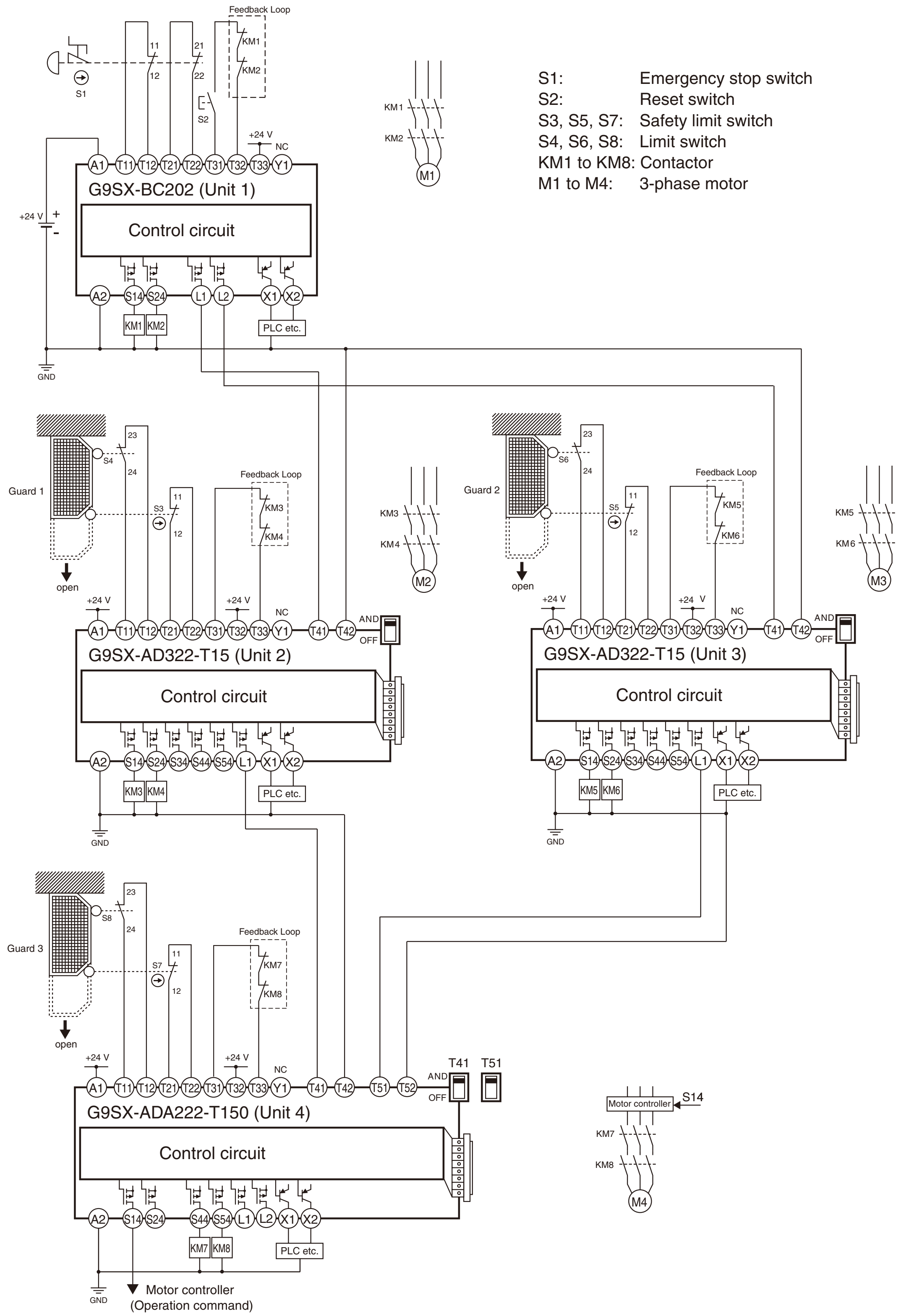


S1: Safety limit switch
S2: Guard lock safety door switch
S3: Reset switch
S4: Lock release switch
KM1 to KM6: Contactor
M1 to M3: 3-phase motor



Note: 1. This example corresponds to category 4.
2. Connect the N.C. contacts of contactors KM1, KM2, KM3, KM4, KM5, and KM6 in series.

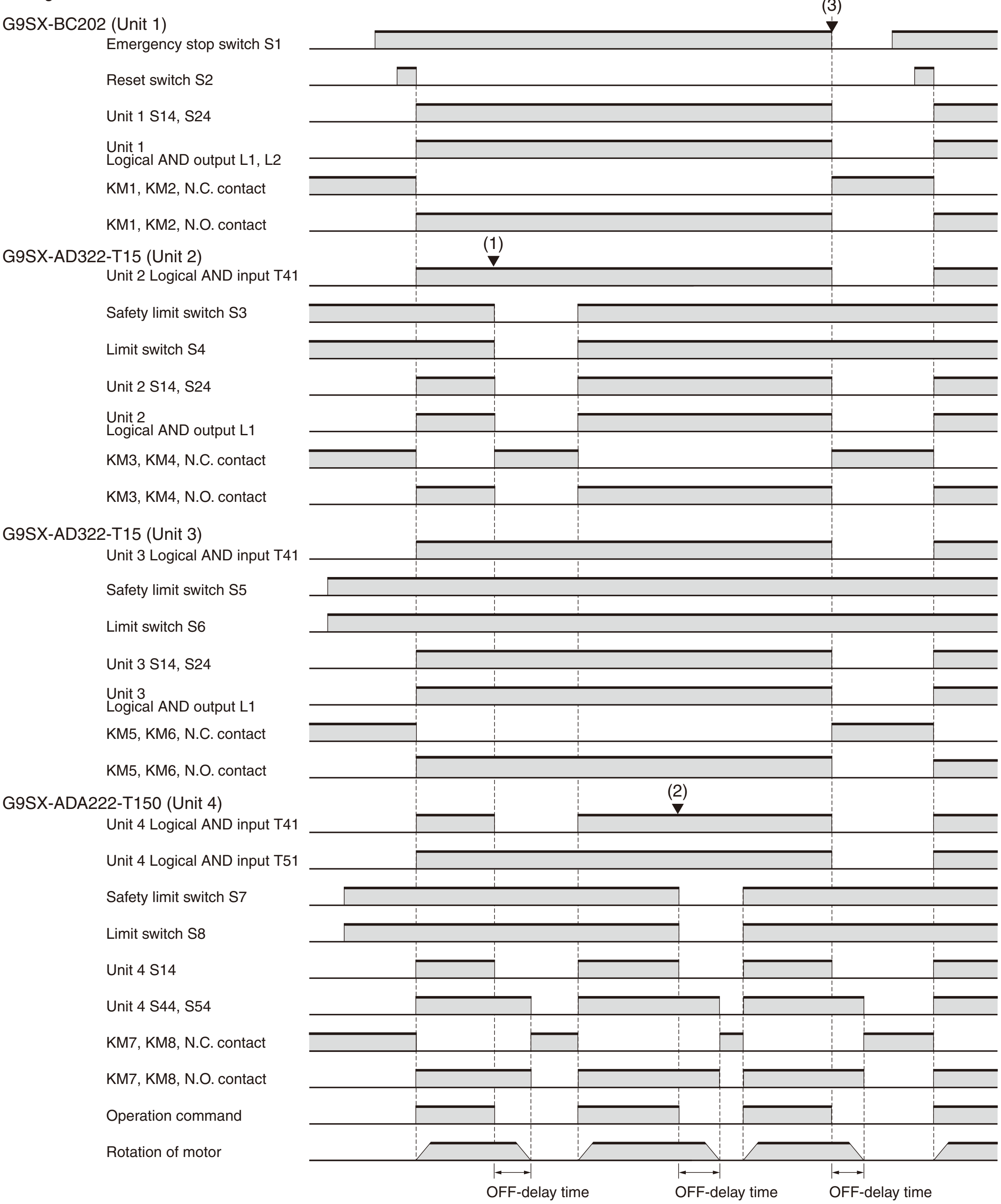
G9SX-BC202 (24 VDC) (2-channel Emergency Stop Switch Input/Manual Reset) + G9SX-AD322-T15 (24 VDC) (2-channel Safety Limit Switch Input/Auto Reset) + G9SX-AD322-T15 (24 VDC) (2-channel Safety Limit Switch Input/Auto Reset) + G9SX-ADA222-T150 (24 VDC) (2-channel Safety Limit Switch Input/Auto Reset)



S1:	Emergency stop switch
S2:	Reset switch
S3, S5, S7:	Safety limit switch
S4, S6, S8:	Limit switch
KM1 to KM8:	Contactor
M1 to M4:	3-phase motor

Note: This example corresponds to category 4.

Timing chart



(1) Guard 1 opened: Unit 2 and Unit 4 stop.
(2) Guard 3 opened: Unit 4 stops.
(3) Emergency stop button pressed: All units stop.

Safety Precautions

Refer to *"Precautions for All Relays"* and Precautions for *"Precautions for All Relays with Forcibly Guided Contacts"* for more detailed information.

⚠ WARNING

Serious injury may possibly occur due to breakdown of safety outputs.
Do not connect loads beyond the rated value to the safety outputs.

Serious injury may possibly occur due to loss of required safety functions.
Wire the G9SX properly so that the safety outputs do not short-circuit with the Unit power supply or load power supply.

Serious injury may possibly occur due output failure.
Apply protection circuitry against back electromotive force when connecting inductive loads to safety outputs.

Serious injury may possibly occur due to loss of safety functions. Use appropriate devices as given in the following table.

Control Devices	Requirements
Emergency stop switches	Use approved devices with Direct Opening Mechanism complying with IEC/EN 60947-5-1
Door interlocking switches or Safety limit switches	Use approved devices with Direct Opening Mechanism complying with IEC/EN 60947-5-1 and capable of switching micro loads of 24VDC, 5mA.
Safety sensors	Use approved devices complying with the relevant product standards, regulations and rules in the country where it is used. Consult a certification body to assess that the entire system satisfies the required safety category level.
Relays with forcibly guided contacts	Use approved devices with forcibly guided contacts complying with EN 50205. For feedback purpose use devices with contacts capable of switching micro loads of 24VDC, 5mA.
Contactors	Use contactors with forcibly guided mechanism to input the signal to Feedback/Reset input of G9SX through the NC contact of the contactor. For feedback purpose use devices with contacts capable of switching micro loads of 24VDC, 5mA. Failure to open contacts of a contactor cannot be detected by monitoring its auxiliary NC contact without forcibly guided mechanism.
Other devices	Evaluate whether devices used are appropriate to satisfy the requirements of safety category level.

Precautions for Safe Use

1. Use G9SX within an enclosure with IP54 protection or higher of IEC/EN60529.
2. Incorrect wiring may lead to loss of safety function. Wire conductors correctly and verify the operation of G9SX before commissioning the system in which G9SX is incorporated.
3. Do not apply DC voltages exceeding the rated voltages, or any AC voltages to the G9SX power supply input.
4. Use DC supply satisfying requirements below to prevent electric shock.
   - DC power supply with double or reinforced insulation, for example, according to IEC/EN60950 or EN50178 or a transformer according to IEC/EN61558.
   - DC supply satisfies the requirement for class 2 circuits or limited voltage/current circuit stated in UL 508.
5. Apply properly specified voltages to G9SX inputs.
   Applying inappropriate voltages cause G9SX to fail to perform its specified function, which leads to the loss of safety functions, damages to G9SX, or burning.
6. Auxiliary error outputs and auxiliary monitoring outputs are NOT safety outputs. Do not use auxiliary outputs as any safety output. Such incorrect use causes loss of safety function of G9SX and its relevant system.
   Also Logical AND connection outputs can only be used for logical AND connections between G9SXs.
7. After installation of G9SX, qualified personnel should confirm the installation, and should conduct test operations and maintenance. The qualified personnel should be qualified and authorized to secure the safety on each phases of design, installation, running, maintenance and disposal of system.
8. A person in charge, who is familiar to the machine in which G9SX is to be installed, should conduct and verify the installation.
9. Turn OFF the signal to Safety input or Logical AND connection input every 24hours and make sure G9SX operates without faults by checking the state of the ERR indicator.
10. Do not dismantle, repair, or modify G9SX. It may lead to loss of its safety functions, creating a dangerous situation.
11. Use only appropriate components or devices complying with relevant safety standards corresponding to the required level of safety categories.
    Conformity to requirements of safety category is determined as an entire system.
    It is recommended to consult a certification body regarding assessment of conformity to the required safety level.
12. OMRON shall not be responsible for conformity with any safety standards regarding to customer's entire system.
13. Disconnect G9SX from power supply when wiring, to prevent electric shock or unexpected operation.
14. Be cautious not to have your fingers caught when attaching terminal sockets to the plugs on G9SX.
15. The lifetime of G9SX depends on the conditions of switching of its outputs. Be sure to conduct its test operation under actual operating conditions in advance and use it within appropriate number of switching operations
16. Do not use in combustible gases or explosive gases. Arcs or heat generated by switching elements of G9SX can lead to fire or explosion.

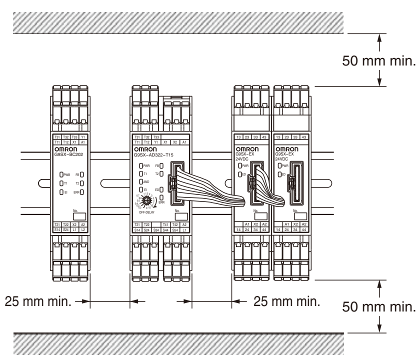
Precautions for Correct Use

1. Handle with care
Do not drop G9SX to the ground or expose to excessive vibration or mechanical shocks. G9SX may be damaged and may not function properly.

2. Conditions of storage
G9SX may be damaged and may not function properly.
Do not store in such conditions stated below.
1. In direct sunlight
2. At ambient temperatures out of the range of –10 to 55°C.
3. At relative humidity out of the range of 25% to 85% or under such temperature change that causes condensation.
4. In corrosive or combustible gases
5. With vibration or mechanical shocks out of the rated values.
6. Under splashing of water, oil, chemicals
7. In the atmosphere containing dust, saline or metal powder.

3. Mounting
Mount G9SX to DIN track with attachments (PFP-M, not incorporated to this product), not to drop off the track by vibration or other force especially when the length of DIN track is short compared to the widths of G9SX.

4. Following spacing around G9SX should be available to apply rated current to outputs of G9SX and for enough ventilation and wiring:
1. At least 25 mm beside side faces of the Advanced Unit (G9SX-AD322-□/G9SX-ADA222-□) and side faces of the Basic Unit.
2. At least 50 mm above top face of G9SX and below bottom face of G9SX.



5. Wiring
1. For model G9SX-□-RT (with screw terminals)
   - Use the following to wire to G9SX-□-RT.

Solid wire	0.2 to 2.5 mm^2 AWG24 to AWG12
Stranded wire	0.2 to 2.5 mm^2 AWG24 to AWG12

   - Tighten each screw with a specified torque of 0.5 to 0.6 N·m, or the G9SX may malfunction or generate heat.
   - Strip the cover of wire no longer than 7 mm.
   - When using twisted wire, connect a 0.25 to 2.5-mm^2 covered ferrule before connecting the wire.
2. For model G9SX-□-RC (with spring-cage terminals)
   - Use the following to wire to G9SX-□-RC

Solid wire	0.2 to 2.5 mm^2 AWG24 to AWG12
Stranded wire	0.34 to 1.5 mm^2 AWG22 to AWG16

   - When using twisted wire, connect a 0.25 to 2.5-mm^2 covered ferrule before connecting the wire.

6. When connecting Expansion Units (G9SX-EX□-□) to Advanced Unit (G9SX-AD322-□/G9SX-ADA222-□):
1. Remove the termination connector on the Advanced Unit (G9SX-AD322-□, G9SX-ADA222-□), and insert the connector of the Expansion Unit into the Advanced Unit to connect it.
2. Insert the termination connector into the last Expansion Unit as viewed from the Advanced Unit.
   When the Advanced Unit is used without any Expansion Units, do not remove the termination connector from the Advanced Unit.
3. Do not remove the termination connector or the connecting cable of the Expansion Unit while the system is operating.
4. Before applying supply voltage, confirm that the connecting sockets and plugs are locked.
5. Make sure that all connected Expansion Units are supplied with power within 10 s after the power for the Advanced Unit is turned ON. Otherwise, the Advanced Unit will detect a power-supply error for the Expansion Units.

7. Use cables with a length of 100 m max. to connect to Safety Inputs, Feed-back/Reset inputs, or between Logical AND connection inputs and Logical AND connection outputs, respectively.

8. Set the time duration of OFF-delay to an appropriate value that does not cause the loss of safety function of system.

9. Logical AND connection between Units: (Refer to *"Functions"* on page 13.)
1. When using Logical AND connection inputs, set the logical AND connection input for the Advanced Units that will receive the input to AND "Enable logical AND input".
2. Be sure to wire the logical AND connection input correctly with respect to the logical AND connection output of the Advanced Unit or Basic Unit.
3. Give careful consideration to the response time delay during logical AND connection in order to prevent any reduction in the safety of the safety control system.
4. Use two-conductor cabtyre cable or shielded cable for wiring the logical AND connections between Units.

10. To determine safety distance to hazards, take into account the delay of Safety outputs caused by the following time:
1. Response time of Safety inputs
2. Response time of Logical AND connection input
3. Preset off-delay time
4. Accuracy of off-delay time

11. Start entire system after more than 5s have passed since applying supply voltage to all G9SXs in the system.

12. G9SX may malfunction due to electro-magnetic disturbances. Be sure to connect the terminal A2 to ground. To suppress electrical noise, apply a surge absorber to the coil of inductive load.

13. Devices connected to G9SX may operate unexpectedly. When replacing G9SX, disconnect it from power supply.

14. Adhesion of solvent such as alcohol, thinner, trichloroethane or gasoline on the product should be avoided. Such solvents make the marking on G9SX illegible and cause deterioration of parts.

15. Do NOT mix AC load and DC load to be switched in one G9SX-EX□-□. When switching of both AC load and DC load is necessary, connect more than two G9SX-EX□-□ and use each unit for AC load and DC load exclusively.

16. Use the following operation according to the reset mode when an input is to be re-entered during the OFF delay time of the G9SX-AD□/ADA□:
For auto reset, after the OFF delay time has ended and the output has turned OFF, turn the output ON again.
For manual reset, after the OFF delay time has ended and the output has turned OFF, turn the output ON again at the exact time that the reset is input.

17. Safety Application Controller's Relay durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay or the Safety Application Controller immediately.
If the Relay or the Safety Application Controller is used continuously without replacing, then it can lead to loss of safety function.

Category of EN 954-1

In the condition shown in *Application Examples*, G9SX can be used for the corresponding categories up to category 4.
This does NOT mean that G9SX can always be used for required category under all the similar conditions and situations.
Conformity to the categories must be assessed as a whole system.
When using G9SX for safety categories, be sure to confirm the conformity as a whole system.

Safety Categories (EN954-1)

1. Input the signals to both of the Safety inputs (T11-T12 and T21-T22).
2. Input a signal to the Safety inputs (T11-T12 and T21-T22) through switches with Direct Opening Mechanism.
   When using limit switches, at least one of them must have Direct Opening Mechanism.
3. When connecting Safety sensor with G9SX, use TYPE 4 safety sensor.
4. Input the signal through a NC contact of the contactor to Feedback/ Reset input (T31-T32 for manual reset or T31-T33 for auto reset). (Refer to *Application Examples*)
5. Keep Cross fault detection mode input (Y1) open. However, when connecting devices with self-diagnosis function, such as safety sensors, apply 24 VDC to Y1.
6. Be sure to Connect A2 to ground.
7. When using a G9SX-EX-□-□ Expansion Unit, connect fuses with a current rating of 3.15 A max. to the safety relay outputs to prevent the contacts from welding.

Compliance with International Standards

G9SX-AD-□/G9SX-ADA-□/G9SX-BC-□/G9SX-EX-□

- Approved by TÜV Product Service
  EN50178
  IEC/EN60204-1
  EN954-1 Cat.4
  IEC/EN61508 SIL3
  IEC/EN61000-6-2
  IEC/EN61000-6-4
- Approved by UL
  UL508
  UL1998
  NFPA79
  IEC61508
  CAN/CSA C22.2 No.142
- KOSHA certification
  IEC/EN61508

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)

To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).

Refer to the *Safety Components Technical Guide* (Cat No. Y107). The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

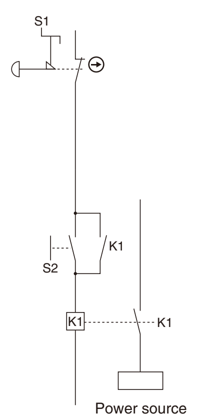
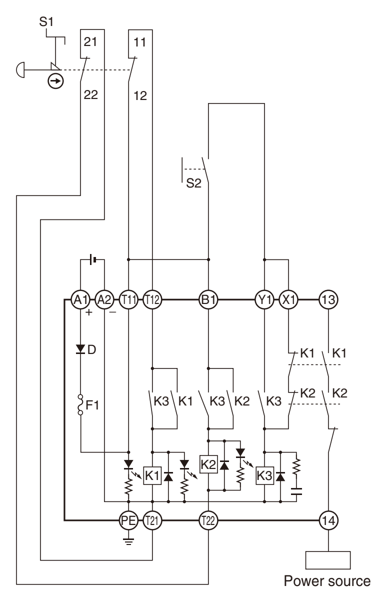


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.

When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)

The G7SA, G7S and G7S-□-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-□-E, however, do not display the CE Marking according to the concepts in the guidelines.

VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-□-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

No.	Area	No.	Classification	No.	Item	Page
❹	Operating and Storage Environments			1 2 3 4 5 6 7 8	Operating, Storage, and Transport Operating Atmosphere Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas) Adhesion of Water, Chemicals, Solvent, and Oil Vibration and Shock External Magnetic Fields External Loads Adhesion of Magnetic Dust	C-9 to C-10
❺	Relay Mounting Operations	①	Plug-in Relays	1 2 3	Panel-mounting Sockets Relay Removal Direction Terminal Soldering	C-10
		②	Printed Circuit Board Relays	1	Ultrasonic Cleaning	
		③	Common Items	1 2 3 4	Removing the Case and Cutting Terminals Deformed Terminals Replacing Relays and Performing Wiring Operations Coating and Packing	
❻	Handling Relays			1 2	Vibration and Shock Dropped Products	C-11
❼	Relays for Printed Circuit Boards (PCBs)			1 2 3 4 5 6 7 8 9 10	Selecting PCBs, (1) PCB Materials Selecting PCBs, (2) PCB Thickness Selecting PCBs, (3) Terminal Hole and Land Diameters Mounting Space ① Ambient Temperature ② Mutual Magnetic Interference Pattern Design for Noise Countermeasures ① Noise from Coils ② Noise from Contacts ③ High-frequency Patterns Shape of Lands Pattern Conductor Width and Thickness Conductor Pitch Securing the PCB Automatic Mounting of PCB Relays	C-11 to C-14
❽	Troubleshooting					C-15

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

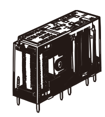
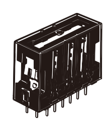
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	Flux protection	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

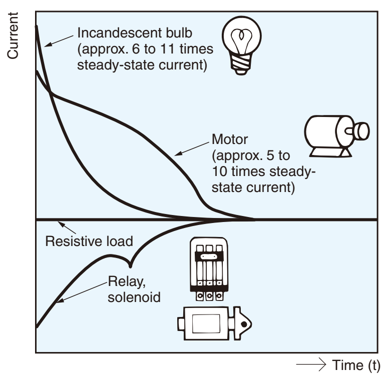
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

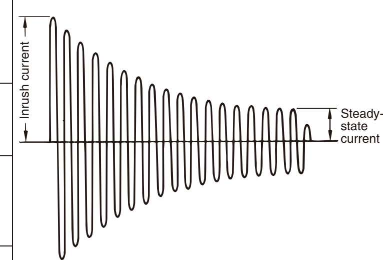
If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	



❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

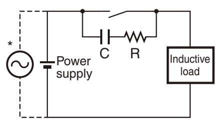
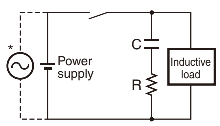
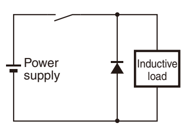
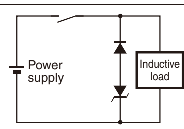
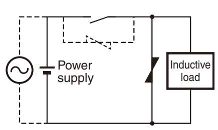
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

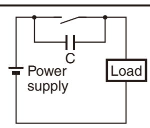
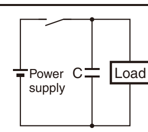
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

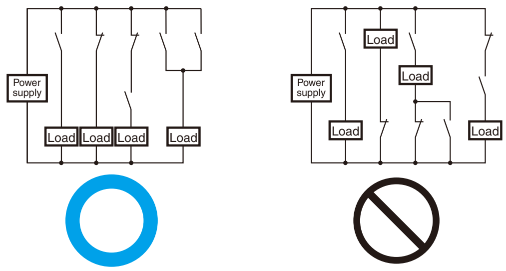
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

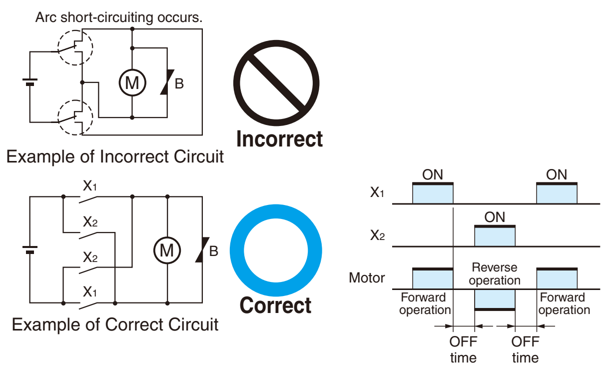
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



a. Correct Connection   b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



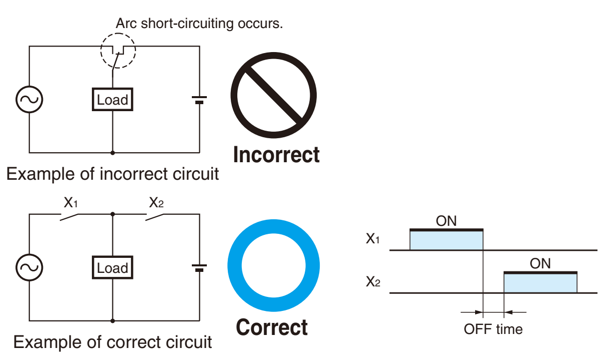
❸-①-8 Power Supply Double Break with Multi-pole Relays

If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.

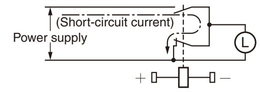
Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.

Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.

The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.

Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.

This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).

This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

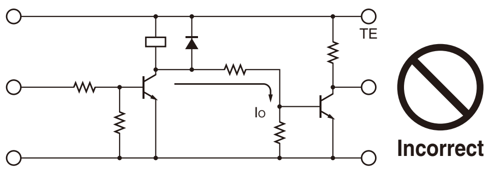
❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.
As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.
Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

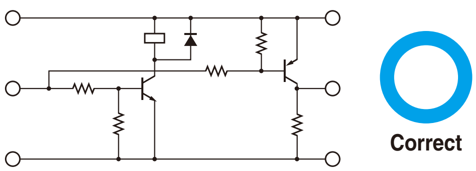
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

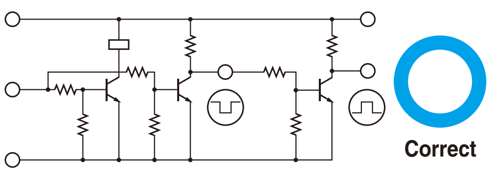
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value

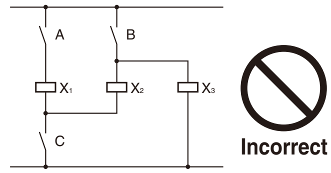


❸-②-7 Using with Infrequent Switching

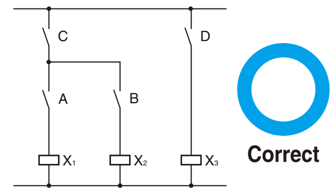
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.
The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.
The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



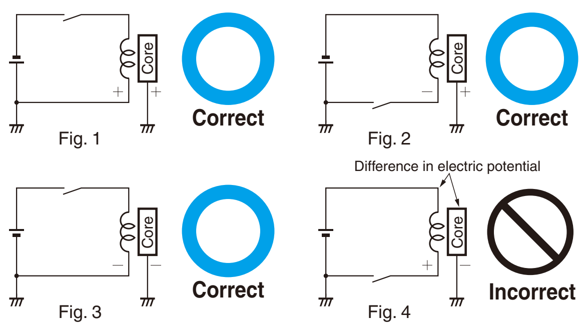
The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)
(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)
(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

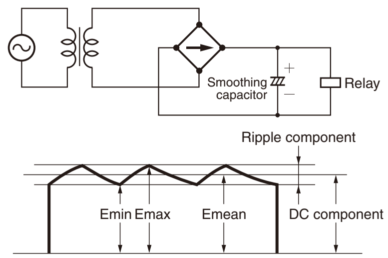


❸-②-10 Individual Specifications for Must-operate/ release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



$$\text{Ripple percentage \%} = \frac{E_{max} - E_{min}}{E_{mean}} \times 100\%$$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON.
Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

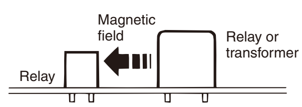
Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock
Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields
Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads
Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust
Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

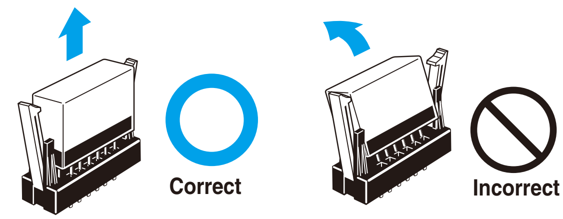
❺ Relay Mounting Operations

① Plug-in Relays

❺-①-1 Panel-mounting Sockets
1. Socket Mounting Screws
When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach. Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.

2. Lead Wire Screw Connections
Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
Conversely, excessive tightening can strip the threads.

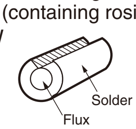
❺-①-2 Relay Removal Direction
Insert and remove Relays from the socket perpendicular to the socket surface.



If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering
Solder General-purpose Relays manually following the precautions described below.

1. Smooth the tip of the solder gun and then begin the soldering.
- Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
- Soldering iron: Rated at 30 to 60 W
- Tip temperature: 280 to 300°C
- Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.

3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning
Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals
Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals
Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations
Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing
G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

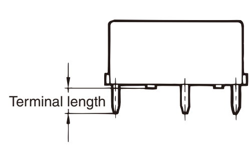
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material / Item	Epoxy		Phenol
	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space
① Ambient Temperature

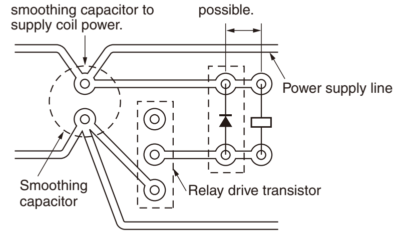
When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures
① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② Noise from Contacts

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ High-frequency Patterns

As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

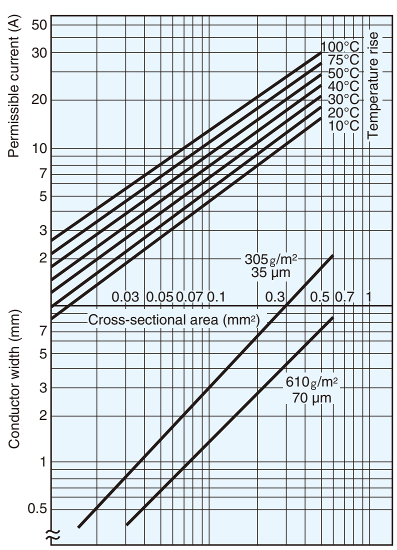
Correct Examples	
Incorrect Examples	

2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.

❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 μm and 70 μm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

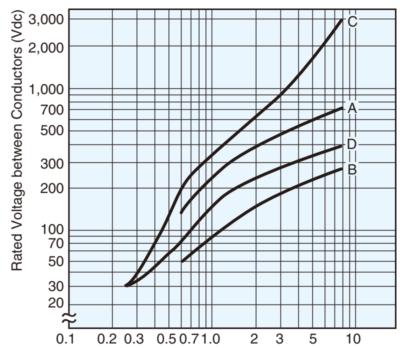
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

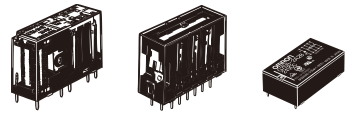
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

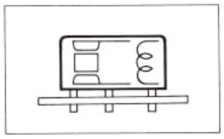
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

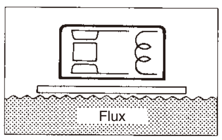
Placement



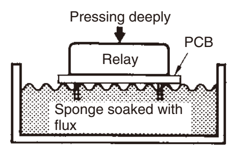
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay. The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials. For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive. Apply the flux sparingly and evenly to prevent penetration into the Relay. When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



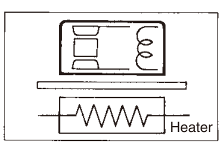
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

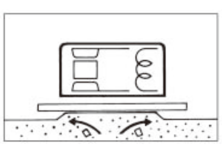
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

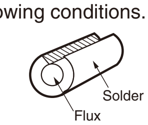
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

Applicability of Manual Soldering

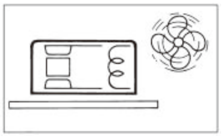
G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5

Cooling



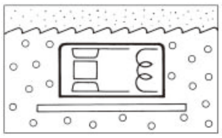
1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6

Cleaning



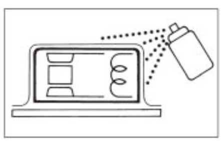
Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7

Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed.
   Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.1

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Safety Guard Switching Unit

G9SX-GS

A Safety Measure for Hazardous Operations That Does Not Lower Productivity

- Two functions support two types of application:
  - Auto switching: For applications where operators work together with machines
  - Manual switching: For applications with limited operations
- External indicator outputs enable indicating the switching status of two safety input devices.
- Auxiliary outputs enable monitoring of safety inputs, safety outputs, and errors.
- Detailed LED indications enable easy diagnosis.
- Logical AND connection allows complicated applications in combination with other G9SX-series Units.
- Certification for compliance with IEC/EN 61508 (SIL3), IEC/EN 62061 (SIL3), and EN 954-1 (category 4).

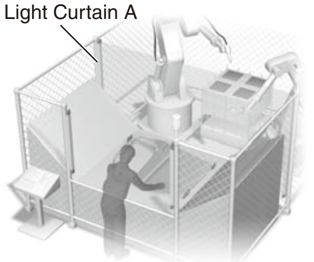
⚠ Be sure to read the "*Safety Precautions*" on page 24.

Features

Auto Switching Function

When the operator inserts the workpiece...

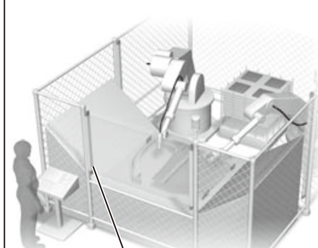
Light Curtain A



- Safety Light Curtain A monitors the robot.
- The robot can continue to operate as long as it does not interrupt Safety Light Curtain A.

Auto switching

While the robot processes the workpiece...



Light Curtain B

- Safety Light Curtain B monitors the operator.
- The robot can continue to operate as long as the operator does not interrupt Safety Light Curtain B.

Note: If the operator is able to completely enter the zone inside Safety Light Curtain B, a presence detection device, such as a Safety Mat, is necessary as an additional safety measure.

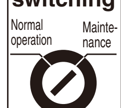
Manual Switching Function

During normal operation...

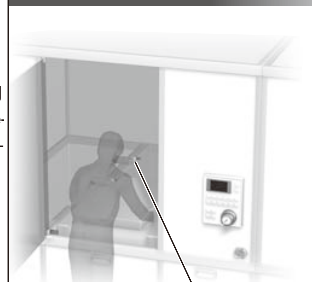
Door Switch

- The Door Switch monitors the opening and closing of the door during normal operation.
- The machine is able to operate while the door is closed.

Manual switching



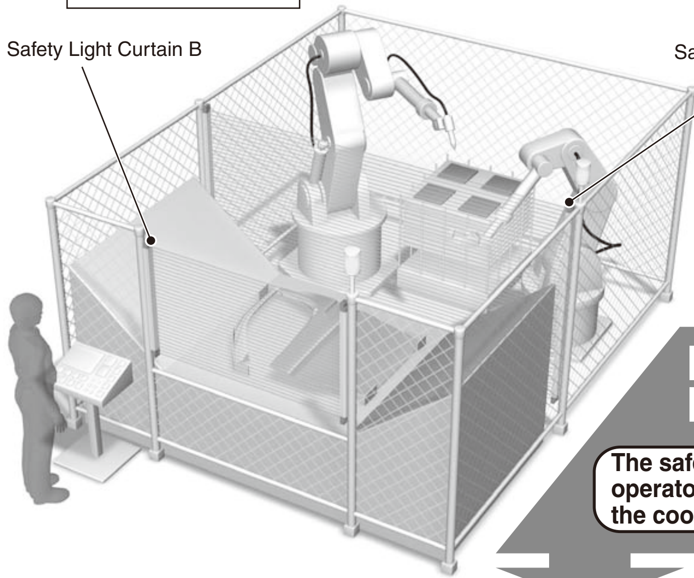
During maintenance...



Limit Switch

- The Limit Switch monitors the conveyor cart position during maintenance.
- The machine is able to operate while the conveyor cart is in a specified area.

With the G9SX-GS



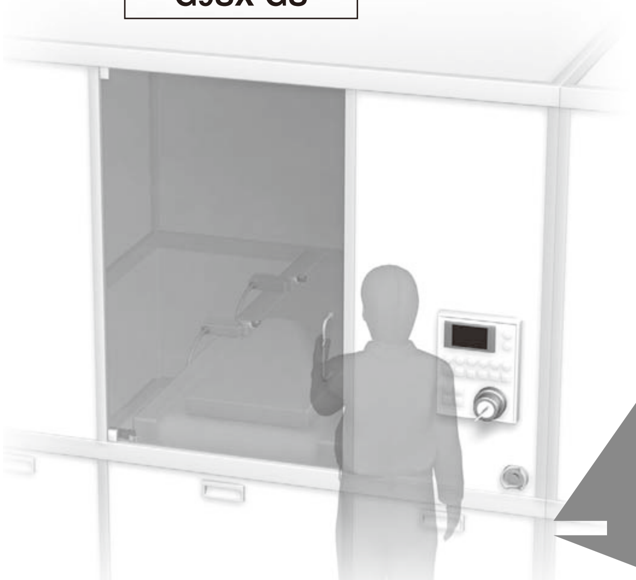
Safety Light Curtain A: Monitors the robot.

Safety Light Curtain B: Monitors the operator.

The safety system monitors the robot and operator to make sure they don't enter the coordinated area at the same time.

The Auto Switching Function of the G9SX-GS supports both operator safety and productivity.

With the G9SX-GS



Normal operating mode:
Door Switch monitors the door.

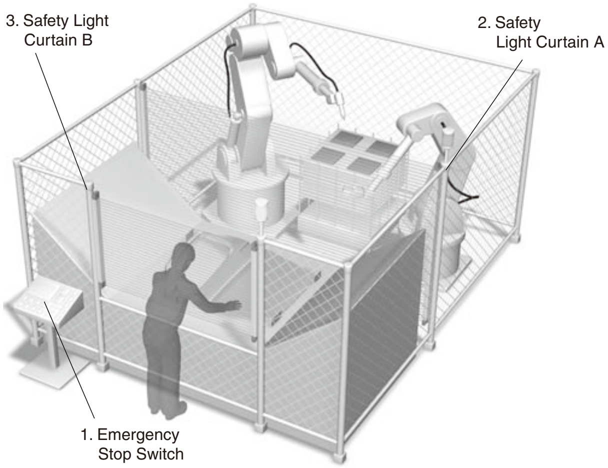
Maintenance mode:
Limit Switch monitors the hazard source.

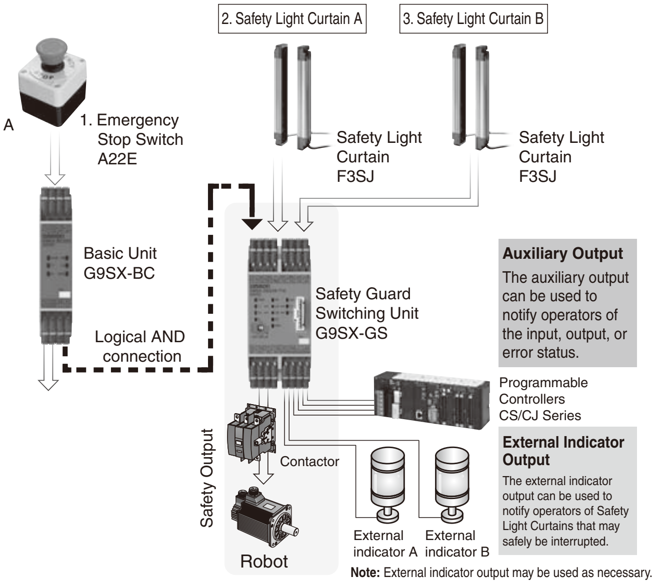
A safe area is ensured during maintenance.

The Manual Switching Function of the G9SX-GS ensures safety during limited operations like maintenance and cleaning.

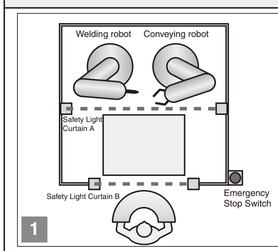
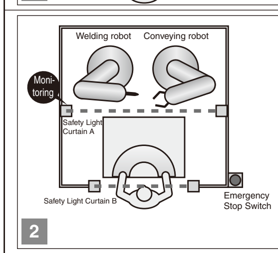
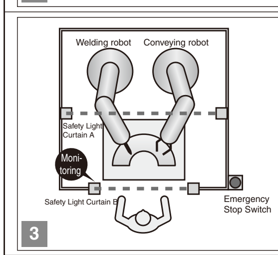
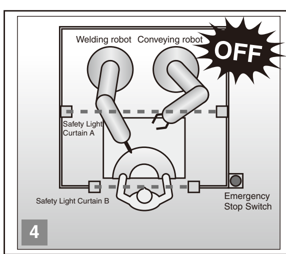
System Configuration Examples

Auto Switching Function

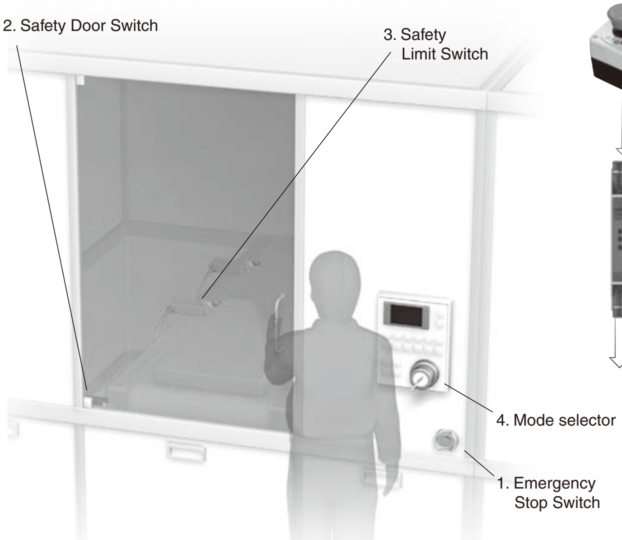


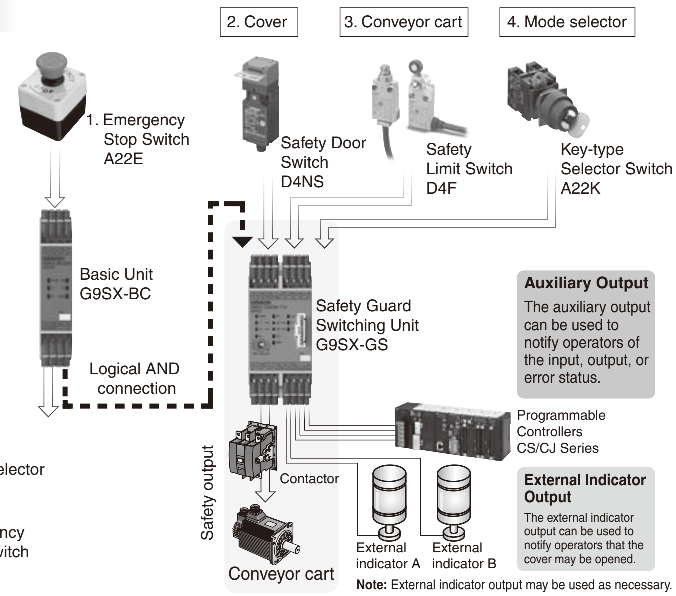


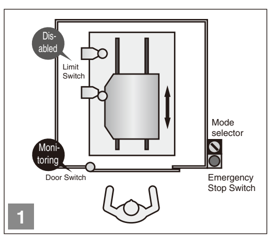
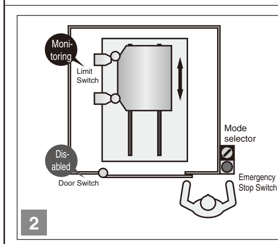
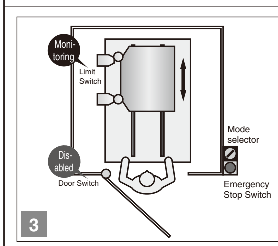
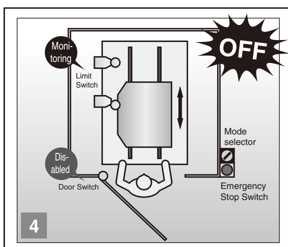
Note: External indicator output may be used as necessary.

	Working condition	External indicator	G9SX-GS Safety input	G9SX-GS Safety output	G9SX-GS Monitor output	G9SX-GS External indicator
Normal operation		OK to work	Safety input A: ON Safety input B: ON	ON Safety output	ON Input A monitor ON Input B monitor	Indicator A Indicator B
Normal operation		OK to work	Safety input A: ON Safety input B: OFF	ON Safety output	ON Input A monitor OFF Input B monitor	Indicator A Indicator B
Normal operation		Not OK to work	Safety input A: OFF Safety input B: ON	ON Safety output	OFF Input A monitor ON Input B monitor	Indicator A Indicator B
Hazardous condition		Not OK to work	Safety input A: OFF Safety input B: OFF	OFF Safety output	OFF Input A monitor OFF Input B monitor	Indicator A Indicator B

Manual Switching Function





	Working condition	External indicator	G9SX-GS Safety input	G9SX-GS Safety output	G9SX-GS Mode selector	G9SX-GS Monitor output	G9SX-GS External indicator
Normal operation	 1	Not OK to open	Safety input A: Dis-abled Safety input B: ON	ON Safety output	Normal operating mode	OFF Input A monitor ON Input B monitor	Indicator A Indicator B
Maintenance	 2	OK to open	Safety input A: ON Safety input B: Dis-abled	ON Safety output	Maintenance mode	ON Input A monitor OFF Input B monitor	Indicator A Indicator B
Maintenance	 3	OK to open	Safety input A: ON Safety input B: Dis-abled	ON Safety output	Maintenance mode	ON Input A monitor OFF Input B monitor	Indicator A Indicator B
Hazardous condition	 4	OK to open	Safety input A: OFF Safety input B: Dis-abled	OFF Safety output	Maintenance mode	OFF Input A monitor OFF Input B monitor	Indicator A Indicator B

Model Number Structure

Model Number Legend

G9SX-□□□□□-□□□-□□
1 2 3 4 5 6

1. **Functions**
   GS: Safety Guard Switching Unit
   EX: Expansion Unit
2. **Output Configuration (Instantaneous Safety Outputs)**
   0: None
   2: 2 outputs
   4: 4 outputs
3. **Output Configuration (OFF-delayed Safety Outputs)**
   0: None
   2: 2 outputs
   4: 4 outputs
4. **Output Configuration (Auxiliary Outputs)**
   1: 1 output
   6: 6 outputs
5. **Max. OFF-delay Time**
   Safety Guard Switching Unit
   T15: 15 s
   Expansion Unit
   No indicator: No OFF delay
   T: OFF delay
6. **Terminal Block Type**
   RT: Screw terminals
   RC: Spring-cage terminals

Ordering Information

Safety Guard Switching Unit

Safety outputs *3		Auxiliary outputs *4	Logical AND connection		Max. OFF-delay time *1	Rated voltage	Terminal block type	Model
Instantaneous	OFF-delayed *2		Inputs	Outputs				
2 (semiconductor)	2 (semiconductor)	6 (semiconductor)	1 (semiconductor)	1 (semiconductor)	15 s	24 VDC	Screw terminals	**G9SX-GS226-T15-RT**
							Spring-cage terminals	**G9SX-GS226-T15-RC**

*1. The OFF-delay time can be set in 16 steps as follows:
T15: 0, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 1, 1.5, 2, 3, 4, 5, 7, 10, or 15 s
*2. The OFF-delayed output becomes an instantaneous output by setting the OFF-delay time to 0 s.
*3. P channel MOS FET transistor output
*4. PNP transistor output (except for the external indicator outputs, which are P channel MOS FET transistor outputs)

Expansion Unit

Safety outputs		Auxiliary outputs *1	OFF-delay time	Rated voltage	Terminal block type	Model
Instantaneous	OFF-delayed					
4 PST-NO (contact)	---	1 (semiconductor)	---	24 VDC	Screw terminals	**G9SX-EX401-RT**
					Spring-cage terminals	**G9SX-EX401-RC**
---	4 PST-NO (contact)		*2		Screw terminals	**G9SX-EX041-T-RT**
					Spring-cage terminals	**G9SX-EX041-T-RC**

*1. PNP transistor output
*2. The OFF-delay time is synchronized to the OFF-delay time setting in the connected Unit (G9SX-GS226-T15-□).

Specifications

Ratings

Power Input

Item Model	G9SX-GS226-T15-□	G9SX-EX-□
Rated supply voltage	24 VDC	
Operating voltage range	–15% to 10% of rated supply voltage	
Rated power consumption *	5 W max.	2 W max.

* Power consumption of loads not included.

Inputs

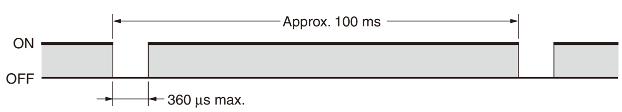
Item Model	G9SX-GS226-T15-□
Safety inputs	Operating voltage: 20.4 VDC to 26.4 VDC, Internal impedance: Approx. 2.8 kΩ *
Mode selector input	
Feedback/reset input	

* Provide a current equal to or higher than that of the minimum applicable load of the connected input control device.

Outputs

Item Model	G9SX-GS226-T15-□
Instantaneous safety outputs *1 **OFF-delayed safety outputs *1**	P channel MOS FET transistor outputs Load current: 0.8 A DC max. *2
Auxiliary outputs **(for input, output, and error monitoring)**	PNP transistor outputs Load current: 100 mA max.
External indicator outputs	P channel MOS FET transistor outputs Connectable indicators • Incandescent lamp: 24 VDC, 3 to 7 W • LED lamp: 10 to 300 mA DC

*1. While safety outputs are in the ON state, the following signal sequence is output continuously for diagnosis.
When using the safety outputs as input signals to control devices (i.e. Programmable Controllers), consider the OFF pulse shown below.



*2. The following derating is required when Units are mounted side-by-side.
G9SX-GS226-T15-□: 0.4 A max. load current

Expansion Unit

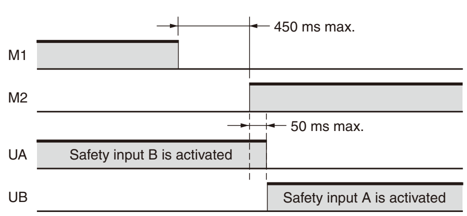
Item Model	G9SX-EX-□
Rated load	250 VAC, 3 A / 30 VDC, 3 A (resistive load)
Rated carry current	3 A
Maximum switching voltage	250 VAC, 125 VDC

Characteristics

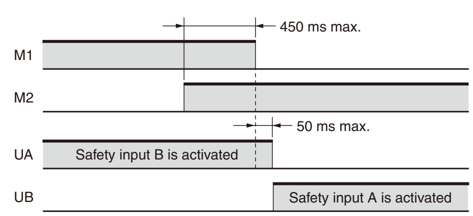
Item	Model	G9SX-GS226-T15-□	G9SX-EX-□
Overvoltage category (IEC/EN 60664-1)		II	II (Safety relay outputs 13 to 43 and 14 to 44: III)
Operating time (OFF to ON state) *1		50 ms max. (Safety input: ON) *2 100 ms max. (Logical AND connection input: ON) *3	30 ms max. *4
Response time (ON to OFF state) *1		15 ms max.	10 ms max. *4
Allowable switching time for mode selector input *5 *7		450 ms max.	---
Response time for switching operating modes *6 *7		50 ms max.	---
ON-state residual voltage		3.0 V max. for safety outputs, auxiliary outputs, and external indicator outputs	
OFF-state leakage current		0.1 mA max. for safety outputs and auxiliary outputs, 1 mA max. for external indicator outputs	
Maximum wiring length of safety input and logical AND input		100 m max. (External connection impedance: 100 Ω max. and 10 nF max.)	
Reset input time (Reset button pressing time)		100 ms min.	
Accuracy of OFF-delay time *8		Within ± 5% of the set value	
Insulation resistance	**Between logical AND connection terminals, and power supply input terminals and other input and output terminals connected together**	20 MΩ min. (at 100 VDC)	---
	Between all terminals connected together and DIN track		100 MΩ min. (at 500 VDC)
Dielectric strength	**Between logical AND connection terminals, and power supply input terminals and other input and output terminals connected together**	500 VAC for 1 min	---
	Between all terminals connected together and DIN track		1,200 VAC for 1 min
	Between different poles of outputs	---	
	Between safety relay outputs connected together and other terminals connected together		2,200 VAC for 1 min
Vibration resistance		Frequency: 10 to 55 to 10 Hz, 0.375-mm single amplitude (0.75-mm double amplitude)	
Shock resistance	**Destruction**	300 m/s²	
	Malfunction	100 m/s²	
Durability	**Electrical**	---	100,000 cycles min. (rated load, switching frequency: 1,800 cycles/hour)
	Mechanical	---	5,000,000 cycles min. (switching frequency: 7,200 cycles/hour)
Ambient operating temperature		−10 to 55°C (with no icing or condensation)	
Ambient operating humidity		25% to 85%	
Terminal tightening torque *9		0.5 N·m	
Weight		Approx. 240 g	Approx. 165 g

*1. When two or more Units are connected by logical AND, the operating time and response time are the sum total of the operating times and response times, respectively, of all the Units connected by logical AND.
*2. Represents the operating time when the safety input turns ON with all other conditions set.
*3. Represents the operating time when the logical AND input turns ON with all other conditions set.
*4. This does not include the operating time or response time of Safety Guard Switching Units that are connected.
*5. This is the allowable switching time for the operating mode selector. If switching takes more than 450 ms, the G9SX-GS□ will detect an error.
*6. This is the time required for the safety input to actually switch to an activated condition after the mode selector input is switched.

(When M2 turns ON after M1 turns OFF)



(When M1 turns OFF after M1 turns ON)



*7. Only when the G9SX-GS□ is used with manual switching.
*8. This does not include the operating time or response time of internal relays in the G9SX-EX-□.
*9. For the G9SX-□-RT (with screw terminals) only.

Logical AND Connection

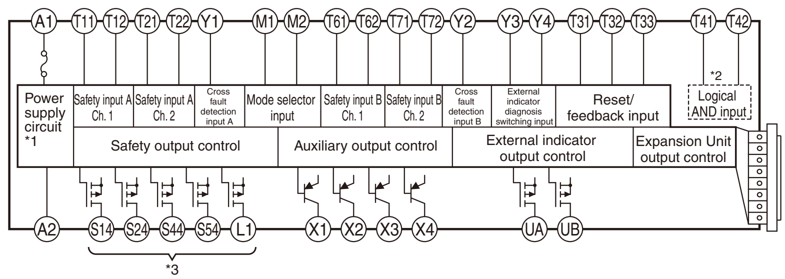
Item Model	G9SX-GS226-T15-□	G9SX-EX-□
Number of Units connected per logical AND output	4 Units max.	---
Total number of Units connected by logical AND *1	20 Units max.	---
Number of Units connected in series by logical AND	5 Units max.	---
Max. number of Expansion Units connected *2	---	5 Units max.
Maximum cable length for logical AND input	100 m max.	---

*1. The number of G9SX-EX401-□ Expansion Units or G9SX-EX041-T-□ Expansion Units (OFF-delayed Model) not included.
*2. G9SX-EX401-□ Expansion Units and G9SX-EX041-T-□ Expansion Units (OFF-delayed Model) can be mixed.

Connections

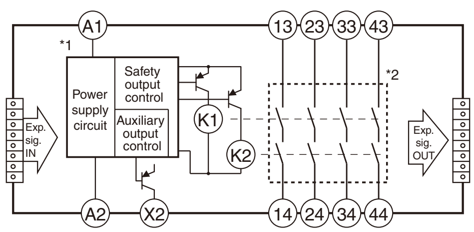
Internal Connection

G9SX-GS226-T15□ (Safety Guard Switching Unit)



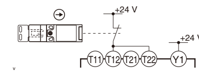
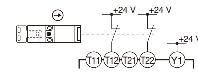
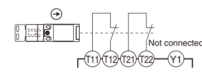
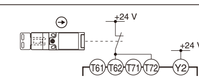
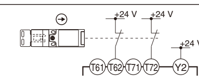
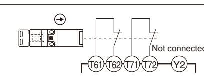
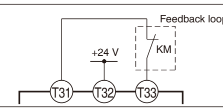
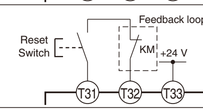
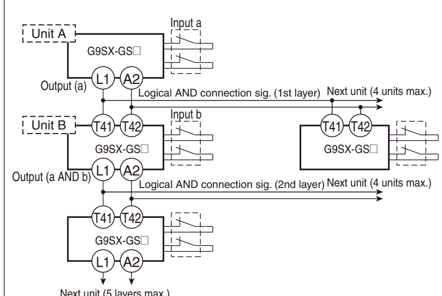
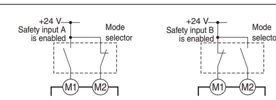
*1. Internal power supply circuit is not isolated.
*2. Logical AND input is isolated.
*3. Outputs S14 to S54 and L1 are internally redundant.

G9SX-EX401-□/G9SX-EX041-T-□ (Expansion Unit/Expansion Unit with OFF Delay)



*1. Internal power supply circuit is not isolated.
*2. Relay outputs are isolated.

Wiring of Inputs and Outputs

Signal name	Terminal name	Description of operation	Wiring	
Power supply input	A1, A2	The power supply input terminals for the G9SX-GS□. Connect the power source to the A1 and A2 terminals.	Connect the power supply plus (24 VDC) to the A1 terminal. Connect the power supply minus (GND) to the A2 terminal.	
Safety input A, channel 1	T11, T12	Using Auto Switching: For the safety output to go to the ON state, both channels 1 and 2 of safety input A must be in the ON state, channels 1 and 2 of safety input B must be in the ON state. Using Manual Switching: For the safety output to go to the ON state when safety input A is activated, both channels 1 and 2 of safety input A must be in the ON state (for maintenance mode). For the safety output to go to the ON state when safety input B is activated, both channels 1 and 2 of safety input B must be in the ON state (for normal operating mode).	Corresponds to Safety Category 2	
			Corresponds to Safety Category 3	
Safety input A, channel 2	T21, T22		Corresponds to Safety Category 4	
Safety input B, channel 1	T61, T62		Corresponds to Safety Category 2	
			Corresponds to Safety Category 3	
Safety input B, channel 2	T71, T72		Corresponds to Safety Category 4	
Feedback/reset input	T31, T32, T33	For the safety output to go to the ON state, the ON state signal must be input to T33. Otherwise the safety outputs cannot be in the ON state.	Auto reset	
		For the safety output to go to the ON state, the signal input to T32 must change from the OFF state to the ON state, and then to the OFF state. Otherwise the safety outputs cannot be in the ON state.	Manual reset	
Logical AND connection input	T41, T42	A logical AND connection means that one Unit (Unit A) outputs a safety signal “a” to a subsequent Unit (Unit B) and Unit B calculates the logical AND of “a” and safety signal “b.” In the example shown at the right, the logical AND connection results in a safety output of “a AND b” for Unit B. Connect L1 of Unit A and T41 of Unit B to the power supply negative terminal (GND) of Unit A and T42 of Unit B. For the safety output to go to the ON state in the subsequent Unit, its logical AND connection preset switch must be set to AND (enabled) and the HIGH state signal must be input to T41 of the subsequent Unit.		
Mode selector input	M1, M2	When manual switching is selected, the SPST-NO/SPST-NC input enables the input of either safety input A or safety input B. The relationship of the safety input enable state and the mode selector input is as follows: M1 = ON, M2 = OFF: Safety input B is enabled (normal operating mode) M1 = OFF, M2 = ON: Safety input A is enabled (maintenance mode)	 Keep the circuits open when using auto switching.	
Cross fault detection inputs	Y1, Y2	Selects the mode for the failure detecting (cross fault detecting) function for the safety inputs of G9SX-GS□ corresponding to the connection of the cross fault detection input.	Keep Y1 open when using T11 and T21 (wiring to enable cross fault detection). Keep Y2 open when using T61 and T71 (wiring to enable cross fault detection). Connect Y1 to 24 VDC when not using T11 and T21 (wiring to disable cross fault detection, or when connecting safety sensors). Connect Y2 to 24 VDC when not using T61 and T71 (wiring to disable cross fault detection, or when connecting safety sensors).	
External indicator diagnosis switching inputs	Y3, Y4	Enables or disables error detection for the external indicator outputs of the G9SX-GS□.	Keep Y3 open when detecting errors for UA. Keep Y4 open when detecting errors for UB. Connect Y3 to 24 VDC when not detecting errors for UA. Connect Y4 to 24 VDC when not detecting errors for UB.	

Signal name	Terminal name	Description of operation	Wiring
Instantaneous safety outputs	S14, S24	Turns ON/OFF according to the state of the safety inputs, feedback/reset input, and logical AND connection input. During OFF-delay state, the instantaneous safety outputs cannot turn ON.	Keep these outputs open when not used.
OFF-delayed safety outputs	S44, S54	OFF-delayed safety outputs. The OFF-delay time is set by the OFF-delay preset switch. When the delay time is set to zero, these outputs can be used as instantaneous safety outputs.	Keep these outputs open when not used.
Logical AND connection output	L1	Outputs a signal of the same logic as the instantaneous safety outputs.	Keep this output open when not used.
Auxiliary monitor output	X1	Outputs a signal of the same logic as the instantaneous safety outputs	Keep this output open when not used.
Auxiliary error output	X2	Outputs when the error indicator is lit or blinking.	Keep this output open when not used.
Auxiliary monitor outputs	X3, X4	X3 outputs a signal that is synchronized with and has the same logic as the input state of safety input A. X4 outputs a signal that is synchronized with and has the same logic as the input state of safety input B.	Keep these outputs open when not used.
External indicator outputs	UA, UB	Outputs the disabled state of the safety input. UA outputs a signal that is synchronized and has the same logic as the disabled state of safety input A. UB outputs a signal that is synchronized and has the same logic as the disabled state of safety input B.	Keep these outputs open when not used.

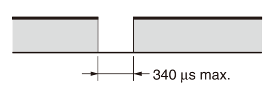
Connecting Safety Sensors and G9SX-GS□

1. To input the control output from safety sensors to the G9SX-GS□, the Y1 terminal must be connected to 24 VDC when the control output is connected to channel A. Likewise, the Y2 terminal must be connected to 24 VDC when the control output is connected to channel B. The G9SX-GS□ will detect a connection error if these terminals are not connected to 24 VDC.

2. In many cases, safety sensor outputs include an OFF-shot pulse for self diagnosis.

The following condition of test pulse is applicable as safety inputs for the G9SX.

- OFF-shot pulse width of the sensor, during the ON-state: 340 µs max.



Operation

Functions

Auto Switching Function

The following table shows the relationship between the safety inputs and safety outputs of the G9SX-GS□ when auto switching is selected.

Safety input A	ON	ON	OFF	OFF
Safety input B	ON	OFF	ON	OFF
Safety output	ON	ON	ON	OFF

Note: 1. If the logical AND connection input is enabled, it must be ON as a necessary condition for the above table.
2. Select either auto reset or manual reset for the reset mode, depending on the operation of the application.

Manual Switching Function

As shown in the following table, the relationship between the safety inputs and safety outputs of the G9SX-GS□ depends on the setting of the connected mode selector when manual switching is selected.

Mode Selector = Normal Operating Mode (M1 = ON, M2 = OFF)

Safety input A	ON	ON	OFF	OFF
Safety input B	ON	OFF	ON	OFF
Safety output	ON	OFF	ON	OFF

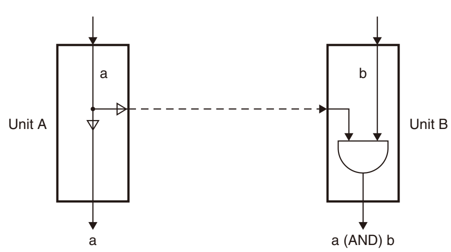
Mode Selector = Maintenance Mode (M1 = OFF, M2 = ON)

Safety input A	ON	ON	OFF	OFF
Safety input B	ON	OFF	ON	OFF
Safety output	ON	ON	OFF	OFF

Note: 1. If the logical AND connection input is enabled, it must be ON as a necessary condition for the above table.
2. Select either auto reset or manual reset for the reset mode, depending on the operation of the application.

Logical AND Connection

The logical AND connection means that one Unit (Unit A) outputs a safety signal “a” to a subsequent Unit (Unit B) and Unit B calculates the logical AND between safety signal “a” and safety signal “b.” In the example shown below, the logical AND connection results in a safety output of “a AND b” for Unit B.



Note: For details on the logical AND connection, refer to the *G9SX-series Flexible Safety Unit catalog* (Cat. No. J150).

External Indicator Outputs

The operator can be notified of two safety input states (enabled/disabled) by connecting external indicator outputs UA and UB to indicators. External indicator outputs UA and UB turn ON when safety inputs A and B, respectively, are disabled, and turn OFF when safety inputs A and B, respectively, are enabled.
If error monitor output X2 turns ON, UA and UB will both turn OFF.

Auto Switching Selected

External indicator output	Description of operation	Output ON condition
UA	Safety input A is disabled.	Safety input B is ON.
UB	Safety input B is disabled.	Safety input A is ON.

Manual Switching Selected

External indicator output	Description of operation	Output ON condition
UA	Safety input A is disabled.	Mode selector switch must be set to normal operating mode.
UB	Safety input B is disabled.	Mode selector switch must be set to maintenance mode.

Note: Fault of external indicators can be detected. (Refer to page 13.)

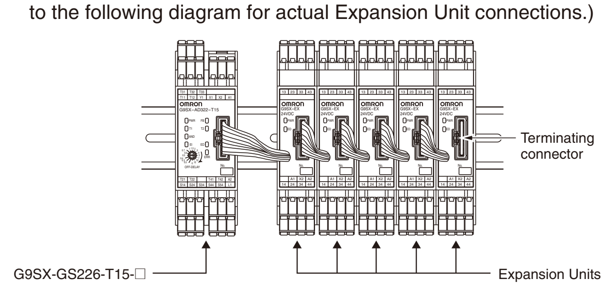
Auxiliary Outputs

Auxiliary outputs X1 to X4 can be used to notify the operator of input, output, and error states, as shown in the following table.

Terminal name	Signal name	Output ON condition
X1	**Auxiliary monitor output**	X1 is ON when the instantaneous safety output is ON.
X2	**Auxiliary error output**	X2 is ON when the error LED is lit or flashing.
X3	**Input A monitor**	X3 is ON when safety input A is ON.
X4	**Input B monitor**	X4 is ON when safety input B is ON.

Connecting Expansion Units

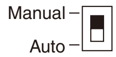
- The G9SX-EX and G9SX-EX-T Expansion Units can be connected to the G9SX-GS226-T15-□ to increase the number of safety outputs.
- A maximum of five Expansion Units can be connected to one G9SX-GS226-T15-□. This may be a combination of the G9SX-EX Instantaneous Expansion Unit and the G9SX-EX-T OFF-delayed Expansion Unit.
- Remove the terminating connector from the receptacle on the G9SX-GS226-T15-□ and insert the Expansion Unit cable connector into the receptacle. Insert the terminating connector into the receptacle on the Expansion Unit at the very end (rightmost).
- When Expansion Units are connected to the G9SX-GS226-T15-□, make sure that power is supplied to every Expansion Unit. (Refer to the following diagram for actual Expansion Unit connections.)



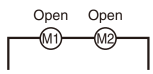
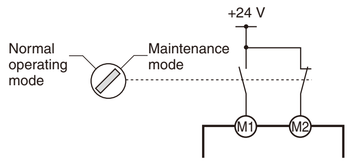
Setting Procedure

1.Switching Function

Auto or manual switching is set by using the Switching Function setting switch on the bottom of the G9SX-GS□. Set the switch to *Auto* for auto switching and *Manual* for manual switching.

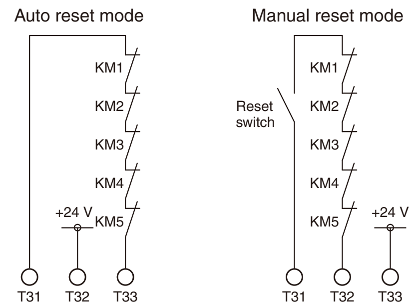


For manual switching, connect the mode selector as shown in the following table.

Switching function	Mode selector connection
Auto switching	
Manual switching	 M1 ON, M2 OFF: Normal operating mode M1 OFF, M2 ON: Maintenance mode

2.Reset Mode

Set the reset mode using feedback/reset input terminals T31, T32, and T33.
Auto reset mode is selected when terminal T32 is shorted to 24 V and manual reset mode is selected when terminal T33 is shorted to 24 V.

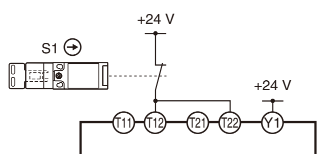
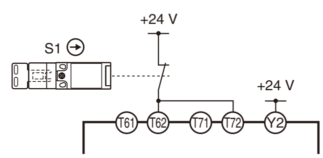
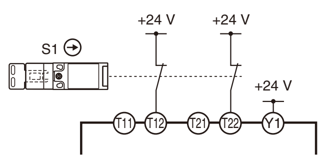
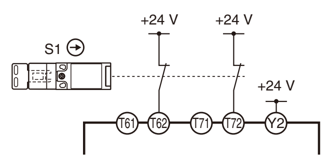
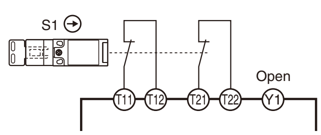
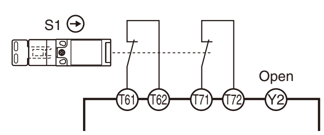


3.Cross Fault Detection

When connecting a Door Switch or other safety input device, you can use Y1 or Y2 to switch the cross fault detection setting.
When Y1 is open, short-circuit failures are detected between safety inputs T11-T12 and T21-T22. When Y2 is open, short-circuit failures are detected between safety inputs T61-T62 and T71-T72. When a cross fault is detected, the following will occur.

1. The safety outputs and logical AND output will be locked out.
2. The LED error indicator will light.
3. The error output (auxiliary output) will turn ON.

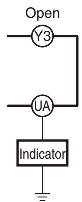
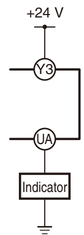
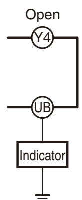
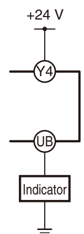
When a safety sensor, such as a Safety Light Curtain, is connected to safety input A, connect Y1 to 24 V. When a safety sensor is connected to safety input B, connect Y2 to 24 V. If they are not connected to 24 V, the G9SX-GS□ will detect an error.

Cross fault detection	Equivalent safety category	Safety input A	Safety input B
OFF	Corresponds to Safety Category 2		
	Corresponds to Safety Category 3		
ON	Corresponds to Safety Category 4		

Note: When a Type 4 safety sensor is connected, a system with Safety Category 3 connection described above is equivalent to Safety Category 4 because cross fault detection is done by the safety sensor.

4.Diagnostic Checks of External Indicators

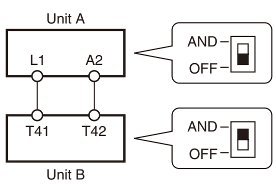
Diagnostic checks of external indicators connected to external indicator outputs UA and UB can be switched with Y3 and Y4, respectively. Enabling the diagnostic check makes it possible to detect indicator burnout or wiring errors.
If there is no indicator connected to external indicator output UA, connect Y3 to 24 V. If there is no indicator connected to external indicator output UB, connect Y4 to 24 V. If they are not connected to 24 V, the G9SX-GS□ will detect an error.

External indicator output	Diagnostic check enabled	Diagnostic check disabled
UA		
UB		

Note: Diagnostic checks cannot be made for LED indicators. Disable the diagnostic check if using LED indicators.

5.Setting Logical AND Connection

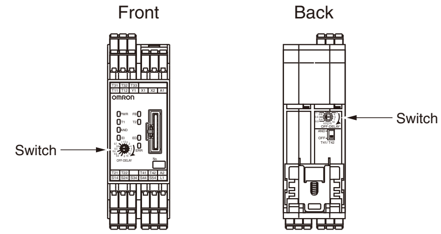
When connecting two or more Units using a logical AND connection, set the logical AND connection preset switch on the Unit that is on the input side to AND.



Note: 1. A setting error will occur and Unit B will lock out if the logical AND setting switch on Unit B is set to OFF.
2. Set the logical AND setting switch on Unit A to OFF, otherwise the Unit A output will not turn ON.

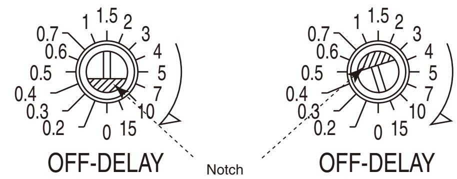
6.Setting the OFF-delay Time

The OFF-delay preset time is set from the OFF-delay time preset switch (1 each on the front and back of the Unit).
Normal operation will only occur if both switches are identically set. An error will occur if the switches are not identically set.



Refer to the following illustration for details on setting switch positions.

G9SX-GS226-T15-□



Example 1: 0-second OFF-delay setting

Example 2: 1-second OFF-delay setting

LED Indicators

Marking	Color	Name	G9SX-GS	G9SX-EX	G9SX-EX-T	Function	Reference
PWR	Green	Power supply indicator	❍	❍	❍	Lit while power is supplied.	*
T1	Orange	Safety input A, channel 1 indicator	❍	---	---	Lit while a HIGH state signal is input to T12. Blinks when an error relating to safety input A channel 1 occurs.	
T2	Orange	Safety input A, channel 2 indicator	❍	---	---	Lit while a HIGH state signal is input to T22. Blinks when an error relating to safety input A channel 2 occurs.	
T6	Orange	Safety input B, channel 1 indicator	❍	---	---	Lit while a HIGH state signal is input to T62. Blinks when an error relating to safety input B channel 1 occurs.	
T7	Orange	Safety input B, channel 2 indicator	❍	---	---	Lit while a HIGH state signal is input to T72. Blinks when an error relating to safety input B channel 2 occurs.	
FB	Orange	Feedback/ reset input indicator	❍	---	---	Lit in the following cases: • With automatic reset while a HIGH state signal is input to T33. • With manual reset while a HIGH state signal is input to T32. Blinks when an error relating to feedback/reset input occurs.	
AND	Orange	Logical AND input indicator	❍	---	---	Lit while a HIGH state signal is input to T41. Blinks when an error relating to logical AND connection input occurs.	
EI	Orange	Safety output indicator	❍	❍	---	Lit while the Instantaneous safety outputs (S14, S24) are in the ON-state. Blinks when an error relating to the instantaneous safety output occurs.	
ED	Orange	OFF-delayed safety output indicator	❍	---	❍	Lit while OFF-delayed safety outputs (S44, S54) are in the ON-state. Blinks when an error relating to OFF-delayed safety output occurs.	
UA	Orange	Safety input A disabled state indicator	❍	---	---	Lit while the input of safety input A (T12, T22) is disabled. Blinks when an error relating to the external indicator (UA) occurs.	
UB	Orange	Safety input B disabled state indicator	❍	---	---	Lit while the input of safety input B (T62, T72) is disabled. Blinks when an error relating to the external indicator (UB) occurs.	
ERR	Red	Error indicator	❍	❍	❍	Lights or blinks when an error occurs.	

* Refer to "*Fault Detection*" on the next page for details.

Settings Indication (at Power ON)

Settings for the G9SX-GS☐ can be checked by the orange indicators for approx. 3 seconds after the power is turned ON. During this settings indication period, the ERR indicator will light, however the auxiliary error output will remain OFF

Indicator	Item	Setting position	Indicator status	Setting mode	Setting status
T1	Cross fault detection mode for safety input A	Y1 terminal	Lit	Enabled	Y1 = open
			Not lit	Disabled	Y1 = 24 VDC
T6	Cross fault detection mode for safety input B	Y2 terminal	Lit	Enabled	Y2 = open
			Not lit	Disabled	Y2 = 24 VDC
FB	Reset mode	T33 or T32 terminal	Lit	Manual reset mode	T33 = 24 VDC
			Not lit	Auto reset mode	T32 = 24 VDC
AND	Logical AND connection input mode	Logical AND connection preset switch	Lit	Enabled	"AND"
			Not lit	Disabled	"OFF"
UA, UB	Switching Function	Switching Function setting switch	Lit	Manual switching	"Manual"
			Not lit	Auto switching	"Auto"

Fault Detection

When the G9SX-GS□ detects a fault, the ERR indicator and/or other indicators light or blink to inform the user about the fault.
Check and take necessary measures referring to the following table, and then re-supply power to the G9SX-GS□.

Safety Guard Switching Unit

ERR indicator	Other indicator	Fault	Expected causes of the fault	Check points and measures to take
Blinks	---	Fault due to electro-magnetic disturbance or of internal circuits.	1) Excessive electromagnetic disturbance 2) Failure of the internal circuit	1) Check the disturbance level around the G9SX-GS□ and the related system. 2) Replace with a new product.
Lights	T1 blinks	Fault involved with safety input A, channel 1	1) Failure involving the wiring of safety input A channel 1 2) Incorrect setting of cross fault detection input 3) Failure of the circuit of safety input A channel 1	1) Check the wiring to T11 and T12. 2) Check the wiring to Y1. 3) Replace with a new product.
Lights	T2 blinks	Fault involved with safety input A, channel 2	1) Failure involving the wiring of safety input A channel 2 2) Incorrect setting of cross fault detection input 3) Failure of the circuit of safety input A channel 2	1) Check the wiring to T21 and T22. 2) Check the wiring to Y1. 3) Replace with a new product.
Lights	T6 blinks	Fault involved with safety input B, channel 1	1) Failure involving the wiring of safety input B channel 1 2) Incorrect setting of cross fault detection input 3) Failure of the circuit of safety input B channel 1	1) Check the wiring to T61 and T62. 2) Check the wiring to Y2. 3) Replace with a new product.
Lights	T7 blinks	Fault involved with safety input B, channel 2	1) Failure involving the wiring of safety input B channel 2 2) Incorrect setting of cross fault detection input 3) Failure of the circuit of safety input B channel 2	1) Check the wiring to T71 and T72. 2) Check the wiring to Y2. 3) Replace with a new product.
Lights	FB blinks	Faults involved with feedback/reset input	1) Failures involving the wiring of feedback/reset input. 2) Failures of the circuit of feedback/reset input	1) Check the wiring to T31, T32 and T33. 2) Replace with a new product.
Lights	FB blinks	Fault in Expansion Unit	1) Improper feedback signals from Expansion Unit 2) Abnormal supply voltage to Expansion Unit 3) Failure of the circuit of safety relay contact outputs	1) Check the connecting cable of Expansion Unit and the connection of the terminating connector 2) Check the supply voltage to Expansion Unit. **Note:** Make sure that all Expansion units' PWR indicators are lit. 3) Replace the Expansion Unit with a new one.
Lights	EI blinks	Fault involved with instantaneous safety outputs or logical AND connection outputs	1) Failure involving the wiring of instantaneous safety outputs 2) Failure of the circuit of Instantaneous safety outputs 3) Failure involving the wiring of the logical AND connection output 4) Failure of the circuit of the logical AND connection output 5) Impermissible high ambient temperature	1) Check the wiring to S14 and S24. 2) Replace with a new product. 3) Check the wiring to L1. 4) Replace with a new product. 5) Check the ambient temperature and spacing around the G9SX-GS□.
Lights	ED blinks	Fault involved with OFF-delayed safety outputs	1) Failure involving the wiring of OFF-delayed safety relay contact outputs 2) Incorrect set values for OFF-delay time 3) Failure of the circuit of OFF-delayed safety relay contact outputs 4) Impermissible high ambient temperature	1) Check the wiring to S44 and S54. 2) Confirm the set values of the OFF-delay time preset switches on the front and back of the Unit. 3) Replace with a new product. 4) Check the ambient temperature and spacing around the G9SX-GS□.

ERR indicator	Other indicator	Fault	Expected causes of the fault	Check points and measures to take
● Lights	AND blinks	Fault involved with logical AND connection input	1) Failure involving the wiring of the logical AND connection input 2) Incorrect setting for the logical AND connection input 3) Failure of the circuit of the logical AND connection input	1) Check the wiring to T41 and T42. **Note:** Make sure that the wiring length for the T41, T42 terminal is less than 100 meters. **Note:** Make sure that the logical AND connection signal is branched for less than 4 units. 2) Confirm the set value of the logical AND connection preset switch. 3) Replace with a new product.
	UA blinks	Fault involved with the external indicator output (UA)	1) Failure involving the wiring of the external indicator output 2) Failure involving the wiring of the external indicator diagnosis switching input 3) Failure of the circuit of the external indicator output 4) Failure of the external indicator	1) Check the wiring to UA. 2) Check the wiring to Y3. **Note:** When no indicator is connected, or an LED indicator is connected, connect Y3 to 24 V. 3) Replace with a new product. 4) Replace the connected external indicator.
	UB blinks	Fault involved with the external indicator output (UB)	1) Failure involving the wiring of the external indicator output 2) Failure involving the wiring of the external indicator diagnosis switching input 3) Failure of the circuit of the external indicator output 4) Failure of the external indicator	1) Check the wiring to UB. 2) Check the wiring to Y4. **Note:** When no indicator is connected, or an LED indicator is connected, connect Y4 to 24 V. 3) Replace with a new product. 4) Replace the connected external indicator.
	UA and UB alternately blink	Fault involved with the Switching Function	1) Failure involving the setting of the Switching Function setting switch 2) Failure involving the wiring of the mode selector input 3) Failure involving the circuit of the mode selector input 4) Failure involving the mode selector switching time	1) Check the setting of the Switching Function setting switch. 2) Check the wiring to M1 and M2. 3) Replace with a new product. 4) Check the signal switching time of the mode selector input (M1, M2).
	All indicators except PWR blink	Supply voltage outside the rated value	1) Supply voltage outside the rated value	1) Check the supply voltage to the Units.

When indicators other than the ERR indicator blink, check and take necessary actions referring to the following table.

ERR indicator	Other indicators		Fault	Expected cause of the fault	Check points and measures to take
○ Off	T1 T2	Blink	Safety input A mismatch	The input status between safety input A channel 1 and safety input A channel 2 is different, due to contact failure or a short circuit of safety input device(s) or a wiring fault.	Check the wiring from safety input devices to the G9SX-GS□. Or check the input sequence of safety input devices. After removing the fault, turn both safety input A channels 1 and 2 to the OFF state.
	T6 T7	Blink	Safety input B mismatch	The input status between safety input B channel 1 and safety input B channel 2 is different, due to contact failure or a short circuit of safety input device(s) or a wiring fault.	Check the wiring from safety input devices to the G9SX-GS□. Or check the input sequence of safety input devices. After removing the fault, turn both safety input B channels 1 and 2 to the OFF state.

(Expansion Unit)

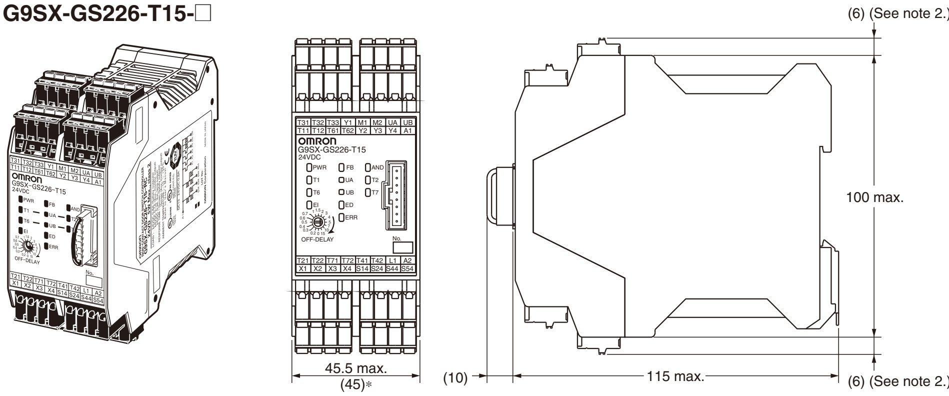
ERR indicator	Other indicators	Fault	Expected cause of the faults	Check points and measures to take
● Lights	---	Fault involved with safety relay outputs of Expansion Units	1) Welding of relay contacts 2) Failure of the internal circuit	Replace with a new product.

Dimensions and Terminal Arrangement

(Unit: mm)

Safety Guard Switching Unit

G9SX-GS226-T15-□



* Typical dimension

Terminal arrangement

T31	T32	T33	Y1	M1	M2	UA	UB
T11	T12	T61	T62	Y2	Y3	Y4	A1

PWR FB AND
T1 UA T2
T6 UB T7
EI ED
ERR

T21	T22	T71	T72	T41	T42	L1	A2
X1	X2	X3	X4	S14	S24	S44	S54

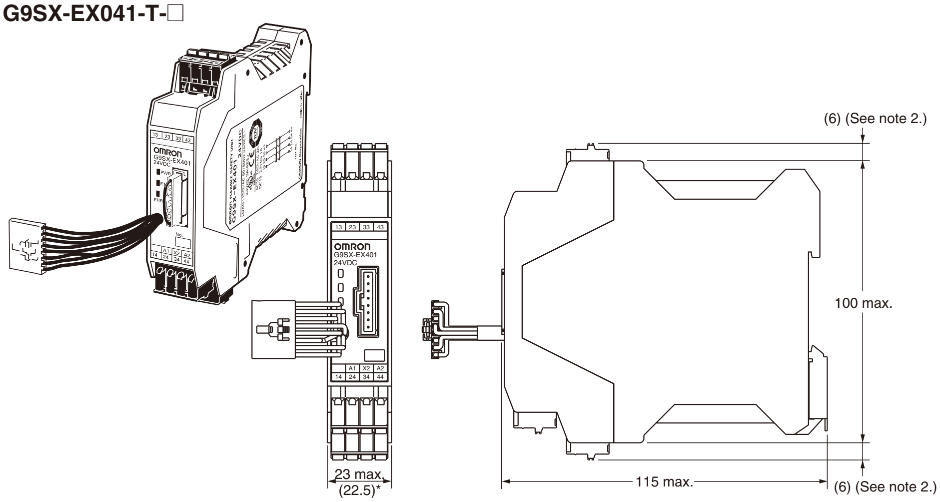
Note: 1. Above outline drawing is for -RC terminal type.
2. For -RC terminal type only.

Expansion Unit

G9SX-EX401-□

Expansion Unit (OFF-delayed Model)

G9SX-EX041-T-□



* Typical dimension

Terminal arrangement

G9SX-EX401-□ (Expansion Unit)

13	23	33	43

PWR
EI
ERR

	A1	X2	A2
14	24	34	44

G9SX-EX041-T-□ (Expansion Unit with OFF Delay)

13	23	33	43

PWR
ED
ERR

	A1	X2	A2
14	24	34	44

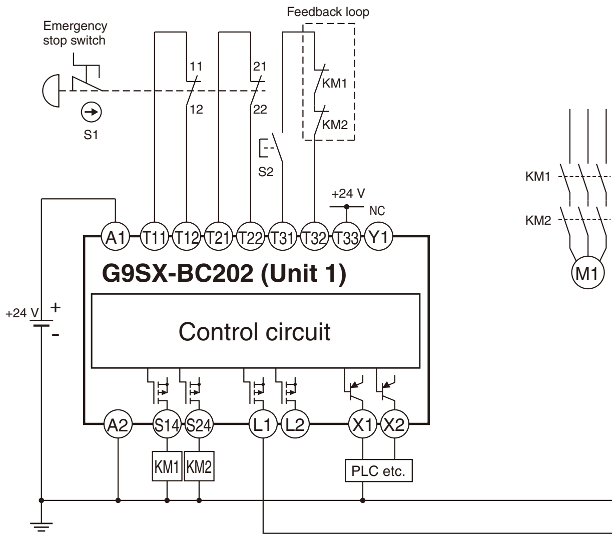
Note: 1. Above outline drawing is for -RC terminal type.
2. For -RC terminal type only.

Application Examples

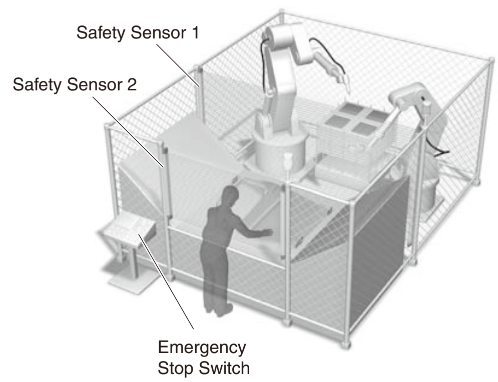
G9SX-BC202 (24 VDC) (2-channel Emergency Stop Switch Input/Manual Reset) + G9SX-GS226-T15 (24 VDC) (Two 2-channel Safety Sensor Inputs/Auto Reset/Auto Switching)

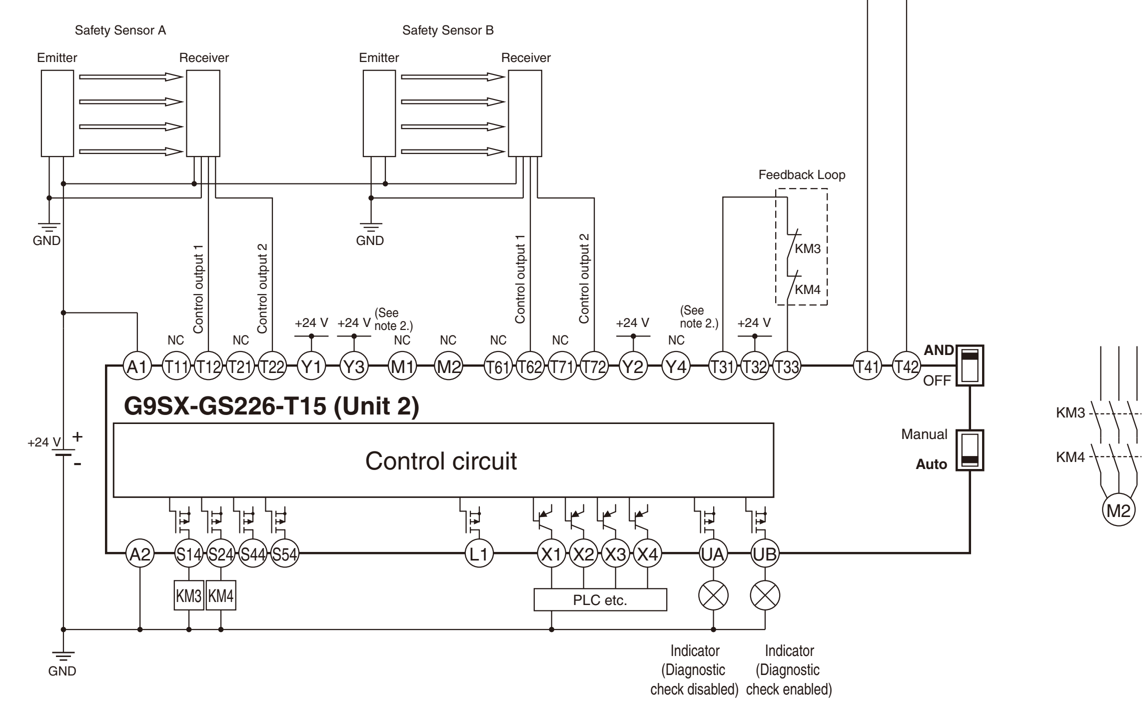
Note: 1. This example corresponds to category 4.
For details, refer to *Safety Categories (EN 954-1)*.

2. Diagnostic checks of the external indicators connected to external indicator outputs UA and UB can be switched with Y3 and Y4, respectively.

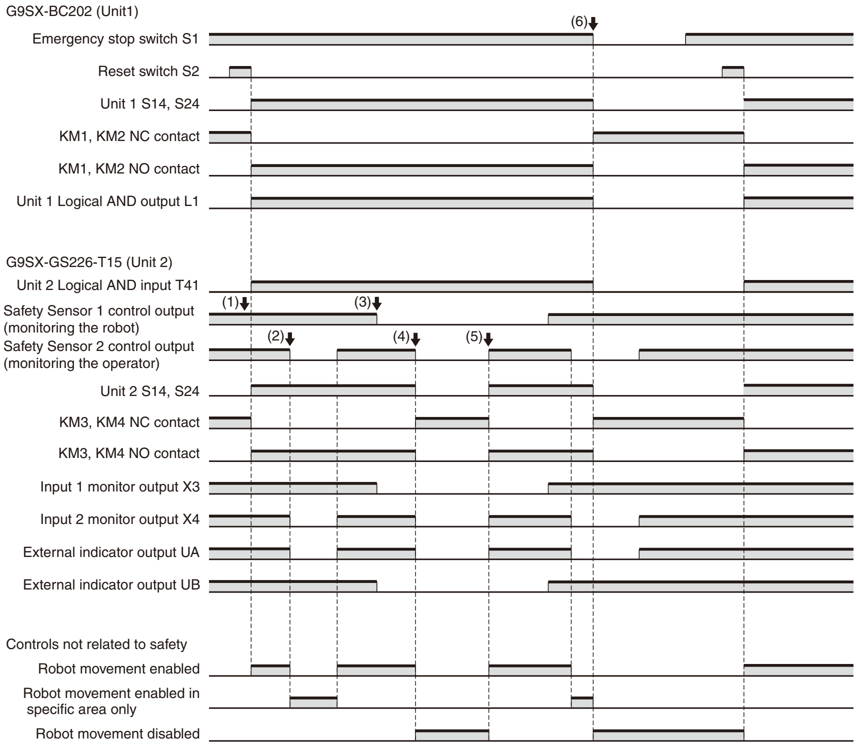


Application Examples





Timing Chart 1

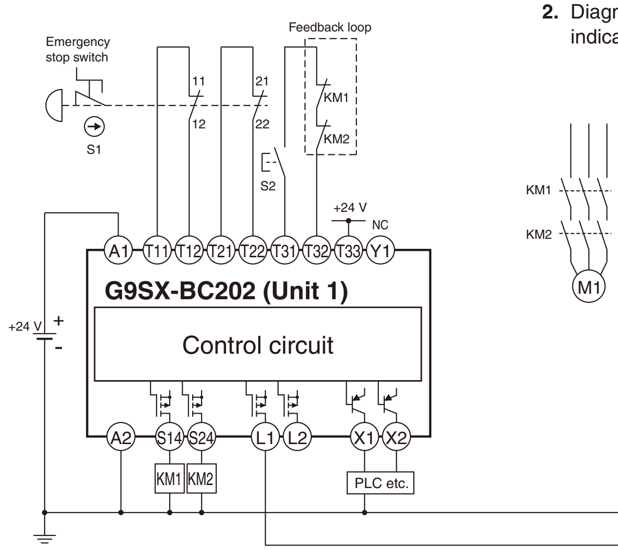


(1) Prior to operation start
(2) Operator inserts workpiece
(3) Robot processes workpiece
(4) Both operator and robot enter the coordinated area: Only the G9SX-GS stops.
(5) The G9SX-GS restarts.
(6) Emergency stop switch pressed: All units stop.

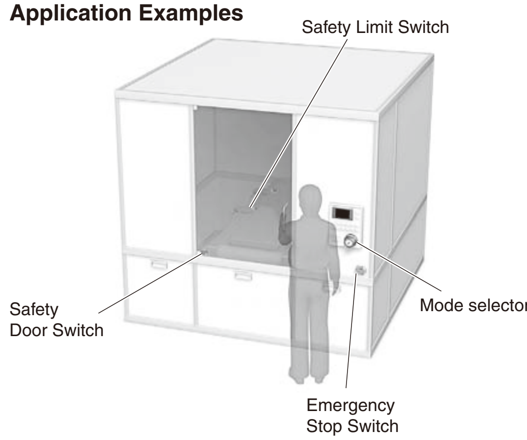
G9SX-BC202 (24 VDC) (2-channel Emergency Stop Switch Input/Manual Reset) + G9SX-GS226-T15 (24 VDC) (Safety Limit Switch, 2-channel Safety Door Switch Inputs/Manual Reset/Manual Switching)

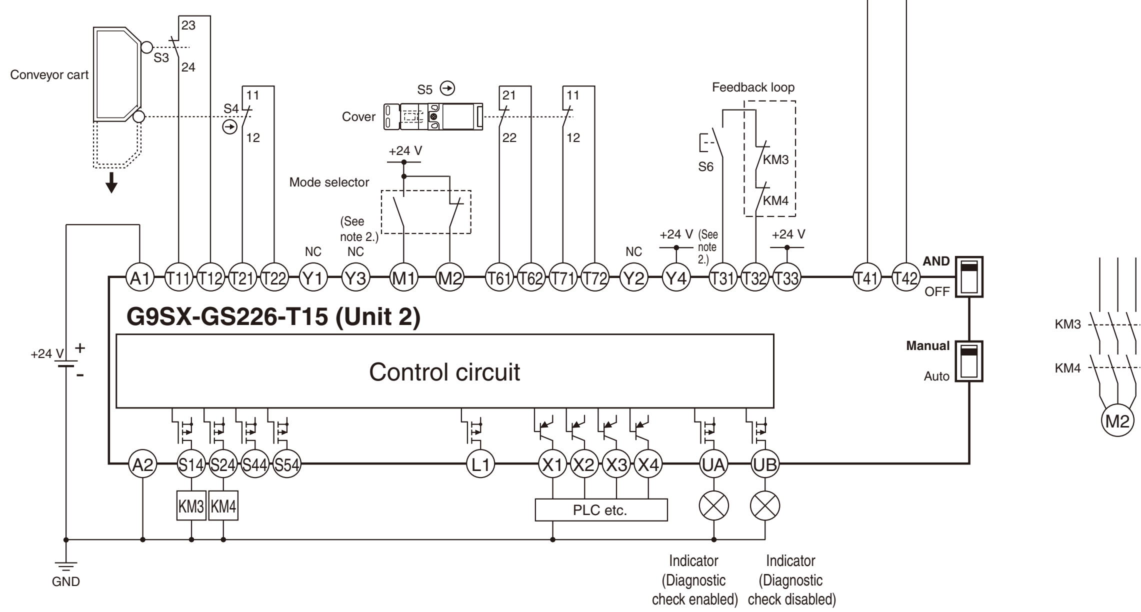
Note: 1. This example corresponds to category 4.
For details, refer to *Safety Categories (EN 954-1)*.

2. Diagnostic checks for the external indicators connected to external indicator outputs UA and UB can be switched with Y3 and Y4, respectively.

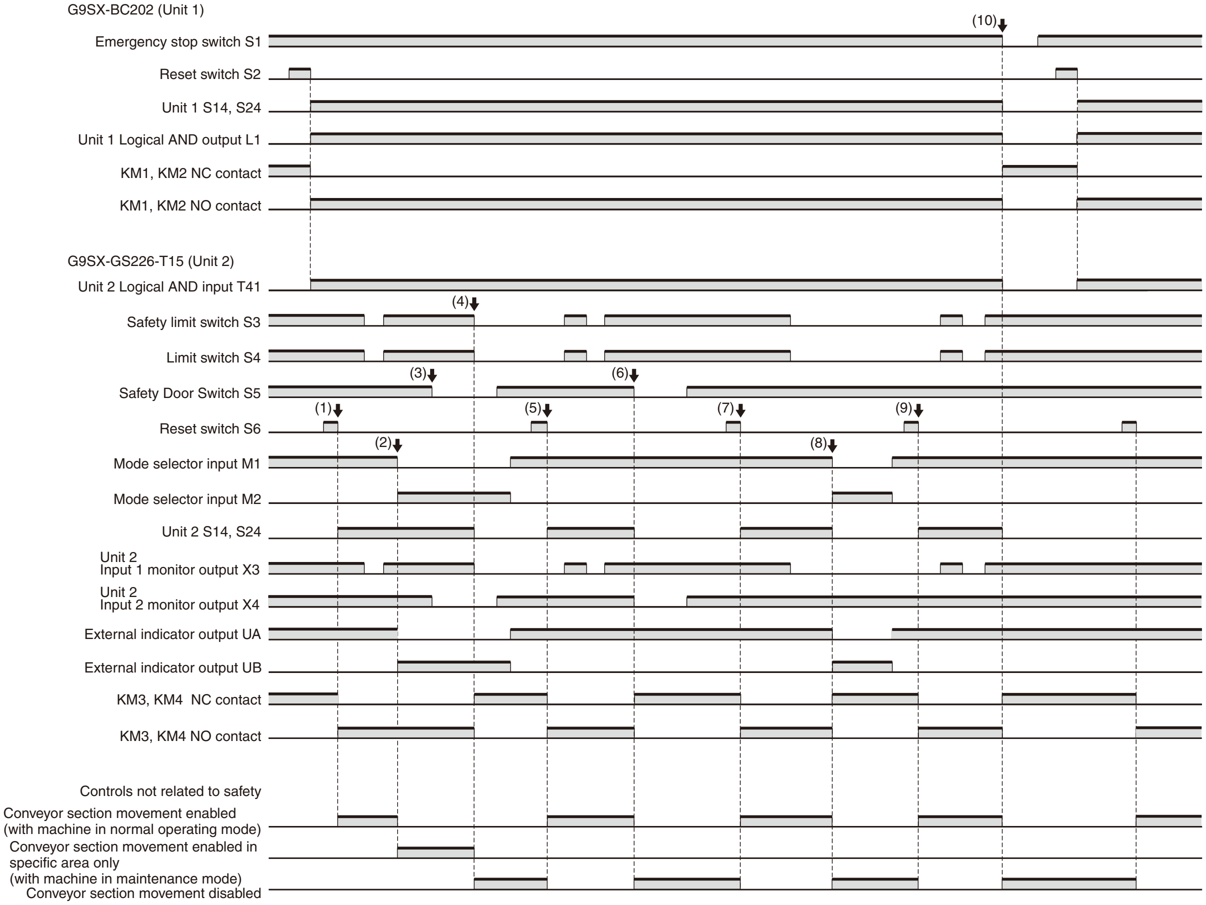


Application Examples





Timing Chart 2



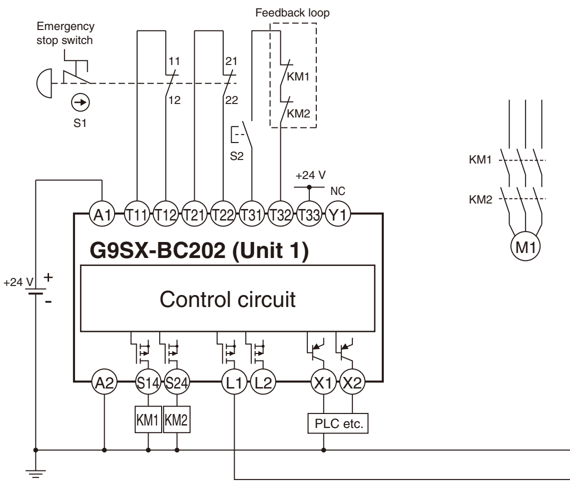
(1) Start the G9SX-GS in normal operating mode.
(2) Switch to maintenance mode.
(3) The operator opens the door and performs maintenance.
(4) When Safety Limit Switch S3 and Limit Switch S4 are turned OFF in maintenance mode, the G9SX-GS stops.
(5) After the door is closed and the operating mode is switched to normal operating mode, restart the G9SX-GS.
(6) When the door is opened during normal operating mode, the G9SX-GS stops.
(7) Close the door and restart the G9SX-GS.
(8) When the operating mode is switched to maintenance mode while Safety Limit Switch S3 and Limit Switch S4 are turned OFF, the G9SX-GS stops.
(9) Switch to normal operating mode, and when the door is closed, restart the G9SX-GS.
(10) Emergency stop switch pressed: All units stop.

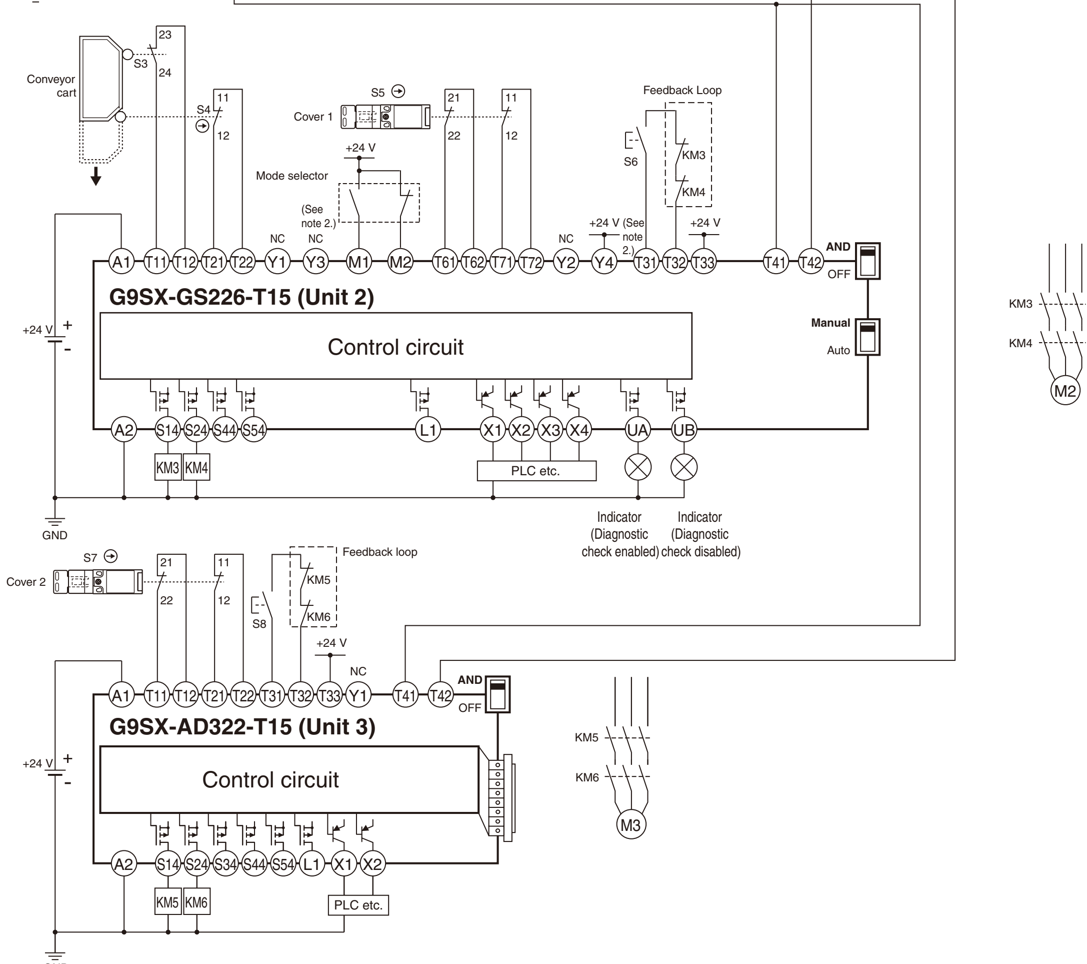
Note: 1. In this example, press reset switch S2, confirm that the G9SX-BC has started operating, then press reset switch S6.
2. To use the set value of the mode selector for control, use external indicator output UA for control and external indicator output UB for the operator's indication. In this case, disable the diagnostic check of the external indicator output UA.

G9SX-BC202 (24 VDC) (2-channel Emergency Stop Switch Input/Manual Reset) + G9SX-GS226-T15 (24 VDC) (Safety Limit Switch, 2-channel Safety Door Switch Inputs/Manual Reset/ Manual Switching) + G9SX-AD322-T15 (24 VDC) (2-channel Safety Door Switch Input/Manual Reset)

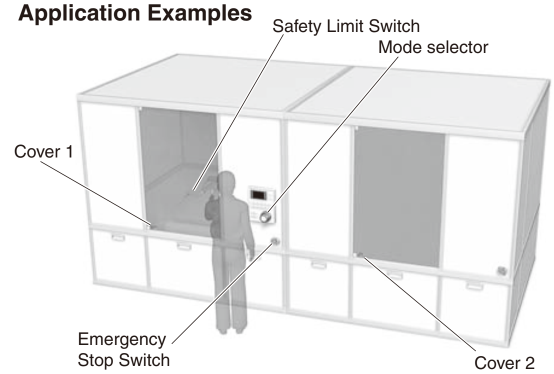
Note: 1. This example corresponds to category 4.
For details, refer to *Safety Categories (EN 954-1)*.

2. Diagnostic checks for the external indicators connected to external indicator outputs UA and UB can be switched with Y3 and Y4 respectively.

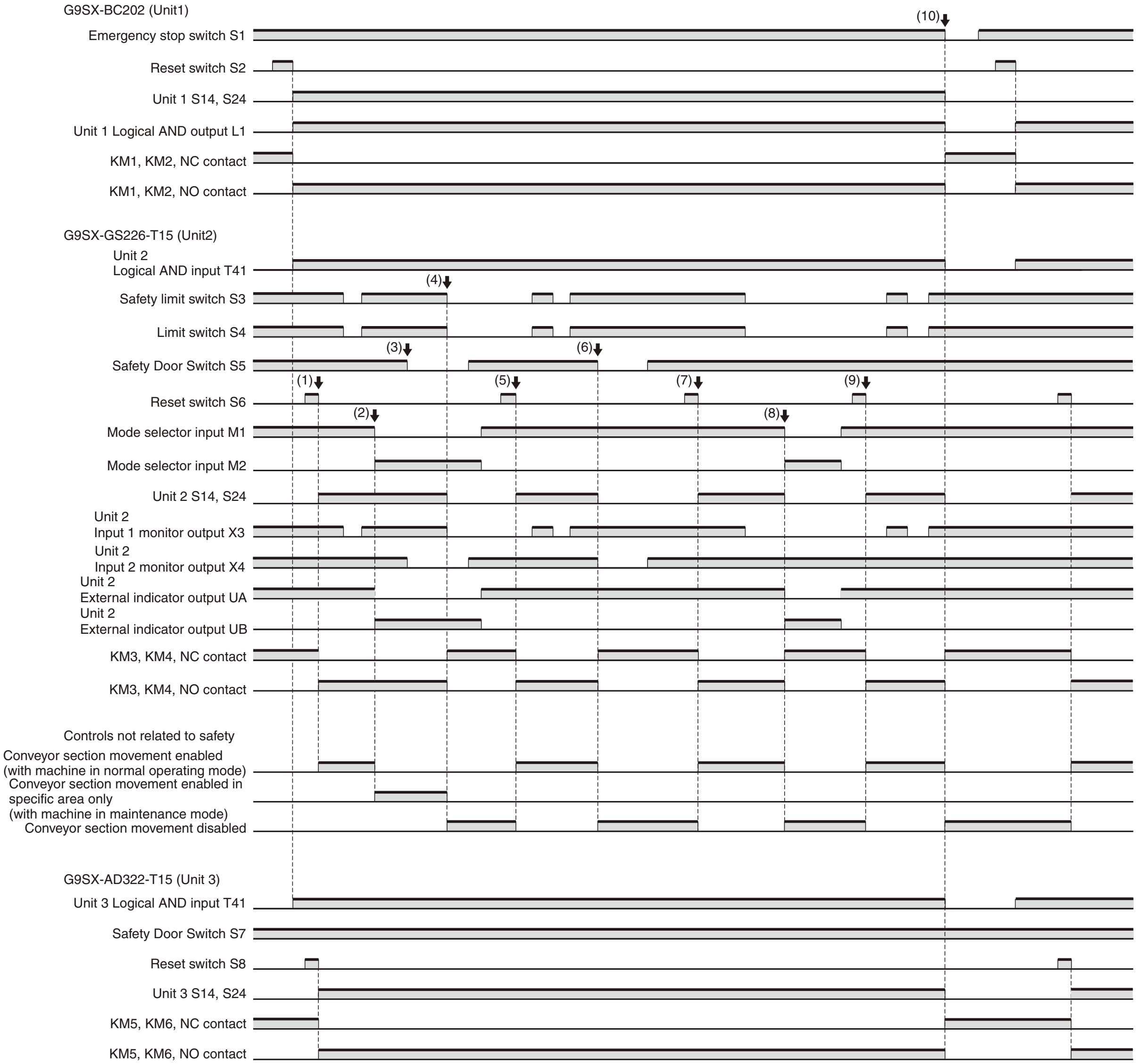




Application Examples



Timing Chart 3



(1) Start the G9SX-GS in normal operating mode
(2) Switch to maintenance mode.
(3) The operator opens the door and performs maintenance.
(4) When Safety Limit Switch S3 and Limit Switch S4 are turned OFF in maintenance mode, the G9SX-GS stops.
(5) After the door is closed and the operating mode is switched to normal operating mode, restart the G9SX-GS.
(6) When the door is opened during normal operating mode, the G9SX-GS stops.
(7) Close the door and restart the G9SX-GS.
(8) When the operating mode is switched to maintenance mode while Safety Limit Switch S3 and Limit Switch S4 are turned OFF, the G9SX-GS stops.
(9) Switch to normal operating mode, and when the door is closed, restart the G9SX-GS.
(10) Emergency stop switch pressed: All units stop.

Note: 1. In this example, press reset switch S2, confirm that the G9SX-BC has started operating, then press reset switch S6 and S8.

2. To use the set value of the mode selector for control, use external indicator output UA for control and external indicator output UB for the operator's indication. In this case, disable the diagnostic check of the external indicator output UA.

Safety Precautions

Refer to "*Precautions for All Relays*", and "*Precautions for All Relays with Forcibly Guided Contacts*" for more detailed information.

⚠ WARNING

Serious injury may possibly occur due to malfunction of safety outputs.
Do not connect loads that are beyond the rating of the safety outputs.

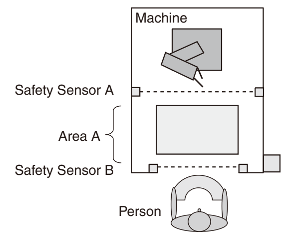
Serious injury may possibly occur due to loss of safety functions.
Wire the G9SX properly so that the safety outputs do not short-circuit with the Unit power supply or load power supply.

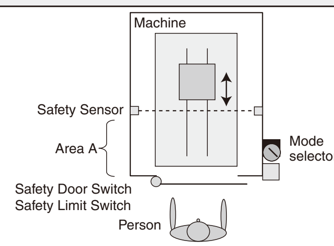
Serious injury may possibly occur due to malfunction of safety outputs.
Add a circuit to protect against back electromotive force when connecting inductive loads to safety outputs.

Serious injury may possibly occur due to loss of safety functions.
Use appropriate control devices as given in the following table.

Control device	Requirements
Door interlocking switch or Safety limit switches	Use approved devices with a direct opening mechanism complying with IEC/EN 60947-5-1 and capable of switching micro loads of 24 VDC, 5 mA.
Safety sensors	Use approved devices complying with the relevant product standards, laws, and regulations in the country where they are used. Consult a certification body to assess that the entire system satisfies the required safety category level.
Relays with forcibly guided contacts	Use approved devices with forcibly guided contacts complying with EN 50205. For feedback purposes, use devices with contacts capable of switching micro loads of 24 VDC, 5 mA.
Contactors	Use contactors with a forcibly guided mechanism to input the signal to the feedback/reset input of the G9SX through the NC contact of the contactor. For feedback purposes, use devices with contacts capable of switching micro loads of 24 VDC, 5 mA. Failure to open the contacts of a contactor cannot be detected by monitoring its auxiliary NC contact without a forcibly guided mechanism.
Emergency stop switches	Do not connect an emergency stop switch to the G9SX-GS□.
Other devices	Evaluate whether devices used are appropriate to satisfy the requirements of the safety category level.

Serious injury may possibly occur due to loss of safety functions.
Construct an appropriate safety system as shown in the following table.

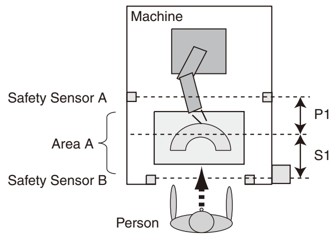
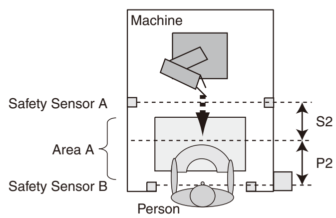
Switching function	Auto switching
Safety system configuration example	
Safety precautions	**1.** Select Safety Sensors that satisfy the following condition: Diameter of the smallest detectable object < Diameter of the object to be detected **2.** Install the Safety Sensors so that they satisfy the following conditions: (1)Use Safety Sensor A to detect the entry of the machine into area A, and Safety Sensor B to detect the entry of a person into area A. (2)Make sure that the machine can reach area A only by passing through Safety Sensor A, and that a person can reach area A only by passing through Safety Sensor B. **3.** Provide a protective structure to prevent a person from passing completely through Safety Sensor B and stepping into area A. If this is not possible, install a sensor that will detect the presence of a person inside area A and prevent the machine from being restarted while the person is inside area A. **4.** Provide a sufficient safety distance (S1) considering the entry speed of a person and a sufficient safety distance (S2) considering the entry speed of the machine. For details, refer to "*Safety Distance*" on page 25.

Switching function	Manual switching
Safety system configuration example	
Safety precautions	**1.** Select Safety Sensors that satisfy the following condition: Diameter of the smallest detectable object < Diameter of the object to be detected **2.** Install the Safety Sensors so that they satisfy the following conditions: (1)Use the Safety Sensor to detect the entry of the machine into area A. (2)Make sure that the machine can reach area A only by passing through the Safety Sensor. **3.** Provide a protective structure to prevent a person from stepping into area A when the door is opened. If this is not possible, install a sensor that will detect the presence of a person inside area A and prevent the machine from being restarted while the person is inside area A. **4.** Provide a sufficient safety distance (S2) considering the entry speed of the machine. For details, refer to "*Safety Distance*" on page 25. **5.** Position the mode selector in a location where it cannot be operated from inside area A.

Safety Distance

The safety distance is the minimum distance that must be provided between the safety input device and a machine's hazardous part to stop the hazardous part before a person or object reaches it.
The safety distance varies according to the standards of each country and the specifications of each machine. In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the safety input device. Always refer to the relevant standards.

Safety Distance Concepts

When a person approaches a hazard (machine)	
	• S1: Safety distance 1 • P1: The closest that a machine can come to a person while operating (the boundary of the machine's operating area)
When a hazard (machine) approaches a person	
	• S2: Safety distance 2 • P2: The closest that a part of a person can come to a machine.

Safety Distance Calculation Examples (Reference)

Calculating the safety distance specified by international standard ISO 13855-2002 (European standard EN 999-1999)	If a person approaches the detection zone perpendicularly, calculate the safety distance as shown below. S1 = K1 × T + C S2 = K2 × T + C S1: Safety distance 1 S2: Safety distance 2 K1: Approach speed of a person to the detection zone (area A) K2: Maximum approach speed of a machine to the detection zone (area A) T: Total response time of the machine and G9SX system C: Additional distance calculated by the detection capability (the diameter of the smallest detectable object) of the Safety Sensor.
Calculating the safety distance specified by American standard ANSI B11.19	If a person approaches the detection zone perpendicularly, calculate the safety distance as shown below. S1 = K1 × (Ts + Tc + Tr + Tbm) + Dpf S2 = K2 × (Ts + Tc + Tr + Tbm) + Dpf S1: Safety distance 1 S2: Safety distance 2 K1: Approach speed of a person to the detection zone (area A) K2: Maximum approach speed of a machine to the detection zone (area A) Ts: Machine's stop time (s) Tr: Response time of the G9SX system from ON to OFF (s) Tc: Machine control circuit's maximum response time required to activate its brake (s) Tbm:Additional time (s) Dpf: Additional distance

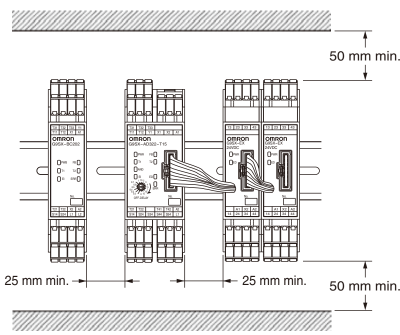
1. To determine the approach speed K1, consider all factors, including the operator's physical abilities.
2. To determine the maximum approach speed K2, consult with a notified body or other authoritative institutes.
3. The response time of a machine is the time from when the machine receives a stop signal to the time when the machine's hazardous part stops. Measure the response time on the actual system. Also, periodically check that the machine's response time has not changed.
4. For information on the response time of the G9SX system, refer to item 11 of "*Precautions for Correct Use*" on page 27.

Precautions for Safe Use

1. Use the G9SX-GS□ within an enclosure with IP54 protection or higher as specified by IEC 60529.
2. Incorrect wiring may lead to loss of safety functions. Wire conductors correctly and verify the operation of the G9SX-GS□ before operating the system in which the G9SX-GS□ is incorporated.
3. Do not apply DC voltages exceeding the rated voltages, or any AC voltages to the G9SX-GS□ power supply input.
4. Use a DC power supply that satisfies the following requirements to prevent electric shock.
   - A DC power supply with double or reinforced insulation, for example, according to IEC/EN 60950 or EN 50178 or a transformer according to IEC/EN 61558.
   - A DC power supply that satisfies the requirements for class 2 circuits or limited voltage/current circuits stated in UL 508.
5. Apply the specified voltages to G9SX-GS□ inputs. Applying inappropriate voltages may cause the G9SX-GS□ to fail to perform its specified functions, which may lead to the loss of safety functions, damage to the G9SX-GS□, or burning.
6. Be sure to correctly connect safety input devices to safety input A and safety input B to ensure proper operation of the safety functions.
7. The auxiliary error output, auxiliary monitoring output, and external indicator output are NOT safety outputs. Do not use them as safety outputs. Such incorrect use will cause loss of the safety functions of G9SX-GS□ and its relevant system. Also the logical AND connection output can be used only for logical AND connections between G9SX-□ Units.
8. When setting the Switching Function, be sure to consider safety control requirements, safety level and safety category of the entire system.
9. After installing the G9SX-GS□, qualified personnel must confirm the installation, and must conduct test operations and maintenance. The personnel must be qualified and authorized to secure the safety on each phase of design, installation, running, maintenance, and disposal of system.
10. A person in charge who is familiar to the machine in which G9SX-GS□ is to be installed must conduct and verify the installation.
11. A qualified personnel who has a thorough understanding of the installed machine must switch the mode selector input. For example, a Switching Unit with Key must be used for the mode selector, and the key must be managed and used in such a way that the machine cannot be operated by unauthorized persons.
12. Perform daily and 6-month inspections on the G9SX-GS□. Otherwise, the system may fail to work properly, resulting in serious injury.
13. Do not dismantle, repair, or modify the G9SX-GS□. Doing so may lead to the loss of its safety functions.
14. Use only appropriate components or devices complying with relevant safety standards corresponding to the required level of the safety category. Conformity to the requirements of the safety category is determined as an entire system. It is recommended to consult a certification body regarding assessment of conformity to the required safety level.
15. OMRON shall not be responsible for conformity with any safety standards for the customer's overall system.
16. Disconnect the G9SX-GS□ from the power supply when wiring to prevent electric shock or unexpected operation.
17. Be careful not to pinch your fingers when attaching terminal sockets to the plugs on the G9SX-GS□.
18. Do not use the G9SX-GS□ in places that are subject to combustible or explosive gases.

Precautions for Correct Use

1. Handle with care
   Do not drop G9SX to the ground or expose to excessive vibration or mechanical shocks. G9SX may be damaged and may not function properly.
2. Conditions of storage
   G9SX may be damaged and may not function properly.
   Do not store in such conditions stated below.
   (1) In direct sunlight
   (2) At ambient temperatures out of the range of −10 to 55°C.
   (3) At relative humidity out of the range of 25% to 85% or under such temperature change that causes condensation.
   (4) In corrosive or combustible gases
   (5) With vibration or mechanical shocks out of the rated values.
   (6) Under splashing of water, oil, chemicals
   (7) In the atmosphere containing dust, saline or metal powder.
3. Mounting
   Mount G9SX to DIN track with attachments (PFP-M, not incorporated to this product), not to drop off the track by vibration or other force especially when the length of DIN track is short compared to the widths of G9SX.
4. Following spacing around G9SX should be available to apply rated current to outputs of G9SX and for enough ventilation and wiring:
   (1) At least 25 mm beside side faces of the Advanced Unit (G9SXAD322-□/G9SX-ADA222-□) and side faces of the Basic Unit.
   (2) At least 50 mm above top face of G9SX and below bottom face of G9SX.



5. Wiring
   (1) G9SX-GS□
   - Wire the G9SX-GS□ as described below.

Solid wire	0.2 to 2.5 mm^2 (AWG24 to AWG12)
Stranded wire	0.2 to 2.5 mm^2 (AWG24 to AWG12)

   - Strip no more than 7 mm of insulation from the end of the wire.
   - It is recommended that stranded wire be covered with insulated 0.25- to 2.5-mm^2 ferrules before connecting it.

   (2) G9SX-GS□-RT (with Screw Terminals)
   - Tighten each screw to 0.5 to 0.6 N·m or the G9SX-GS□-RT may malfunction or generate heat.

   (3) Wiring for a Logical AND Connection
   - Use a 2-conductor cabtire cable or shielded cable to wire a logical AND connection between Units.
6. Connecting Expansion Units (G9SX-EX□-□):
   (1)Remove the termination connector from the G9SX-GS□, and insert the connector of the Expansion Unit into the G9SX-GS□ to connect it.
   (2)Insert the termination connector into the last Expansion Unit as viewed from the G9SX-GS□. When the G9SX-GS□ is used without any Expansion Units, do not remove the termination connector from the G9SX-GS□.
   (3)Do not remove the termination connector while the system is operating.
   (4)Before applying the power supply voltage, confirm that the connecting sockets and plugs are locked.
   (5)Make sure that all connected Expansion Units are supplied with power within 10 s after the power to the G9SX-GS□ is turned ON. Otherwise, the G9SX-GS□ will detect a power supply error for the Expansion Units.

7. Use a mode selector that has an SPST-NO + SPST-NC contact form (e.g., OMRON's A22K-□-11).
8. Use cables with a length of 100 m maximum to connect the safety inputs, feedback/reset input, logical AND connection input, logical AND output, or mode selector inputs.
9. Set the time duration of OFF-delay to an appropriate value that does not cause the loss of safety function of system.
10. Logical AND connection between Units:
    (1) When using Logical AND connection inputs, set the logical AND connection input for the Advanced Units that will receive the input to AND "Enable logical AND input".
    (2) Be sure to wire the logical AND connection input correctly with respect to the logical AND connection output of the Advanced Unit or Basic Unit.
    (3) Use two-conductor cabtire cable or shielded cable for wiring the logical AND connections between Units.
    (4) Use two-conductor cabtire cable or shielded cable to wire logic connections between Units.
11. To determine the safety distance to hazards, take into account the delay of safety outputs caused by the following times:
    (1) Response time of safety inputs
    (2) Response time of logical AND connection input (Also consider the precaution in " * " below)
    (3) Preset OFF-delay time
    (4) Accuracy of OFF-delay time
    * When connecting multiple Units with logical AND connections, the operating time and response time after logical AND connection inputs will be the sum of the operating times and response times of the Units that are connected in series by logical AND connections.
12. Start entire system after more than 5s have passed since applying supply voltage to all G9SXs in the system.
13. Power Supply
    (1) The G9SX-GS□ may malfunction due to electromagnetic disturbances. Be sure to connect terminal A2 to ground.
    (2) When sharing a power supply with a Safety Light Curtain, use a power supply that will not fail for a momentary power interruption of 20 ms or less.
14. Devices connected to G9SX may operate unexpectedly. When replacing G9SX, disconnect it from power supply.
15. Adhesion of solvent such as alcohol, thinner, trichloroethane or gasoline on the product should be avoided. Such solvents make the marking on G9SX illegible and cause deterioration of parts.
16. Safety Application Controller's Relay durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
    When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay or the Safety Application Controller immediately.
    If the Relay or the Safety Application Controller is used continuously without replacing, then it can lead to loss of safety function.

Category of EN954-1

In the condition shown in Application Examples, G9SX can be used for the corresponding categories up to category 4.
This does NOT mean that G9SX can always be used for required category under all the similar conditions and situations.
Conformity to the categories must be assessed as a whole system.
When using G9SX for safety categories, be sure to confirm the conformity as a whole system.

Safety Categories (EN 954-1)

1. Input signals to both safety inputs (T11-T12, T21-T22, T61-T62, and T71-T72).
2. Input signals to the safety inputs (T11-T12, T21-T22, T61-T62, and T71-T72) through switches equipped with a direct opening mechanism.
   When using limit switches, at least one of them must have a direct opening mechanism.
3. When connecting a Safety Sensor to the G9SX-GS□, use a TYPE 4 Safety Sensor.
4. Input the signal through the contactor's N.C. contact to the Feedback/Reset input (T31-T32 for manual reset, or T31-T33 for auto reset). (Refer to *Application Examples*.)
5. Keep the cross fault detection mode input (Y1 and Y2) open. However, when connecting devices that have a self-diagnosis function, such as Safety Sensors, apply 24 VDC to Y1 or Y2.
6. Be sure to connect A2 to ground.
7. When using a G9SX-EX□-□ Expansion Unit, connect fuses with a current rating of 3.15 A maximum to the safety relay outputs to prevent the contacts from welding.

Compliance with International Standards

G9SX-GS226-T15-□/G9SX-EX-□

- Approved by TÜV Product Service
  EN 50178
  IEC/EN 60204-1
  EN 954-1 Cat.4
  IEC/EN 61508 SIL3
  IEC/EN 62061 SIL3
  IEC/EN 61000-6-2
  IEC/EN 61000-6-4
- Approved by UL
  UL 508
  UL 1998
  NFPA 79
  IEC 61508
  CAN/CSA C22.2 No.142

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)
To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).
Refer to the *Safety Components Technical Guide* (Cat No. Y107).
The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

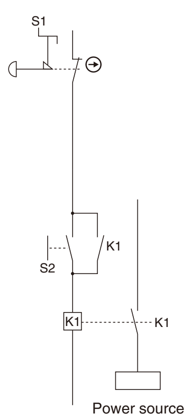
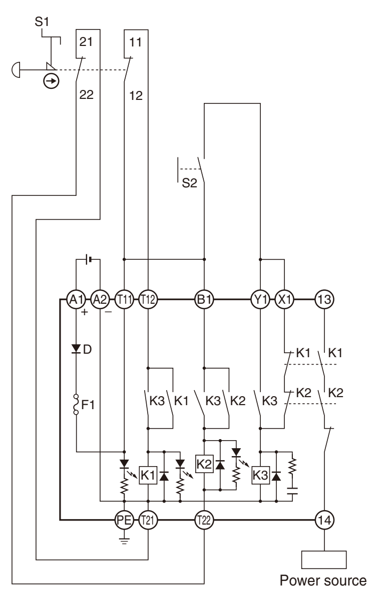


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)
The G7SA, G7S and G7S-□-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-□-E, however, do not display the CE Marking according to the concepts in the guidelines.
VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-□-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

No.	Area	No.	Classification	No.	Item	Page
❹	Operating and Storage Environments			1 2 3 4 5 6 7 8	Operating, Storage, and Transport Operating Atmosphere Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas) Adhesion of Water, Chemicals, Solvent, and Oil Vibration and Shock External Magnetic Fields External Loads Adhesion of Magnetic Dust	C-9 to C-10
❺	Relay Mounting Operations	①	Plug-in Relays	1 2 3	Panel-mounting Sockets Relay Removal Direction Terminal Soldering	C-10
		②	Printed Circuit Board Relays	1	Ultrasonic Cleaning	
		③	Common Items	1 2 3 4	Removing the Case and Cutting Terminals Deformed Terminals Replacing Relays and Performing Wiring Operations Coating and Packing	
❻	Handling Relays			1 2	Vibration and Shock Dropped Products	C-11
❼	Relays for Printed Circuit Boards (PCBs)			1 2 3 4 5 6 7 8 9 10	Selecting PCBs, (1) PCB Materials Selecting PCBs, (2) PCB Thickness Selecting PCBs, (3) Terminal Hole and Land Diameters Mounting Space ① Ambient Temperature ② Mutual Magnetic Interference Pattern Design for Noise Countermeasures ① Noise from Coils ② Noise from Contacts ③ High-frequency Patterns Shape of Lands Pattern Conductor Width and Thickness Conductor Pitch Securing the PCB Automatic Mounting of PCB Relays	C-11 to C-14
❽	Troubleshooting					C-15

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

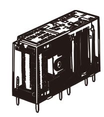
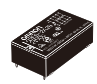
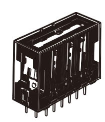
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	**Flux protection**	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

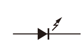
② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED 	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

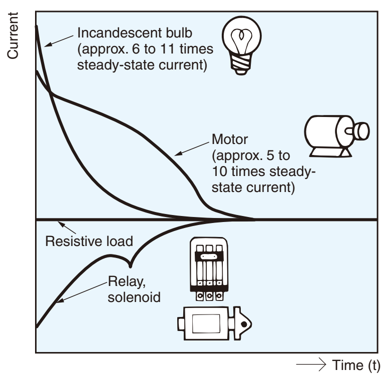
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

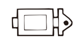
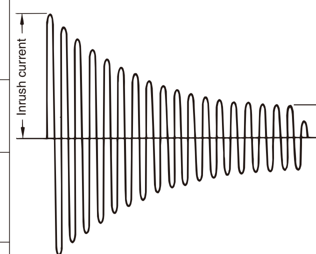
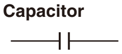
Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid 	Approx. 10	
Incandescent bulb 	Approx. 10 to 15	
Motor 	Approx. 5 to 10	
Relay 	Approx. 2 to 3	
Capacitor 	Approx. 20 to 50	
Resistive load 	1	

❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

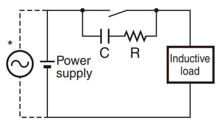
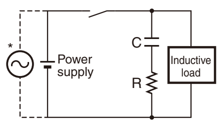
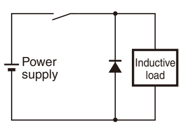
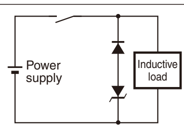
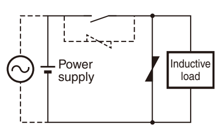
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

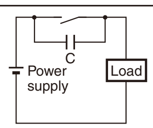
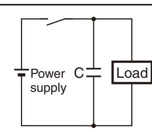
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

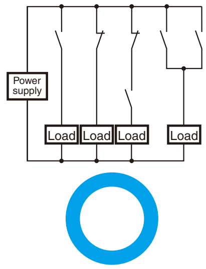
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

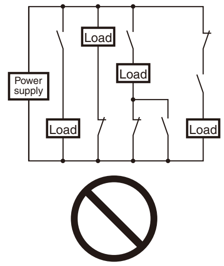
Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



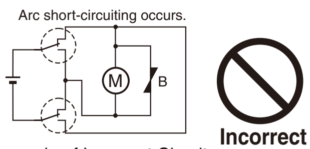
a. Correct Connection



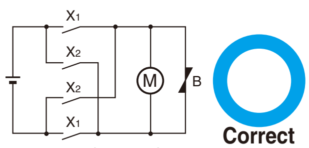
b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

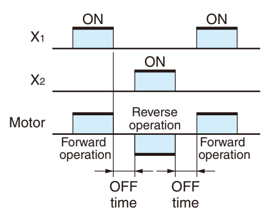
Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



Example of Incorrect Circuit



Example of Correct Circuit

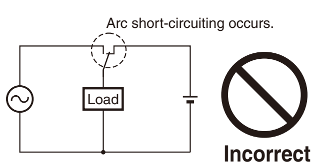


❸-①-8 Power Supply Double Break with Multi-pole Relays

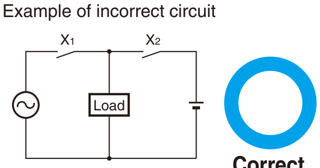
If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

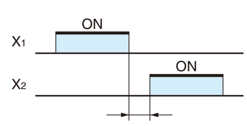
With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.
Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



Example of incorrect circuit

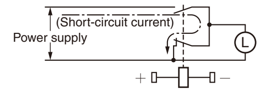


Example of correct circuit



❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.
Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.
The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.
Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.
This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).
This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

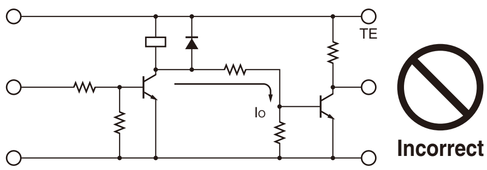
❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.
As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.
Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

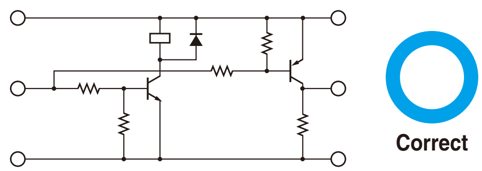
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

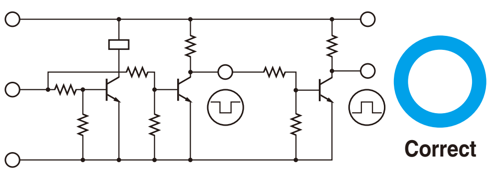
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value

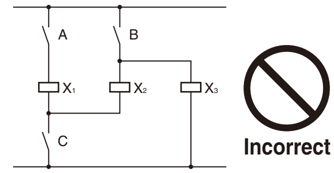


❸-②-7 Using with Infrequent Switching

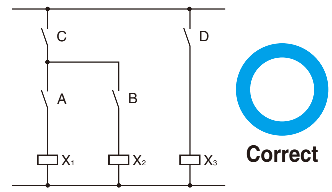
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.
The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.
The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



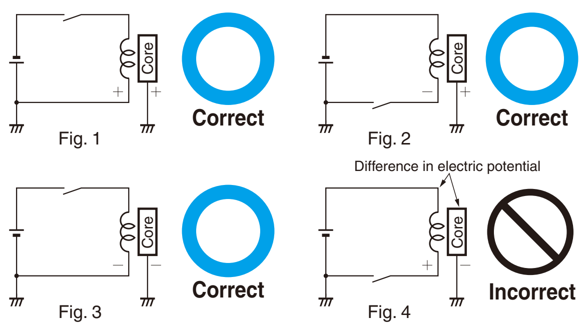
The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)
(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)
(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

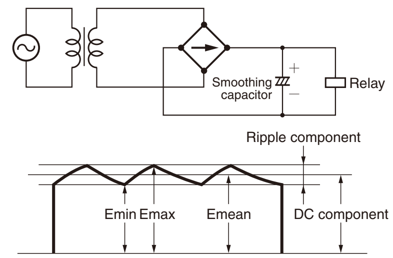


❸-②-10 Individual Specifications for Must-operate/ release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



Ripple percentage %= $\frac{\text{Emax–Emin}}{\text{Emean}} \times 100\%$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON.
Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

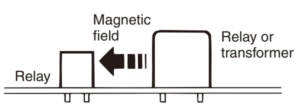
Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock
Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields
Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads
Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust
Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

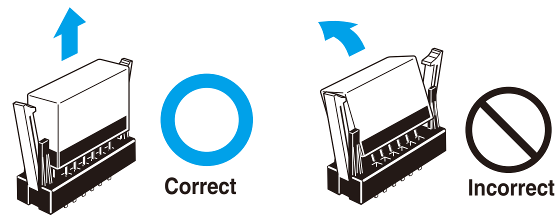
❺ Relay Mounting Operations

① Plug-in Relays

❺-①-1 Panel-mounting Sockets
1. Socket Mounting Screws
When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach.
Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.

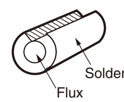
2. Lead Wire Screw Connections
Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
Conversely, excessive tightening can strip the threads.

❺-①-2 Relay Removal Direction
Insert and remove Relays from the socket perpendicular to the socket surface.



If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering
Solder General-purpose Relays manually following the precautions described below.
1. Smooth the tip of the solder gun and then begin the soldering.
- Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
- Soldering iron: Rated at 30 to 60 W
- Tip temperature: 280 to 300°C
- Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.

3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning
Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals
Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals
Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations
Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing
G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

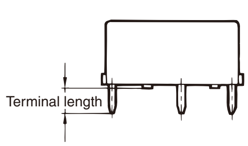
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material / Item	Epoxy		Phenol
	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

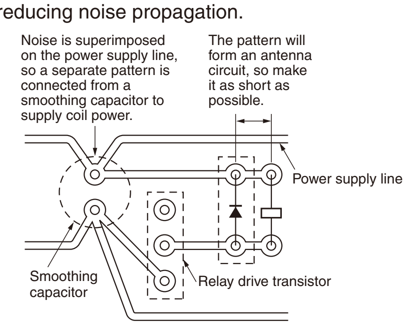
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② Noise from Contacts

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ High-frequency Patterns

As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

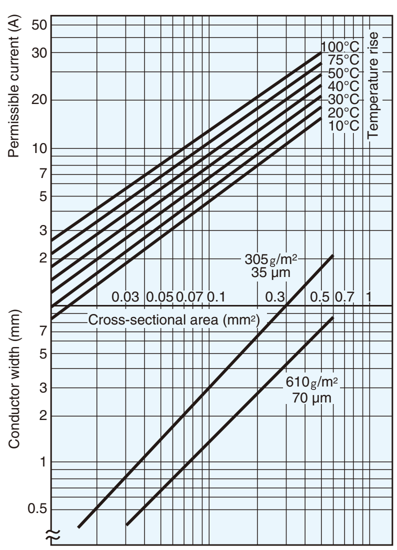
Correct Examples	
Incorrect Examples	

2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.

❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 μm and 70 μm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

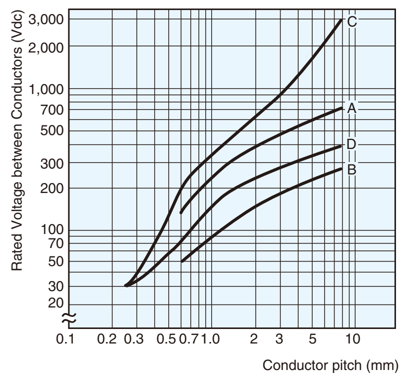
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

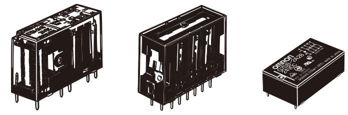
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

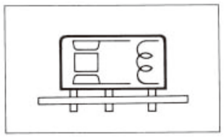
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

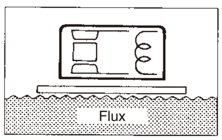
Placement



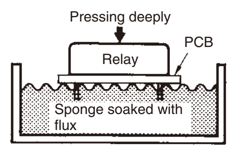
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay. The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials. For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive. Apply the flux sparingly and evenly to prevent penetration into the Relay. When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



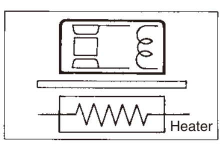
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

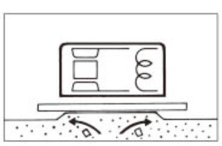
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

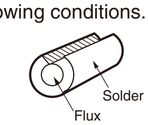
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

Applicability of Manual Soldering

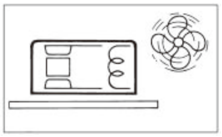
G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5

Cooling



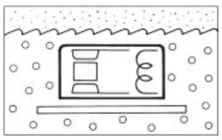
1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6

Cleaning



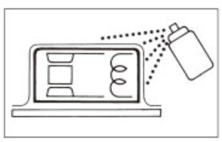
Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7

Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed.
   Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Safety Network Controller

NE1A-SCPU Series

Achieve Safety Control through Programming.

■ Compact Safety Controller.
■ The NE1A-SCPU01-V1 provides 16 built-in safety inputs and 8 built-in safety outputs.
The NE1A-SCPU02 provides 40 built-in safety inputs and 8 built-in safety outputs.
■ Reduced wiring with safety networks. Connect up to 32 Safety Terminals.
■ Monitor the safety system from Standard Controllers across the network.
■ EN 954-1/ISO13849-1 CAT4 and IEC 61508 SIL3 certification.

Ordering Information

List of Models

Name	No. of I/O points			Model	Unit version
	Safety inputs	Test outputs	Safety outputs		
Safety Network Controllers	16	4	8	**NE1A-SCPU01-V1**	2.0
	40	8	8	**NE1A-SCPU02**	2.0

Note: The standard NE1A Controllers are equipped with spring-cage terminal blocks, but other screw terminal blocks are available if desired, e.g., to replace previous terminals. Refer to DeviceNet Safety Accessories.

Specifications

Certified Standards

Certification body	Standard
TÜV Rheinland	EN954-1:1996, ISO13849-1:1999, ISO13849-2:2003, prEN954-2:1999, IEC60204-1:2005, EN60204-1:2006, EN61000-6-2:2001, EN61000-6-4:2001, EN418:1993, IEC61508 part1-7/12.98-05.00, IEC61131-2:2003, NFPA 79-2002, ANSI RIA15.06-1999, ANSI B11.19-2003
UL	UL1998, NFPA79, UL508, IEC61508 CSA22.2 No. 142, CSA22.2 No. 213, UL1604

Specifications

Item	Model	NE1A-SCPU01-V1	NE1A-SCPU02
Communications power supply voltage		11 to 25 VDC supplied via communications connector	
Unit power supply voltage (V0)*		20.4 to 26.4 VDC (24 VDC −15%/+10%)	
I/O power supply voltage (V1, V2)*			
Current consumption	Communications power supply	24 VDC, 15 mA	
	Internal circuit power supply	24 VDC, 230 mA	24 VDC, 280 mA
Overvoltage category		II	
Noise immunity		Conforms to IEC61131-2.	
Vibration resistance		10 to 57 Hz: 0.35 mm, 57 to 150 Hz: 50 m/s^2	
Shock resistance		150 m/s^2: 11 ms	
Mounting method		DIN Track (IEC 60715 TH35-7.5/TH35-15)	
Ambient operating temperature		−10 to 55°C	
Ambient operating humidity		10% to 95% (with no condensation)	
Ambient storage temperature		−40 to 70°C	
Degree of protection		IP20	
Serial interface		USB version 1.1	
Weight		460 g max.	690 g max.

* V0-G0: Internal control circuit
V1-G1 (G): For external input device, test output
V2-G2 (G): For external output device
The two ground terminals on the NE1A-SCPU02 are internally connected.

Safety Input Specifications

Input type	Sinking inputs (PNP)
ON voltage	11 VDC min. between each terminal and ground
OFF voltage	5 VDC min. between each terminal and ground
OFF current	1 mA max.
Input current	4.5 mA

Safety Output Specifications

Output type	Sourcing outputs (PNP)
Rated output current	0.5 A max./output
ON residual voltage	1.2 V max. between each output terminal and V2
Leakage current	0.1 mA max.

Test Output Specifications

Output type	Sourcing outputs (PNP)
Rated output current	0.7 A max./output *
ON residual voltage	1.2 V max. between each output terminal and V1
Leakage current	0.1 mA max.

* The maximum current for simultaneously ON outputs is 1.4 A.
(T0 to T3: NE1A-SCPU01-V1, T0 to T7: NE1A-SCPU02)
A 15 to 400-mA, 24-VDC external indicator can be connected to T3 and T7.

DeviceNet Communications Specifications

Communications protocol	DeviceNet compliant
Connection form	Multi-drop system and T-branch system can be combined (for trunk line and branch lines)
Communications speed	500/250/125 kbps
Communications media	Special cable, 5 conductors (2 for communications, 2 for power supply, 1 for shielding)
Communications distance	See table below.
Communications power supply	11 to 25 VDC
No. of connectable nodes	63
Safety I/O communications (Pre-Ver. 1.0)	Safety Master function • Max. no. of connections: 16 • Max. data size: Input 16 bytes or output 16 bytes (per connection) • Connection type: Single-cast, multi-cast Safety Slave function • Max. no. of connections: 4 • Max. data size: Input 16 bytes or output 16 bytes (per connection) • Connection type: Single-cast, multi-cast
Safety I/O communications (unit version 1.0 or later)	Safety Master function • Max. no. of connections: 32 • Max. data size: Input 16 bytes or output 16 bytes (per connection) • Connection type: Single-cast, multi-cast Safety Slave function • Max. no. of connections: 4 • Max. data size: Input 16 bytes or output 16 bytes (per connection) • Connection type: Single-cast, multi-cast
Standard I/O communications (all unit versions)	Standard Slave function • Max. no. of connections: 2 • Max. data size: Input 16 bytes or output 16 bytes (per connection) • Connection type: Poll, bit-strobe, COS, cyclic
Message communications	Max. message length: 552 bytes

Communications distance:

Communications speed	Max. network length	Branch length	Total branch length
500 kbps	100 m max. (100 m max.)	6 m max.	39 m max.
250 kbps	250 m max. (100 m max.)		78 m max.
125 kbps	500 m max. (100 m max.)		156 m max.

Note: Figures in parentheses ( ) indicate values when a thin cable is used.

Functions

Function Blocks

NE1A-SCPU-series Controller support the following logic functions and function blocks. Support depends on the unit version.

Logic Functions

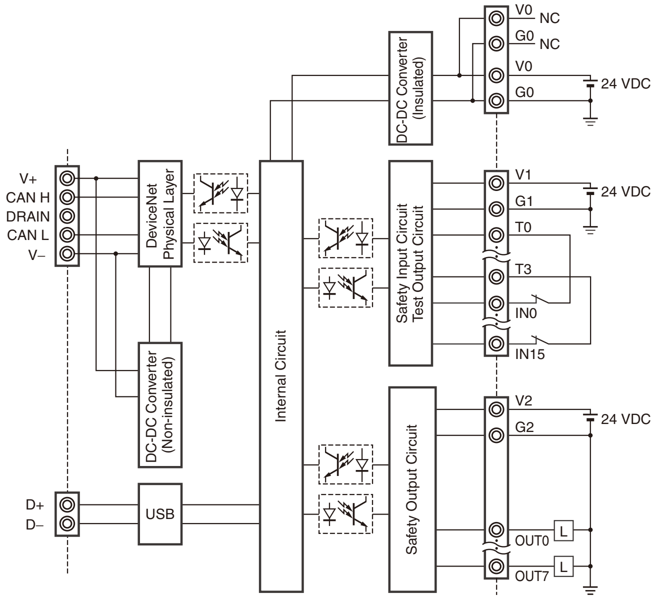
Name	Supporting unit versions
NOT	All
AND	
OR	
Exclusive OR	
Exclusive NOR	
RS Flip-flop	1.0 or later
Comparator	

Function Blocks

Name	Supporting unit versions
Reset	All
Restart	
Emergency Stop Monitoring	
Light Curtain Monitoring	
Safety Gate Monitoring	
Two-hand Controller	
Off-Delay Timer	
On-Delay Timer	
User Mode Switch Monitoring	
External Device Monitoring	
Routing	
Muting	1.0 or later
Enable Switch Monitoring	
Pulse Generator	
Counter	
Multiconnector	

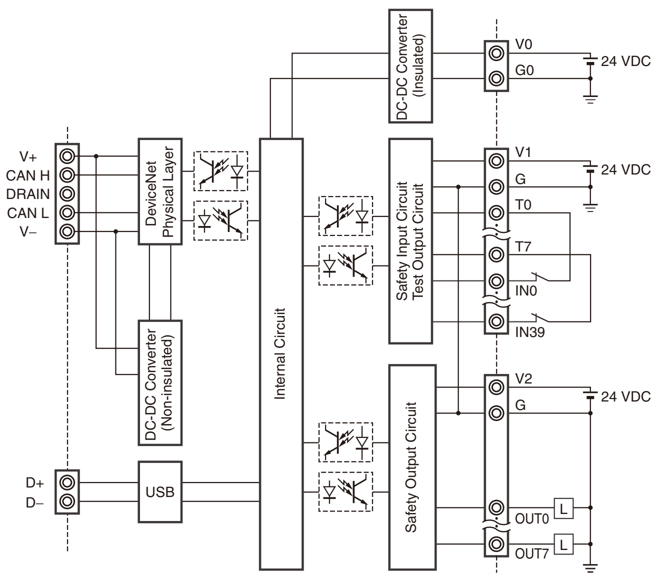
Internal Circuit Diagrams

NE1A-SCPU01-V1



Terminal name	Description
V0	Power supply terminal for internal circuit The two V0 terminals are internally connected.
G0	Power supply terminal for internal circuit The two G0 terminals are internally connected.
V1	Power supply terminal for external input device and test output
G1	Power supply terminal for external input device and test output
V2	Power supply terminal for external output device
G2	Power supply terminal for external output device
IN0 to IN15	Safety input terminal
T0 to T3	Test output terminal Connected to IN0 to IN15 safety inputs. Each test output terminal outputs a different test pulse pattern. Terminal T3 also supports a current monitoring function for the output signal. Example: Muting lamp
OUT0 to OUT7	Safety output terminals

NE1A-SCPU02



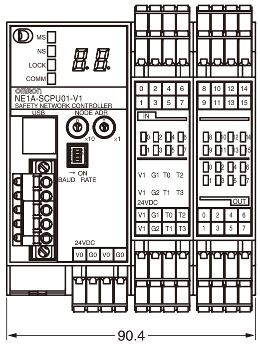
Terminal name	Description
V0	Power supply terminal for internal circuit The two V0 terminals are internally connected.
G0	Power supply terminal for internal circuit The two G0 terminals are internally connected.
V1	Power supply terminal for external input device and test output
G	Power supply terminal for external input device and test output
V2	Power supply terminal for external output device
G	Power supply terminal for external output device
IN0 to IN39	Safety input terminal
T0 to T3	Test output terminal Connected to IN0 to IN19 safety inputs. Each test output terminal outputs a different test pulse pattern. Terminal T3 also supports a current monitoring function for the output signal. Example: Muting lamp
T4 to T7	Test output terminal Connected to IN20 to IN39 safety inputs. Each test output terminal outputs a different test pulse pattern. Terminal T7 also supports a current monitoring function for the output signal. Example: Muting lamp
OUT0 to OUT7	Safety output terminals

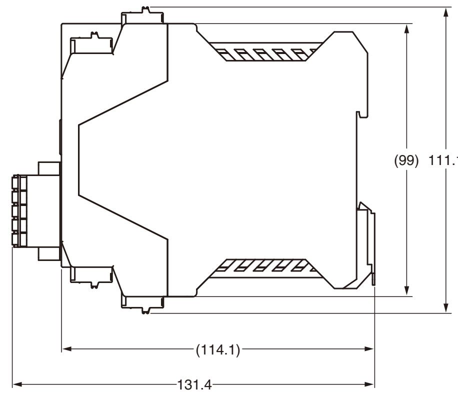
Refer to the *DeviceNet Safety Safety Network Controllers Operation Manual* (Cat. No. Z906) for wiring examples.

Dimensions

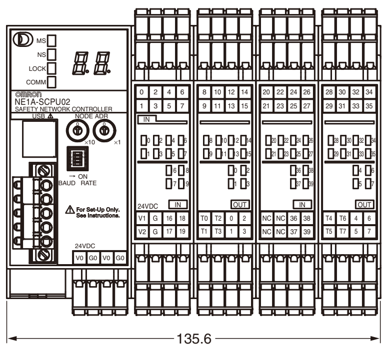
(Unit: mm)

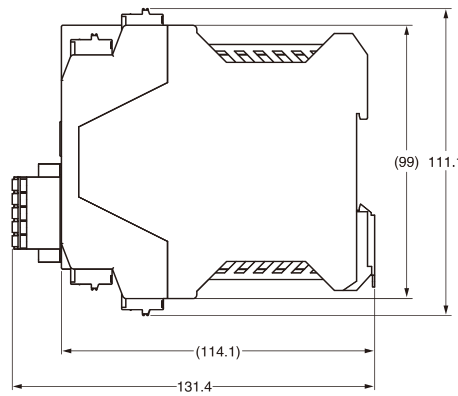
NE1A-SCPU01-V1





NE1A-SCPU02





Safety Precautions

Be sure to read the following operation manual for precautions and other details required for correct use of the Safety Network Controller.
DeviceNet Safety Safety Network Controller Operation Manual **(Cat. No. Z906)**

Functions Supported According to Unit Version

❍ : Supported, ---: Not supported

Function	Model / Unit version	NE1A-SCPU01	NE1A-SCPU01-V1, NE1A-SCPU02	
		Pre-Ver. 1.0	Unit version 1.0	Unit version 2.0
Logic processing functions	Maximum program size (total number of function blocks)	128	254	254
	New Function Blocks • RS flip-flop • Multiconnector • Muting • Enable Switch Monitoring • Pulse Generator • Counter • Comparator	---	❍	❍
	Selecting a rising edge as the reset condition for Reset and Restart function blocks	---	❍	❍
	Using local I/O status in logic programming	---	❍	❍
	Using overall Unit status in logic programming	---	❍	❍
I/O control functions	Monitoring contact operation counter	---	❍	❍
	Mounting total ON time monitor	---	❍	❍
DeviceNet communications functions	Number of safety I/O connections for Safety Master	16	32	32
	Selecting operating mode for safety I/O communications when communications errors occur	---	❍	❍
	Attaching local output data to send data during slave operation	---	❍	❍
	Attaching local I/O monitor data to send data during slave operation	---	❍	❍
System startup and error recovery functions	Storing log of nonfatal errors in nonvolatile memory	---	❍	❍
	Adding function block errors to error log	---	❍	❍
Compatible with the NE1A-EDR01 EtherNet/IP-DeviceNet Router		---	---	❍

Unit Versions and Network Configurator Versions

Network Configurator version 2.0□ or higher must be used when using a NE1A-SCPU01-V1 or NE1A-SCPU02 Safety Logic Controller with unit version 2.0. The following table shows the relationship between unit versions and Network Configurator versions.

❍ : Applicable, ×: Not applicable

Model	Version	Network Configurator			
		Ver. 1.32	Ver. 1.51	Ver. 1.6□	Ver. 2.0
NE1A-SCPU01	Pre-Ver. 1.0	❍	❍	❍	❍
NE1A-SCPU01-V1 NE1A-SCPU02	Unit version 1.0	×	×	❍	❍
	Unit version 2.0	×	×	❍ *	❍

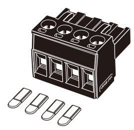
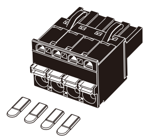
* When using Network Configurator version 1.6□, there are no operational differences in the NE1A-SCPU01-V1 and NE1A-SCPU02 Safety Logic Controllers that derive from the unit version.

Version Upgrade

If you have purchased Ver.1.□□, you will need to buy the upgrade CD-ROM. (Refer to WS02-CFSC1-E.)

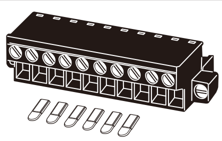
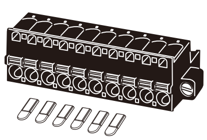
Accessories

Terminal Blocks for the NE1A

Appearance	Specification	Applicable Controllers	Model	Remarks
	Screw terminal blocks (4 pins)	NE1A-SCPU01 NE1A-SCPU01-V1 NE1A-SCPU02 NE1A-EDR01	**Y9S-04T1B-02A**	A set including two screw terminal blocks (black) and six code marks to prevent incorrect insertion
	Spring-cage terminal blocks (4 pins)		**Y9S-04C1B-02A**	A set including two spring-cage terminal blocks (black) and six code marks to prevent incorrect insertion

Note: The standard NE1A Controllers are equipped with spring-cage terminal blocks. Screw terminal blocks can be ordered if desired, e.g., to replace previous terminals.

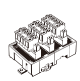
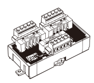
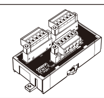
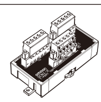
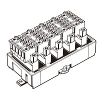
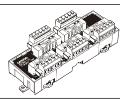
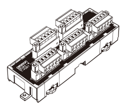
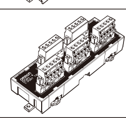
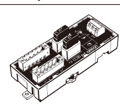
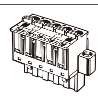
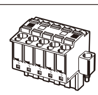
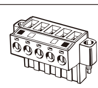
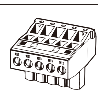
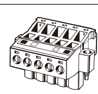
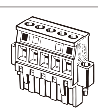
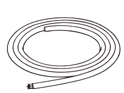
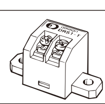
Terminal Blocks for the DST1

Appearance	Specification	Applicable Safety I/O Terminals	Model	Remarks
	Screw terminal blocks (10 pins)	DST1-ID12SL-1 DST1-MD16SL-1 DST1-XD0808SL-1 DST1-MRD08SL-1	**Y9S-10T1B-04B**	A set including four screw terminal blocks (black), six code marks to prevent incorrect insertion, one set of terminal labels *, and code mark instructions
	Spring-cage terminal blocks (10 pins)		**Y9S-10C1B-04B**	A set including four spring-cage terminal blocks (black), six code marks to prevent incorrect insertion, one set of terminal labels *, and code mark instructions

Note: The standard DS1T Safety I/O Terminals are equipped with spring-cage terminal blocks. Screw terminal blocks can be ordered if desired, e.g., to replace previous terminals.

* The set of terminal labels is one sheet containing four sets of labels required for one Terminal Block, i.e., [1, 2 ... 10], [11, 12 ... 20], [21, 22 ... 30] and [31, 32 ... 40].

Peripheral Devices for DeviceNet Communications

Product	Appearance	Model	Specification	
T-branch Tap for 1 branch line		**DCN1-1NC**	Cable wiring direction: Toward top Cable lock direction: From top Connector screw direction: From top	Provided with 3 parallel connectors with clamps (XW4G-05C1-H1-D), standard terminating resistor
		**DCN1-1C**	Cable wiring direction: Toward side Cable screw direction: From top Connector screw direction: From side	Provided with 3 parallel connectors with screws (XW4B-05C1-H1-D), standard terminating resistor
		**DCN1-2C**	Cable wiring direction: Toward top Cable screw direction: From side Connector screw direction: From top	
		**DCN1-2R**	Cable wiring direction: Toward side Cable screw direction: From top Connector screw direction: From top	Provided with 3 orthogonal connectors with screws (XW4B-05C1-VIR-D), standard terminating resistor
T-branch Tap for 3 branch lines		**DCN1-3NC**	Cable wiring direction: Toward top Cable lock direction: From top Connector screw direction: From top	Provided with 5 parallel clamp connectors with screws (XW4G-05C1-H1-D), standard terminating resistor
		**DCN1-3C**	Cable wiring direction: Toward side Cable screw direction: From top Connector screw direction: From side	Provided with 5 parallel connectors with screws (XW4B-05C1-H1-D), standard terminating resistor
		**DCN1-4C**	Cable wiring direction: Toward top Cable screw direction: From side Connector screw direction: From top	
		**DCN1-4R**	Cable wiring direction: Toward side Cable screw direction: From top Connector screw direction: From top	Provided with 5 orthogonal clamp connectors with screws (XW4B-05C1-VIR-D), standard terminating resistor
Power Supply Tap		**DCN1-1P**	One-branch tap provided with 2 connectors, standard terminating resistor, and fuse	
Connectors		**XW4G-05C1-H1-D**	Parallel clamp connector with screws Connector insertion and wiring both performed horizontally.	
		**XW4G-05C4-TF-D**	Parallel multi-branching clamp connector with screws Connector insertion and wiring performed in same direction.	
		**XW4B-05C1-H1-D**	Parallel connector with screws Connector insertion and wiring performed in same direction.	
		**XW4B-05C4-T-D**	Parallel, screw-less, multi-branching connector Connector insertion and wiring performed in same direction.	
		**XW4B-05C4-TF-D**	Parallel, multi-branching connector with screws Connector insertion and wiring performed in same direction.	
		**XW4B-05C1-VIR-D**	Orthogonal connector with screws Connector insertion and wiring performed at a right angle.	
DeviceNet Cables		**DCA1-5C10 (-B)**	Thin cable length: 100 m DCA1-5C10-B: Cable color: Blue DCA1-5C10: Cable color: Gray	
		DCA2-5C10 (-B)	Thick cable length: 100 m DCA2-5C10-B: Cable color: Blue DCA2-5C10: Cable color: Gray	
Terminal-block Terminator		**DRS1-T**	Resistance of 121 Ω	

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

In the interest of product improvement, specifications are subject to change without notice.

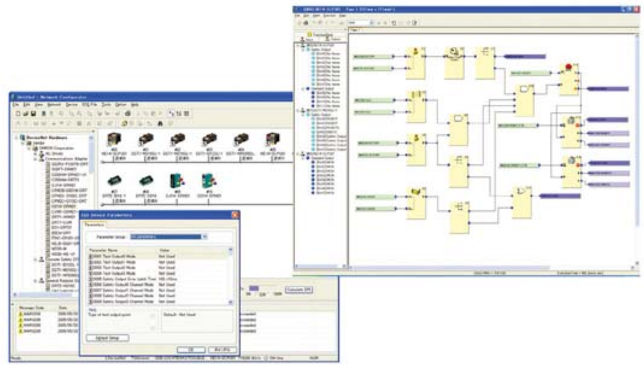
OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

Network Configurator
WS02-CFSC1-E

Programming Software for Creating Safety Circuits.

- Performs settings for the Safety Network Controllers and Safety I/O Terminals.
- Provides safety circuit programming functions.
- Provides monitoring functions for safety circuits.
- Includes DeviceNet Configurator functions.

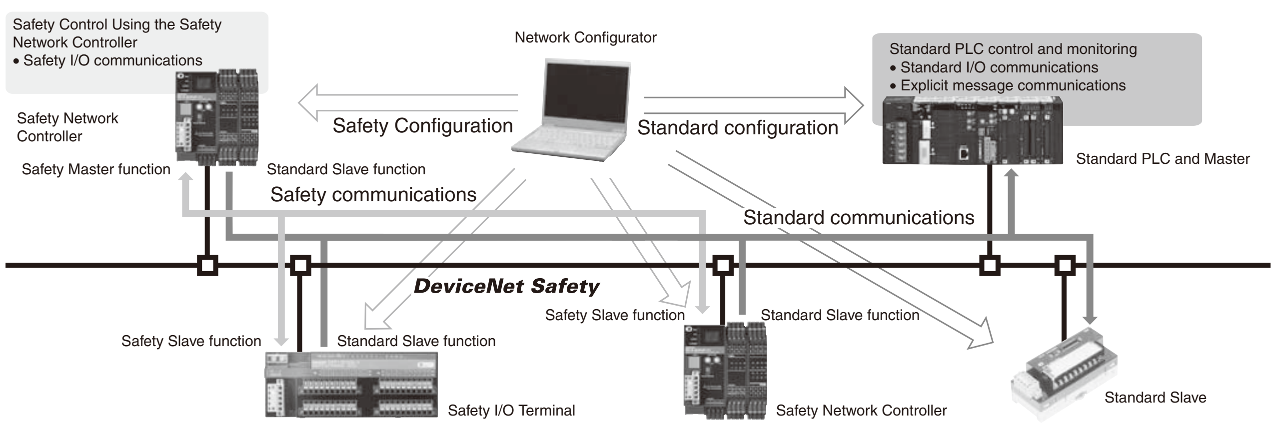


Ordering Information

List of Models

Name	Components	Applicable computer	Applicable OS	Model
Network Configurator	Installation disc (CD-ROM: 1 license)	IBM PC/AT or compatible	Windows 2000 Windows XP	**WS02-CFSC1-E**
	Upgrade disc (CD-ROM: 1 license)			**WS02-CFSC1-E-UP**

System Configuration



Specifications

Applicable computer	IBM PC/AT or compatible
CPU	Intel Pentium PC, 300 MHz or higher (Pentium III, 1-GHz or higher recommended)
OS	Microsoft Windows 2000 Microsoft Windows XP
Supported languages	English
RAM	256 MB or higher
Hard disk	At least 200 MB of available hard disk space
Monitor	S-VGA or better display capability
CD-ROM	One CD-ROM drive min.
Communications ports	One of the following communications ports is required. • USB port Connecting online via the USB port (USB 1.1) of the NE1A-SCPU-series Controllers • DeviceNet Interface Card 3G8E2-DRM21-V1: Connecting online via DeviceNet

Note: Windows is a registered trademark of Microsoft. IBM is a registered trademark of International Business Machines Corp.

Safety Precautions

Be sure to read the following operation manual for precautions and other details required for correct use of the Safety Network Controller.
DeviceNet Safety Safety Network Configurator Operation Manual **(Cat. No. Z905)**

Unit Versions and Network Configurator Versions

Network Configurator version 2.0□ or higher must be used when using a NE1A-SCPU01-V1 or NE1A-SCPU02 Safety Logic Controller with unit version 2.0. The following table shows the relationship between unit versions and Network Configurator versions.

❍ : Applicable, ×: Not applicable

Model	Version	Network Configurator			
		Ver. 1.32	Ver. 1.51	Ver. 1.6□	Ver. 2.0
NE1A-SCPU01	**Pre-Ver. 1.0**	❍	❍	❍	❍
NE1A-SCPU01-V1 **NE1A-SCPU02**	**Unit version 1.0**	×	×	❍	❍
	Unit version 2.0	×	×	❍ *	❍

* When using Network Configurator version 1.6□, there are no operational differences in the NE1A-SCPU01-V1 and NE1A-SCPU02 Safety Logic Controllers that derive from the unit version.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Safety Laser Scanner

OS3101

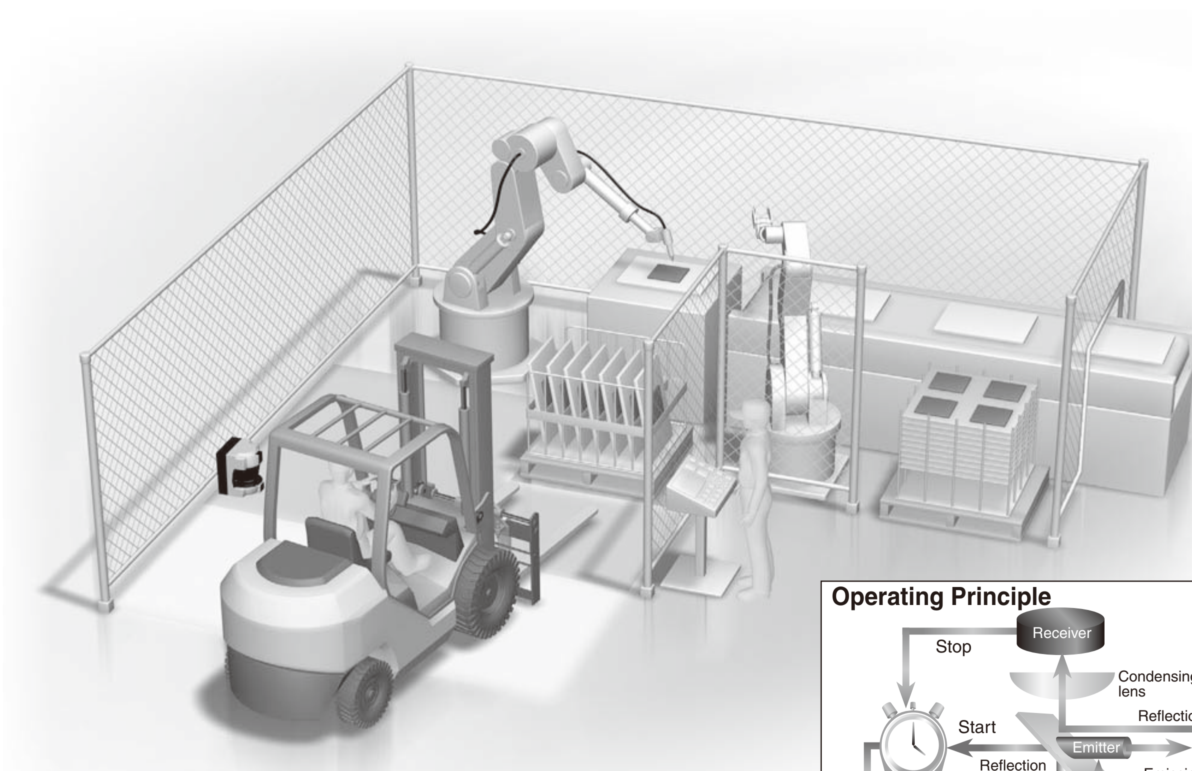
Operator Presence Detection in Work Areas with Complex Shapes

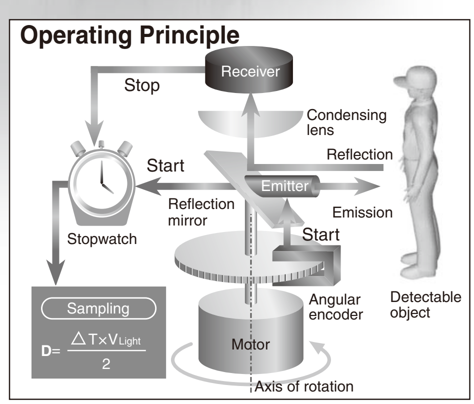
■ A Type 3 Safety Laser Scanner in compliance with IEC 61496-1/-3.

⚠ Be sure to read the *"Safety Precautions"* on page 13.

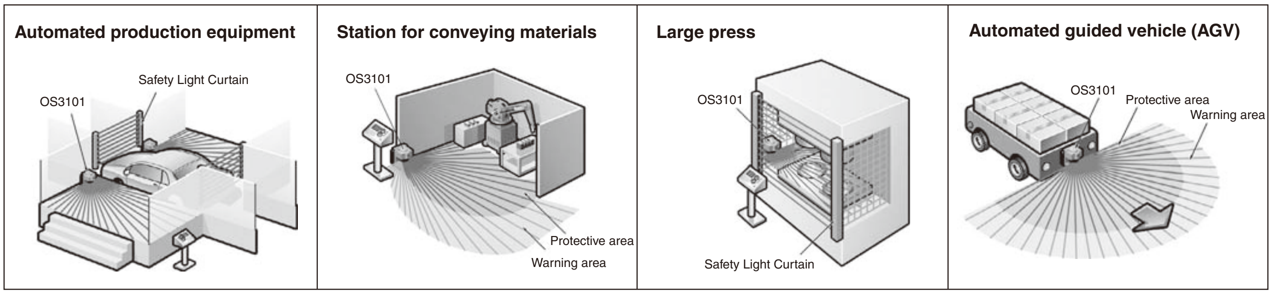
Features

The OS3101 Safety Laser Scanner is designed for use in hazardous zones that change irregularly.
Parameters for even highly complex areas can be easily set using personal computer software.
In addition to protecting operators on conveyor lines and at robot stations, the OS3101 can be mounted onto automated guided vehicles (AGVs) and other mobile objects for which the monitoring area must be frequently switched, during obstacle detection.





Applications



Features

Laser Beams Scan in 2-Dimensional Space to Constantly Monitor the Presence of Operators in the Monitoring Area

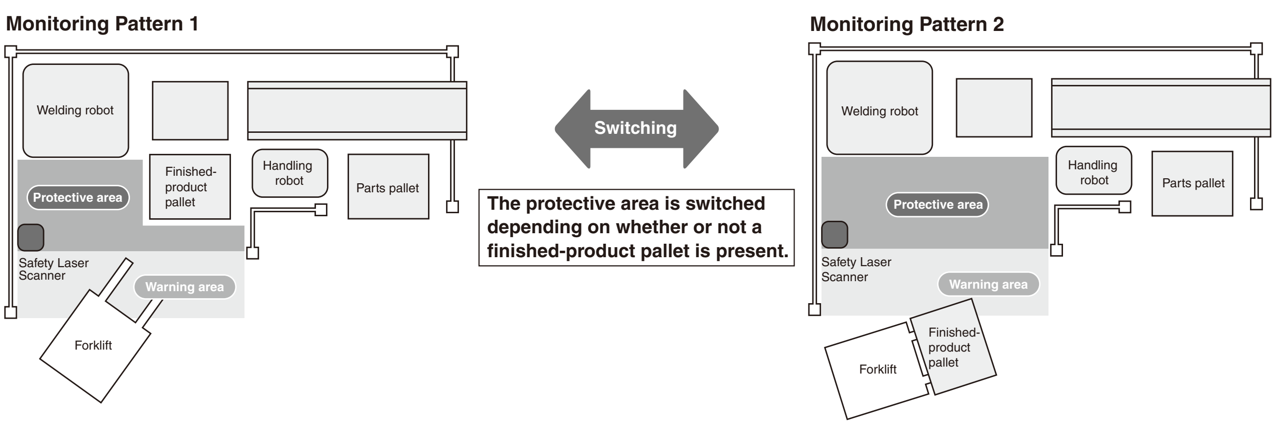
The guiding principle in providing safety for operators is to prevent machines from operating whenever a person is inside the working area of a robot or other machine.

The OS3101 Safety Laser Scanner uses 2-dimensional laser-beam scanning to detect whether an operator is present in the preset area by monitoring reflected beams, in order to maintain operator safety.

Depending on Work Details, Two Patterns Can Be Set for Two Different Area Combinations

Two different protective area and warning area combinations can be preset, allowing the OS3101 to respond to even complex changes in the work environment.

The patterns can be switched using only the OS3101, without having to use the special Controller, to quickly meet the needs of various work steps.



Features

A Wide Range of Functions Allow Flexible Setting of the Monitoring Area.

Allows the Setting of a Protective Area with a Radius of 4 Meters and a Warning Area with a Radius of 15 Meters.

It is possible to set both a protective area with a maximum radius of 4 meters, which prevents the machine from operating when entry is detected, and a warning area with a maximum radius of 15 meters, which monitors and warns of people approaching the machine. Because the OS3101 warns with indicators, sirens, and other means that something has entered the warning area, it makes it possible to prevent unintended stops. Two patterns of protective and warning area combinations can also be set to meet various needs.

An Array of 16 Intrusion Indicators and an LED Display Show the OS3101 Condition at a Glance.

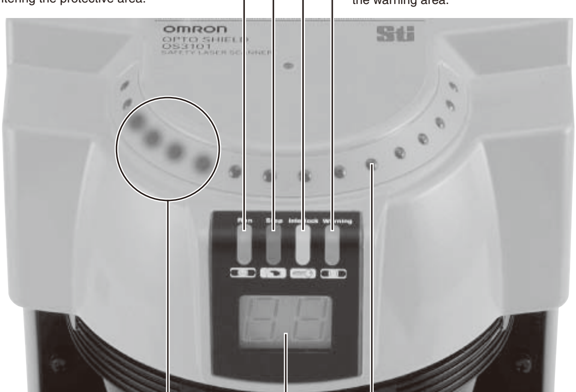
When the OS3101 detects an object entering the protective area, the intrusion indicators immediately light in red. The positions of the lit indicators from among the total of 16 indicators show the direction of the intrusion. The LED status indicators and 2-digit numerical, self-diagnostic display show the condition of the OS3101 with a single glance.

OFF Output Indicator (Red)
Lights when an object is detected entering the protective area.

ON Output Indicator (Green)
Lights while there is no object detected entering the protective area.

Interlock Indicator (Yellow)
Lights while the OS3101 is in standby mode waiting for start input. Blinks when there is a malfunction.

Warning Output Indicator (Orange)
Lights when an object is detected entering the warning area.



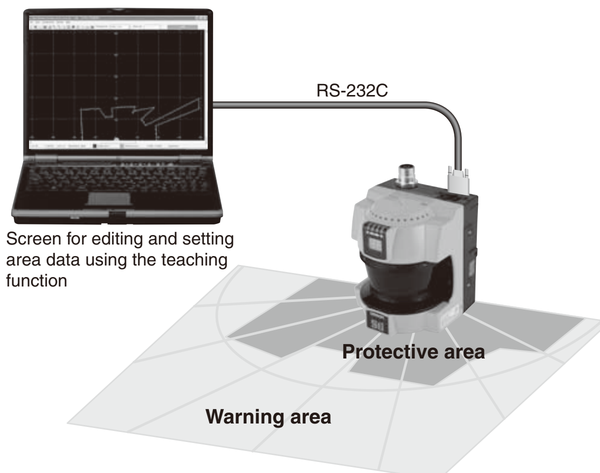
Only the intrusion indicators for the direction in which the object has entered lights, so the operator can confirm the direction of entry at a glance.

Intrusion Indicators
Light when the OS3101 detects an object entering the protective area.
The protective area is displayed in 16 sections (11.25° for each indicator).

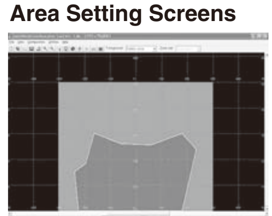
Status/Self-diagnosis Display
Displays numerical codes to indicate the status of the OS3101 during normal operation or a lockout.

Even Complicated Areas Can Be Easily Set with Software

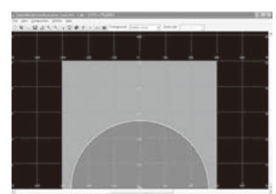
Highly flexible protective and warning areas can be set to match the shape of the work area, allowing for the presence of machines and other equipment. Area parameters are selected from semicircular, rectangular, or polygonal.
A teaching function also allows the OS3101's scanning data to be edited and registered as area setting data. These functions bring considerable flexibility and ease to area setting.



Area Setting Screens



A protective area set with a polygonal shape, and a warning area set with a rectangular shape



A protective area set with a semicircular shape, and a warning area set with a rectangular shape

Category 3 Safety Circuits Can Be Set without Using the Controller

Two high-capacity PNP transistor control outputs allow direct connection of output equipment such as safety relays and contactors with rated current up to 625 mA at 24 VDC.
The OS3101 also features an external device monitor (EDM) that makes it possible to configure safety circuits to the Category 3 level without having to use the Controller.

Response Time from 80 ms to a Maximum of 680 ms

The response time can be set for use in locations subject to special conditions, such as spattering in welding stations. This reduces the chances of the spattering material being mistakenly detected and stopping the machine, thus helping to improve productivity.

Ordering Information

OS3101 Safety Laser Scanner (Cable should be purchased separately.)

Appearance	Model	Remarks
	**OS3101-2-PN-S**	CD-ROM containing setting software included. Applicable OS: Windows 2000, Windows XP Professional, Windows XP Home Edition

Note: There is no cable included with the OS3101 Safety Laser Scanner.

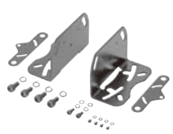
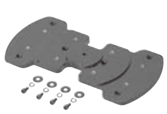
Power Cables

Appearance	Specification	Model	Remarks
	Cable length: 10 m	**OS3101-CBL-10PT**	The Safety Laser Scanner requires one cable.
	Cable length: 20 m	**OS3101-CBL-20PT**	
	Cable length: 30 m	**OS3101-CBL-30PT**	

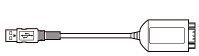
Communications Cables

Appearance	Specification	Model	Remarks
	Cable length: 2 m	**F39-RS2-C2**	An RS-232C 9-pin straight cable is necessary only when making settings for the Safety Laser Scanner.
	Cable length: 4 m	**F39-RS2-C4**	

Mounting Brackets

Appearance	Specification	Model	Remarks
	L-shaped Mounting Brackets	**OS3101-BKT**	Includes two L-shaped Mounting Brackets, two positioning brackets, and screws to mount the Safety Laser Scanner to the L-shaped Mounting Brackets.
	Rear Surface Mounting Brackets	**OS3101-BPT**	Includes Rear Surface Mounting Brackets and screws to mount the L-shaped Mounting Brackets to the Rear Surface Mounting Bracket. L-shaped Mounting Brackets should be purchased separately to use the Rear Surface Mounting Bracket.
	Mounting Stand	**OS3101-MT**	L-shaped Mounting Brackets should be purchased separately to use the Mounting Stand.

Accessories

Appearance	Specification	Model	Remarks
	Window	**OS3101-WIN-KT**	Provided for replacement in case the original is broken.
	Dust Ring	**OS3101-DST-KT**	Provided for replacement in case the original is broken.
	USB-Serial Conversion Cable	**CS1W-CIF31**	Necessary for communications via the USB port on personal computers that are not equipped with an RS-232C interface.

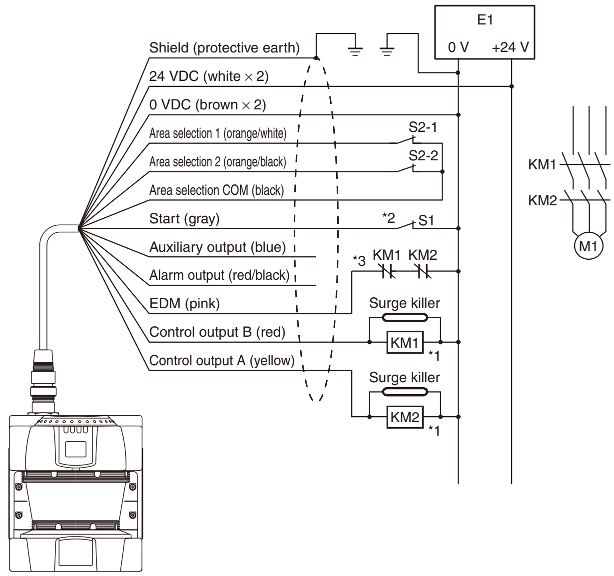
Specificatons

Sensor type		Type 3 Safety Laser Scanner
Safety category		Category 3, 2, 1, or B safety applications
Detection capability		Opaque objects: 62-mm diameter (1.8% min. reflection factor)
Monitoring area		Number of settable monitoring areas: Two sets of protective and warning areas
Operating range		Protective area: 4-m radius max., warning area: 15-m radius max.
Maximum measurement error		135 mm *1
Detection angle		180°
Response time		ON to OFF response time: 80 ms max. (2 scans) to 680 ms max. (17 scans max.) OFF to ON response time: ON to OFF response time plus 400 ms
Power supply voltage		24 VDC±20% (ripple p-p 2.5 V max.) *2
Power consumption		20 W (with no output load) *3
Light source (wavelength)		Infrared laser diode (905 nm)
Laser protection class		Class 1: IEC/EN 60825-1 (2001) Class 1: JIS 6802 (2005) Class I: CFR21 1040.10, 1040.11
Control outputs (OSSD)		PNP transistor output × 2, load current 625 mA max. *4 *5
Auxiliary output (non-safety output)		PNP transistor output × 1, load current 100 mA max. *4 *5
Alarm output (non-safety output)		PNP transistor output × 1, load current 100 mA max. *4 *5
Output operation modes		Auto start, start interlock, start/restart interlock
Inputs	**EDM**	ON: Short-circuit current of 0 V (input current: 50 mA), OFF: open
	Start	ON: Short-circuit current of 0 V (input current: 20 mA), OFF: open
	Area selection	ON: Connected to area selection COM (input current: 20 mA), OFF: open
Connection type		Power cable: 14-pin special round connector Communications cable: RS-232C 9-pin D-sub connector, straight cable
Connection with a personal computer *6		Communications: RS-232C, baud rate: 9600, 19200, 38400, 115200 bps Applicable OS: Windows 2000, Windows XP Professional, Windows XP Home Edition
Indications		ON output indicator (green), OFF output indicator (red), interlock indicator (yellow), alarm output indicator (orange) Status/self-diagnosis display (2-digit, 7-segment indicator), intrusion indicator (red LED × 16)
Protective circuits		Output load short-circuit protection, power supply reverse-connection protection
Ambient temperature		Operating: 0 to 50°C, storage: –25 to 70°C
Ambient humidity		Operating and storage: 95% max. (with no condensation)
Ambient operating light intensity		Incandescent lamp: receiving-surface light intensity of 1,500 lx max. (The angle between the laser scanning surface and the disturbance light should be ±8° min.)
Degree of protection		IP65 (IEC 60529)
Casing material		Aluminum die-cast
Dimensions		115 × 177 × 156 mm
Dielectric strength		350 VAC, 50/60 Hz for 1 min.
Insulation resistance		100 kΩ min. at 500 VDC
Shock resistance		98 m/s^2, 1,000 times each in X, Y, and Z directions (IEC 60028-2-29)
Vibration resistance		10 to 55 Hz, double amplitude of 0.7 mm, 20 sweeps in X, Y, and Z directions (IEC 60028-2-6)
Weight (Safety Laser Scanner only)		3.7 kg
Power cable		Maximum cable length: 30 m
Communications cable		Maximum cable length: 15 m
Accessories		Instruction manual, CD-ROM (setting software), two surge killers
Applicable standards		Certification institutes: TÜV Rheinland, UL, CSA Applicable standards: IEC 61496-1/-3 type 3, EN 954-1 category 3, UL 508

*1. An additional tolerance for measurement error may be necessary due to background effects.
*2. For details on power supply specifications, refer to "*Safety Precautions*" on page 13.
*3. The maximum rated current for the OS3101 is 2.3 A (850 mA for the OS3101 plus the load for control output A, the load for control output B, the auxiliary output load, and the alarm output load).
*4. The output voltage is the input voltage minus 2.0 VDC.
*5. Current consumption (the total of the two control outputs, the auxiliary output, and the alarm output) should not exceed 1.45 A.
*6. A USB-serial Conversion Cable is required for USB connection.

Connections

Basic Connection Example (Using Only the OS3101, Category 3)

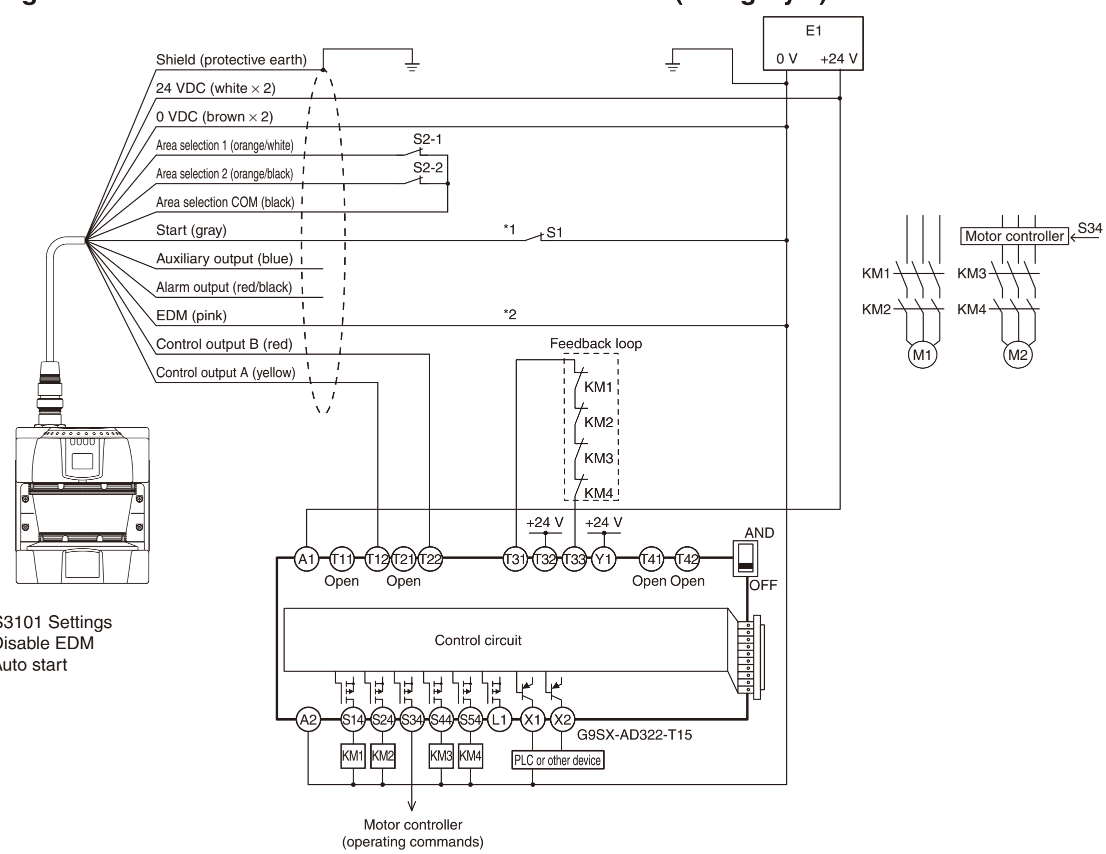


OS3101 Settings
- EDM
- Start/restart interlock

S1: Start input
S2-1/S2-2: Area setting selector
When area setting 1 is selected: S2-1 is short-circuited, S2-2 is open
When area setting 2 is selected: S2-1 is open, S2-2 is short-circuited
(For details, refer to the *Instruction Manual*.)
KM1, KM2: Safety relays with forcibly guided contacts
M1: 3-phase motor
E1: 24-VDC power supply

*1. Connect the surge killer that is included with the Safety Laser Scanner in parallel with KM1, KM2.
*2. Use NC contacts for the start input.
*3. If the EDM is not used, use the setting software to set the EDM to OFF, and then connect the EDM wire (pink) to 0 VDC.

Wiring for Connection to the G9SX-AD322-T15 Controller (Category 3)

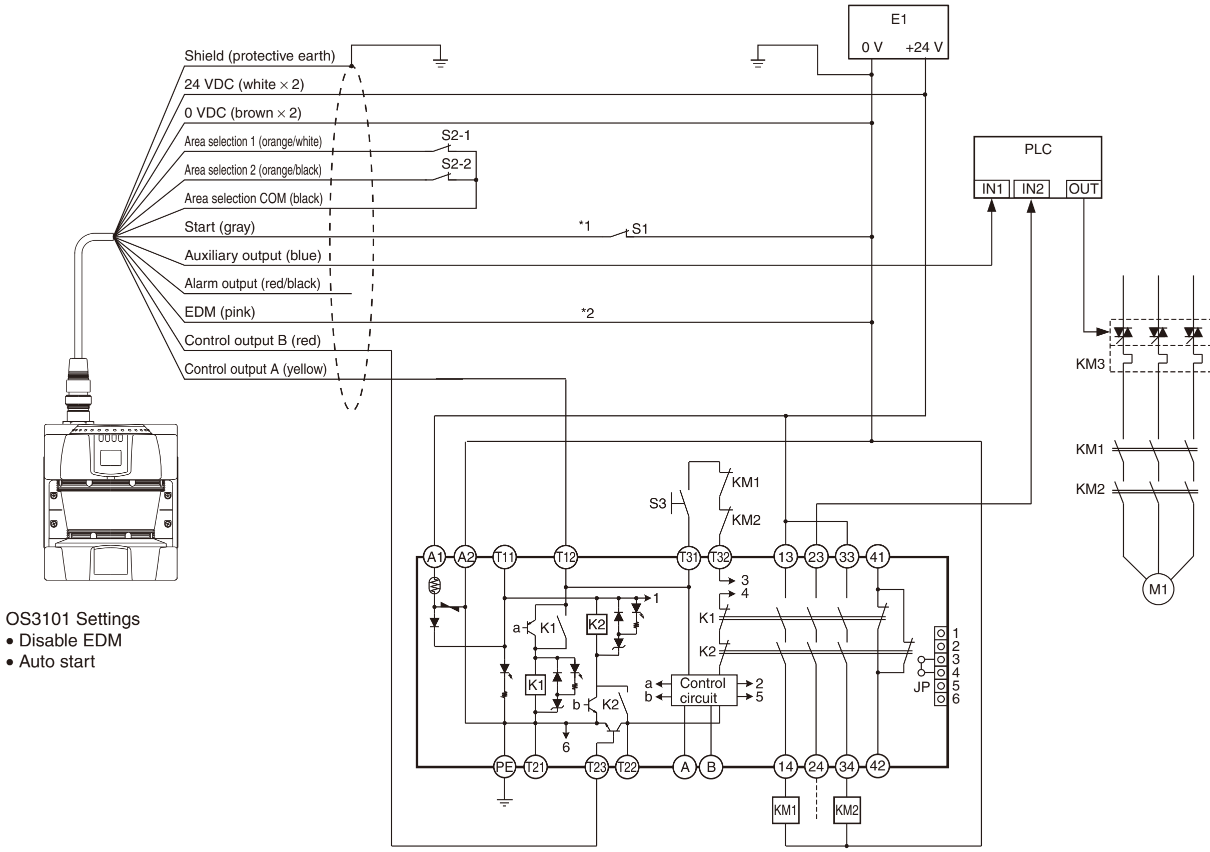


OS3101 Settings
- Disable EDM
- Auto start

S1: Start input
S2-1/S2-2: Area setting selector
When area setting 1 is selected: S2-1 is short-circuited, S2-2 is open
When area setting 2 is selected: S2-1 is open, S2-2 is short-circuited
(For details, refer to the *Instruction Manual*.)
KM1 to KM4: Safety relays with forcibly guided contacts
M1, M2: 3-phase motors
E1: 24-VDC power supply
PLC: Programmable Controller
(For monitoring use. Not related to the safety system.)

*1. Use NC contacts for the start input.
*2. If the EDM is not used, use the setting software to set the EDM to OFF, and then connect the EDM monitor wire (pink) to 0 VDC.

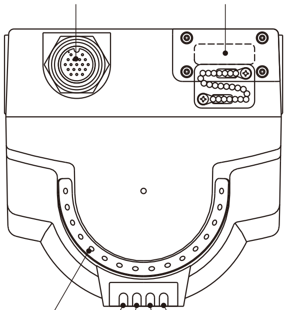
Wiring for Connection to the G9SA-301 Controller (Category 3)

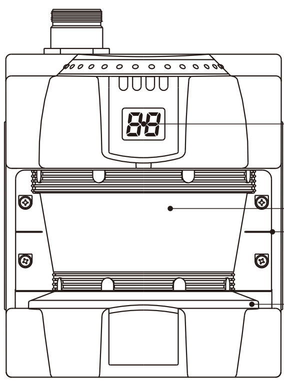


S1: Start input (used to cancel lockout)
S2-1/S2-2: Area setting selector
When area setting 1 is selected: S2-1 is short-circuited, S2-2 is open
When area setting 2 is selected: S2-1 is open, S2-2 is short-circuited
(For details, refer to the *Instruction Manual*.)
S3: Reset switch
KM1, KM2: Safety relays with forcibly guided contacts
M1: 3-phase motor
E1: 24-VDC power supply
PLC: Programmable Controller (For monitoring use. Not related to the safety system.)

*1. Use NC contacts for the start input.
*2. If the EDM is not used, use the setting software to set the EDM to OFF, and then connect the EDM monitor wire (pink) to 0 VDC.

Names and Functions of Parts





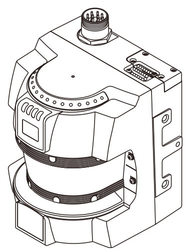
No.	Name	Function
1	ON output indicator (green)	Lit when control output is in ON-state.
2	OFF output indicator (red)	Lit when control output is in OFF-state.
3	Interlock indicator (yellow)	Lit when during start input standby, flashing during malfunction.
4	Alarm output indicator (orange)	Lit when an object entering the warning area is detected.
5	Power supply connector	14-pin power supply connector.
6	Intrusion indicators	Lit when an object entering the protective area is detected. Protective area is displayed in 16 sections (11.25° for each indicator).
7	Communications connector	Allows connection of an RS-232C D-sub straight cable for communication with a personal computer.
8	Status/self-diagnosis display	Displays numerical codes to indicate status of the OS3101 during normal operation or a lockout.
9	Window	Allows laser beam emission/reception.
10	Laser scanning plane indicator	A mark showing the laser scanning plane.
11	Dust ring	Detects dust and other foreign matter on the Window.

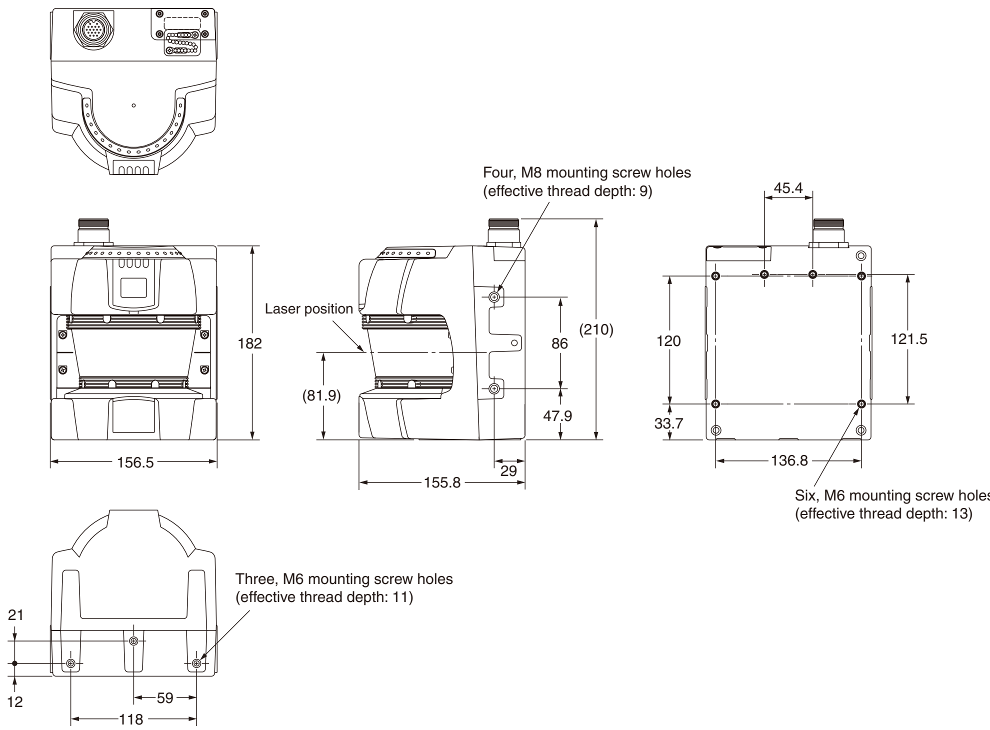
Dimensions

(Unit: mm)

Safety Laser Scanner

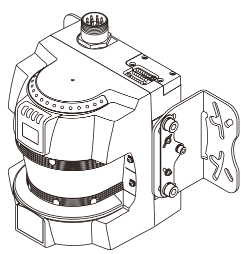
OS3101-2-PN-S

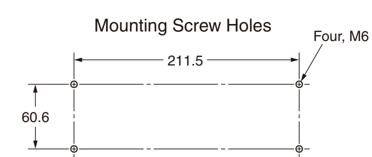


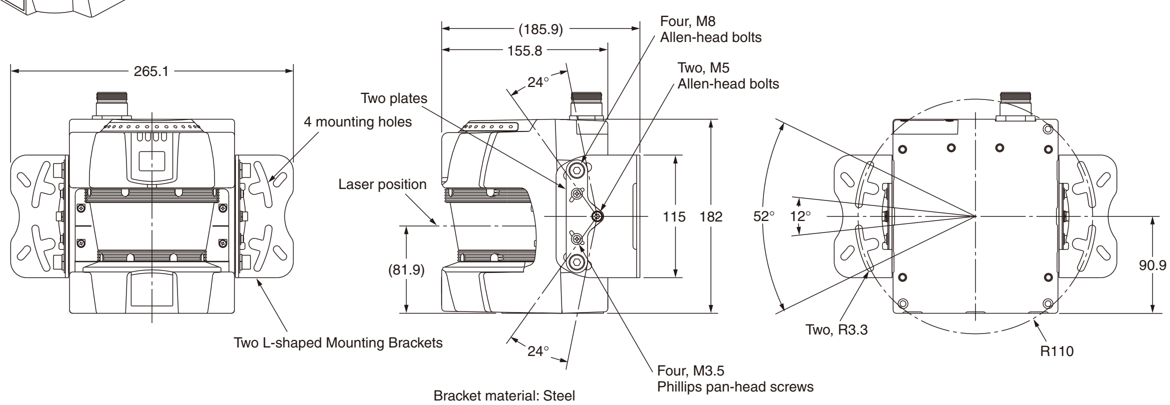


Safety Laser Scanner with L-shaped Mounting Brackets (Outward Bracket Mounting)

OS3101-2-PN-S + OS3101-BKT

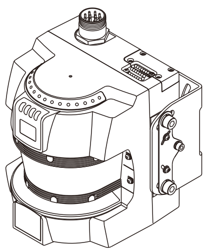


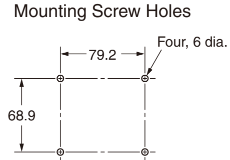


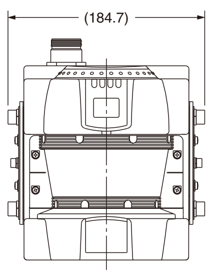


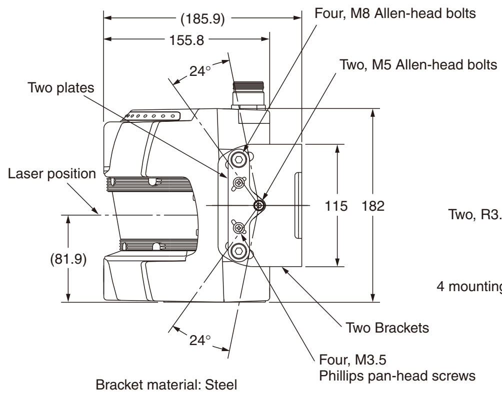
Safety Laser Scanner with L-shaped Mounting Brackets (Inward Bracket Mounting)

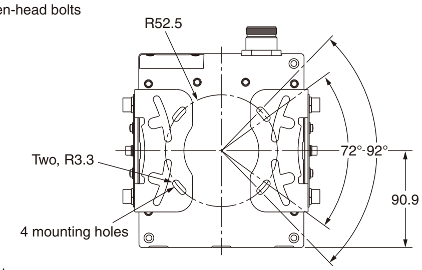
OS3101-2-PN-S + OS3101-BKT





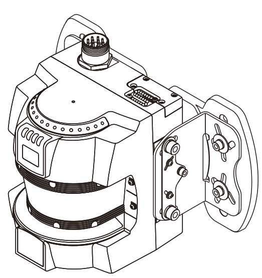


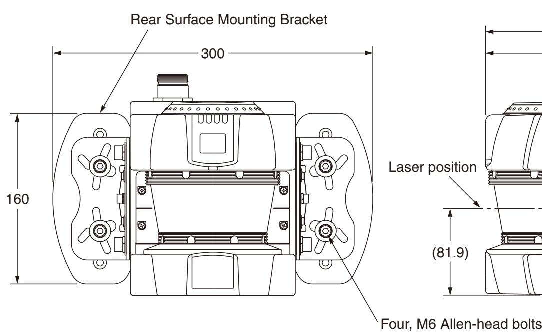


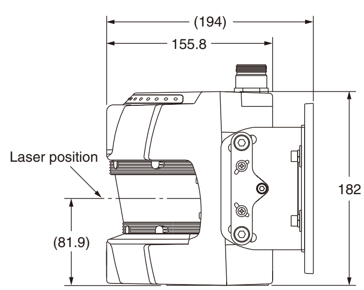


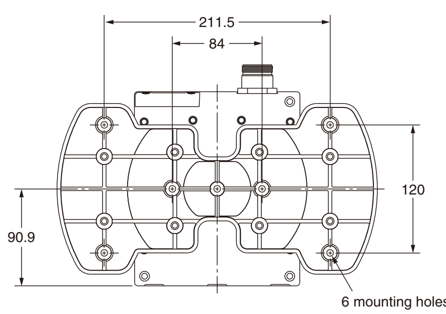
Safety Laser Scanner with L-shaped Mounting Brackets and Rear Surface Mounting Bracket

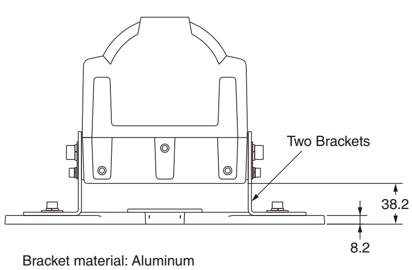
OS3101-2-PN-S + OS3101-BKT + OS3101-BPT

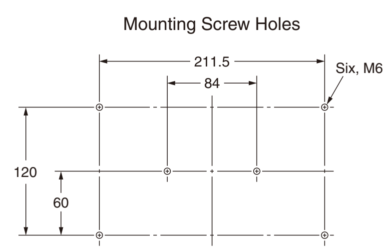






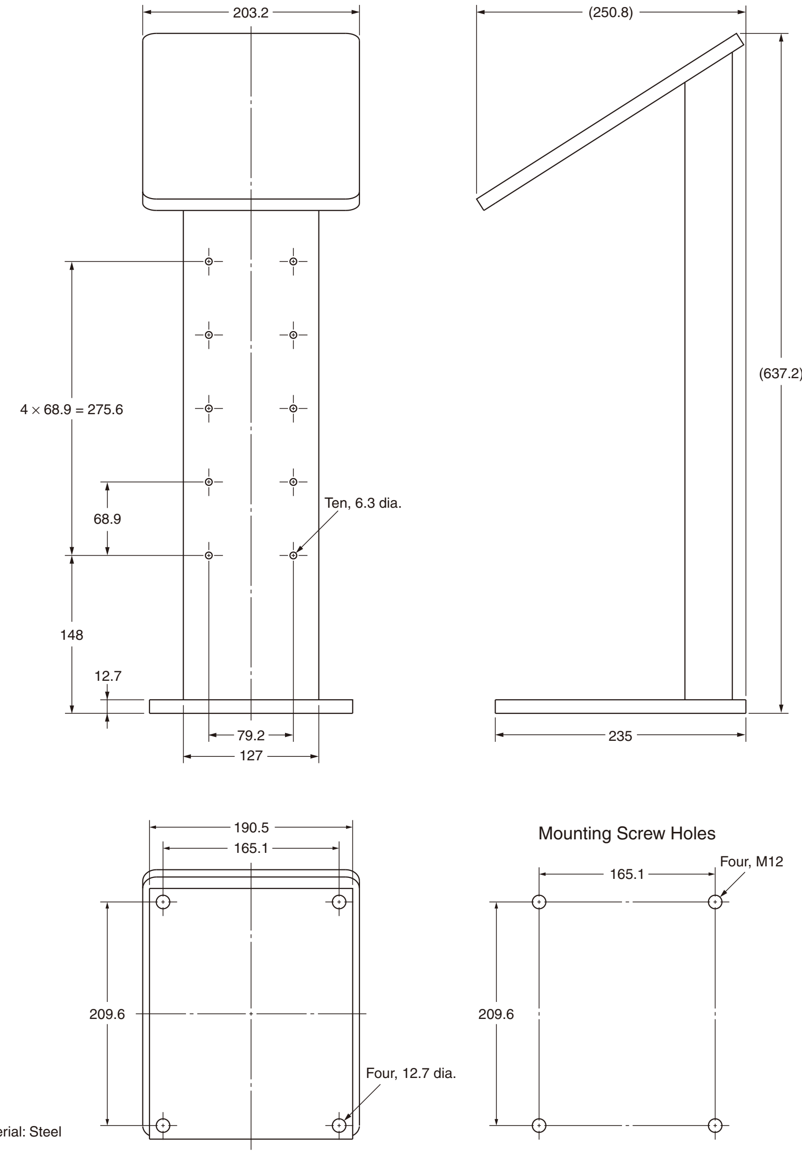






Mounting Stand

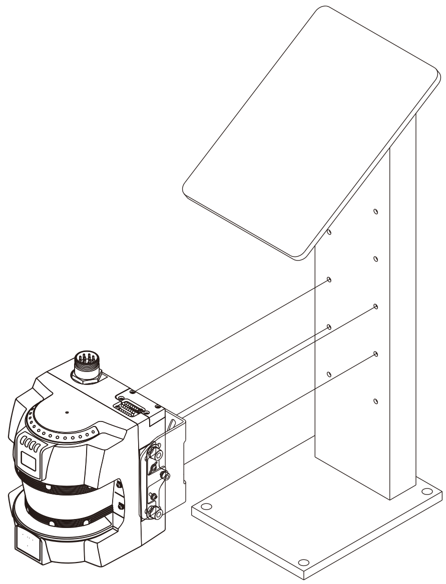
OS3101-MT

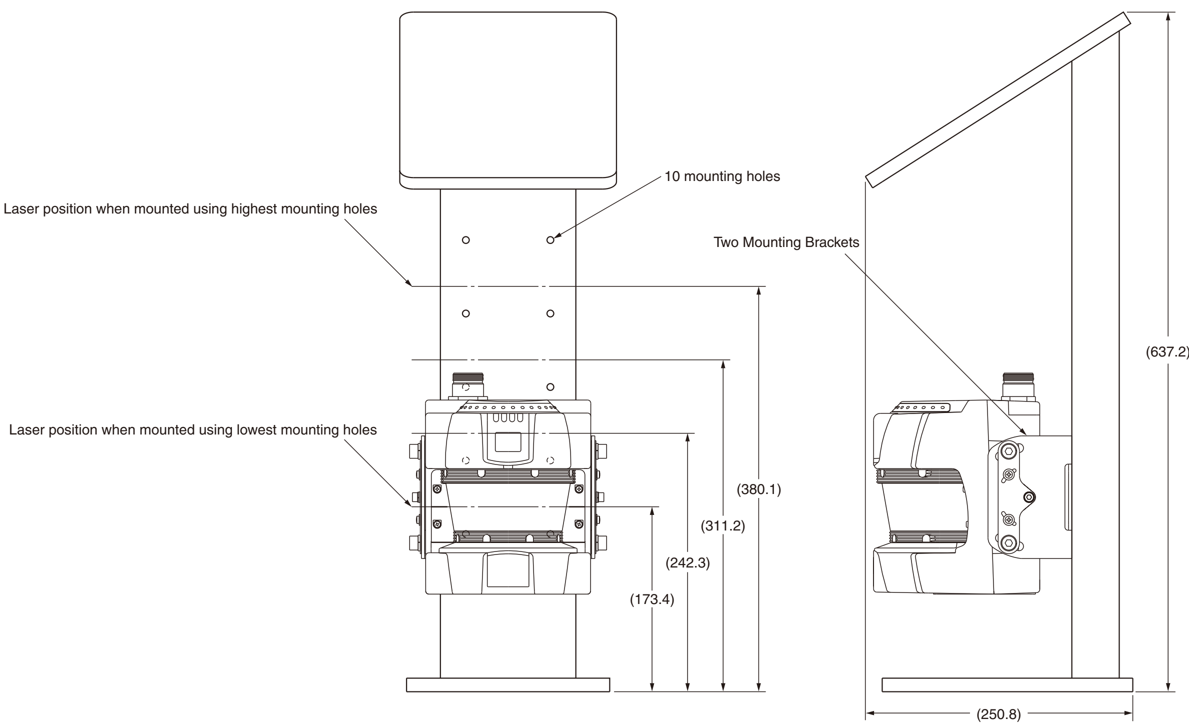


Bracket material: Steel

Safety Laser Scanner with L-shaped Mounting Brackets and Mounting Stand

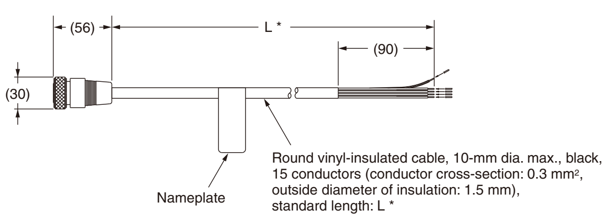
OS3101-2-PN-S + OS3101-BKT + OS3101-MT





Power Cable

OS3101-CBL-□□PT



* The length depends on the model, as shown in the following table.

Model	L
OS3101-CBL-10PT	1,000 $^{+300}_{0}$
OS3101-CBL-20PT	2,000 $^{+300}_{0}$
OS3101-CBL-30PT	3,000 $^{+300}_{0}$

Safety Precautions

This catalog is intended as a guide for selecting the appropriate Safety Laser Scanner.
Be sure to use the *Instruction Manual* provided with the product for actual operation.

Regulations and Standards

1. Application of an OS3101 Safety Laser Scanner alone cannot receive type certification provided by Article 44-2 of the Labor Safety and Health Law of Japan. It is necessary to apply it in a system. Therefore, when using the OS3101 in Japan as a "safety system for pressing or shearing machines" prescribed in Article 42 of that law, the system should receive type certification.
2. (1) The OS3101 is electro-sensitive protective equipment (ESPE) in accordance with European Union (EU) Machinery Directive Index Annex IV, B, Safety Components, Item 1.
   (2) The OS3101 complies with the following legislation and standards:
   1. EU Regulations
      - Machinery Directive: 98/37/EC
      - EMC Directive: 2004/108/EC
   2. European Standards: EN 61496-1:2004 (Type 3 ESPE), EN 61496-3:2001 (Type 3 AOPDDR)
   3. International Standards: IEC 61496-1:2004 (Type 3 ESPE), IEC 61496-3:2001 (Type 3 AOPDDR)
   4. North American Standards: UL 508, UL 1998, CAN/CSA 22.2 No.14, CAN/CSA 22.2 No.0.8, CAN/CSA 22.2 No.205
   5. JIS Standards: JIS B 9704-1:2006, JIS B9704-3:2004 (Type 3 ESPE)

   (3) The OS3101 received the following certification from TÜV Rheinland, an EU-accredited body:
   - EC type test based on the Machinery Directive
     Type 3 ESPE (IEC 61496-1),
     Type 3 AOPDDR (IEC 61496-3)
   - TÜV Rheinland Type Certification
     Type 3 ESPE (IEC 61496-1)
     Type 3 AOPDDR (IEC 61496-3)

   (4) The OS3101 received the following approvals from the Third Party Assessment Body UL:
   - Certificate of UL listing for US and Canadian safety standards:
     Type 3 ESPE (IEC 61496-1)
     Type 3 AOPDDR (IEC 61496-3)

Precautions for Safe Use

Indication and Meaning of Safe Use

This catalog contains safety-related instructions to ensure safe use of the OS3101 Safety Laser Scanner. Because these instructions describe details very important to your safety, it is extremely important that you understand and follow the instructions.

Do not drop the OS3101.

⚠ WARNING

The system administrator should select and train qualified persons to be responsible for the correct installation, operation, and maintenance of all machinery and protective devices.

The OS3101 should only be installed, checked out, and maintained by a qualified person. A qualified person is defined by ANSI B30.2-1983 as a person or persons who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.

Compliance with the safety standards for the OS3101's specific application and installation is possible only when it is used, installed, maintained, and operated safely. Each of these steps should be fully confirmed by the customer who purchases the OS3101, the person or persons who install it, and the employer of the operator of the OS3101.

After the OS3101 parameters have been set, test the protective area and warning area to confirm that they have been set correctly before operating any hazardous parts of the machinery.

Do not try to disassemble the OS3101. Doing so may cause the safety functions to stop working properly.

Be sure to observe the following conditions when using the OS3101.
- The machine for which protection is being provided should be capable of being stopped at any time within its operating cycle. Do not use the OS3101 for presses that are equipped with a full-revolution clutch.
- The OS3101 cannot protect a person from an object flying from a hazardous area. Install protective covers or fences.
- The machine for which protection is being provided should be stoppable within a constant length of time, and should be equipped with appropriate control mechanisms.
- The OS3101 is not capable of accurate detection in smoky or dusty environments. Using the OS3101 in these environments may cause the machine to suddenly stop.
- Do not use mirror-like objects on surfaces in the protective area. Their use may make it impossible to detect parts of the protective area.
- Comply with all laws and regulations of the country or region where the OS3101 is used. This is the employer's responsibility.
- Design all safety-related machine control elements so that a hazardous condition will not result from control circuit failures or similar problems.
- Additional protective measures should be taken if it is possible for a person to approach the hazardous area without being detected by the OS3101.
- Conduct the test described in the Instruction Manual when installing the OS3101, when a change is made to the machine for which protection is being provided, or when a change is made to the OS3101 parameters.
- Follow the procedures given in the Instruction Manual for tests and repairs.
- Be sure to thoroughly read the Instruction Manual and understand the procedures for installation, operation, and maintenance before use.
- An additional tolerance for measurement error may be necessary due to the type of background with which the OS3101 is used.

The employer is responsible for observing all requirements described herein, as well as the procedures and requirements for each machine and device that is used.

The OS3101 is designed to be used with a 24-VDC, negative (protective) ground electrical system. Do not connect it to a positive (protective) ground electrical system. Connecting the OS3101 to a positive (protective) ground electrical system may cause the machine that is being controlled to fail to stop, resulting in serious injury.

Do not connect any of the OS3101 lines to a DC power supply higher than 24 V+20%. Also, do not connect to an AC power supply. Failure to do so may result in electric shock.

For the OS3101 to comply with IEC 61496-1 and UL 508, the DC power supply unit should satisfy all of the following conditions:

- Should be within rated power voltage (24 VDC±20%).
- Should comply with EMC Directives (industrial environment)
- Double or enhanced insulation should be applied between the primary and secondary circuits.
- Automatic recovery of overcurrent protection characteristics
- Output holding time should be 20 ms or longer.
- Should satisfy output characteristic requirements for class 2 circuit or limited voltage current circuit defined by UL508.
- Should comply with the EMC, laws, and regulations of the country or region where the OS3101 is used. (Example: In the EU, the power supply should comply with the EMC Low Voltage Directive.)

Double or enhanced insulation should be applied between the OS3101 and hazardous voltage sources (such as 230 VAC) to protect against electric shock.

The cable extension length should be no greater than the specified length. Otherwise, the safety functions may fail to work properly, resulting in danger.

When the OS3101 is used in a category 3 safety system, use both control outputs to build the safety system. Using only one control output may result in serious injury due to a malfunction in the output circuit.

The protective area should be correctly defined and the parameters related to the protective area should be correctly set in order to use the protective functions of the OS3101.

When changing the response time of the OS3101, the safety distance should be recalculated and the OS3101 should be re-installed to match the recalculated safety distance. Failure to do so may cause the machine to fail to stop before an operator reaches the dangerous area and may result in serious injury.

Do not allow the following types of light to shine directly on the OS3101.

- Incandescent light
- Strobe light
- Light from optical sensors using infrared light

If the Window is cracked, broken, or otherwise damaged, replace it immediately. Failure to do so may lower the degree of protection. Also, when replacing the Window, take the necessary steps to prevent dust or other particles from entering the OS3101.

If the Dust Ring is damaged, replace it immediately. Failure to do so may lower the degree of protection. Also, when replacing the Dust Ring, take the necessary steps to prevent dust or other particles from entering the OS3101.

To maintain the IP65 enclosure rating, make sure that there is no foreign matter adhering to the seals of the connectors, Window, or Dust Ring, and that all screws are properly tightened.

Install the OS3101 securely.

When disposing of the OS3101, do so in accordance with the laws and regulations for waste disposal in the country where it is used.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON’s test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Enabling Grip Switch
A4EG

Enabling Grip Switch with Distinct Feel for Three Easily Discernible Positions

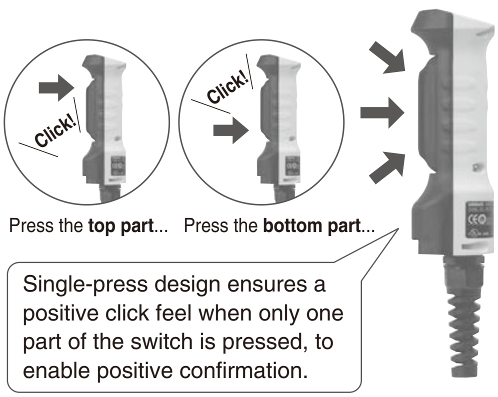
- The difficult task of configuring safety circuits is now easily achieved by combining the A4EG with the G9SX-GS.
- In addition to the standard models, the lineup also includes models with an emergency stop switch and models with a momentary operation switch.
- An optional Holding Key (sold separately) provides a versatile method for selecting modes.
- Equipped with conduit connector.

⚠ Be sure to read the *"Safety Precautions"* on page 11.

Features

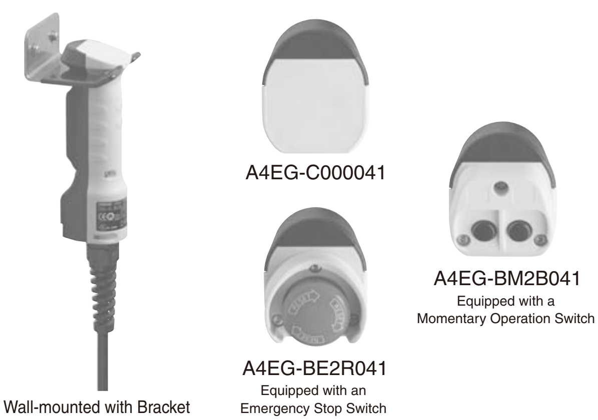
Positive Operating Feel

Original Double Snap Action switch mechanism lets the operator precisely confirm the enable position.



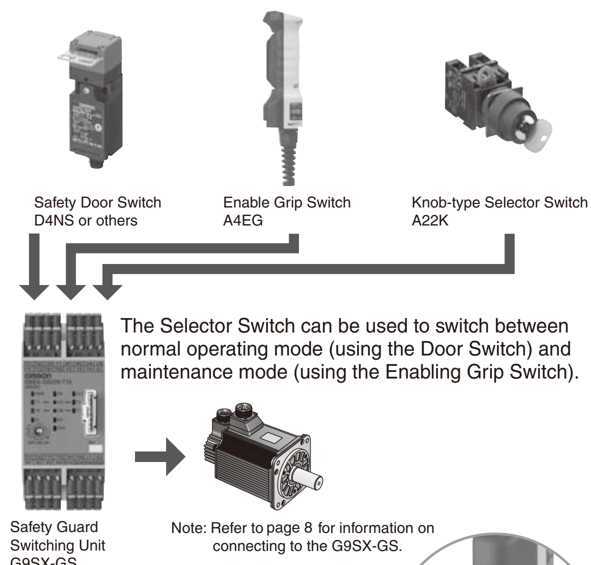
Selection Based on Application

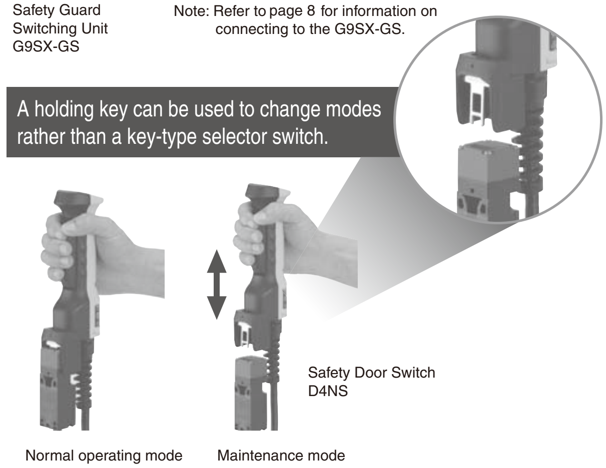
In addition to the standard models, the lineup also includes models with an emergency stop switch and models with a momentary operation switch.



Safety Circuits Are Easy to Configure

Safety circuits can be easily configured by combining the A4EG with the G9SX-GS Safety Guard Switching Unit.





Ordering Information

Enabling Grip Switches

Appearance	Contact form			Model
	Enabling switch	Monitor switch	Pushbutton switch	
	Two contacts	1NC (grip output)	None	**A4EG-C000041**
	Two contacts	None	Emergency stop switch (2NC)	**A4EG-BE2R041**
	Two contacts	None	Momentary operation switch (2NO)	**A4EG-BM2B041**

Accessories (Order Separately)

Appearance	Item	Model
	Rubber Cover (replacement part)	**A4EG-OP1**
	Mounting Bracket (for securing the A4EG)	**A4EG-OP2**
	Holding Key	**A4EG-OP3**

Specifications

Standards and EC Directives

Compliance with EC Directives and International Standards

- Low Voltage Directive
- GS-ET-22

Certified Standards

Certifying body	Standard	File No.
TÜV Product Service	EN 60947-5-1 (certified direct opening)	Ask your OMRON representative.
UL *	UL 508, CSA C22.2 No.14	E76675
CQC (CCC)	GB 14048.5	Pending approval

* Certification for CSA C22.2 No. 14 by UL is indicated by the .

Certified Standard Ratings (Enabling Switch Section)

TÜV (EN 60947-5-1)

Item / Utilization category	AC-15	DC-13
Rated operating current (Ie)	0.75 A	0.55 A
Rated operating voltage (Ue)	240 V	125 V

Note: Use a 10-A fuse type gI or gG that conforms to IEC 60269 as the short-circuit protection device.
The fuse is not built into the Switch.

UL/CSA (UL 508, CSA C22.2 No.14), CCC (GB 14048.5)

- 24 VDC, 0.3 A (inductive load)
- 125 VAC, 1 A (resistive load)

Ratings

Item / Section	Enabling switch	Emergency stop switch (A4EG-BE2R041 only)	Pushbutton (A4EG-BM2B041 only)
Rated insulation voltage	250 V		---
Rated ON current	2.5 A	5 A	0.1 A
Rated load	24 VDC, 0.3 A (inductive load) 125 VAC, 1 A (resistive load) EN certification rating: AC-15 0.75 A/240 V DC-13 0.55 A/125 V	General rating: 125 VAC, 5 A (resistive load) 250 VAC, 3 A (resistive load) 30 VDC, 3 A (resistive load) UL and cUL rating: 125 VAC, 5A (inductive load, power factor: 0.75 to 0.8) 250 VAC, 3 A (inductive load, power factor: 0.75 to 0.8) 30 VDC, 3 A (resistive load)	General rating: 125 VAC, 0.1 A (resistive load) 8 VDC, 0.1 A (resistive load) 14 VDC, 0.1 A (resistive load) 30 VDC, 0.1 A (resistive load)
Minimum applicable load	24 VDC, 4 mA		5 VDC, 1 mA

Characteristics

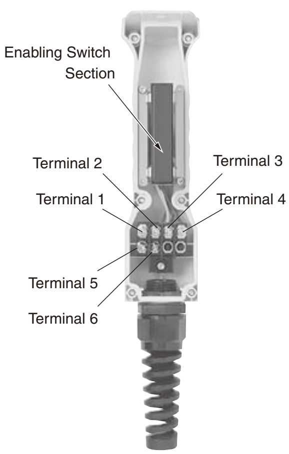
Item		Enabling switch	Emergency stop switch (A4EG-BE2R041 only)	Pushbutton (A4EG-BM2B041 only)
Degree of protection		IP66 (A4EG-C000041), IP65 (A4EG-BE2R041, A4EG-BM2B041)		
Operating section strength		Operating direction: 200 N, 1 min	Operating direction: 367 N, 1 min Rotating direction: 0.49 N·m, 1 min	Operating direction: 50 N, 1 min
Cable pull strength		30 N, 1 min		
Allowable operating frequency	Electrical	20 operations/minute max.	10 operations/minute max. (set/reset for one operation)	60 operations/minute max.
	Mechanical	20 operations/minute max.	10 operations/minute max. (set/reset for one operation)	120 operations/minute max.
Electrical durability		100,000 operations min. (rated load)	100,000 operations min. (set/reset for one operation) (rated load)	100,000 operations min. (rated load)
Mechanical durability		OFF-ON-OFF (direct opening): 100,000 operations min. OFF-ON: 1,000,000 operations min.	100,000 operations min. (set/reset for one operation)	2,000,000 operations min.
Dielectric strength	Between terminals of the same polarity	2,500 VAC, 50/60 Hz, 1 minute (impulse voltage)	1,000 VAC, 50/60 Hz, 1 minute	1,000 VAC, 50/60 Hz, 1 minute
	Between terminals of the different polarity	2,500 VAC, 50/60 Hz, 1 minute (impulse voltage)	2,000 VAC, 50/60 Hz, 1 minute	2,000 VAC, 50/60 Hz, 1 minute
	Between each terminal and non-current carrying metallic parts	2,500 VAC, 50/60 Hz, 1 minute (impulse voltage)	2,000 VAC, 50/60 Hz, 1 minute	2,000 VAC, 50/60 Hz, 1 minute
Insulation resistance		100 MΩ min. (at 500 VDC)		
Vibration resistance	Malfunction	1.5 mm double amplitude, 10 to 55 Hz		
Shock resistance	Malfunction	150 m/s^2 max.		
Ambient operating temperature		–10 to 55°C (with no icing or condensation)		
Ambient operating humidity		35% to 85%		
Ambient storage temperature		–25 to 65°C (with no icing or condensation)		
Protection against electric shock		Class II (double insulation)		
Pollution degree (operating environment)		3 (EN 60947-5-1)		
Conditional short-circuit current		100 A (EN 60947-5-1)		

Note: The timing of contact outputs for two or more circuits is not synchronized. Confirm performance before application.

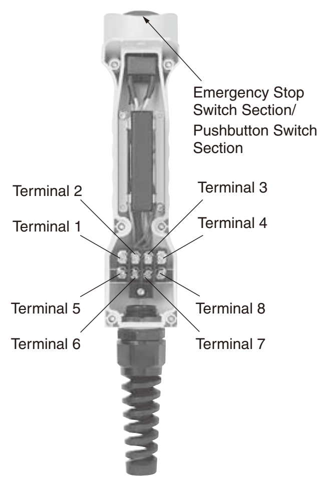
Structure and Nomenclature

Structure

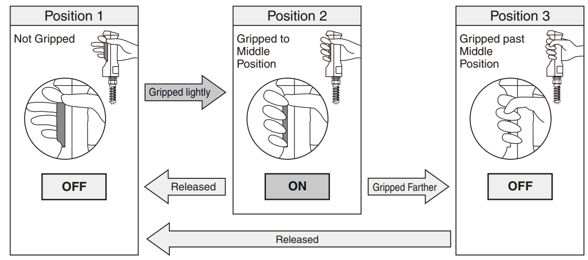
A4EG-C000041



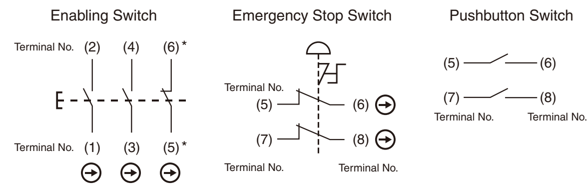
A4EG-BE2R041
A4EG-BM2B041



Three Positions: OFF - ON - OFF



Contact Configuration



*Terminal No. (5), (6): A4EG-C000041 only

Contact Forms

Operating Patterns

A4EG-C000041

Operation	Terminal No.	Position 1 ▼	Position 2 ▼	Position 3 ▼
Enable output	1 to 2			
	3 to 4			
Grip output	5 to 6			

A4EG-BE2R041

Operation	Terminal No.	Position 1 ▼	Position 2 ▼	Position 3 ▼
Enable output	1 to 2			
	3 to 4			

Pushbutton switch	Terminal No.	Operation	Contact
Emergency stop switch output	5 to 6 7 to 8	Operation (push)	ON → OFF
		Reset (turn reset)	OFF → ON

A4EG-BM2B041

Operation	Terminal No.	Position 1 ▼	Position 2 ▼	Position 3 ▼
Enable output	1 to 2			
	3 to 4			

Pushbutton switch	Terminal No.	Operation	Contact
Pushbutton switch output	5 to 6 (pushbutton switch A) *	Push	OFF → ON
	7 to 8 (pushbutton switch B) *	Push	OFF → ON

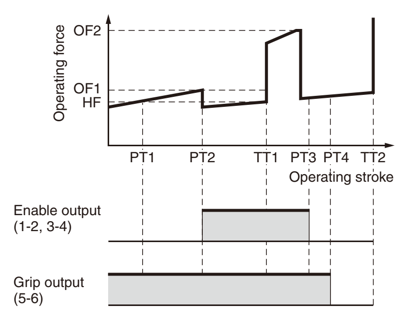
* Refer to *Dimensions* on page 6 for information on the positions of pushbutton switches A and B.

OPEN	ON: CLOSED
CLOSED	OFF: OPEN

Note: 1. The contact ON/OFF timing is not synchronized. Confirm performance before application.
2. Direct opening only during grip.

Operating Characteristics

Chart (Enabling Switch Section)



Operating Stroke (Enabling Switch Section)

Operating characteristics		Specified value
Enable output (ON)	**PT2 max.**	3.6 mm
Max. enable holding position	**TT1**	Approx. 4.2 mm
Enable direct opening position	**PT3 max.**	6.0 mm
Max. stroke	**TT2**	Approx. 6.7 mm

Operating Force (Enabling Switch Section: Reference Values)

Operating characteristics		Specified value
Enable operating force	**OF1 max.**	14 N
Enable holding force	**HF ***	Approx. 8 N
Grip operating force	**OF2 max.**	40 N

* HF: Holding force

Operating Force (Emergency Stop Switch Section: Reference Values)

Operating characteristics		Specified value
Operating force	**OF max.**	14.7 N
Reset force	**RF max.**	0.1 N·m

Operating Force (Pushbutton Switch Section: Reference Value)

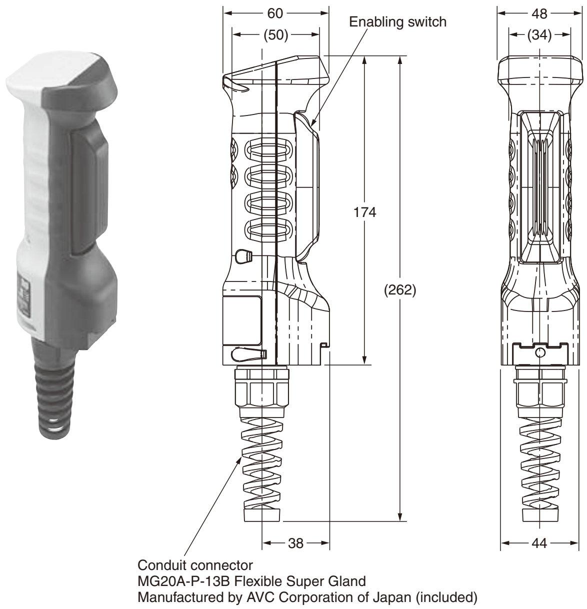
Operating characteristics		Specified value
Operating force	**OF max.**	4 N

Dimensions

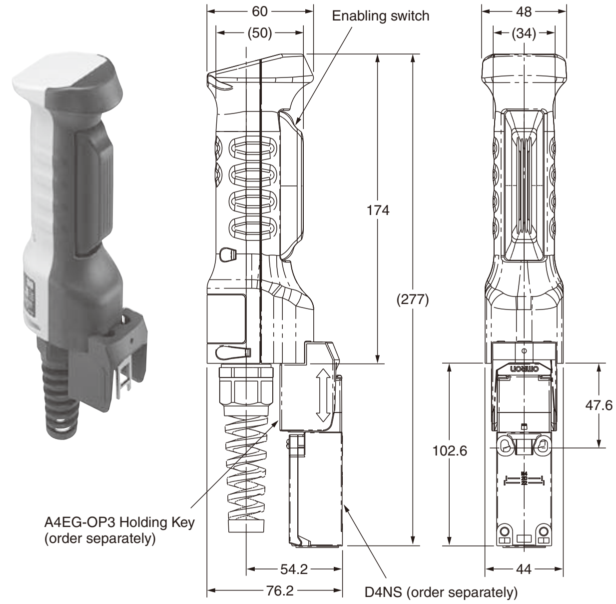
(Unit: mm)

Enabling Grip Switches

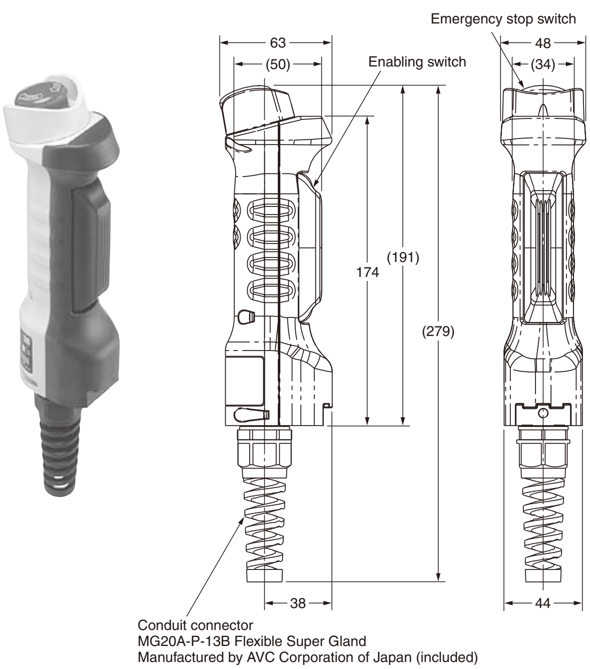
A4EG-C000041



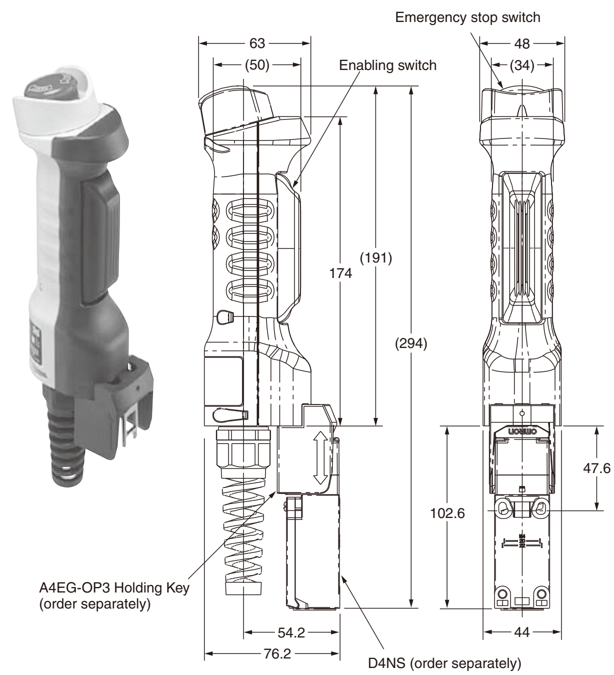
Holding Key Mounted



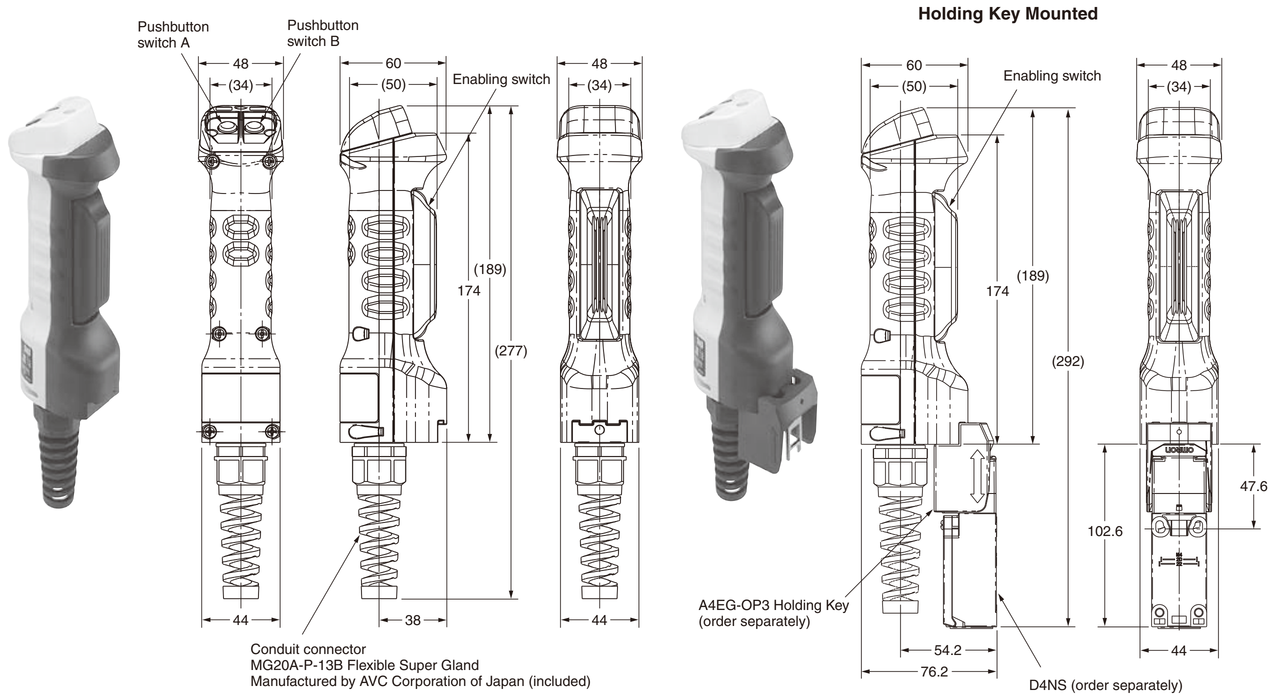
A4EG-BE2R041



Holding Key Mounted



A4EG-BM2B041



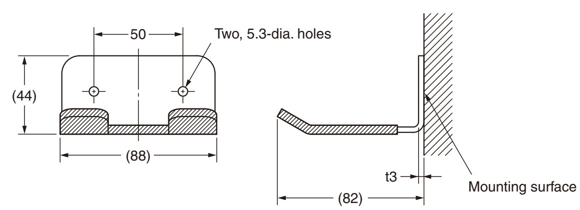
Accessories (Order Separately)

Rubber Cover (Replacement Part)

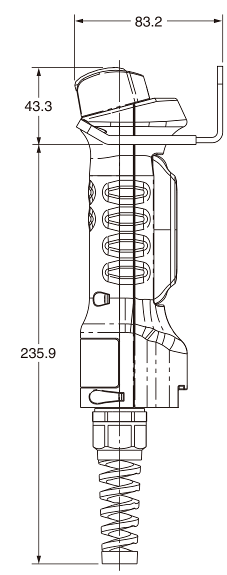
A4EG-OP1

Mounting Bracket (for Securing the A4EG)

A4EG-OP2



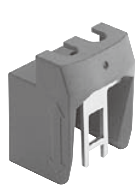
Enabling Grip Switch Mounted



Note: The screws are not included.

Holding Key

A4EG-OP3

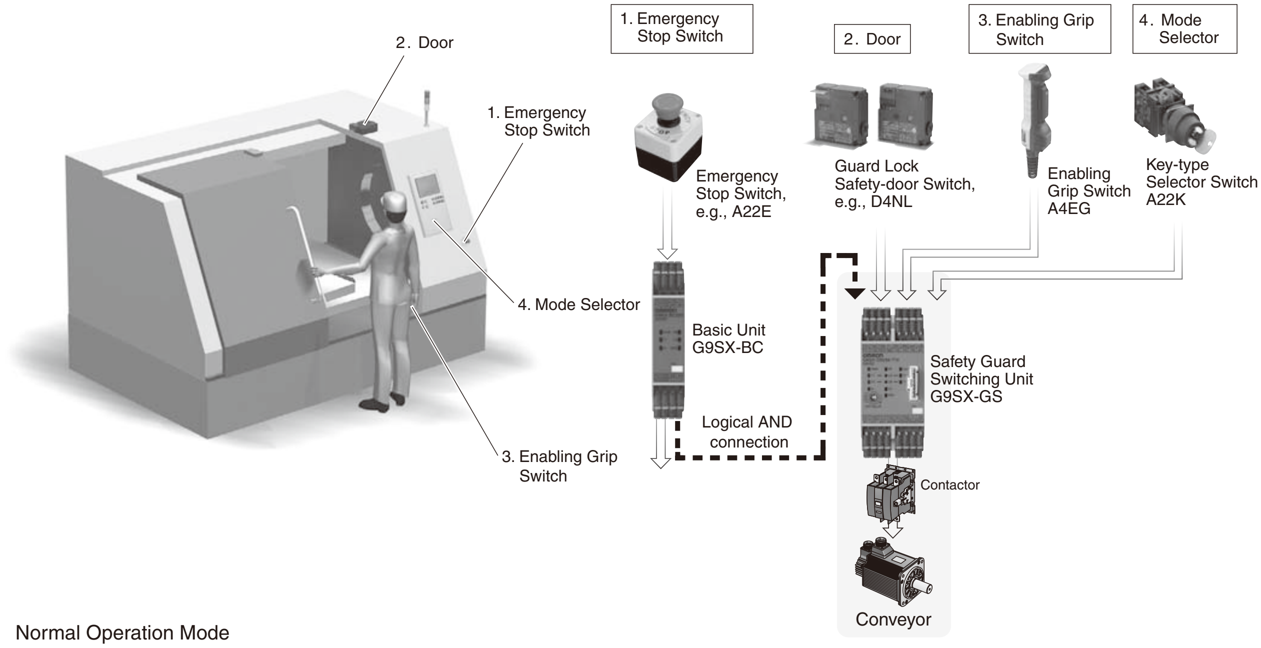


Application Examples

Application Examples

Machining Equipment Maintenance Mode

- Switching between normal operation mode and maintenance mode is performed manually.
- In normal operation mode, the Safety Door Switch is enabled, and in maintenance mode, the Enabling Grip Switch is enabled.



Normal Operation Mode

- Emergency Stop Switch — When pressed, processing will stop.
- Door — When the door is opened, processing will stop.
- Enabling Grip Switch — The Enabling Grip Switch will be disabled.

Maintenance Mode

- Emergency Stop Switch — When pressed, processing will stop.
- Door — The Door Switch will be disabled.
- Enabling Grip Switch — Processing will be possible only when the operator is gripping the Enabling Grip Switch.

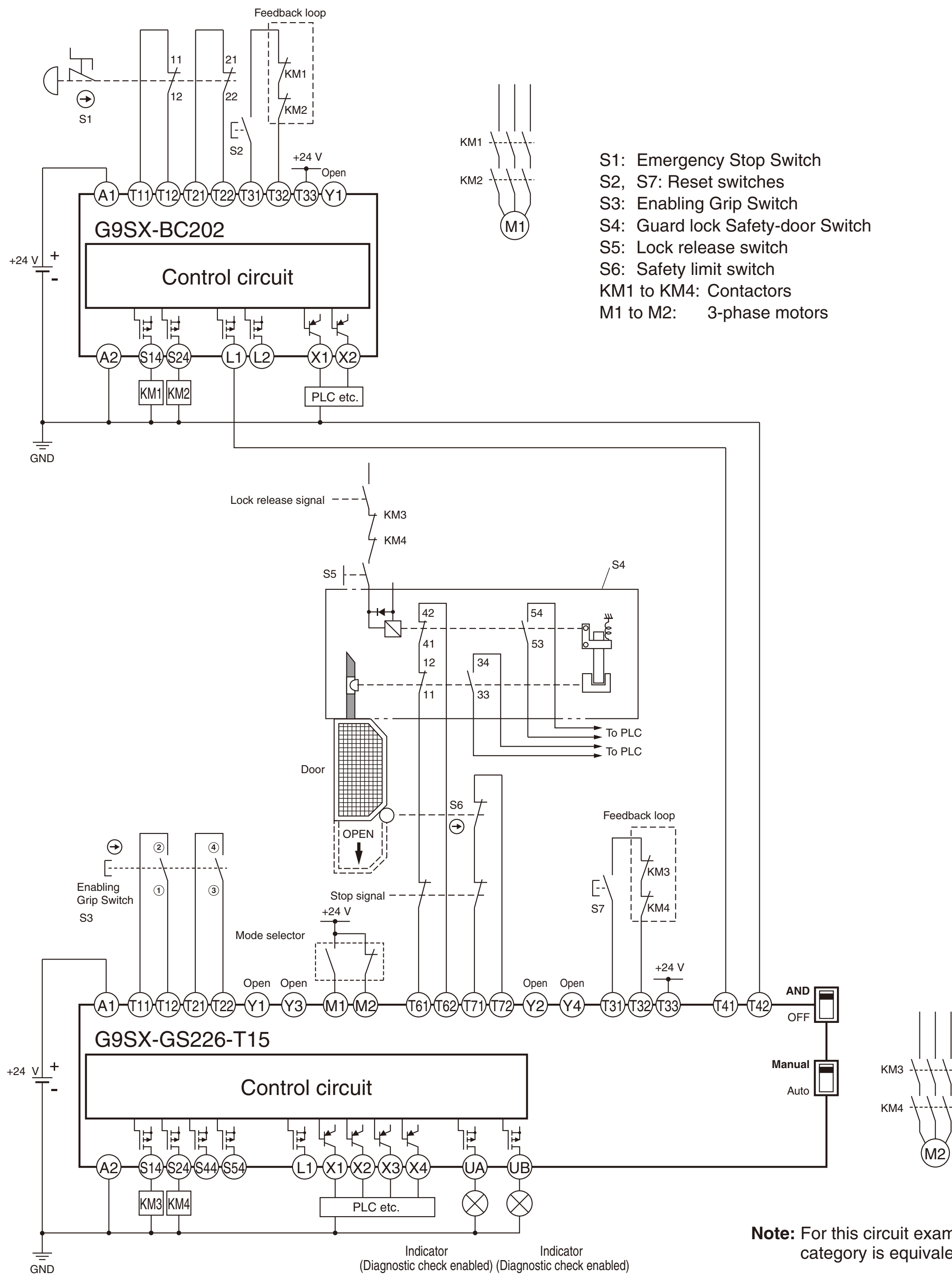
Note: For information on the G9SX-GS, refer to G9SX-GS and *G9SX User's Guide* (Cat. No. Z255).

Wiring Example

Settings (For details, refer to section 3 of the *G9SX User's Guide* (Cat. No. Z255).)

G9SX-BC: Manual reset, cross fault detection: ON (category 4 wiring)
G9SX-GS: Manual reset, cross fault detection: ON (category 4 wiring), logical AND connection setting: AND
ON-delay time setting: Time is set.
Switching mode: Manual
External indicator diagnosis: Enabled

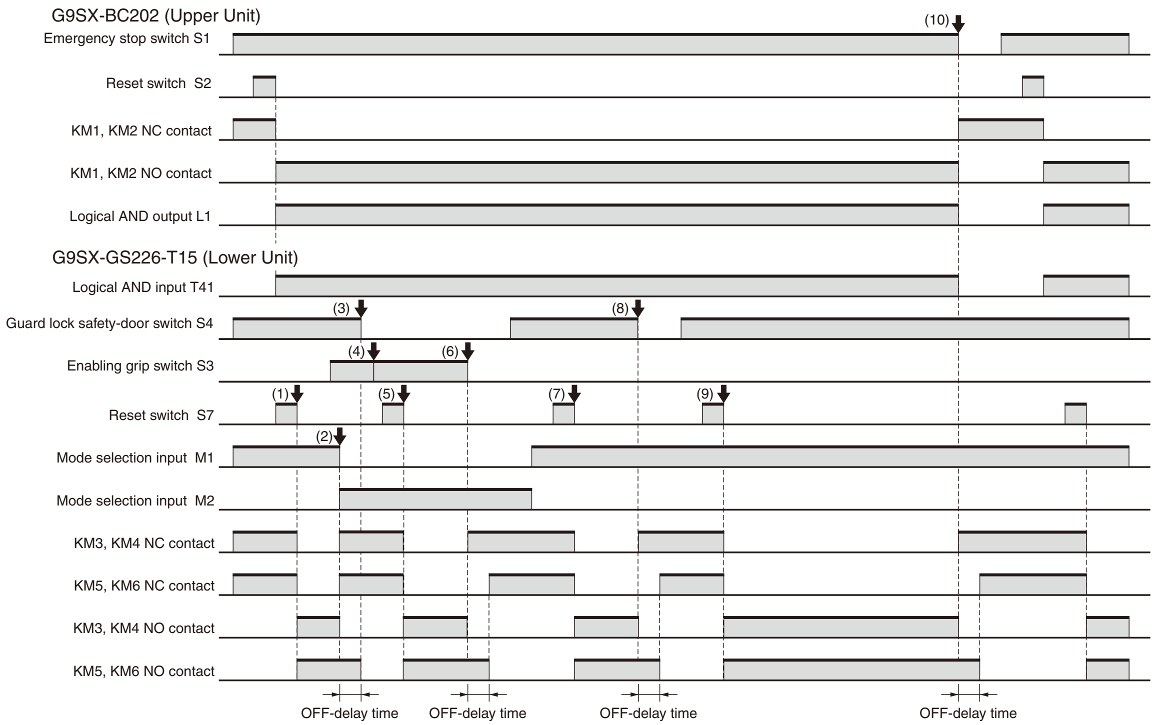
Wiring Example



S1: Emergency Stop Switch
S2, S7: Reset switches
S3: Enabling Grip Switch
S4: Guard lock Safety-door Switch
S5: Lock release switch
S6: Safety limit switch
KM1 to KM4: Contactors
M1 to M2: 3-phase motors

Note: For this circuit example, the category is equivalent to 4.

Timing Chart



(1) The lower unit starts in operation mode.
(2) The mode switches to maintenance mode.
(3) The operator opens the door and performs maintenance work.
(4) The Enabling Grip Switch is gripped to the middle position.
(5) The lower unit starts in maintenance mode.
(6) The lower unit will stop when the Enabling Grip Switch is released or gripped.
(7) The lower unit will start again after the door is closed and the mode is switched to operation mode.
(8) The lower unit will stop when the door is open while in operation mode.
(9) The door is closed and the lower unit starts again.
(10) The upper unit and lower unit will stop if the emergency stop is pressed.

Safety Precautions

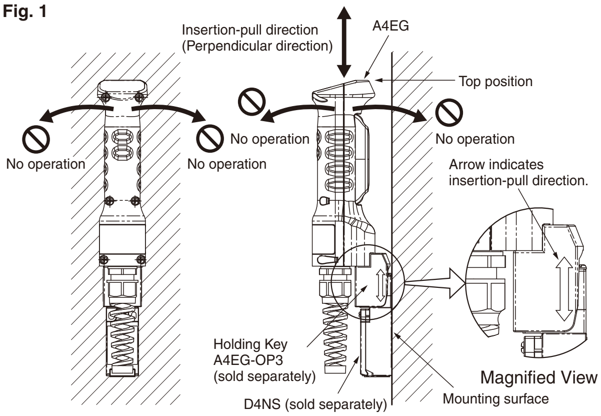
⚠ WARNING

Always verify the operation of the safety functions before starting the system. Not doing so may result in the safety functions not performing as expected if the wiring or settings are incorrect or the switches have failed.	
Do not drop the switch. Doing so may damage the switch and the system may continue to operate, possibly causing injury or death.	

Precautions for Safe Use

- This product is a switch for teaching the machine such as robot in hazardous area. The machine is allowed to operate only when operating the switch continuously. Configure the system so that the machine can be operated only at position 2.
- Apply load current not to exceed the rated value.
- Do not use the switch submerged in oil or water or in locations continuously subject to splashes of oil or water. Doing so may result in oil or water entering the switch.
- Do not use the switch in locations where explosive or flammable gasses may be present.
- Mount the switch securely to prevent it from falling. Otherwise, injuries may occur.
- The durability of the switch is greatly influenced by the switching conditions. Always test the switch under actual conditions before application and use it in a switching circuit for which there are no problems with performance.
- Always attach the cover after completing wiring and before using the switch. Electric shock may occur if the switch is used without the cover attached.
- The user must not maintain or repair equipment incorporating the switch. Contact the manufacturer of the equipment for any maintenance or repairs required.
- Do not disassemble or remodel the switch in any case, or the switch will not operate normally.
- Do not override by inserting the Holding Key itself in the door switch.
- Configure the circuit so that the machine does not operate when operating the Enabling Switch while the Holding Key is being inserted in the door switch.
- Do not impose excessive vibration or shock on the Door Switch while the Holding Key is inserted. Excessive vibration or shock may cause the Switch to fail or break.
- Do not incline and pull the switch body or do not impose shock on the switch body in the directions shown with the arrows in Fig.1. Otherwise, the switch may be damaged and may not operate properly.
- Refer to the *D4NS Safety-door Switch Datasheet* and *Instruction Sheet* about the storage, ambient conditions, the details and handling of the Switch.

Fig. 1



Precautions for Correct Use

- Do not hold the Enabling Switch Device at Position 2 by any other methods except for handling. Otherwise, the original function of the Enabling Switch Device is not worked.

Operating Environment

- This switch is designed for use indoors. Using the switch outdoors may damage it.
- The switch contacts can be used with either standard loads or microloads. Once the contact be used to switch smaller loads. The contact surfaces will become rough once they have been used and contact reliability for smaller loads may be reduced.
- Do not use the switch in the following locations.
  - Locations where the interior of the Protective Door may into direct contact with cutting chips, metal filings, oil chemicals
  - Locations subject to detergents, thinners, or other solvents
  - Locations subject to sudden temperature changes
  - Locations subject to high humidity and condensation
  - Locations subject to severe vibration
- Do not use the switch where corrosive gasses (e.g.,H_2S, SO_2, NH_3,HNO_3, or Cl_2) are present or in locations subject to high temperature and humidity. Doing so may result in damage to the switch as a result of contact failure or corrosion.
- Do not store the switch where corrosive gasses (e.g.,H_2S, SO_2, NH_3,HNO_3, or Cl_2) or dust are present or in high temperature and humidity.
- If the switch is not turned ON and OFF for a long period of time, contact resistance may be increased or continuity failure may occur due to contact oxidation.

Mounting Method

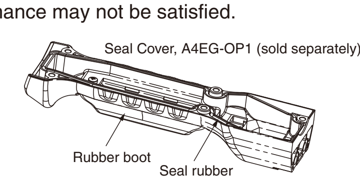
Specified Tightening Torque

Loose screws may result in malfunction. Tighten the screws at the specified torques.

Item	Specified torque
Cover mounting screw	1.1 to 1.3 N·m
Terminal screw	0.4 to 0.5 N·m
Holding Key mounting screw	0.5 to 0.7 N·m
Conduit Connector mounting (Conforming spanner 27 mm (width across flats))	2.0 to 2.4 N·m
Mounting Bracket	2.4 to 2.8 N·m

Cover Mounting

- Dislocation of the seal rubber or foreign substance on the seal rubber reduces seal performance of the switch. Mount the cover after confirming that there is no abnormality on the seal rubber. If the seal rubber cracks or breaks, replace the Cover with a new one (A4EG-OP1 Rubber Cover, separately sold).
- Do not touch the rubber boot with sharp objects. Otherwise, the rubber boot may break and the operating characteristics and the seal performance may not be satisfied.

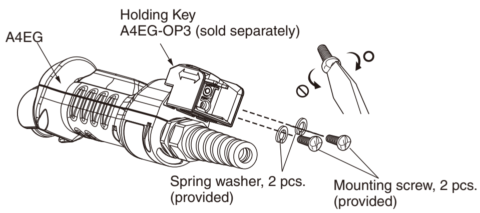


Installing Mounting Bracket

- Securely install the Mounting Bracket using M5 screws and washers and tighten them to a torque of 2.4 to 2.8 N·m.

Holding Key Type (sold separately)

- Use the A4EG-OP3 Holding Key when using the A4EG combining with the door switch.
- Use the D4NS Safety-door Switch.
- Loose screws may result in malfunction. Tighten the screws at the specified torques. Adhesive is recommended to prevent screws from being loose.
  The specified torque: 0.5 to 0.7 N·m (Mounting screw, 2pcs.)
- Do not impose excessive force on the tip of the Holding Key or do not drop the switch body when the Holding Key is mounted on the switch body. Otherwise the Holding Key may deform or break. Stop using in case that deformation or breakage of the Holding Key occurs.
- Use the provide Spring washers and Mounting screws when mounting the Holding Key. Fit a tip of a slotted-screw driver on the head of the Mounting screw as shown in the following figure when tightening Mounting screws. The Mounting screws cannot be released once tightened.



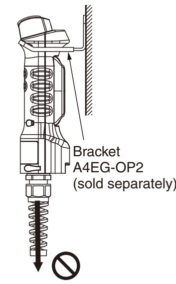
- As shown in figure 1 in *Precautions for Safe Use*, install the D4NS so that its mounting surface is above the highest part of the A4EG.
- As shown in figure 1 in the *Precautions for Safe Use*, use the Holding Key inserted vertically to the insert hole.

Using the A4EG-BE2R041 (Enabling Grip Switch Equipped with an Emergency Stop Button)

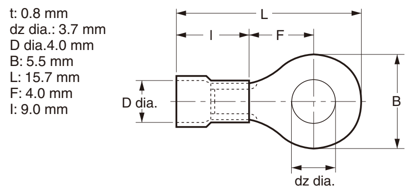
If the A4EG is installed in a machine, do not use the A4EG alone as an emergency stop switch or as an emergency shutoff switch as specified by SEMI-S2.
SEMI-S2 specifies the installation of emergency shutoff switches at specified intervals on equipment. The A4EG can be removed from the equipment, and so may not satisfy the requirements of SEMI. Use the A4EG in combination with emergency stop switches or emergency shutoff switches that are installed at fixed positions.

Wiring

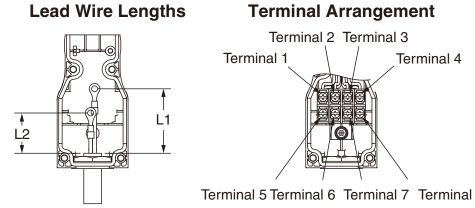
- Confirm that safety is satisfied on the operation of the equipment to wire.
- Do not put the electric power when wiring. Otherwise electric shock may occur.
- Use an adequate diameter of cable. The seal performance is reduced when the diameter is smaller than the adequate diameter.
- Use the conforming sizes of lead wires to the apply voltage and current.
  Conforming cable size
  Recommended multi-wire cable size: AWG20 to 18 (0.5 to 0.75 mm^2)
  Recommended cable diameter: 8.0 to 13 mm (used with provided Conduit Connector)
- Do not pull the lead wires with excessive force. Doing so may disconnect them.
- Do not pull the cable when the Enabling Switch Device is hung on the Bracket.



- Use crimp terminals with insulator tube for wiring.
  Recommended crimp terminal (Ring tongue terminal, Nylon-insulated): J.S.T. Mfg Co. FN1.25-3.7 (F Type)/ N1.25-3.7 (Straight Type)



- Cut and crimp the lead wires in length as shown in the following table.
  Otherwise, excess length may cause the cover to rise and not fit properly.



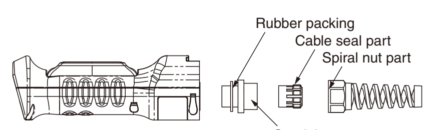
Length of lead wires Terminal No.	1-4	5-8
L1/L2 (Length to the centers of crimp terminals)	40±2 mm	25±2 mm

- Do not let particles such as small piece of lead wire in the switch body when wiring.

Terminal No. and Circuit Configuration

Model	Circuit	Terminal No.
A4EG-C000041	Enable output	1-2, 3-4
	Grip output	5-6
A4EG-BE2R041	Enable output	1-2, 3-4
	Emergency Stop Pushbutton Switch output	5-6, 7-8
A4EG-BM2B041	Enable output	1-2, 3-4
	Pushbutton Switch output	5-6, 7-8

- Assemble all of the parts without leaving any parts as shown in the following figure when mounting Conduit Connector.
  Mount Rubber packing, Conduit part, Cable Seal part and Spiral Nut part in order.



- Both of the switches is ON when pushing the two push buttons simultaneously. Confirm that safety is satisfied on the operation of the equipment to wire. (A4EG-BM2B041)
- Perform maintenance inspections periodically.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.2

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Emergency Stop Switch (22-dia./25-dia.)

A22E

Install in 22-dia. or 25-dia. Panel Cutout

- Direct opening mechanism to open the circuit when the contact welds ⊖.
- Safety lock mechanism prevents operating errors.
- Easy mounting and removal of Switch Blocks using a lever.
- Mount three Switch Units in series to improve wiring efficiency (with non-lighted Switch Units, three Units can be mounted for multiple contacts).
- Finger protection mechanism on Switch Unit provided as a standard feature.
- Install using either round, or forked crimp terminals.
- Oil-resistant to IP65 (non-lighted models)/IP65 (lighted models)

⚠ Be sure to read the precautions for all pushbutton switches in the *Pushbutton Switches Group Catalog* (Cat. No. X032), as well as the *"Safety Precautions"* on page 16.

Model Number Structure

Model Number Legend (Completely Assembled)

........Shipped as a set which includes the Operation Unit, Lamp (lighted models only), and Switch.

1 2 3 4 5

A22E L - M - 24A - 01 - □

1. Lighted/Non-lighted

Code	Description
None	Non-lighted
L	Lighted *

* Lighted Emergency Stop Switches are available only for the medium (M). push-lock turn-reset models.

2. Head Size

Code	Size	Description
MP	Medium 40 dia.	Push-pull
LP	Large 60 dia.	Push-pull
S	Small 30 dia.	Push-lock turn-reset
M	Medium 40 dia.	Push-lock turn-reset
L	Large 60 dia.	Push-lock turn-reset
SK	Small 30 dia.	Push-lock key reset
MK	Medium 40 dia.	Push-lock key reset

3. Light Source

Without Voltage Reduction Unit

Code	Description	Operating Voltage
None	Non-lighted	---
6D	LED	6 VDC
6A	LED	6 VAC
12A	LED	12 VAC/VDC
24A	LED	24 VAC/VDC

With Voltage Reduction Unit

Code	Description	Operating Voltage
T1	LED	100 VAC
T2	LED	200 VAC

Equipped with 24-VAC/DC LED.

4. Contacts

Code	Description
01	SPST-NC
11	SPST-NO + SPST-NC
02	DPST-NC
12	DPST-NC + SPST-NO
03	TPST-NC

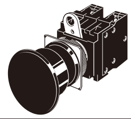
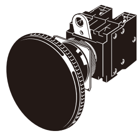
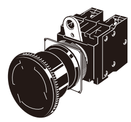
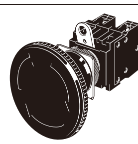
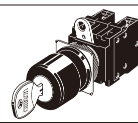
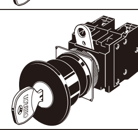
5. Configuration

Code	Configuration
None	Switch only
B	Switch with Integrated Control Box

Ordering Information

List of Models (Completely Assembled)

Non-lighted Models

Operating			Set Model	Color of cap
Appearance		Contact Configuration		
40-dia. head Medium Push-pull A22E-MP		SPST-NC	**A22E-MP-01**	Red
		SPST-NO/SPST-NC	**A22E-MP-11**	
		DPST-NC	**A22E-MP-02**	
60-dia. head Large Push-pull A22E-LP		SPST-NC	**A22E-LP-01**	
		SPST-NO/SPST-NC	**A22E-LP-11**	
		DPST-NC	**A22E-LP-02**	
30-dia. head Small Push-lock Turn-reset A22E-S		SPST-NC	**A22E-S-01**	
		SPST-NO/SPST-NC	**A22E-S-11**	
		DPST-NC	**A22E-S-02**	
		DPST-NC + SPST-NO	**A22E-S12 ***	
		TPST-NC	**A22E-S-03 ***	
40-dia. head Medium Push-lock Turn-reset A22E-M		SPST-NC	**A22E-M-01**	
		SPST-NO/SPST-NC	**A22E-M-11**	
		DPST-NC	**A22E-M-02**	
		DPST-NC + SPST-NO	**A22E-M-12 ***	
		TPST-NC	**A22E-M-03 ***	
60-dia. head Large Push-lock Turn-reset A22E-L		SPST-NC	**A22E-L-01**	
		SPST-NO/SPST-NC	**A22E-L-11**	
		DPST-NC	**A22E-L-02**	
30-dia. head Small Push-lock Key-reset A22E-SK		SPST-NC	**A22E-SK-01**	
		SPST-NO/SPST-NC	**A22E-SK-11**	
		DPST-NC	**A22E-SK-02**	
40-dia. head Medium Push-lock Key-reset A22E-MK		SPST-NC	**A22E-MK-01**	
		SPST-NO/SPST-NC	**A22E-MK-11**	
		DPST-NC	**A22E-MK-02**	

* Models with Korean S-mark certification.

Lighted Models

Appearance	Operating			Push-lock turn-reset system	Color of cap
	Contact configuration	Lighting	Rated voltage	Set Model	
40-dia. head Push-lock Turn-reset without Voltage Reduction Unit A22E 	SPST-NC	LED	6 VDC	**A22EL-M-6D-01**	Red
			6 VAC	**A22EL-M-6A-01**	
			12 VAC/VDC	**A22EL-M-12A-01**	
			24 VAC/VDC	**A22EL-M-24A-01**	
	SPST-NO/SPST-NC		6 VDC	**A22EL-M-6D-11**	
			6 VAC	**A22EL-M-6A-11**	
			12 VAC/VDC	**A22EL-M-12A-11**	
			24 VAC/VDC	**A22EL-M-24A-11**	
	DPST-NC		6 VDC	**A22EL-M-6D-02**	
			6 VAC	**A22EL-M-6A-02**	
			12 VAC/VDC	**A22EL-M-12A-02**	
			24 VAC/VDC	**A22EL-M-24A-02**	
40-dia. head Push-lock Turn-reset with Voltage Reduction Unit A22E 	SPST-NC		100 VAC	**A22EL-M-T1-01**	
			200 VAC	**A22EL-M-T2-01**	
	SPST-NO/SPST-NC		100 VAC	**A22EL-M-T1-11**	
			200 VAC	**A22EL-M-T2-11**	
	DPST-NC		100 VAC	**A22EL-M-T1-02**	
			200 VAC	**A22EL-M-T2-02**	

Switch with Integrated Control Box

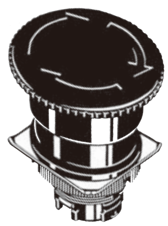
Appearance	Contact configuration	Model
	SPST-NC	**A22E-M-01B**
	SPST-NO/SPST-NC	**A22E-M-11B**
	DPST-NC	**A22E-M-02B**

Subassembled

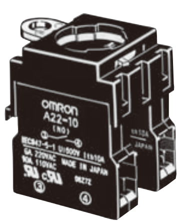
The Operation Unit, Lamp, or Switch can be ordered separately. Use them in combination for models that are not available as assembled Units. These can also be used as inventory for maintenance parts.

Non-lighted

Operation Unit

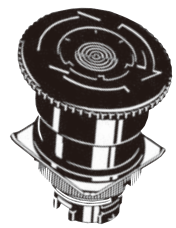


Switch *



Lighted (without Voltage Reduction Unit)

Operation Unit

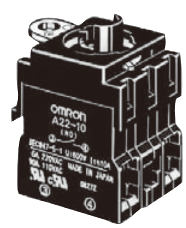


Lamp

Incandescent

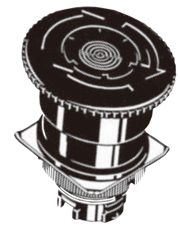
LED

Switch (without Voltage Reduction Unit)



Lighted (with Voltage Reduction Unit)

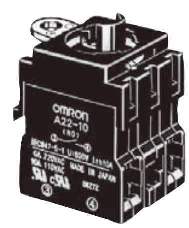
Operation Unit



Lamp

LED

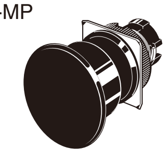
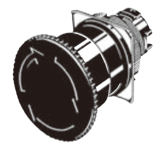
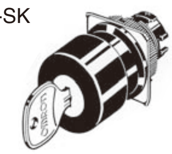
Switch (with Voltage Reduction Unit)



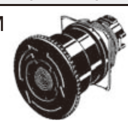
* Up to three Switch Units can be mounted for multiple contacts.

Operation Units

Non-lighted

Sealing capability / Function / Size	IP65 oil-resistant models		
	Small (30 dia.)	Medium (40 dia.)	Large (60 dia.)
Push-pull	---	A22E-MP 	A22E-LP 
Push-lock, turn-reset	A22E-S 	A22E-M 	A22E-L 
Push-lock, key-reset (push-lock, turn-reset)	A22E-SK 	A22E-MK 	---

Lighted

Sealing capability / Function / Size	IP65
	Medium (40 dia.)
Push-lock, turn-reset	A22EL-M 

Lamp

LED

Appearance	LED light		Rated voltage	Model
	Red	Standard	6 VDC	**A22-6DR**
			6 VAC	**A22-6AR**
			12 VAC/VDC	**A22-12AR**
			24 VAC/VDC	**A22-24AR**
		Bright	24 VAC/VDC	**A22-24ASR**

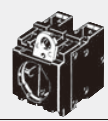
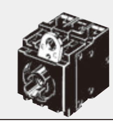
Note: For voltage-reduction lighting, use the A22-24AR.

Incandescent

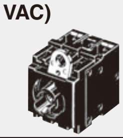
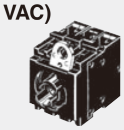
Appearance	Rated voltage	Model
	6 VDC	**A22-5**
	14 VAC	**A22-12**
	28 VAC	**A22-24**
	130 VAC	**A22-H1**

Switch (Standard Load)

Without Voltage Reduction Unit

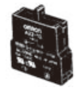
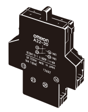
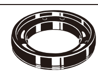
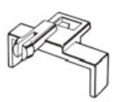
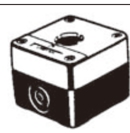
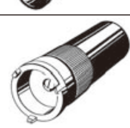
	Classification / Appearance	Non-lighted 	Lighted 
	Switch Action	Momentary	Momentary
Contacts		Model	Model
For standard loads	SPST-NC	A22-01M	A22L-01M
	SPST-NO + SPST-NC	A22-11M	A22L-11M
	DPST-NC	A22-02M	A22L-02M

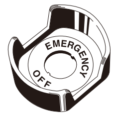
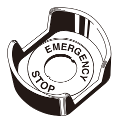
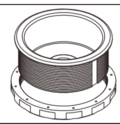
With Voltage Reduction Unit

	Classification / Appearance	Lighted (110 VAC) 	Lighted (220 VAC) 
	Switch Action	Momentary	Momentary
Contacts		Model	Model
For standard loads	SPST-NC	A22L-01M-T1	A22L-01M-T2
	SPST-NO + SPST-NC	A22L-11M-T1	A22L-11M-T2
	DPST-NC	A22L-02M-T1	A22L-02M-T2

Note: When using with a Voltage Reduction Unit, use the A22-24AR.

Accessories (Order Separately)

Item	Appearance	Classification		Model	Remarks
Switch Blocks		SPST-NO		**A22-10**	Provided as standard. Order Switch Blocks only when adding or replacing them.
		SPST-NC		**A22-01**	
		DPST-NO, one-piece		**A22-20**	
		DPST-NC, one-piece		**A22-02**	
Lamp Sockets		Direct lighting		**A22-TN**	Used when changing the lighting method.
		Voltage-reduction lighting	100 VAC	**A22-T1**	
			200 VAC	**A22-T2**	
Mounting Latches		---		**A22-3200**	Provided as standard. Order Mounting Latches only when mounting Switch Blocks or Lamp Sockets that are purchased individually.
Legend Plates for Emergency Stop		60-dia. black letters on yellow back-ground		**A22Z-3466-1**	"EMERGENCY STOP" is indicated on the plate.
		90-dia. black letters on yellow back-ground		**A22Z-3476-1**	
		60-dia. black letters on yellow back-ground		**A22Z-3466-2**	"EMERGENCY OFF" is indicated on the plate.
Hole Plug		Round		**A22Z-3530**	Can be plugged into pre-cut panel holes for future expansion. The color is black.
Connectors		Applicable cable diameter	7 to 9 dia.	**A22Z-3500-1**	Plastic connector used to extend a cable from the Switch Box.
			9 to 11 dia.	**A22Z-3500-2**	
25-dia. Ring		---		**A22Z-R25**	Can be fit into a 25-dia. hole in the panel. Since this is not attached to the main body, order separately. (Refer to page 14.)
30-dia. Resin Attachment		---		**A22Z-A30**	Can be fit into a 30-dia. hole in the panel. (Refer to page 14.)
Lock Plate		---		**A22Z-3380**	Use to fix the lever on the Switch.
Control Boxes (Enclosures)		One hole, yellow box (for emergency stop)		**A22Z-B101Y**	Material: Polycarbonate resin
Operation Keys		---		**A22K-K**	Two keys are provided.
Lock Ring		Rounded shape		**A22Z-3360**	The body is equipped with a Lock Fitting. This Lock Fitting is used when a more secure lock feature is required. (Refer to page 14.)
Lamp Extractor		---		**A22Z-3901**	Rubber tool used to replace Lamps easily
Tightening Tool		---		**A22Z-3905**	Tool used to tighten nuts from the back of the panel and to attach caps to lighted models.

Item	Appearance	Classification	Model	Remarks
E-stop Shroud for EMO, Yellow		---	**A22Z-EG1**	Provides SEMI-S2/SEMATECH Application Guide for SEMI-S2 compatibility. The SEMI-S2-compatible Shroud and legend plate for EMERGENCY OFF come as a set. Use with an A22E Emergency Stop Switch.
E-stop Shroud for EMS, White		---	**A22Z-EG1-W**	Provides SEMI-S2/SEMATECH Application Guide for SEMI-S2 compatibility. The SEMI-S2-compatible Shroud and legend plate for EMERGENCY STOP come as a set. Use with an A22E Emergency Stop Switch.
E-stop Shroud		---	**A22Z-EG2**	SEMI-S2/SEMATECH Application Guide for SEMI S2-compatible Shroud. Use together with an A22E Emergency Stop Switch.

Specifications

Certified Standard Ratings

- UL, cUL (File No.E41515)
  6A at 220 VAC, 10 A at 110 VAC
- TÜV (EN60947-5-1) (Low Voltage Directive)
  3 A at 220 VAC
- CCC (GB14048.5)
  3 A at 240 VAC, 1.5 A at 24 VDC

Certified Standards

Certification body	Standards	File No.
UL *1	UL508	E41515
TÜV Product Service	EN60947-5-1, EN60947-5-5 (certified direct opening mechanism)	Inquire
CQC (CCC)	GB14048.5	2003010303070635
KOSHA *2	EN60947-5-1	2007-27

Note: Only models with NC contacts have a direct opening mechanism.
*1. UL-certification for CSA C22.2 No. 14 and bears the cULus mark.
*2. Some models have been certified. Contact your OMRON sales representative.

Ratings

Contacts (Standard Load)

<table>
<tr><th rowspan="2">Rated carry current (A)</th><th rowspan="2">Rated voltage (V)</th><th colspan="4">Rated current (A)</th></tr>
<tr><th>AC15 (inductive load)</th><th>AC12 (resistive load)</th><th>DC13 (inductive load)</th><th>DC12 (resistive load)</th></tr>
<tr><td rowspan="9">10</td><td>24 VAC</td><td>10</td><td>10</td><td rowspan="5">---</td><td rowspan="5">---</td></tr>
<tr><td>110 VAC</td><td>5</td><td>10</td></tr>
<tr><td>220 VAC</td><td>3</td><td>6</td></tr>
<tr><td>380 VAC</td><td>2</td><td>3</td></tr>
<tr><td>440 VAC</td><td>1</td><td>2</td></tr>
<tr><td>24 VDC</td><td rowspan="4">---</td><td rowspan="4">---</td><td>1.5</td><td>10</td></tr>
<tr><td>110 VDC</td><td>0.5</td><td>2</td></tr>
<tr><td>220 VDC</td><td>0.2</td><td>0.6</td></tr>
<tr><td>380 VDC</td><td>0.1</td><td>0.2</td></tr>
</table>

Note: 1. Rated current values are determined according to the testing conditions. The above ratings were obtained by conducting tests under the following conditions.
(1) Ambient temperature: 20°±2°C
(2) Ambient humidity: 65±5%
(3) Operating frequency: 20 operations/minute

2. Minimum applicable load: 10 mA at 5 VDC

LED Indicators without Voltage Reduction Unit

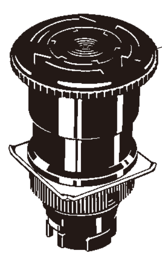
Rated voltage	Rated current	Operating voltage
6 VDC	60 mA	6 VDC±5%
6 VAC	60 mA	6 VAC±5%
12 VAC/VDC	30 mA	12 VAC/VDC±5%
24 VAC/VDC	15 mA	24 VAC/VDC±5%

Characteristics

Item		Type: Emergency Stop Switches — Non-lighted model: A22E	Lighted model: A22EL
Allowable operating frequency	Mechanical	30 operations/minute *3	
	Electrical	30 operations/minute *3	
Insulation resistance		100 MΩ min. (at 500 VDC)	
Dielectric strength	Between terminals of same polarity	2,500 VAC, 50/60 Hz for 1 min	
	Between each terminal and ground	2,500 VAC, 50/60 Hz for 1 min	
Vibration resistance *2		10 to 55 Hz, 1.5-mm double amplitude (within 1 ms)	
Shock resistance	Destruction	1,000 m/s^2	
	Malfunction *2	250 m/s^2 max.	
Durability	Mechanical	300,000 operations min. *3	
	Electrical	300,000 operations min. *3	
Ambient operating temperature *1		−20 to 70°C	−20 to 55°C
Ambient operating humidity		35% to 85%	
Ambient storage temperature		−40 to 70°C	
Degree of protection		IP65 (oil-resistant) *4	IP65 *4
Electric shock protection class		Class II	
PTI (tracking characteristic)		175	
Degree of contamination		3 (EN60947-5-1)	

*1. With no icing or condensation.
*2. Malfunction within 1 ms.
*3. Setting and resetting once is counted as one operation.
*4. The degree of protection from the front of the panel.

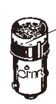
Structure and Nomenclature



Operation Unit

Color: Red

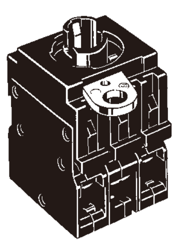
Non-lighted
Lighted



Lamp

Light source

- LED Lamp
- Incandescent Lamp



Switch

Contact Ratings

10 A at 110 VAC (resistive load)
10 A at 24 VDC (resistive load)

Lighting Method

Non-lighted
Lighted (without Voltage Reduction Unit)
Lighted (with Voltage Reduction Unit)

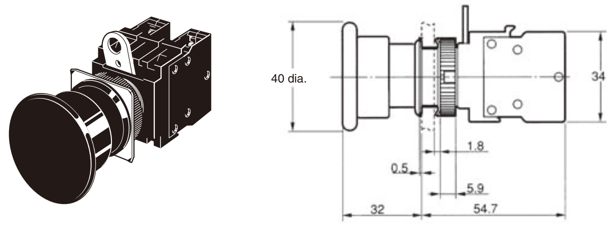
(The above figures are examples of the lighted model.)

Dimensions

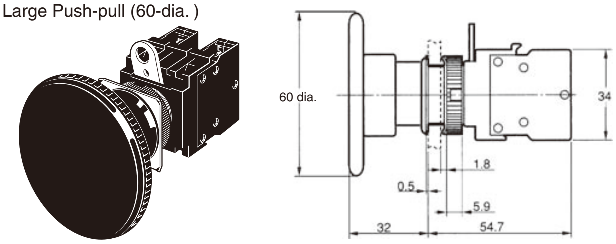
(Unit: mm)

Non-lighted Models

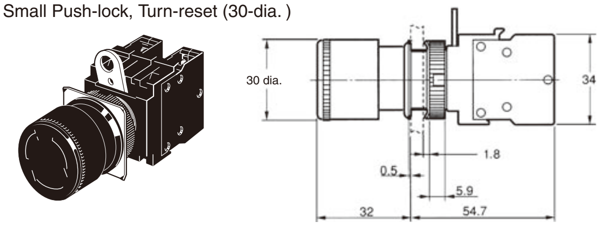
A22E-MP
Medium Push-pull (40-dia.)



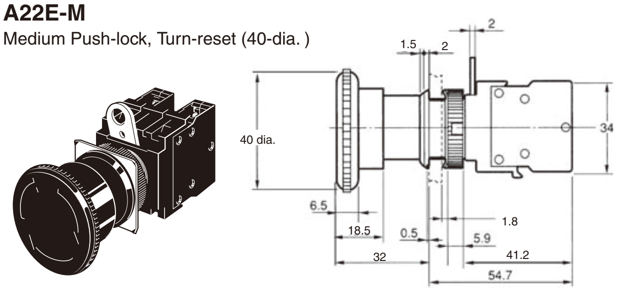
A22E-LP
Large Push-pull (60-dia.)



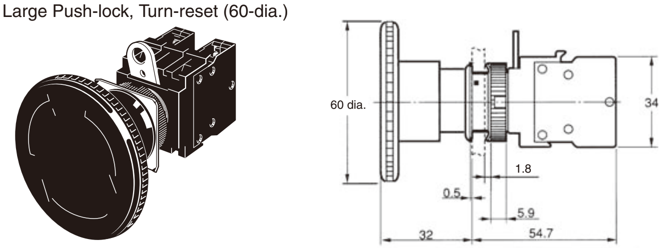
A22E-S
Small Push-lock, Turn-reset (30-dia.)



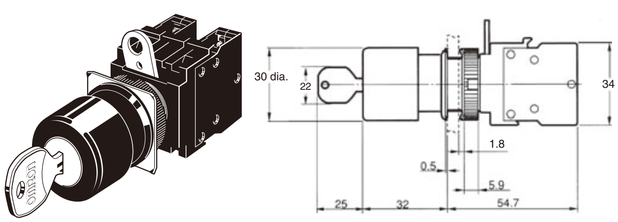
A22E-M
Medium Push-lock, Turn-reset (40-dia.)



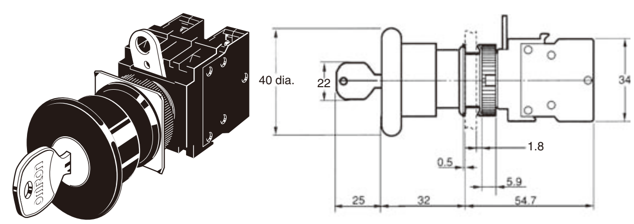
A22E-L
Large Push-lock, Turn-reset (60-dia.)



A22E-SK
Small Push-lock, Key-reset (30-dia.)

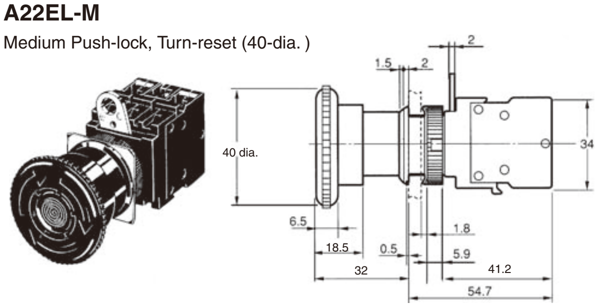


A22E-MK
Medium Push-lock, Key-reset (40-dia.)

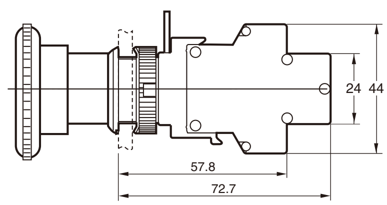


Lighted Models

A22EL-M
Medium Push-lock, Turn-reset (40-dia.)



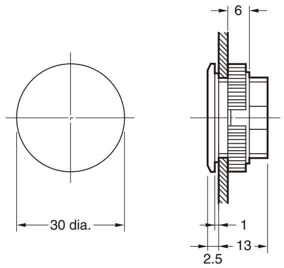
Switch dimensions when mounted to a DPST-NO (or DPST-NC) one-piece Switch Block



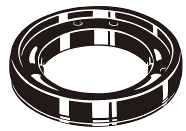
Note: The operation unit is an example for the A22E-M.

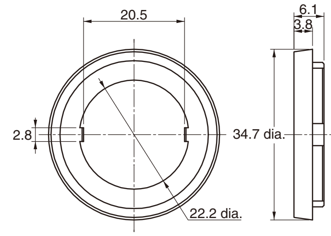
Dimensions for Accessories

Hole Plug
Round A22Z-3530

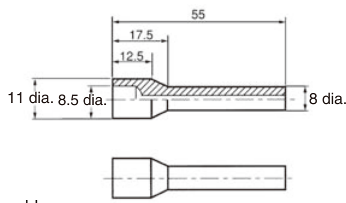


30-dia. Resin Attachment
A22Z-A30



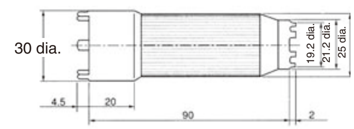


Lamp Extractor
A22Z-3901



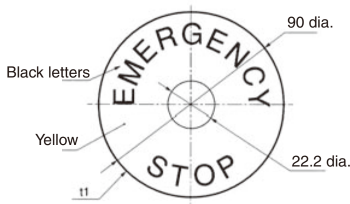
Material: Chloroprene rubber

Tightening Tool
A22Z-3905

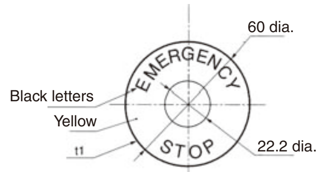


Legend Plates for Emergency Stop

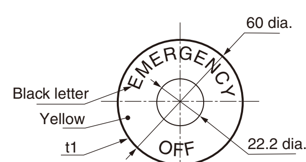
A22Z-3476-1 (90 dia.)



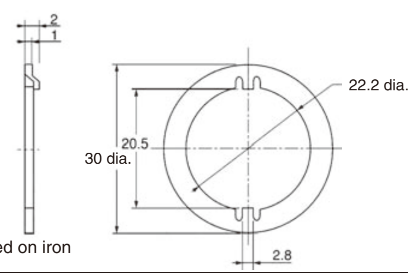
A22Z-3466-1 (60 dia.)



A22Z-3466-2 (60 dia.)

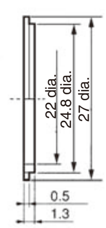


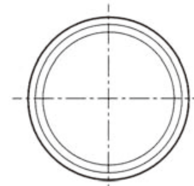
Lock Ring
A22Z-3360



Material: Nickel plated on iron

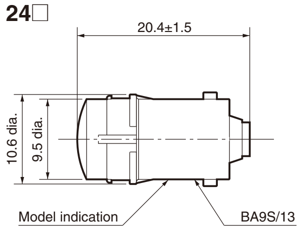
25-dia. Ring
A22Z-R25



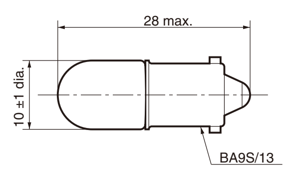


Material: NBR (black)

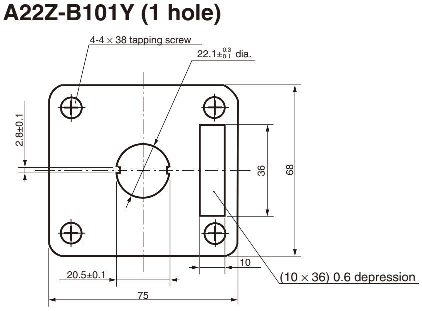
Lamp
LED A22-6□, 12□, 24□

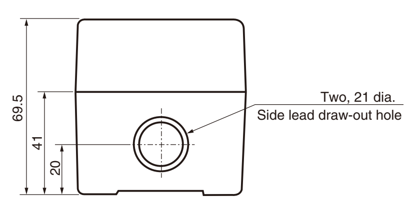


Incandescent Lamp A22-5, 12, 24, H1

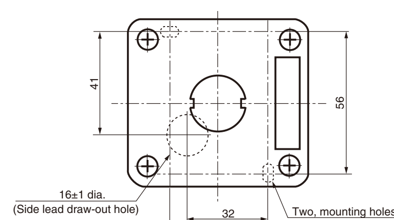


Control Box
A22Z-B101Y (1 hole)



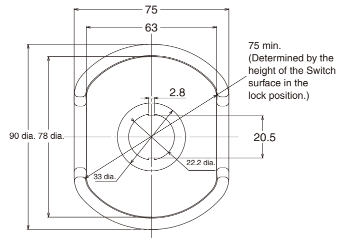


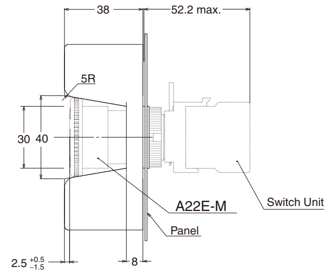
Cable Draw-out Hole (Top View)

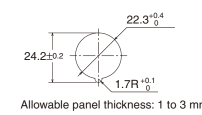


E-stop Shroud

A22Z-EG1, A22Z-EG1-W



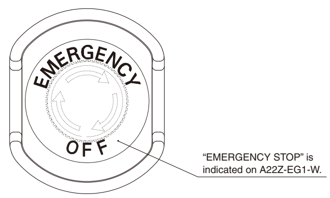


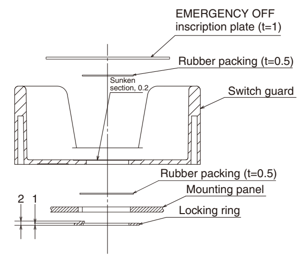


Note: 1. The dimensions of the Shroud conform to the specifications of the SEMATECH Application Guide for SEMI S2-93.

2. The Shroud is not provided with the Switch.

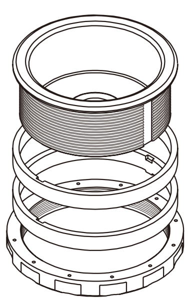
3. These Shrouds are designed for use only in semiconductor manufacturing equipment. Do not use them for any other application.

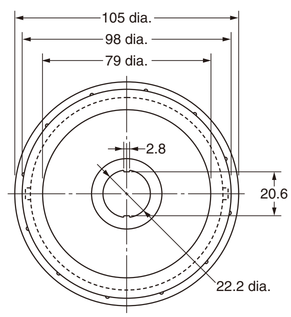


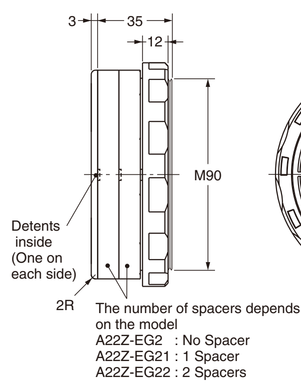


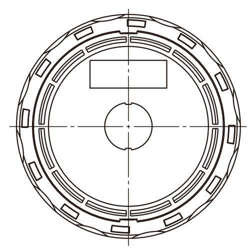
E-stop Shroud

A22Z-EG2, A22Z-EG21, A22Z-EG22

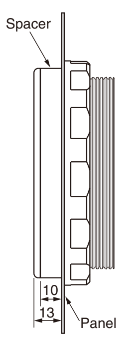


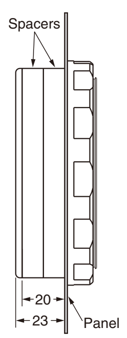


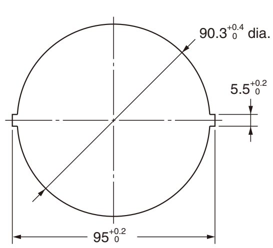


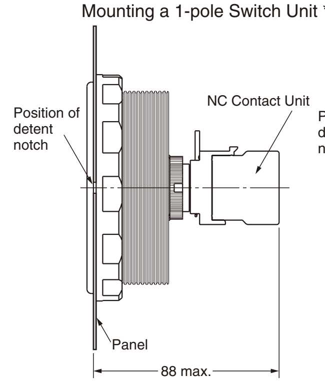


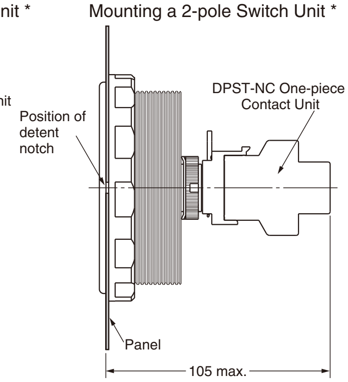
· Mounting with Spacers











Note: 1. The dimensions of the Shroud conform to the specifications of the *SEMATECH Application Guide for SEMI S2-93*.

2. The Shroud is not provided with the Switch.

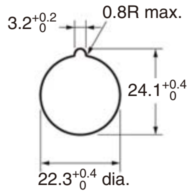
3. These Shrouds are designed for use only in semiconductor manufacturing equipment. Do not use them for any other application.

4. Tighten to a torque of 1.96 to 2.94 N·m.

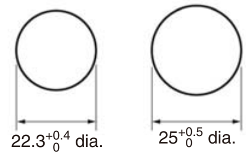
5. The allowable panel thicknesses are as follows:
Without Spacers: t=1.3 to 22.5 mm
With 1 Spacer: t=1.3 to 12.5 mm
With 2 Spacers: t=1.3 to 2.5 mm

* These are the dimension from the front of the panel when the Switch Unit is attached.

Panel Cutouts



With Lock Fitting

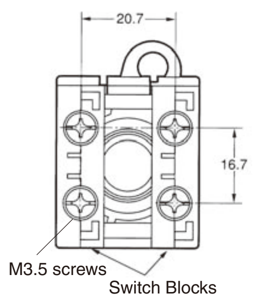
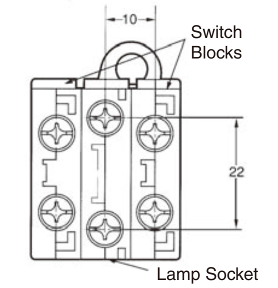


Without Lock Fitting

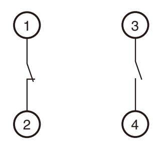
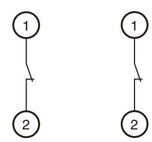
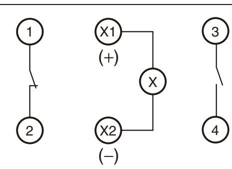
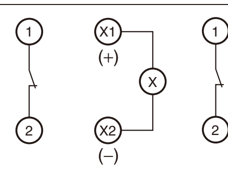
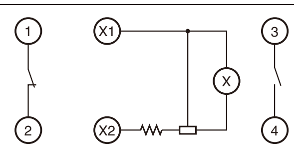
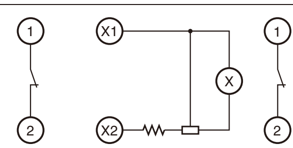
A Lock Ring is provided as a standard feature.

- When painting or coating the panel, make sure that the specified panel dimensions apply to the panel after painting or coating.
- Use an A22Z-R25 Ring when mounting to a panel with a 25-mm diameter hole.

Terminal Arrangement (Bottom View)

Non-lighted	Lighted
	

Terminal Connection

Type	Terminal connection (BOTTOM VIEW)	
	SPST-NO + SPST-NC	DPST-NC
Non-lighted		
Lighted without Voltage Reduction Unit		
Lighted with Voltage Reduction Unit		

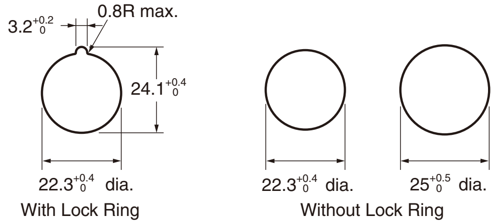
Note: The above terminal connection diagrams are examples for SPST-NO + SPST-NC and DPST-NC.

Installation

Mounting to the Panel

(1) Preparing the Panel

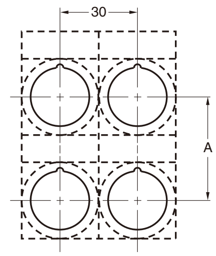
- The panel dimensions are shown below.
- The panel thickness must be 1 to 5 mm.



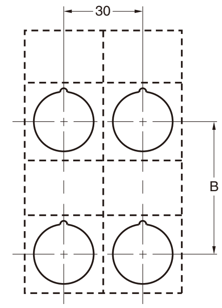
- Always use a 25-mm-dia. Lock Ring for a 25-mm-dia. hole.
  IP65 degree of protection will be lost if the 25-mm-dia. Lock Ring is not used because of the larger size of a 25-mm-dia. hole.
- When painting or coating the panel, make sure that the specified panel dimensions apply to the panel after painting or coating.

(2) Matrix Mounting

1. The following diagram provides the dimensions for mounting individual Switches, Legend Plates, and Lock Rings with leads connected directly to Switch terminals.



2. The following diagram provides the dimensions for mounting Large Legend Plates with crimp terminals connected to Switch terminals.



Dimensions A and B between mounting hole centers are given in the following tables.

For 1., Above

Switch model	Dimension A
A22-10, A22-10S, A22-01, A22-01S	45 mm min.
A22-20, A22-20S, A-22-02, A22-02S, A22-11, A22-11S	55 mm min.

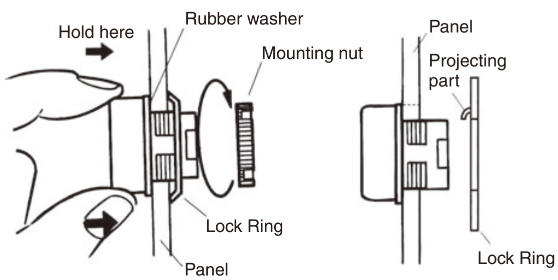
For 2., Above

Type of crimp terminal	Switch model	Dimension B
Naked crimp terminals	A22-10, A22-10S, A22-01, A22-01S	51 mm min.
	A22-20, A22-20S, A22-02, A22-02S, A22-11, A22-11S	61 mm min.
Crimp terminals with insulating sheaths	A22-10, A22-10S, A22-01, A22-01S	60 mm min.
	A22-20, A22-20S, A22-02, A22-02S, A22-11, A22-11S	70 mm min.

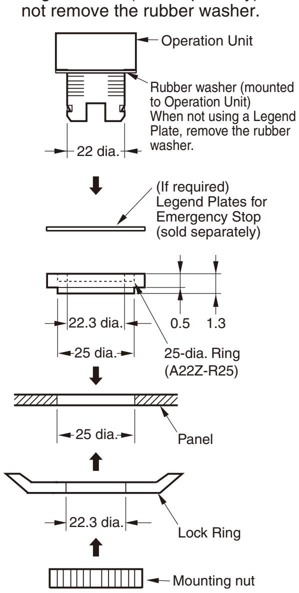
Note: 1. The above dimensions are the minimum dimensions when using the applicable wiring materials listed on page 17. If any other materials are used, check the suitability of dimensions in advance.
2. When using pushbuttons exceeding 30 mm, adjust dimension A or B accordingly. (When mounting the A22-M□ in a matrix, "30 mm" would have to be increased to 40 mm.

(3) Mounting the Operation Unit on the Panel

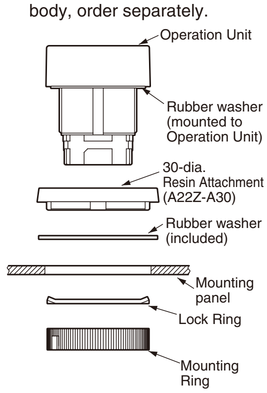
- Insert the Operation Unit from the front surface of the panel, insert the Lock Ring and the mounting nut from the terminal side, then tighten the nut. Before tightening, check that the rubber washer is present between the Operation Unit and the panel.
- When using a Legend Plate Frame, put one rubber washer each between the Legend Plate Frame and the panel and between the Operation Unit and the Legend Plate Frame. (One rubber washer will be provided when one Legend Plate Frame is ordered.)
- Align the Lock Ring with the groove in the casing, then insert the Lock Ring so that its edge is located on the panel side.
- Tighten the mounting nut at a torque of 0.98 to 1.96 N·m.
- When using a Lock Ring, replace with the supplied Lock Ring, insert the projecting part into the lock slot, and then tighten the mounting nut.



1. When the panel cutout dimension is 25 dia., remove the supplied rubber washer and mount the 25-dia. Ring as shown below. (Since the A22Z-R25 is not attached to the main body, order separately.) When using a Legend Plate (sold separately), do not remove the rubber washer.

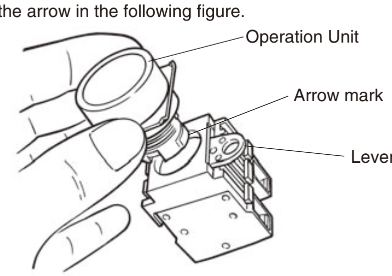


2. When the panel cutout dimension is 30 dia., use resin attachment A22Z-A30. Since it is not attached to the main body, order separately.



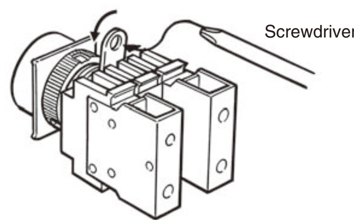
(4) Mounting the Switch on the Operation Unit

- Insert the Operation Unit into the Switch Unit, aligning the arrow mark inscribed on the Case with the lever on the Switch Blocks, then move the lever in the direction indicated by the arrow in the following figure.



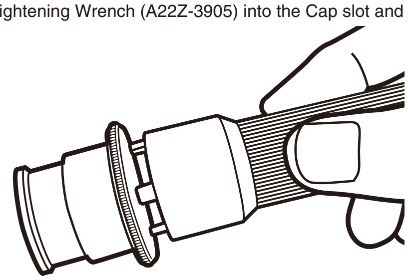
(5) Removing the Switch

- Move the lever in the direction indicated by the arrow in the following figure, then pull the Operation Unit or the Switch Blocks.
  Since the lever has a hole with an inside diameter of 6.5 mm, the lever can be moved in the specified direction by inserting a screwdriver into the hole and then moving the screwdriver.



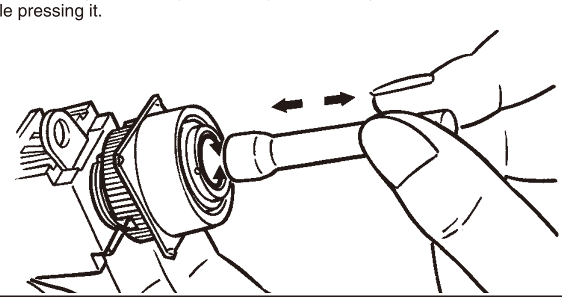
Assembling the Cap

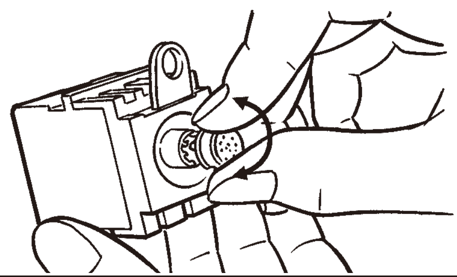
Emergency Stop Switch
• Insert the protrusion of the Tightening Wrench (A22Z-3905) into the Cap slot and then turn to remove the Cap.



Installing/Replacing the Lamp

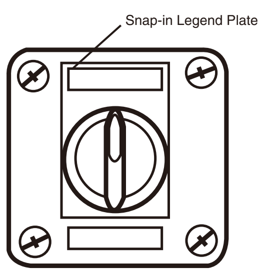
(1) Installing/Replacing from the Panel Surface	(2) Installing/Replacing on the Switch
• Insert the Lamp Extractor (A22Z-3901) into the lamp, then rotate the Extractor while pressing it.	• Grip the indicator with your fingers, then rotate the indicator while pressing it against the Switch.

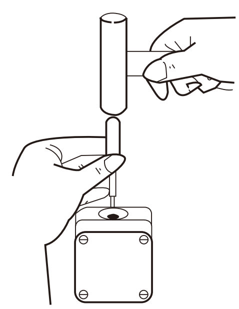


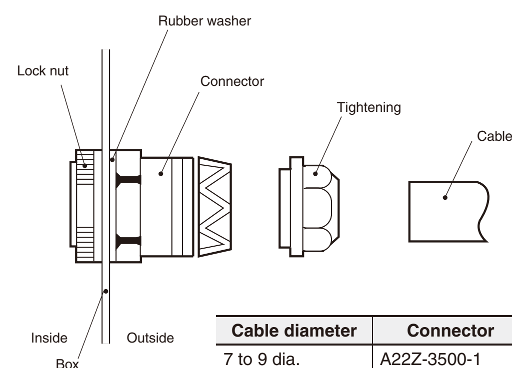


Control Box (Enclosure)

(1) Mounting the Switch	(2) Creating a Cable Port Hole	(3) Securing the Connector Cable
The Standard-size Legend Plate Frame can be mounted. Mount the Frame as shown in the following diagram. Mount the Switch in the same way as for an ordinary panel.	Place the tip of a screwdriver on the surface where the cable port hole is to be created with the cover attached and strike the screwdriver to punch a hole. Attempts to punch a hole on the other side of the case will damage the Box.	**1.** Insert the connector into the cable port hole in the Box and secure with the fixing nut inside the box. **2.** Open a hole in the thin rubber section of the rubber ring. **3.** Pass the tightening cap through the cable, insert the cable into the connector, and tighten the hexagonal nut to secure the cable.

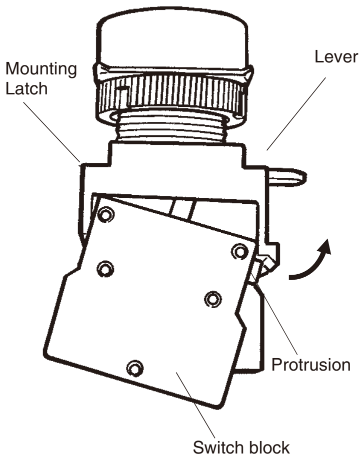
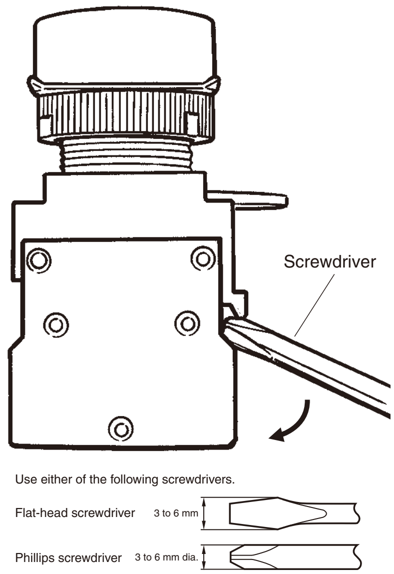


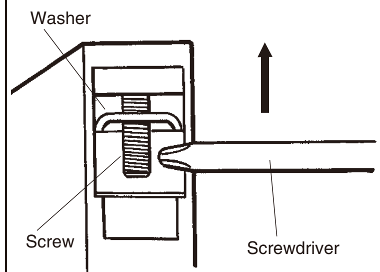




Cable diameter	Connector
7 to 9 dia.	A22Z-3500-1
9 to 11 dia.	A22Z-3500-2

Installing/Removing the Switch Blocks

(1) Installing the Switch Blocks	(2) Removing the Switch Blocks
• Hook the small protrusion on the Mounting Latch into the groove on the other side of the lever, then push up the Switch Block in the direction indicated by the arrow in the figure below.	• Insert a screwdriver between the Mounting Latch and the Switch Block, then push down the screwdriver in the direction indicated by the arrow in the following figure.
	

Wiring
• Loosen the terminal screw from the Switch Unit until it completely comes off the groove, insert a screwdriver as shown in the following figure, then push up the washer in the direction indicated by the arrow to temporarily secure it. Now, a round crimp terminal can be connected. After inserting the terminal, tighten the screws to complete wiring.


Safety Precautions

Be sure to read the precautions for all pushbutton switches in the *Pushbutton Switches Group Catalog* (Cat. No. X032).

⚠ CAUTION
Do not apply a voltage exceeding the rated voltage across the incandescent lamp terminals. The lamp may be destroyed and the operation unit may fly out.
If the Operation Unit is separated from the Socket Unit, the equipment will not stop, creating a hazardous condition. Secure the lever on the Socket Unit by using the A22Z-3380 Lock Plate so that the Operation Unit cannot be easily separated from the Socket Unit. (Refer to "*Mounting the Lock Plate*" at the right.)

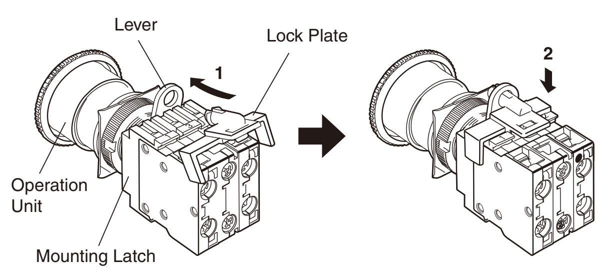
Precautions for Correct Use

Mounting

- Always make sure that the power is turned OFF before wiring the Switch. Also, do not touch the terminals or other current-carrying ports while power is being supplied. Electric shock may occur.
- Do not tighten the mounting ring more than necessary using tools such as pointed-nose pliers. Doing so will damage the mounting ring. The tightening torque is 0.98 to 1.96 N·m.
- Recommended panel thickness: 1 to 5 mm.

Mounting the Lock Plate

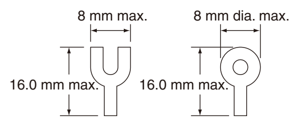
1. Confirm that the lever on the Mounting Latch is on the side where the Operation Unit is secured and then insert the protrusion on the Lock Plate into the hole in the lever on the Mounting Latch.
2. Press the hole on the Lock Plate onto the protrusion on the Mounting Latch until it clicks into place.



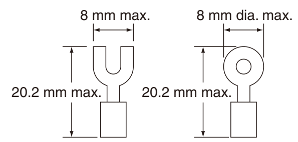
Wiring

- When DC-specific LEDs are used, wire the Switch so that the X1 terminal is positive.
- Terminal screws must be Phillips or slotted M3.5 screws with a square washer.
- The tightening torque is 1.08 to 1.27 N·m.
- Single wires, stranded wires, and crimp terminals can be connected to the Switch.
- Applicable Wiring Materials:
  Twisted strands: 2 mm^2 max.
  Solid wire: 1.6 mm dia. max.

Naked Crimp Terminals



Crimp Terminals with Insulating Sheaths



- After wiring the Switch, maintain an appropriate clearance and creepage distance.

Operating Environment

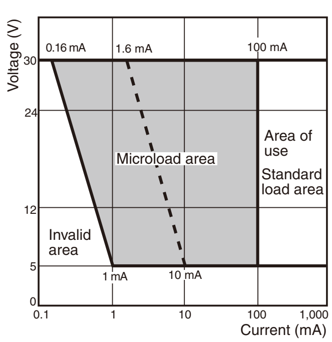
- The IP65 model is designed with a protective structure so that it will not sustain damage if it is subjected to water from any direction to the front of the panel.
- The Switch is intended for indoor use only. Using the Switch outdoor may cause it to fail.

LEDs

- The LED current-limiting resistor is built-in, so internal resistance is not required.
- If commercially available LEDs are used, select the ones that meet the following conditions:
  Base: BA9S/13
  Overall length: 26 mm max.
  Power consumption: 2.6 W max.

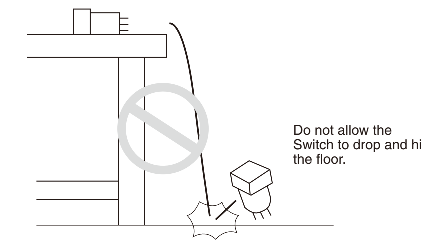
Using the Microload

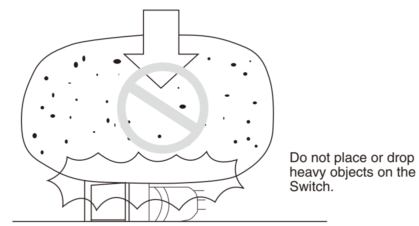
- Contact failure may occur if a Switch designed for a standard load is used to switch a microload. Use Switches within the application ranges shown in the following graph. Even within the application range, insert a contact protection circuit, if necessary, to prevent the reduction of life expectancy due to extreme wear on the contacts caused by loads where inrush current occurs when the contact is opened and closed.
  The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (conforming to JIS C5003).
  The equation, $\lambda_{60} = 0.5 \times 10^{-6}$/time indicates that the estimated malfunction rate is less than 1/2,000,000 with a reliability level of 60%.

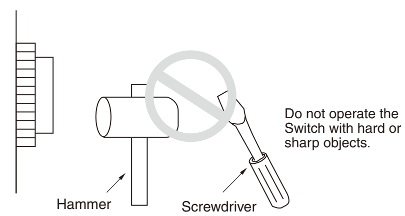


Others

- If the panel is to be coated, make sure that the panel meets the specified dimensions after coating.
- Due to the structure of the Switch, severe shock or vibration may cause malfunctions or damage to the Switch.
  Also, most Switches are made from resin and will be damaged if they come into contact with sharp objects. Particularly scratches on the Operation Unit may create visual and operational obtrusions.
  Handle the Switches with care, and do not throw or drop them.







Safety Precautions for All Pushbutton Switches

For the individual precautions for a Switch, refer to the *Safety Precautions* in the section for that Switch.

⚠ WARNING

Do not perform wiring with power supplied to the Switch. Do not touch the terminals or other charged parts of the Switch while power is being supplied. Doing so may result in electric shock.

⚠ Caution

Do not apply a voltage between the incandescent lamp and the terminal that is greater than the rated voltage. Doing so may damage the lamp or LED and cause the Operation Unit to pop out.

Always turn OFF the power and wait for 10 minutes before replacing the incandescent lamp. If the lamp is replaced immediately after the power is turned OFF, the remaining heat may cause burns.

Precautions for Correct Use

For details, refer to the *Precautions for Correct Use* in the *Technical Guide for Pushbutton Switches*.

Precautions for Correct Use of Pushbutton Switches

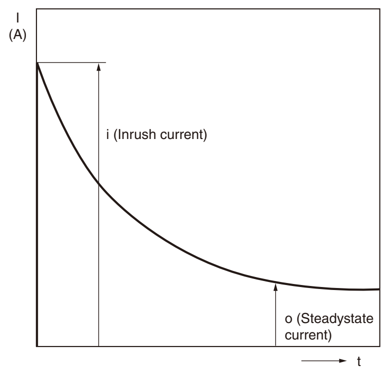
●For the individual precautions for a Switch, refer to the precautions in the section for that Switch.

Electrical Characteristics

1. Operating Load

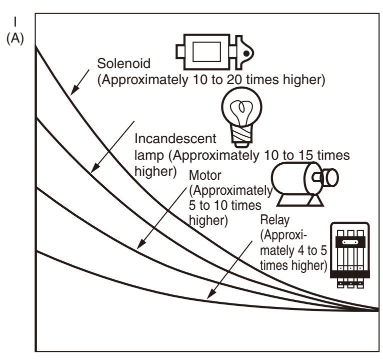
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue for a comparatively long time. Furthermore, the current direction is always the same, which results in a contact relocation phenomena whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact weld, contact separation failures, or insulation failures may result. Furthermore, the Switch may be broken or damaged.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation phenomena. Be sure to use the Switch within the rated conditions.

Inrush Current



- Approximate control capacities are given in ratings tables, but these alone are insufficient to guarantee correct operation. For special types of load, with unusual switching voltage or current waveforms, test whether correct operation is possible with the actual load before application.
- When switching for microloads (voltage or current), use a Switch with microload specifications. The reliability of silver-plated contacts, which are used in Switches for standard loads, will be insufficient for microloads.
- When switching microloads or very high loads that are beyond the switching capacity of the Switch, connect a relay suitable for the load.

Type of Load vs. Inrush Current



All the performance ratings given are for operation under the following conditions unless otherwise specified.

Inductive load: A minimum power factor of 0.4 (AC) and a maximum time constant of 7 ms (DC)
Lamp load: An inrush current 10 times higher than the steady-state current
Motor load: An inrush current 6 times higher than the steady-state current

Note: Inductive loads can cause problems especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.

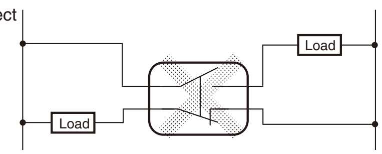
2. Load Connections

Do not contact a single Switch to two power supplies that are different in polarity or type.

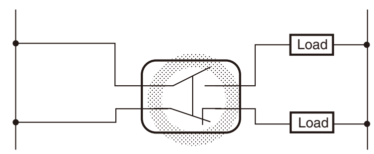
Connection of Different Polarities

The power supply may short-circuit if the loads are connected in the way shown in the "incorrect" example below.

Incorrect



correct



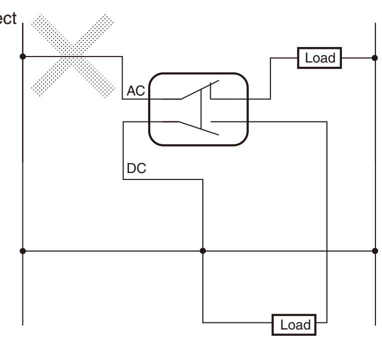
Connect the load to the same polarity.

Even in the "correct" example, note that the insulation performance of the switch may deteriorate and the switch life may be shortened because loads are connected to both contacts.

Connection of Different Power Supplies

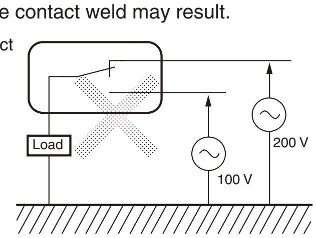
The DC and AC power may be mixed for the circuit shown below.

Incorrect



Do not design a circuit where voltage is imposed between contacts, otherwise contact weld may result.

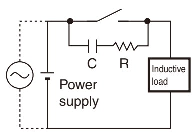
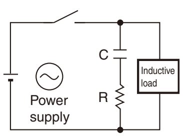
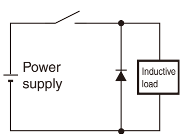
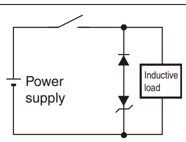
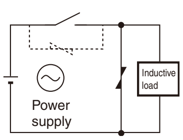
Incorrect



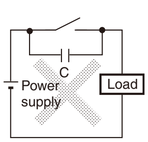
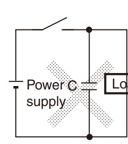
3. Contact Protective Circuit

Apply a contact protective circuit to extend the contact life, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protective circuit correctly, otherwise an adverse effect may occur. The following provides typical examples of contact protective circuits. If the Limit Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 if it reacts with moisture. Consequently, the internal metal parts may corrode and the Limit Switch may fail. Be sure to select the ideal contact preventive circuit from the following.

Typical Examples of Contact Protective Circuits

Circuit example		Applicable current AC	Applicable current DC	Feature and details	Element selection
CR circuit		*	Yes	*When AC is switched, the load impedance must be lower than the CR impedance.	C: 1 to 0.5 μF × switching current (A) R: 0.5 to 1 Ω × switching voltage (V) The values may change according to the characteristics of the load. The capacitor suppresses the spark discharge of current when the contacts are open. The resistor limits the inrush current when the contacts are closed again. Consider the roles of the capacitor and resistor and determine ideal capacitance and resistance values through testing. Basically, use a capacitor with a dielectric strength between 200 and 300 V. When AC is switched, make sure that the capacitor has no polarity.
CR circuit		Yes	Yes	The operating time will be greater if the load is a relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode method		No	Yes	Energy stored in the coil is changed into current by the diode connected in parallel to the load. Then the current flowing to the coil is consumed and Joule heat is generated by the resistance of the inductive load. The reset time delay with this method is longer than that in the CR method.	The diode must withstand a peak inverse voltage 10 times higher than the circuit voltage and a forward current as high or higher than the load current.
Diode and Zener diode method		No	Yes	This method will be effective if the reset time delay caused by the diode method is too long.	Use a Zener diode with a Zener voltage that is approximately 1.2 × power supply voltage as, depending on the environment, the load may not operate.
Varistor method		Yes	Yes	This method makes use of constant-voltage characteristic of the varistor so that no high-voltage is imposed on the contacts. This method causes a reset time delay. Connecting a varistor in parallel to the load is effective when the supply voltage is 24 to 48 V and in parallel to the contacts when the supply voltage is 100 to 200 V.	---

Do not apply contact protective circuits as shown below.

	This circuit effectively suppresses arcs when the contacts are OFF. The capacitor will be charged, however, when the contacts are OFF. Consequently, when the contacts are ON again, short-circuited current from the capacitance may cause contact weld.		This circuit effectively suppresses arcs when the contacts are OFF. When the contacts are ON again, however, charge current will flow to the capacitor, which may result in contact weld.

Switching a DC inductive load is usually more difficult than switching a resistive load. By using an appropriate contact protective circuit, however, switching a DC inductive load will be as easy as switching a resistive load.

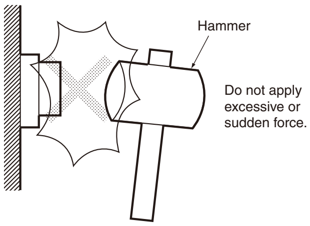
4. Switching

- Do not use the Switch for loads that exceed the rated switching capacity or other contact ratings. Doing so may result in contact weld, contact separation failures, or insulation failures. Furthermore, the Switch may be broken or damaged.
- Do not touch the charged switch terminals while power is supplied, otherwise an electric shock may be received.
- The life of the Switch varies greatly with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range. If a deteriorated Switch is used continuously, insulation failures, contact weld, contact failures, switch damage, or switch burnout may result.
- Do not apply excessive or incorrect voltages to the Switch or incorrectly wire the terminals. Otherwise, the Switch may not function properly and have an adverse effect on external circuitry. Furthermore, the Switch itself may become damaged or burnt.
- Do not use the Switch in locations where flammable or explosive gases are present. Otherwise switching arcs or heat radiation may cause a fire or explosion.
- Do not drop or disassemble the Switch, otherwise it may not be capable of full performance. Furthermore, it may be broken or burnt.

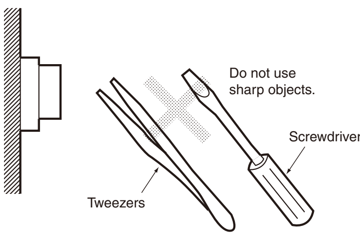
Mechanical Conditions

Operating Force and Operating Method

- Fingertip operation is an important feature of Pushbutton Switches. In terms of Switch operation, Pushbutton Switches differ greatly from detection switches such as Microswitches. Operating the Switch using a hard object (e.g., metal), or with a large or sudden force, may deform or damage the Switch, resulting in faulty or rough operation, or shortening of the Switch life. The strength varies with the size and construction of the Switch. Use the appropriate Switch for the application after confirming the operating method and operating force with this catalog.



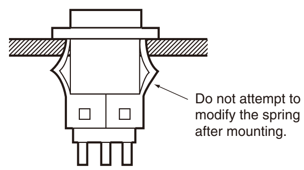
- The pushbutton surface is composed of resin. Therefore, do not attempt to operate the pushbutton using a sharp object, such as a screwdriver or a pair of tweezers. Doing so may damage or deform the pushbutton surface and result in faulty operation.



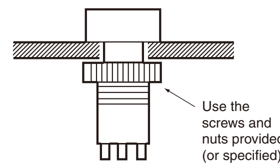
Mounting

- Switches can be broadly divided into two categories according to mounting method: panel-mounting models and PCB-mounting models. Use the appropriate model for the mounting method required. Basically, panel-mounting Switches can withstand a greater operating force than PCB-mounting Switches. If, however, the panel thickness or the panel-cutout dimensions are not suitable for the Switch, it may not be able to withstand the normal operating force. With continuous mounting in particular, select a panel of a thickness that is easily sufficient to withstand the total operating force.
- Panel-mounting Switches can be divided into two categories according to the mounting method: snap-in mounting models and screw-mounting models. Snap-in mounting Switches are held in place with the elasticity of resin or a metal leaf spring. Do not attempt to modify the spring after mounting. Doing so may result in faulty operation or damage the mounting structure. Mount screw-mounting models using the screws and nuts provided (or individually specified). Tighten the screws to the specified torque. Mounting with different screws or nuts, or tightening beyond the specified torque may result in distortion of the inside of the case or damage to the screw section.

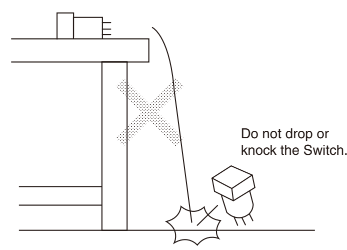
Snap-in Mounting

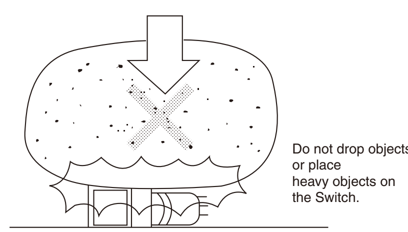


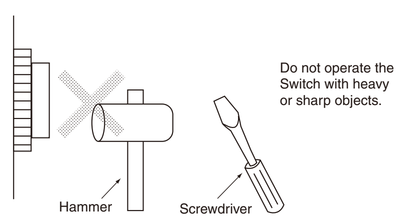
Screw Mounting



- Subjecting the Switch to severe vibrations or shock may result in faulty operation or damage. Also, many of the Switches are composed of resin so contact with sharp objects may result in damage to the surface. This kind of damage may spoil the appearance of the Switch or result in faulty operation. Do not throw or drop the Switch.



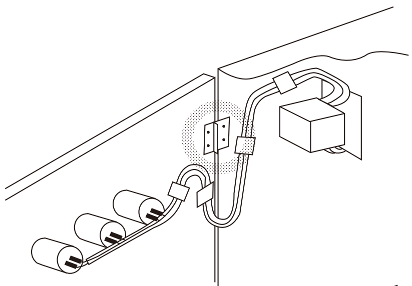


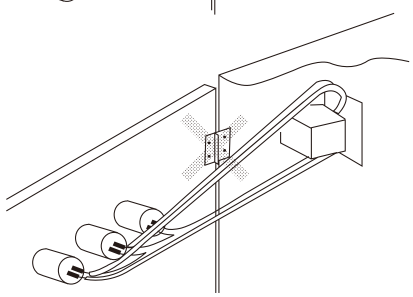


Mounting Precautions

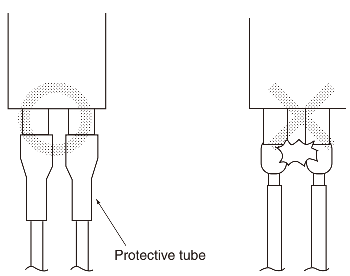
Wiring

- Perform wiring so that the lead wires will not be caught on other objects as this will cause stress on the Switch terminals. Wire the Switch so that there is slack in the lead wires and fix lead wires at intermediate points. If the panel to which the Switch is mounted needs to be opened and closed for maintenance purposes, perform wiring so that the opening and closing of the panel will not interfere with the wiring.





- With miniature Switches, the gap between the terminals is very narrow. Use protective or heat-absorbing tubes to prevent burning of the wire sheath or shorting.



Soldering

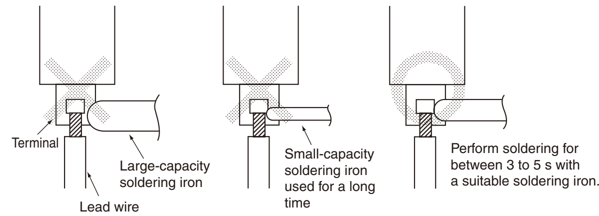
- There are two methods for soldering the Switch: hand soldering and automatic soldering. In addition, automatic soldering itself can be divided into two types : dip soldering and reflow soldering. Use the soldering method appropriate for the mounting method.

Typical Soldering Example

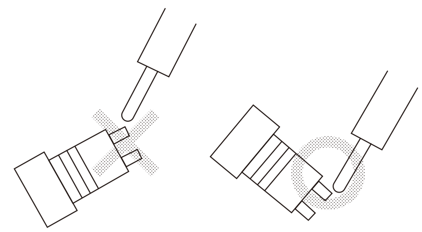
Method		Soldering device	Application
Hand soldering		Soldering iron	Small quantities Different materials Lead wire terminals
Automatic soldering	Dip soldering	Jet soldering bath Dip soldering bath	Large quantities of discrete terminals
	Reflow soldering	Infrared reflow (IR) soldering bath Vapor-phase (VPS) reflow soldering bath	Large quantities of miniature SMD terminals

- Do not use soldering flux that contains chlorine. Doing so may result in metal corrosion.

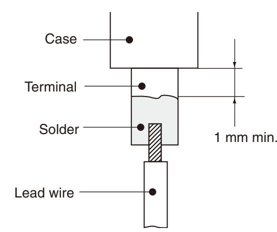
- Perform hand soldering using the appropriate soldering iron.



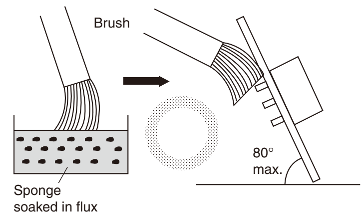
- With the exception of PCB-mounting Switches, when performing hand soldering, hold the Switch so that the terminals point downwards so that flux does not get inside the Switch.

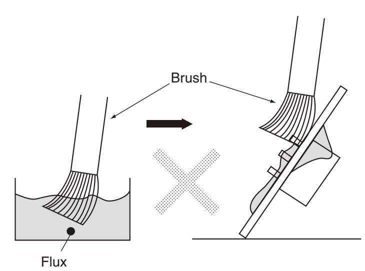


- Leave a gap of at least 1 mm between the soldered parts and the surface of the case so that flux does not get inside the Switch.

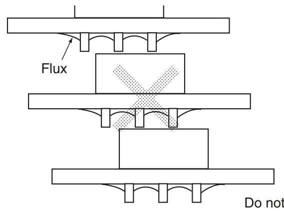


- When applying flux using a brush, use a sponge soaked in flux as shown below. Do not apply more than is necessary. Also, apply the flux with the PCB inclined at an angle of less than 80° so that flux does not flow onto the mounting surface of the Switch.

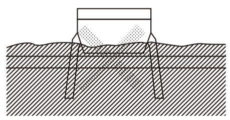


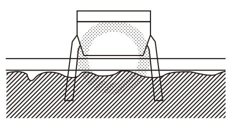


- Do not place PCBs that have had flux applied or have been soldered on top of each other. Otherwise, the flux on the PCBs solder surface may stain the upper part of the Switch or even permeate the inside of the Switch and cause contact failure. Be sure to insert a special PCB stocker.

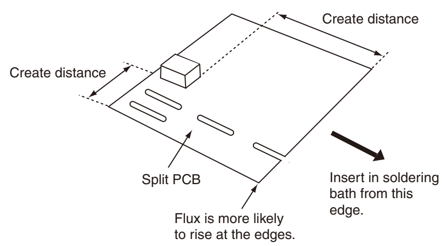


- When performing soldering with a dip soldering bath, ensure that the flux does not reach a higher level than the PCB.



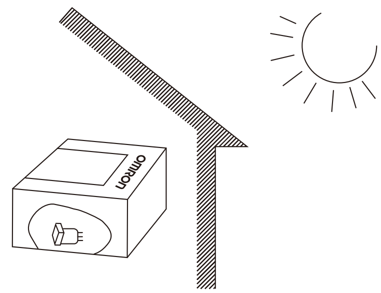


- Flux is especially likely to rise up at the edges of the PCB. If the Switch is mounted near the edge of the PCB, create a gap between the edge by using a split PCB, and insert the PCB in the soldering bath so that the edge that is farthest from the Switch enters the bath first.



Storage

- When the Switch is left unused or stored for long periods, the ambient conditions can have a great effect on the condition of the Switch. In certain environments, leaving the Switch exposed may result in deterioration (i.e., oxidation, or the creation of an oxide film) of the contacts and terminals, causing the contact resistance to increase, and making it difficult to solder the lead wires. Therefore, store in a well-ventilated room, inside, for example, a non-hygroscopic case, in a location where no corrosive gases are present.



- If the Switch is stored in a location where it will be exposed to direct light, colored resin in the colored plate may fade. Therefore, do not store the Switch in locations where it will be exposed to direct light.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.2

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Emergency Stop Switch (16-dia.)

A165E

Separate Construction with Smallest Class of Depth in the World

- Direct opening mechanism to open contacts in emergencies, such as when they are welded.
- Conforms to EN418.
- Includes a safety lock to prevent misuse.
- Features separate construction that allows the Switch to be separated for easier wiring and one-piece-like construction that allows easier handling.
- Models available with 3 contacts built into a single block (A165E-U).

⚠ Be sure to read the precautions for all pushbutton switches in the *Pushbutton Switches Group Catalog* (Cat. No. X032), as well as the *"Safety Precautions"* on page 9.

Model Number Structure

List of Models

Diameter of Operation Unit	Function	Model	Shape	
30-mm models 40-mm models	Push-Lock, turn-reset	**A165E**	Separate construction	 (30-mm model)
		A165E-□-03U	One-piece construction	 (30-mm model)

Model Number Legend (Completely Assembled)

........................Shipped as a set that includes the Operation Unit and light source.

A165E-LS-24D-02 (1 = LS, 2 = 24D, 3 = 02)

IP65 (Oil-resistant)

1. Operation Unit Shape and Functions

Code	Functions		Pushbutton
S	Non-lighted	Push-lock, turn-reset	30 dia.
LS	Lighted		
M	Non-lighted		40 dia.
LM	Lighted		

2. Light Source

Code	Type	Operation voltage	Rated voltage
None	Non-lighted	---	---
24D	LED	24 VDC	24 VDC

Note: Models with separate construction (SPST-NC and DPST-NC) are for normal loads only. One-piece models (TPST-NC) are for either normal loads or microloads.

3. Contacts

Code	Description
01	SPST-NC
02	DPST-NC
03U	TPST-NC *

* TPST-NC models have one-piece construction with the contact unit. Only non-lighted models are available.

Ordering Information

List of Sets

Illumination	Rated voltage	Pushbutton color	Pushbutton size	Terminal	Contact form	Model
LED	24 VDC	Red	30 dia.	Solder terminal	SPST-NC	**A165E-LS-24D-01**
					DPST-NC	**A165E-LS-24D-02**
Non-lighted	---				SPST-NC	**A165E-S-01**
					DPST-NC	**A165E-S-02**
LED	24 VDC		40 dia.		SPST-NC	**A165E-LM-24D-01**
					DPST-NC	**A165E-LM-24D-02**
Non-lighted	---				SPST-NC	**A165E-M-01**
					DPST-NC	**A165E-M-02**
Non-lighted	---		30 dia.		TPST-NC	**A165E-S-03U**
			40 dia.			**A165E-M-03U**

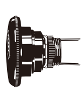
List of Sets (in Different Colors)

Illumination	Pushbutton color *	Pushbutton size	Terminal	Contact form	Model
Non-lighted	Yellow	30 dia.	Solder terminal	SPST-NC	**A165E-SY-01**
	Gray				**A165E-SGR-01**
	Yellow			DPST-NC	**A165E-SY-02**
	Gray				**A165E-SGR-02**
	Yellow	40 dia.		SPST-NC	**A165E-MY-01**
	Gray				**A165E-MGR-01**
	Yellow			DPST-NC	**A165E-MY-02**
	Gray				**A165E-MGR-02**
	Yellow	30 dia.		TPST-NC	**A165E-SY-03U**
	Gray				**A165E-SGR-03U**
	Yellow	40 dia.			**A165E-MY-03U**
	Gray				**A165E-MGR-03U**

* Models with yellow or gray pushbutton colors cannot be used as emergency switches.

Individual Parts (for Switches with Separate Construction)

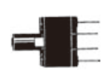
Operation Units

Appearance	Illumination	Model
30 dia. 	Non-lighted	**A165E-S**
	Lighted	**A165E-LS**
40 dia. 	Non-lighted	**A165E-M**
	Lighted	**A165E-LM**

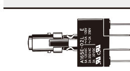
Lamps

Appearance	LED color		Rated voltage	Model
	Red	Bright	5 VDC	**A16-5DSR**
			12 VDC	**A16-12DSR**
			24 VDC	**A16-24DSR**

Sockets

Appearance	Illumination	Contact form	Model
	Non-lighted	SPST-NC	**A165E-01**
		DPST-NC	**A165E-02**
	Lighted	SPST-NC	**A165E-01L**
		DPST-NC	**A165E-02L**

Socket Units

Appearance	Illumination	Contact form	Model
	Lighted	SPST-NC	**A165E-R-24D-01**
		DPST-NC	**A165E-R-24D-02**

Accessories (Order Separately)

Item	Appearance	Type	Model	Precautions
Yellow Plate		Yellow, 45 dia.	**A16Z-5070**	Use this as an emergency stop nameplate.
Panel Plug		Round	**A16ZT-3003**	Used for covering the panel cutouts for future panel expansion. Degree of protection: IP40 Color: Black
Tightening Tool		---	**A16Z-3004**	Useful for repetitive mounting. Be careful not to tighten excessively.
Extractor			**A16Z-5080**	Convenient for extracting the Switch and Lamp.

Specifications

Certified Standard Ratings

UL508, CSA C22.2 No.14, CCC(GB14048.5)

Models with Separate Construction

Rated voltage	Resistive load
125 VAC 250 VAC 30 VDC	5 A 3 A 3 A

Models with One-piece Construction

Rated voltage	Resistive load
125 VAC 250 VAC 30 VDC	1 A 0.5 A 1 A

TÜV(EN60947-5-1)

Models with Separate Construction

Rated voltage	Resistive load
250 VAC 30 VDC	3 A 3 A

Models with One-piece Construction

Rated voltage	Resistive load
250 VAC 30 VDC	0.5 A 1 A

Certified Standards

Certification body	Standards	File No.
UL *	UL508, CSA C22.2 No.14	E41515
TÜV Product Service	EN60947-5-1, EN60947-5-5	Inquire
CQC (CCC)	GB14048.5	2003010303070678

* Certification for CSA C22.2 No. 14 is indicated by the mark.

Switch Ratings

Models with Separate Construction

Rated voltage	Resistive load
125 VAC 250 VAC 30 VDC	5 A 3 A 3 A

Minimum applicable load: 5 VDC, 150 mA

Models with One-piece Construction

Rated voltage	Resistive load
125 VAC 250 VAC 30 VDC	1 A 0.5 A 1 A

Minimum applicable load: 5 VDC, 1 mA

LED Ratings

(Only for Models with LEDs)

Rated voltage	Rated current	Operation voltage
24 VDC	10 mA	24 VDC±5%

Characteristics

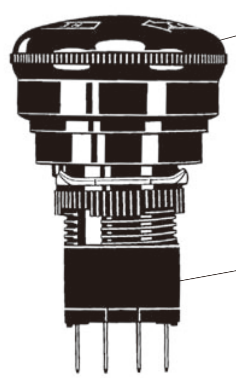
Item		Emergency Stop Switch: Non-lighted A165E-S/A165E-M	Emergency Stop Switch: Lighted A165E-LS/A165-LM	Emergency Stop Switch: Non-lighted, One-piece construction A165E-U
Allowable operating frequency	Mechanical	20 operations/minute max.		
	Electrical	10 operations/minute max.		
Insulation resistance		100 MΩ min. (at 500 VDC)		
Dielectric strength	Between terminals of same polarity	1,000 VAC, 50/60 Hz for 1 min		
	Between terminals of different polarity	2,000 VAC 50/60 Hz for 1 min		
	Between each terminal and ground	2,000 VAC 50/60 Hz for 1 min		
	Between lamp terminals	1,000 VAC, 50/60 Hz for 1 min *1		---
Vibration resistance	Malfunction	10 to 55 Hz, 1.5-mm double amplitude (malfunction within 1 ms)		
Shock resistance	Destruction	500 m/s^2		
	Malfunction	300 m/s^2 max. (malfunction within 1 ms)		150 m/s^2 max. (malfunction within 1 ms)
Durability	Mechanical	100,000 operations min.		
	Electrical	100,000 operations min.		
Degree of protection		IP65 Oil-resistant *2	IP65 *2	IP65 Oil-resistant *2
Electric shock protection class		Class II		
PTI (tracking characteristic)		175		
Degree of contamination		3 (EN60947-5-1)		
Weight		Approx. 16 g (in case of DPST-NC Switches)		
Ambient operating temperature		–10 to 55°C (with no icing or condensation)		
Ambient operating humidity		35% to 85%		
Ambient storage temperature		–25 to 65°C (with no icing or condensation)		

*1. LED not mounted. (Test them with the LED removed.)
*2. Degree of protection from the front of the panel.

Operating Characteristics

Item		Characteristics of models with separate construction	Characteristics of models with one-piece construction
Operating force	OF max.	14.7 N	14.7 N
Releasing force	RF min.	0.1 N·m	0.1 N·m
Pretravel	PT	3.5±0.5 mm	3±0.5 mm

Structure and Nomenclature



(The above figure is example of the separate construction model.)

Operation Unit

Color

Operation Unit Color

- Models with LED illumination: Red
- Non-lighted models * : Red, yellow, or gray

Degree of Protection

IP65 oil resistance

Socket

Specifications

For standard load
125 VAC, 5 A
250 VAC, 3 A
30 VDC, 3 A

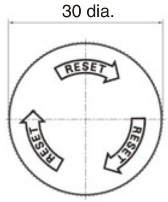
* Models with yellow or gray pushbutton colors cannot be used as emergency switches.

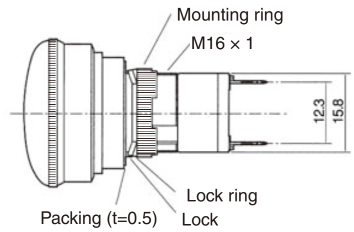
Dimensions

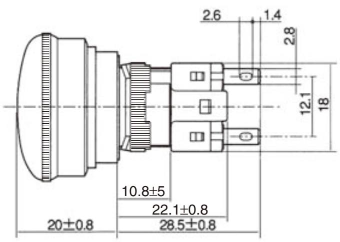
(Unit: mm)

A165E-S

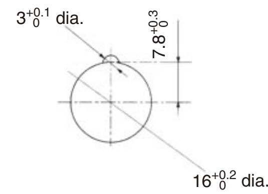
Non-lighted models
30 mm diameter







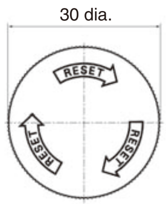
Panel cutout dimensions

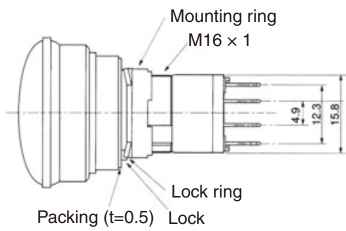


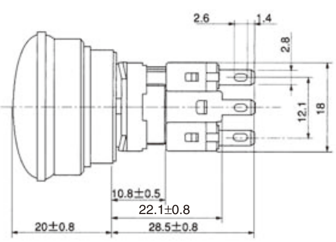
- When applying a coating such as paint to the panel, dimensions after the coating must satisfy the specified dimensions.
- Recommended panel thickness: 0.5 to 3.2 mm.

A165E-LS

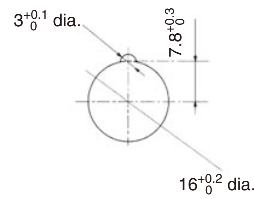
Lighted models
30 mm diameter







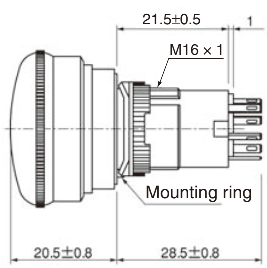
Panel cutout dimensions

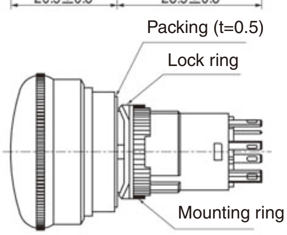


- When applying a coating such as paint to the panel, dimensions after the coating must satisfy the specified dimensions.
- Recommended panel thickness: 0.5 to 3.2 mm.

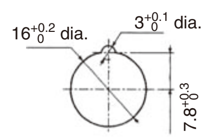
A165E-S-03U

Non-lighted,
One-piece construction models
30 mm diameter



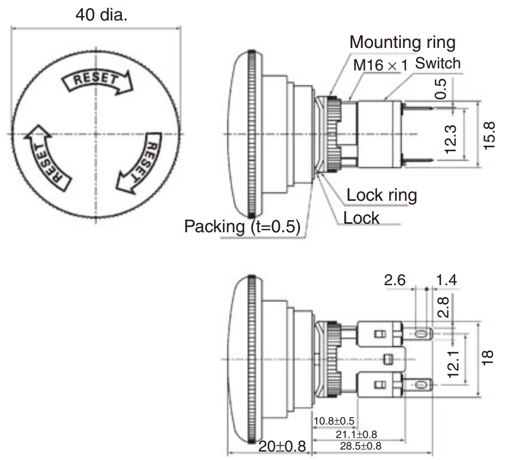


Panel cutout dimensions

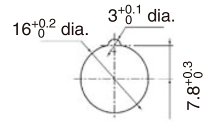


- When applying a coating such as paint to the panel, dimensions after the coating must satisfy the specified dimensions.
- Recommended panel thickness: 0.5 to 3.2 mm.

A165E-M
Non-lighted models
40 mm diameter

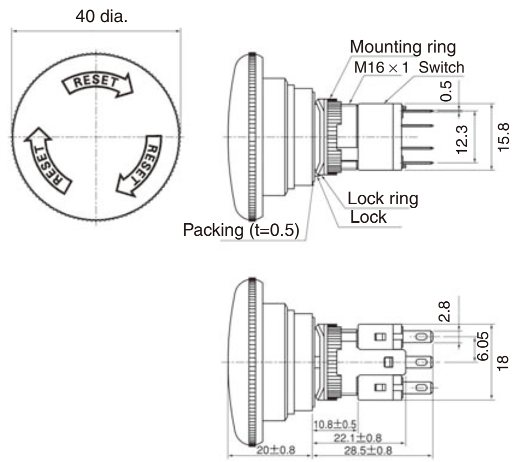


Panel cutout dimensions

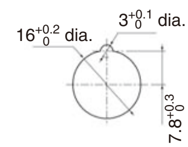


- When applying a coating such as paint to the panel, dimensions after the coating must satisfy the specified dimensions.
- Recommended panel thickness: 0.5 to 3.2 mm.

A165E-LM
Lighted models
40 mm diameter

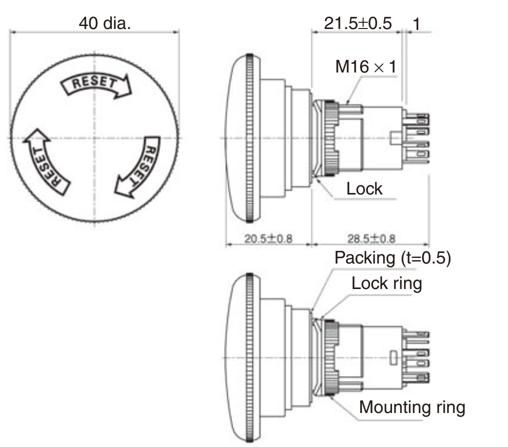


Panel cutout dimensions

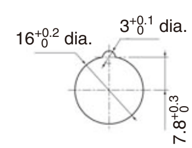


- When applying a coating such as paint to the panel, dimensions after the coating must satisfy the specified dimensions.
- Recommended panel thickness: 0.5 to 3.2 mm.

A165E-M-03U
One-piece construction models
40 mm diameter



Panel cutout dimensions

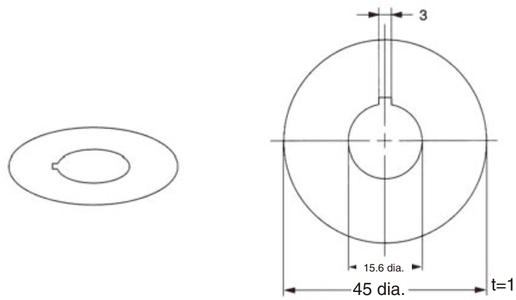


- When applying a coating such as paint to the panel, dimensions after the coating must satisfy the specified dimensions.
- Recommended panel thickness: 0.5 to 3.2 mm.

Accessories

Yellow Plate (Vinyl Chloride)

A16Z-5070

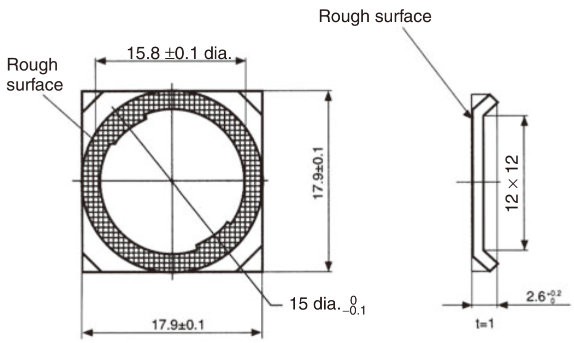


Panel Plugs (Round Type)

A16ZT-3003

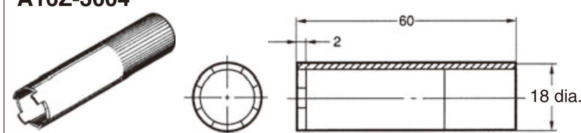
- Select an appropriate Panel Plug according to the panel design and mount from the front side of the panel. Panel cutout dimensions are the same as those for the Switch.

Lock Ring



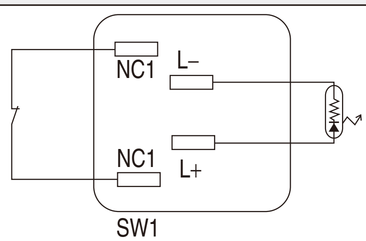
Tightening Tool

A16Z-3004

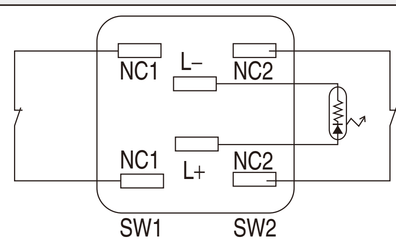


Terminal Arrangement

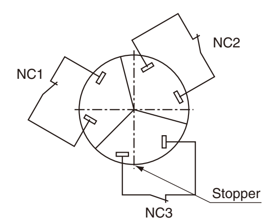
SPST Switches



DPST Switches



TPST Switches



Note: The L+ and L− terminals are not available with the non-lighted models.

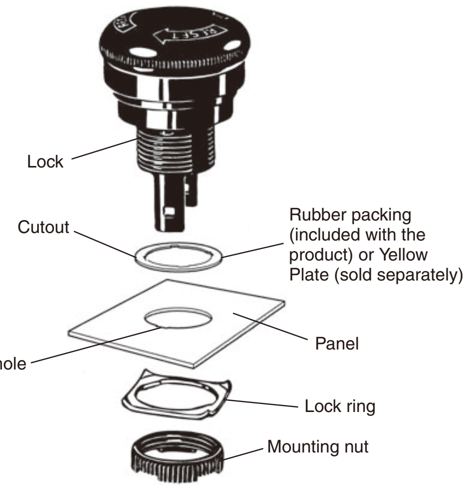
Installation

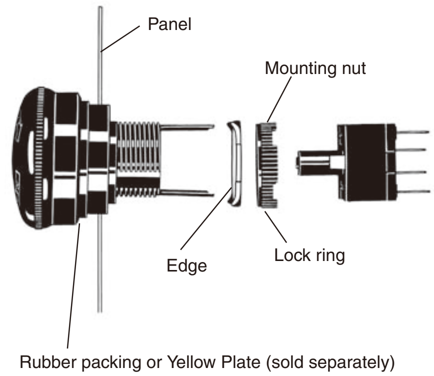
Mounting to the Panel (Models with Separate Construction)

After installing the Operation Unit, snap in the Switch from the back of the panel.

(1) Installing the Operation Unit

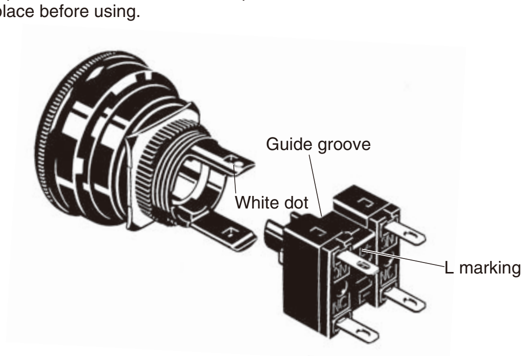
- Attach rubber packing or the Yellow Plate onto the Switch from its terminal side. Insert the Switch into the panel from the front. Install the lock ring and mounting nut from the terminal side and tighten.
- Adjust the slits on the hole of rubber packing and Yellow Plate to the protruding part of the Unit.
- Rubber packing is not necessary when the Yellow Plate is used.
- Tighten the nut to the torque of 0.29 to 0.49 N·m.
- Casing should be installed with its protruding part adjusted to the slit of the panel hole.
- Align the lock ring to the groove of the casing so that the edge is drawn to the panel side.





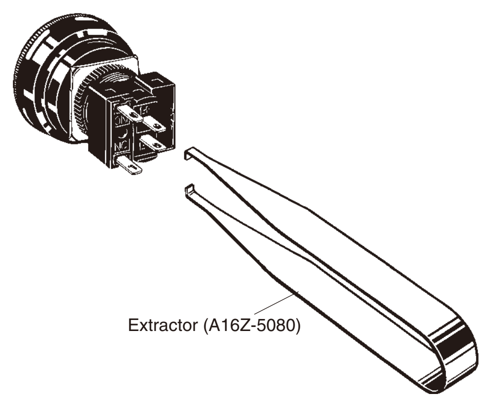
(2) Mounting the Switch

- Snap on the Switch to the Operation Unit.
- Make sure that the Switch has the correct orientation when snapping it onto the Operation Unit.
- Align the white dot on the Operation Unit with the guide groove on the side of the Switch marked with an “L” as shown below, and push the Switch into the Operation Unit until it clicks into place. Confirm that the Switch is securely in place before using.



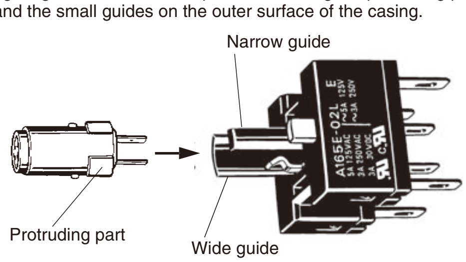
(3) Removing the Switch

- Insert the prongs of the A16Z-5080 Extractor between the Switch and the Operation Unit, grip the Switch, and pull to remove.



(4) Installing the LED Lamp

- When mounting the Lamp, make sure it is facing the direction shown in the following diagram. Insert the Lamp while matching the protruding part of the Lamp and the small guides on the outer surface of the casing.



Safety Precautions

Be sure to read the precautions for all pushbutton switches in the *Pushbutton Switches Group Catalog* (Cat. No. X032).

⚠ CAUTION

If the Operation Unit is separated from the Socket Unit, the equipment will not stop, creating a hazardous condition. Always confirm that safety functions are operating before starting operation.

Precautions for Correct Use

Mounting

- Always make sure that the power is turned OFF before mounting, removing, or wiring the Switch, or performing maintenance. Electrical shock or fire may result if the power is not turned OFF.
- The tightening torque is 0.29 to 0.49 N·m.

Wiring

- Be sure to use electrical wires that are a size appropriate for the applied voltage and carry current. Perform soldering according to the conditions given below. If the soldering is not properly performed, abnormal heating may result, possibly resulting in fire.
  1. Hand soldering: 30 W, within 5 s
  2. Dip soldering: 240°C, within 3 s

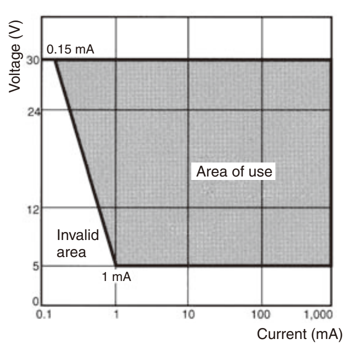
  Wait for one minute after soldering before exerting any external force on the solder.
- Use non-corrosive resin fluid as the flux.
- Make sure that the electric cord is wired so that it does not touch the Unit. If the electric cord will touch the Unit, then electric wires with a heat resistance of 100°C min. must be used.
- After wiring the Switch, maintain an appropriate clearance and creepage distance.

Operating Environment

- The IP65 model is designed with a degree of protection so that it will not sustain damage if it is subjected to water from any direction to the front of the panel.
- The Switch is intended for indoor use only. Using the Switch outdoor may cause it to fail.

Using the Microload

- Insert a contact protection circuit, if necessary, to prevent the reduction of life expectancy due to extreme wear on the contacts caused by loads where inrush current occurs when the contact is opened and closed.
- The A165E-□U (one-piece construction) allows both a standard load (125 V at 1 A, 250 V at 0.5 A) and a microload. If a standard load is applied, however, the microload area cannot be used. If the microload area is used with a standard load, the contact surface will become rough, and the opening and closing of the contact for a microload may become unreliable.
- The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (conforming to JIS C5003).
  The equation, $\lambda_{60} = 0.5 \times 10^{-6}$/time indicates that the estimated malfunction rate is less than 1/2,000,000 with a reliability level of 60%.



LEDs

- The LED current-limiting resistor is built-in, so external resistance is not required.

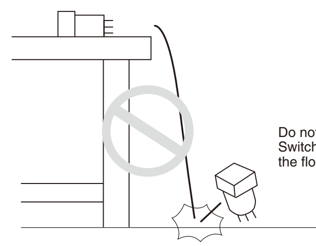
Rated voltage	Internal limiting resistor
24 VDC	2000 Ω

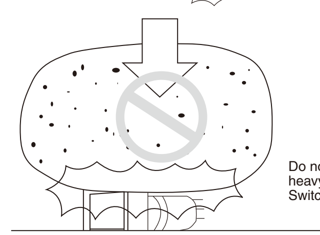
Operating Torque

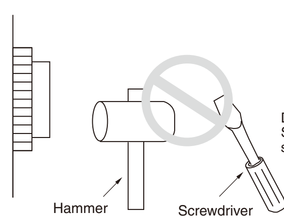
- Do not exceed an operating torque of 0.49 N·m in the direction of rotation.
- Do not pull the operating button or apply excessive force to any side of the button.
  Otherwise it may be damaged.

Others

- The oil-resistant IP65 uses NBR rubber and is resistant to general cutting oil and cooling oil. Some special oils cannot be used with the oil-resistant IP65, however, so contact your OMRON representative for details.
- If the panel is to be coated, make sure that the panel meets the specified dimensions after coating.
- Due to the structure of the Switch, severe shock or vibration may cause malfunctions or damage to the Switch.
  Also, most Switches are made from resin and will be damaged if they come into contact with sharp objects. Particularly scratches on the Operation Unit may create visual and operational obtrusions. Handle the Switches with care, and do not throw or drop them.







Safety Precautions for All Pushbutton Switches

For the individual precautions for a Switch, refer to the *Safety Precautions* in the section for that Switch.

⚠ WARNING

Do not perform wiring with power supplied to the Switch. Do not touch the terminals or other charged parts of the Switch while power is being supplied. Doing so may result in electric shock.

⚠ Caution

Do not apply a voltage between the incandescent lamp and the terminal that is greater than the rated voltage. Doing so may damage the lamp or LED and cause the Operation Unit to pop out.

Always turn OFF the power and wait for 10 minutes before replacing the incandescent lamp. If the lamp is replaced immediately after the power is turned OFF, the remaining heat may cause burns.

Precautions for Correct Use

For details, refer to the *Precautions for Correct Use* in the *Technical Guide for Pushbutton Switches*.

Precautions for Correct Use of Pushbutton Switches

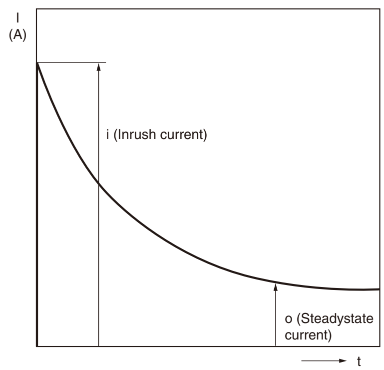
●For the individual precautions for a Switch, refer to the precautions in the section for that Switch.

Electrical Characteristics

1. Operating Load

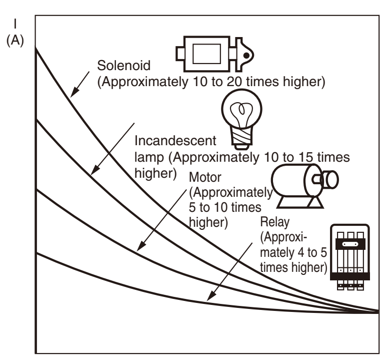
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue for a comparatively long time. Furthermore, the current direction is always the same, which results in a contact relocation phenomena whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact weld, contact separation failures, or insulation failures may result. Furthermore, the Switch may be broken or damaged.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation phenomena. Be sure to use the Switch within the rated conditions.

Inrush Current



- Approximate control capacities are given in ratings tables, but these alone are insufficient to guarantee correct operation. For special types of load, with unusual switching voltage or current waveforms, test whether correct operation is possible with the actual load before application.
- When switching for microloads (voltage or current), use a Switch with microload specifications. The reliability of silver-plated contacts, which are used in Switches for standard loads, will be insufficient for microloads.
- When switching microloads or very high loads that are beyond the switching capacity of the Switch, connect a relay suitable for the load.

Type of Load vs. Inrush Current



All the performance ratings given are for operation under the following conditions unless otherwise specified.

Inductive load: A minimum power factor of 0.4 (AC) and a maximum time constant of 7 ms (DC)

Lamp load: An inrush current 10 times higher than the steady-state current

Motor load: An inrush current 6 times higher than the steady-state current

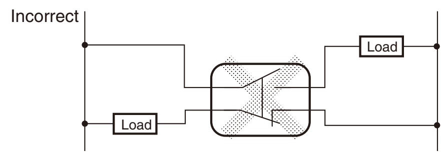
Note: Inductive loads can cause problems especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.

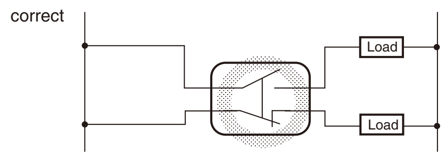
2. Load Connections

Do not contact a single Switch to two power supplies that are different in polarity or type.

Connection of Different Polarities

The power supply may short-circuit if the loads are connected in the way shown in the "incorrect" example below.



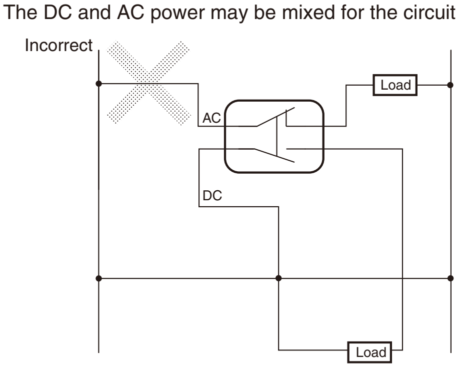


Connect the load to the same polarity.

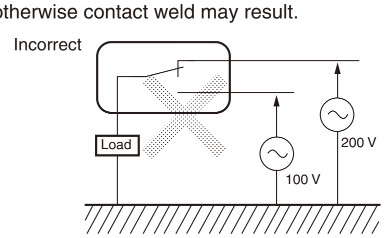
Even in the "correct" example, note that the insulation performance of the switch may deteriorate and the switch life may be shortened because loads are connected to both contacts.

Connection of Different Power Supplies

The DC and AC power may be mixed for the circuit shown below.



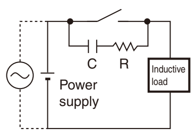
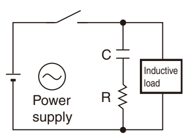
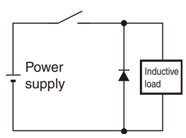
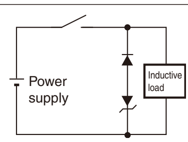
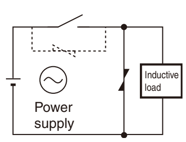
Do not design a circuit where voltage is imposed between contacts, otherwise contact weld may result.



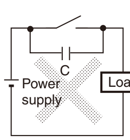
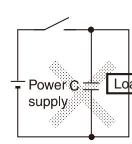
3. Contact Protective Circuit

Apply a contact protective circuit to extend the contact life, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protective circuit correctly, otherwise an adverse effect may occur. The following provides typical examples of contact protective circuits. If the Limit Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 if it reacts with moisture. Consequently, the internal metal parts may corrode and the Limit Switch may fail. Be sure to select the ideal contact preventive circuit from the following.

Typical Examples of Contact Protective Circuits

Circuit example		Applicable current AC	Applicable current DC	Feature and details	Element selection
CR circuit		*	Yes	*When AC is switched, the load impedance must be lower than the CR impedance.	C: 1 to 0.5 μF × switching current (A) R: 0.5 to 1 Ω × switching voltage (V) The values may change according to the characteristics of the load. The capacitor suppresses the spark discharge of current when the contacts are open. The resistor limits the inrush current when the contacts are closed again. Consider the roles of the capacitor and resistor and determine ideal capacitance and resistance values through testing. Basically, use a capacitor with a dielectric strength between 200 and 300 V. When AC is switched, make sure that the capacitor has no polarity.
		Yes	Yes	The operating time will be greater if the load is a relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode method		No	Yes	Energy stored in the coil is changed into current by the diode connected in parallel to the load. Then the current flowing to the coil is consumed and Joule heat is generated by the resistance of the inductive load. The reset time delay with this method is longer than that in the CR method.	The diode must withstand a peak inverse voltage 10 times higher than the circuit voltage and a forward current as high or higher than the load current.
Diode and Zener diode method		No	Yes	This method will be effective if the reset time delay caused by the diode method is too long.	Use a Zener diode with a Zener voltage that is approximately 1.2 × power supply voltage as, depending on the environment, the load may not operate.
Varistor method		Yes	Yes	This method makes use of constant-voltage characteristic of the varistor so that no high-voltage is imposed on the contacts. This method causes a reset time delay. Connecting a varistor in parallel to the load is effective when the supply voltage is 24 to 48 V and in parallel to the contacts when the supply voltage is 100 to 200 V.	---

Do not apply contact protective circuits as shown below.

	This circuit effectively suppresses arcs when the contacts are OFF. The capacitor will be charged, however, when the contacts are OFF. Consequently, when the contacts are ON again, short-circuited current from the capacitance may cause contact weld.		This circuit effectively suppresses arcs when the contacts are OFF. When the contacts are ON again, however, charge current will flow to the capacitor, which may result in contact weld.

Switching a DC inductive load is usually more difficult than switching a resistive load. By using an appropriate contact protective circuit, however, switching a DC inductive load will be as easy as switching a resistive load.

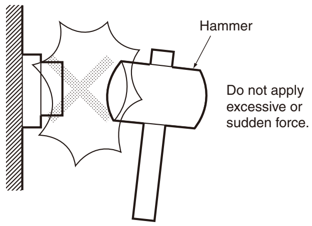
4. Switching

- Do not use the Switch for loads that exceed the rated switching capacity or other contact ratings. Doing so may result in contact weld, contact separation failures, or insulation failures. Furthermore, the Switch may be broken or damaged.
- Do not touch the charged switch terminals while power is supplied, otherwise an electric shock may be received.
- The life of the Switch varies greatly with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range. If a deteriorated Switch is used continuously, insulation failures, contact weld, contact failures, switch damage, or switch burnout may result.
- Do not apply excessive or incorrect voltages to the Switch or incorrectly wire the terminals. Otherwise, the Switch may not function properly and have an adverse effect on external circuitry. Furthermore, the Switch itself may become damaged or burnt.
- Do not use the Switch in locations where flammable or explosive gases are present. Otherwise switching arcs or heat radiation may cause a fire or explosion.
- Do not drop or disassemble the Switch, otherwise it may not be capable of full performance. Furthermore, it may be broken or burnt.

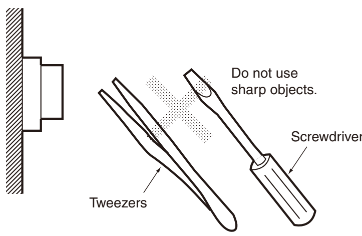
Mechanical Conditions

Operating Force and Operating Method

- Fingertip operation is an important feature of Pushbutton Switches. In terms of Switch operation, Pushbutton Switches differ greatly from detection switches such as Microswitches. Operating the Switch using a hard object (e.g., metal), or with a large or sudden force, may deform or damage the Switch, resulting in faulty or rough operation, or shortening of the Switch life. The strength varies with the size and construction of the Switch. Use the appropriate Switch for the application after confirming the operating method and operating force with this catalog.



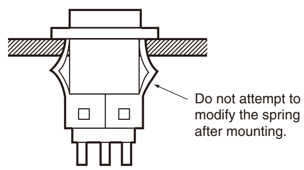
- The pushbutton surface is composed of resin. Therefore, do not attempt to operate the pushbutton using a sharp object, such as a screwdriver or a pair of tweezers. Doing so may damage or deform the pushbutton surface and result in faulty operation.



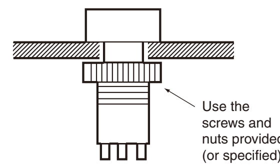
Mounting

- Switches can be broadly divided into two categories according to mounting method: panel-mounting models and PCB-mounting models. Use the appropriate model for the mounting method required. Basically, panel-mounting Switches can withstand a greater operating force than PCB-mounting Switches. If, however, the panel thickness or the panel-cutout dimensions are not suitable for the Switch, it may not be able to withstand the normal operating force. With continuous mounting in particular, select a panel of a thickness that is easily sufficient to withstand the total operating force.
- Panel-mounting Switches can be divided into two categories according to the mounting method: snap-in mounting models and screw-mounting models. Snap-in mounting Switches are held in place with the elasticity of resin or a metal leaf spring. Do not attempt to modify the spring after mounting. Doing so may result in faulty operation or damage the mounting structure. Mount screw-mounting models using the screws and nuts provided (or individually specified). Tighten the screws to the specified torque. Mounting with different screws or nuts, or tightening beyond the specified torque may result in distortion of the inside of the case or damage to the screw section.

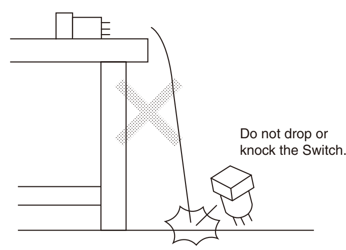
Snap-in Mounting

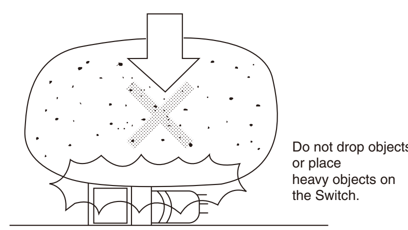


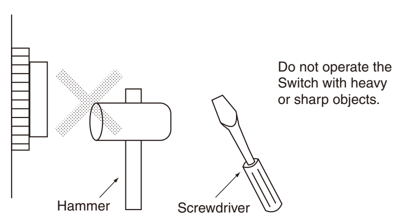
Screw Mounting



- Subjecting the Switch to severe vibrations or shock may result in faulty operation or damage. Also, many of the Switches are composed of resin so contact with sharp objects may result in damage to the surface. This kind of damage may spoil the appearance of the Switch or result in faulty operation. Do not throw or drop the Switch.



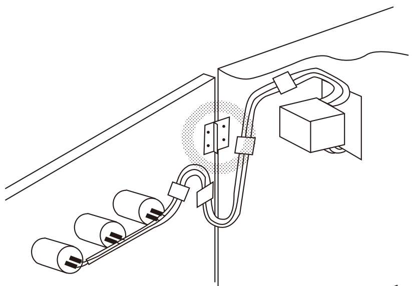


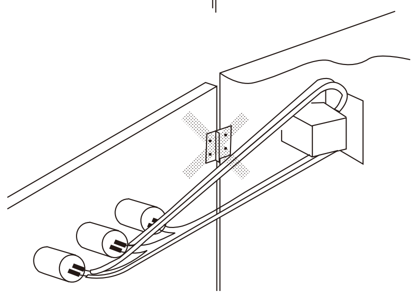


Mounting Precautions

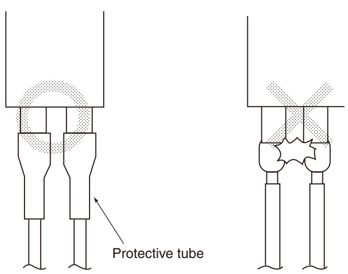
Wiring

- Perform wiring so that the lead wires will not be caught on other objects as this will cause stress on the Switch terminals. Wire the Switch so that there is slack in the lead wires and fix lead wires at intermediate points. If the panel to which the Switch is mounted needs to be opened and closed for maintenance purposes, perform wiring so that the opening and closing of the panel will not interfere with the wiring.





- With miniature Switches, the gap between the terminals is very narrow. Use protective or heat-absorbing tubes to prevent burning of the wire sheath or shorting.



Soldering

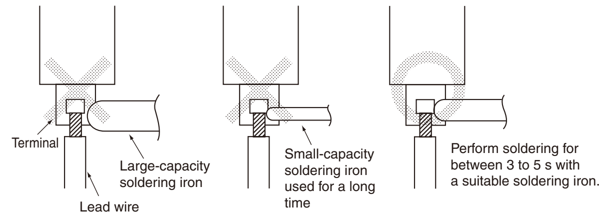
- There are two methods for soldering the Switch: hand soldering and automatic soldering. In addition, automatic soldering itself can be divided into two types : dip soldering and reflow soldering. Use the soldering method appropriate for the mounting method.

Typical Soldering Example

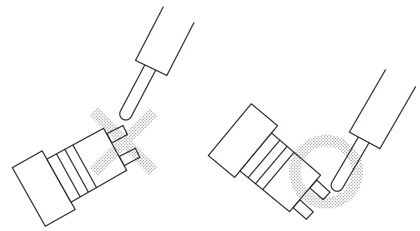
Method		Soldering device	Application
Hand soldering		Soldering iron	Small quantities Different materials Lead wire terminals
Automatic soldering	Dip soldering	Jet soldering bath Dip soldering bath	Large quantities of discrete terminals
	Reflow soldering	Infrared reflow (IR) soldering bath Vapor-phase (VPS) reflow soldering bath	Large quantities of miniature SMD terminals

- Do not use soldering flux that contains chlorine. Doing so may result in metal corrosion.

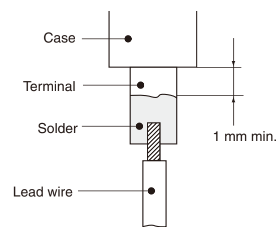
- Perform hand soldering using the appropriate soldering iron.



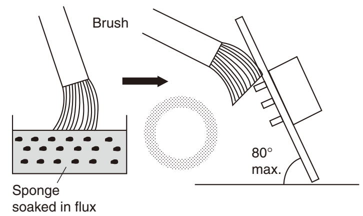
- With the exception of PCB-mounting Switches, when performing hand soldering, hold the Switch so that the terminals point downwards so that flux does not get inside the Switch.

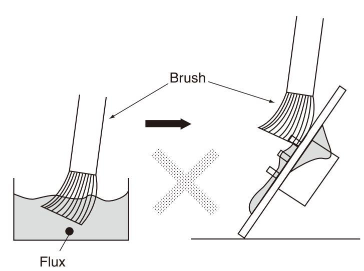


- Leave a gap of at least 1 mm between the soldered parts and the surface of the case so that flux does not get inside the Switch.

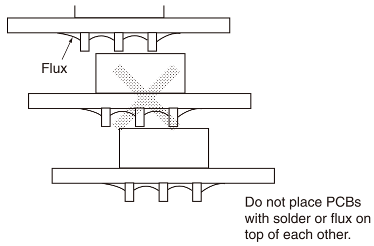


- When applying flux using a brush, use a sponge soaked in flux as shown below. Do not apply more than is necessary. Also, apply the flux with the PCB inclined at an angle of less than 80° so that flux does not flow onto the mounting surface of the Switch.

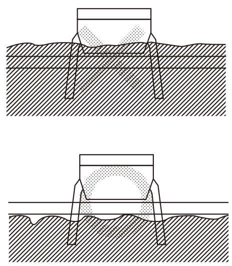




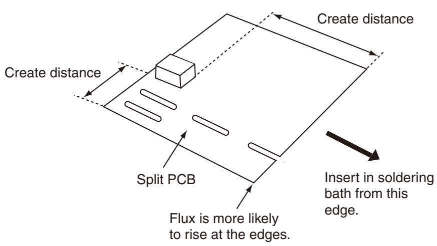
- Do not place PCBs that have had flux applied or have been soldered on top of each other. Otherwise, the flux on the PCBs solder surface may stain the upper part of the Switch or even permeate the inside of the Switch and cause contact failure. Be sure to insert a special PCB stocker.



- When performing soldering with a dip soldering bath, ensure that the flux does not reach a higher level than the PCB.

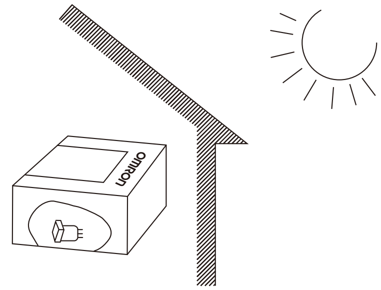


- Flux is especially likely to rise up at the edges of the PCB. If the Switch is mounted near the edge of the PCB, create a gap between the edge by using a split PCB, and insert the PCB in the soldering bath so that the edge that is farthest from the Switch enters the bath first.



Storage

- When the Switch is left unused or stored for long periods, the ambient conditions can have a great effect on the condition of the Switch. In certain environments, leaving the Switch exposed may result in deterioration (i.e., oxidation, or the creation of an oxide film) of the contacts and terminals, causing the contact resistance to increase, and making it difficult to solder the lead wires. Therefore, store in a well-ventilated room, inside, for example, a non-hygroscopic case, in a location where no corrosive gases are present.



- If the Switch is stored in a location where it will be exposed to direct light, colored resin in the colored plate may fade. Therefore, do not store the Switch in locations where it will be exposed to direct light.

⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

In the interest of product improvement, specifications are subject to change without notice.

OMRON Corporation
Industrial Automation Company

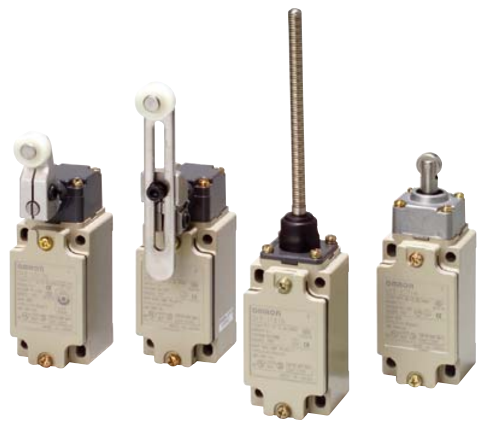
http://www.ia.omron.com/

Safety Limit Switch

D4B-□N

Snap-action contact with certified direct opening operation certification . Maintenance, seal, and resistance to shock increased and direct opening mechanism added. Three-conduit switches and 2NC switches are also available.

Note: Contact your sales representative for details on models with safety standard certification.



- Direct opening mechanism (NC contacts only) added to enable opening contacts when faults occur, such as fused contacts.
- Safety of lever settings ensured using a mechanism that engages a gear between the operating position indicator plate and the lever.
- Equipped with a mechanism that indicates the applicable operating zone, as well as push-button switching to control left and right motion.
- Head seal structure strengthened to improve seal properties (TÜV: IEC IP67, UL: NEMA 3, 4, 4X, 6P, and 13).
- Wide standard operating temperature range: –40 to 80°C (standard type).
- Models with gold-plated contacts added to the series to enable handling microloads.
- Certified standards: UL, CSA, EN (TÜV), and CCC.

⚠ Be sure to read the *"Safety Precautions"* on page 13 and the *"Precautions for All Safety Limit Switches"* .

Model Number Structure

Model Number Legend

D4B-□□□□N

1 2 3

1. Conduit size
- 1: PG13.5 (1-conduit)
- 2: G1/2 (PF1/2) (1-conduit)
- 3: 1/2-14NPT (1-conduit)
- 5: PG13.5 (3-conduit)
- 6: G1/2 (PF1/2) (3-conduit)
- 7: 1/2-14NPT (3-conduit)

2. Built-in Switch
- 1: 1NC/1NO (snap-action)
- 3: 1NC/1NO (snap-action) gold-plated contacts
- 5: 1NC/1NO (slow-action) *
- 6: 1NC/1NO (slow-action) gold-plated contacts *
- A: 2NC (slow-action)
- B: 2NC (slow-action) gold-plated contacts

* Excluding D4B-□□81N and D4B-□□87N models.

3. Actuator
- 00: Switch box (without head)
- 11: Roller lever (resin roller)
- 15: Roller lever (stainless steel roller)
- 1R: Roller lever (conventional D4B-compatible)
- 16: Adjustable roller lever
- 17: Adjustable rod lever
- 70: Top plunger
- 71: Top roller plunger
- 81: Coil spring
- 87: Plastic rod

Ordering Information

Set Model Numbers

Safety Limit Switches (with Direct Opening Mechanism)

Actuator	Conduit openings	1NC/1NO (Snap-action)		1NC/1NO (Slow-action)		2NC (Slow-action)	
		Model	Direct opening	Model	Direct opening	Model	Direct opening
Roller lever (resin roller)	Pg13.5	**D4B-1111N**		**D4B-1511N**		**D4B-1A11N**	
	G1/2 (PF1/2)	**D4B-2111N**		**D4B-2511N**		**D4B-2A11N**	
	1/2-14NPT	**D4B-3111N**		**D4B-3511N**		**D4B-3A11N**	
	Pg13.5 (3-conduit)	**D4B-5111N**		**D4B-5511N**		**D4B-5A11N**	
	G1/2 (3-conduit)	**D4B-6111N**		**D4B-6511N**		**D4B-6A11N**	
	1/2-14NPT (3-conduit)	**D4B-7111N**		**D4B-7511N**		**D4B-7A11N**	
Roller lever (stainless steel roller)	Pg13.5	**D4B-1115N**		**D4B-1515N**		**D4B-1A15N**	
	G1/2 (PF1/2)	**D4B-2115N**		**D4B-2515N**		**D4B-2A15N**	
	1/2-14NPT	**D4B-3115N**		**D4B-3515N**		**D4B-3A15N**	
	Pg13.5 (3-conduit)	**D4B-5115N**		**D4B-5515N**		**D4B-5A15N**	
Top plunger	Pg13.5	**D4B-1170N**		**D4B-1570N**		**D4B-1A70N**	
	G1/2 (PF1/2)	**D4B-2170N**		**D4B-2570N**		**D4B-2A70N**	
	1/2-14NPT	**D4B-3170N**		**D4B-3570N**		**D4B-3A70N**	
	Pg13.5 (3-conduit)	**D4B-5170N**		**D4B-5570N**		**D4B-5A70N**	
	G1/2 (3-conduit)	**D4B-6170N**		**D4B-6570N**		**D4B-6A70N**	
	1/2-14NPT (3-conduit)	**D4B-7170N**		**D4B-7570N**		**D4B-7A70N**	
Top roller plunger	Pg13.5	**D4B-1171N**		**D4B-1571N**		**D4B-1A71N**	
	G1/2 (PF1/2)	**D4B-2171N**		**D4B-2571N**		**D4B-2A71N**	
	1/2-14NPT	**D4B-3171N**		**D4B-3571N**		**D4B-3A71N**	
	Pg13.5 (3-conduit)	**D4B-5171N**		**D4B-5571N**		**D4B-5A71N**	
	G1/2 (3-conduit)	**D4B-6171N**		**D4B-6571N**		**D4B-6A71N**	
	1/2-14NPT (3-conduit)	**D4B-7171N**		**D4B-7571N**		**D4B-7A71N**	

General-purpose Limit Switches

Actuator	Conduit openings	1NC/1NO (Snap-action)		1NC/1NO (Slow-action)		2NC (Slow-action)	
		Model	Direct opening	Model	Direct opening	Model	Direct opening
Adjustable roller lever	Pg13.5	**D4B-1116N**	---	**D4B-1516N**	---	**D4B-1A16N**	---
	G1/2 (PF1/2)	**D4B-2116N**		**D4B-2516N**		**D4B-2A16N**	
	1/2-14NPT	**D4B-3116N**		**D4B-3516N**		**D4B-3A16N**	
	Pg13.5 (3-conduit)	**D4B-5116N**		**D4B-5516N**		**D4B-5A16N**	
	G1/2 (3-conduit)	**D4B-6116N**		**D4B-6516N**		**D4B-6A16N**	
	1/2-14NPT (3-conduit)	**D4B-7116N**		**D4B-7516N**		**D4B-7A16N**	
Adjustable rod lever	Pg13.5	**D4B-1117N**	---	**D4B-1517N**	---	**D4B-1A17N**	---
	G1/2 (PF1/2)	**D4B-2117N**		**D4B-2517N**		**D4B-2A17N**	
	1/2-14NPT	**D4B-3117N**		**D4B-3517N**		**D4B-3A17N**	
	Pg13.5 (3-conduit)	**D4B-5117N**		**D4B-5517N**		**D4B-5A17N**	
	G1/2 (3-conduit)	**D4B-6117N**		**D4B-6517N**		**D4B-6A17N**	
	1/2-14NPT (3-conduit)	**D4B-7117N**		**D4B-7517N**		**D4B-7A17N**	
Coil spring (non-directional)	Pg13.5	**D4B-1181N**	---	---		**D4B-1A81N**	---
	G1/2 (PF1/2)	**D4B-2181N**				**D4B-2A81N**	
	1/2-14NPT	**D4B-3181N**				**D4B-3A81N**	
	Pg13.5 (3-conduit)	**D4B-5181N**				**D4B-5A81N**	
	G1/2 (3-conduit)	**D4B-6181N**				**D4B-6A81N**	
	1/2-14NPT (3-conduit)	**D4B-7181N**				**D4B-7A81N**	
Plastic rod (non-directional)	Pg13.5	**D4B-1187N**	---			**D4B-1A87N**	---
	G1/2 (PF1/2)	**D4B-2187N**				**D4B-2A87N**	
	1/2-14NPT	**D4B-3187N**				**D4B-3A87N**	
	Pg13.5 (3-conduit)	**D4B-5187N**				**D4B-5A87N**	
	G1/2 (3-conduit)	**D4B-6187N**				**D4B-6A87N**	
	1/2-14NPT (3-conduit)	**D4B-7187N**				**D4B-7A87N**	

Note: 1. In addition to the above models, models compatible with the previous D4B Switches (with standard rotary levers) are available.
Model number examples: D4B-1□1RN(Pg13.5) or D4B-2□1RN(PF1/2)

2. Consult your OMRON representative for products with BIA or SUVA certification.

Replacement Parts

Switch Boxes

Built-in switch \ Conduit	1-conduit type			3-conduit type		
	PG13.5	G1/2	1/2-14NPT	PG13.5	G1/2	1/2-14NPT
1NC/1NO (Snap-action)	D4B-1100N	D4B-2100N	D4B-3100N	D4B-5100N	D4B-6100N	D4B-7100N
1NC/1NO (Slow-action)	D4B-1500N	D4B-2500N	D4B-3500N	D4B-5500N	D4B-6500N	D4B-7500N
2NC (Slow-action)	D4B-1A00N	D4B-2A00N	D4B-3A00N	D4B-5A00N	D4B-6A00N	D4B-7A00N

Operating Heads

Actuator	Type	Model
Side rotary *	Standard	D4B-0010N
Top plunger	Plain	D4B-0070N
	Top roller plunger	D4B-0071N
Flexible-rod	Coil spring	D4B-0081N
	Plastic rod	D4B-0087N

* The Lever is not included with the Side Rotary Operating Head.

Levers

Actuator	Length (mm)	Diameter of roller	Model
Standard	31.5	17.5 dia.	D4B-0001N
Stainless steel roller lever	31.5	17.5 dia.	D4B-0005N
Adjustable roller lever	25 to 89	19 dia.	D4B-0006N
Adjustable rod lever	145 max.	---	D4B-0007N
Interchangeable with D4B-0001	33.7	19 dia.	D4B-000RN

Note: Other types of lever are also available.

Specifications

Standards and EC Directives

Conforms to the following EC Directives:

- Machinery Directive
- Low Voltage Directive
- EN1088
- EN50041

Certified Standards

Snap-action Models

Certification body	Standard	File No.
TÜV Rheinland	EN60947-5-1 (certified direct opening mechanism) GS-ET-15	J9851083
	EN60947-5-1 (uncertified direct opening mechanism)	J50005477 *
UL	UL508	E76675
CSA	C22.2 No. 14	LR45746
CQC (CCC)	GB14048.5	2003010305077612

* Adjustable roller lever, adjustable rod lever, coil spring, and plastic rod models only.

Slow-action Models

Certification body	Standard	File No.
TÜV Rheinland	EN60947-5-1 (certified direct opening mechanism) GS-ET-15	J9851083
	EN60947-5-1 (uncertified direct opening mechanism)	J50005477 *
UL	UL508	E76675
CSA	C22.2 No. 14	LR45746
CQC (CCC)	GB14048.5	2003010305077612

* Adjustable roller lever, adjustable rod lever, coil spring, and plastic rod models only.

Certified Standard Ratings

TÜV (EN60947-5-1), CCC (GB14048.5)

Item Utilization category	AC-15
Rated operating current (I_e)	2 A
Rated operating voltage (U_e)	400 V

Note: As protection against short-circuiting, use either a gI-type or gG-type 10 A fuse that conforms to IEC60269.

UL/CSA: (UL508, CSA C22.2 No. 14)

A600

Rated voltage	Carry current	Current (A)		Volt-amperes (VA)	
		Make	Break	Make	Break
120 VAC 240 VAC 480 VAC 600 VAC	10 A	60 30 15 12	6 3 1.5 1.2	7,200	720

Ratings

Rated voltage (V)	Non-inductive load (A)				Inductive load (A)			
	Resistive load		Lamp load		Inductive load		Motor load	
	NC	NO	NC	NO	NC	NO	NC	NO
125 VAC	10		3	1.5	10		5	2.5
250	10		2	1	10		3	1.5
400	10		1.5	0.8	3		1.5	0.8
8 VDC	10		6	3	10		6	
14	10		6	3	10		6	
30	6		4	3	6		4	
125	0.8		0.2	0.2	0.8		0.2	
250	0.4		0.1	0.1	0.4		0.1	

Note: 1. The above values are continuous currents.
2. Inductive loads have a power factor of 0.4 or higher (AC) or a time constant of 7 ms or lower (DC).
3. Lamp loads have a inrush current of 10 times the normal current.
4. Motor loads have a inrush current of 6 times the normal current.

Inrush current	30 A max.

Characteristics

Degree of protection *1		IP67 (EN60947-5-1)
Durability *2	**Mechanical**	30,000,000 operations min. (snap-action) 10,000,000 operations min. (slow-action)
	Electrical	500,000 operations min. (10 A resistive load at 250 VAC)
Operating speed		1 mm/s to 0.5 m/s
Operating frequency	**Mechanical**	120 operations/minute
	Electrical	30 operations/minute
Contact resistance		25 mΩ max.
Rated insulation voltage (U_i)		600 V (EN60947-5-1)
Rated frequency		50/60 Hz
Protection against electric shock		Class I (with ground terminal)
Pollution degree (operating environment)		3 (EN60947-5-1)
Impulse withstand voltage (EN60947-5-1)	**Between terminals of same polarity**	2.5 kV (snap-action)/4 kV (slow-action)
	Between terminals of different polarity	4 kV (slow-action)
	Between each terminal and ground	4 kV
Insulation resistance		100 MΩ min. (at 500 VDC) between terminals of the same polarity and between each terminal and non-current-carrying part
Contact gap		2 × 2 mm min. (slow-action) 0.5 × 2 mm min. (snap-action)
Vibration resistance	**Malfunction**	10 to 55 Hz, 0.75 mm single amplitude
Shock resistance	**Destruction**	1,000 m/s^2 min.
	Malfunction	300 m/s^2 min.
Conditional short-circuit current		100 A (EN60947-5-1)
Conventional enclosed thermal current (I_{the})		20 A (EN60947-5-1)
Ambient operating temperature		–40 to 80°C (with no icing) *3
Ambient operating humidity		95% max.
Weight		Approx. 250 g

Note: 1. The above values are initial values.
2. The above values may vary depending on the model. Consult your OMRON sales representative for details.

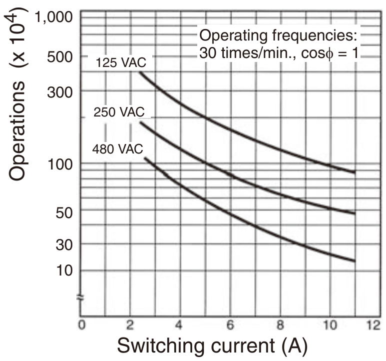
*1. The degree of protection is tested using the method specified by the standard (EN60947-5-1). Confirm that sealing properties are sufficient for the operating conditions and environment beforehand.
*2. The durability is for an ambient temperature of 5 to 35°C and ambient humidity of 40% to 70%. For further conditions, consult your OMRON sales representative.
*3. –20 to 80°C for the flexible-rod type.

Engineering Data

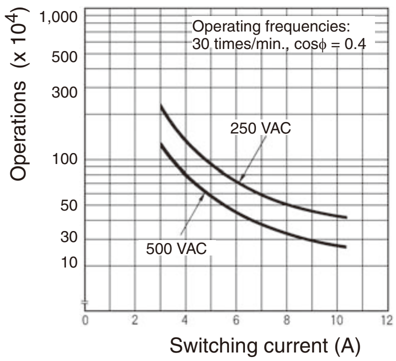
Electrical Durability (Snap-action)

(Ambient temperature: 5 to 30°C, ambient humidity: 40 to 70%)

(cosϕ = 1)



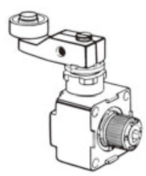
(cosϕ = 0.4)

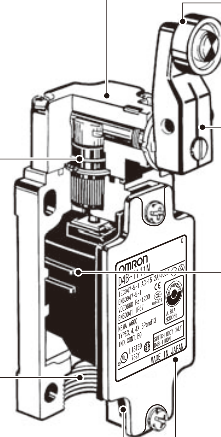


Structure and Nomenclature

Structure

The roller lever switch employs a system which allows selection of operation on only one side (left or right) or both sides without the use of any tools.





Head
Can be connected in any of four directions (except for Roller Plunger Models, which can be connected at either of 2 directions that differ by 90°)

Roller
Nylon rollers used for superior resistance to wear.

Lever (Form Lock Structure)
The lever has an operating position indication plate and grooves that mate every 90° to prevent slipping between the rotary axis and lever.

Seal Ring
Sealing properties improved by using a X ring and bearing-free structure.

Built-in Switch
Direct opening mechanism used for NC contact to separate contact for faults, such as contact welding. The heights of the NC and NO terminals are different to enable easier wiring.

Conduit Opening
Models are available with a wide range of conduits.

Size / Box	1-conduit model	2-conduit model
Pg13.5	Yes	Yes
G1/2	Yes	Yes
1/2-14NPT	Yes	Yes

Note: NBR is used for rubber parts.

Cover

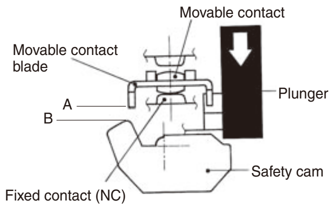
Ground Screw
Ground screws are provided on all models for increased safety.

Direct Opening Mechanism

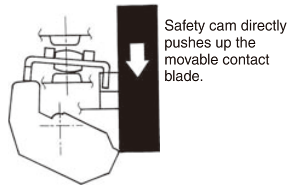
1NO/1NC Contact (Snap-action)

Conforms to EN60947-5-1 Direct Opening (Only NC contact has a direct opening mechanism.)

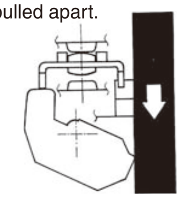
1. When contact welding occurs.



2. When contacts are being pulled apart.

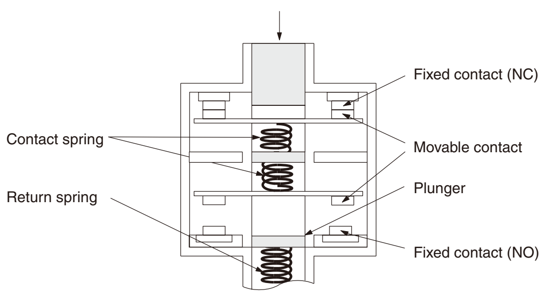


3. When contacts are completely pulled apart.



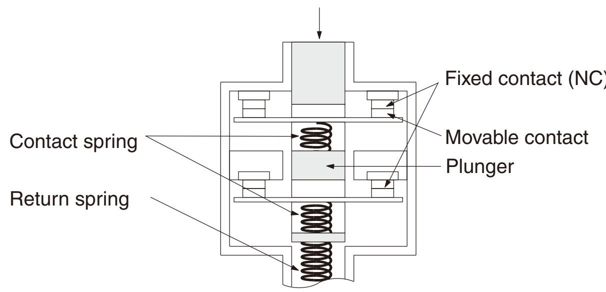
1NC/1NO Contact (Slow-action)

Conforms to EN60947-5-1 Direct Opening
(Only NC contact has a direct opening mechanism.)
When contact welding occurs, the contacts are separated from each other by the plunger being pushed in.

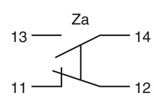
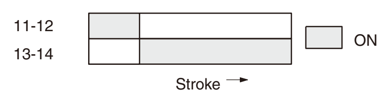
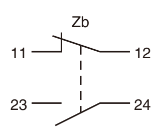
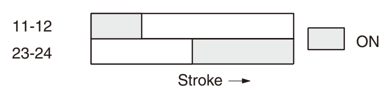
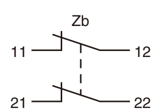
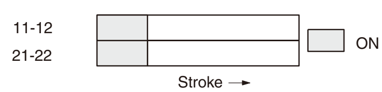


2NC Contact (Slow-action)

Conforms to EN60947-5-1 Direct Opening
(Both NC contacts have a direct opening mechanism.)



Contact Form

Model	Contact	Contact form	Diagrams	Explanation
D4B-□1□N	1NC/1NO (Snap-action)			Only NC contact 11-12 has a certified direct opening mechanism. Terminal numbers 11-12 and 13-14 cannot be used as unlike poles.
D4B-□5□N	1NC/1NO (Slow-action)			Only NC contact 11-12 has a certified direct opening mechanism. Terminal numbers 11-12 or 23-24 can be used as unlike poles.
D4B-□A□N	2NC (Slow-action)			Both NC contacts 11-12 and 21-22 have a certified direct opening mechanism. Terminal numbers 11-12 and 21-22 can be used as unlike poles.

Note: Terminal numbers are according to EN50013; contact symbols are according to IEC60947-5-1.

Dimensions and Operating Characteristics

(Unit: mm)

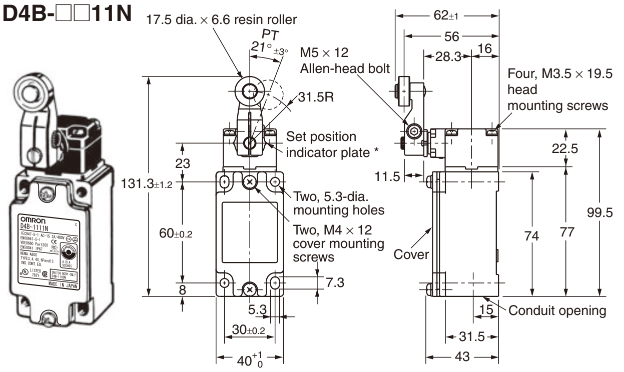
Note: Omitted dimensions are the same as those for the Roller Lever Type Models
D4B-1□□□N and D4B-5□□□N have a PG13.5 conduit opening. D4B-2□□□N and D4B-6□□□N have a G1/2 conduit opening.
D4B-3□□□N and D4B-7□□□N have a 1/2-14NPT conduit opening.

Switches

1-conduit Models

Roller Lever

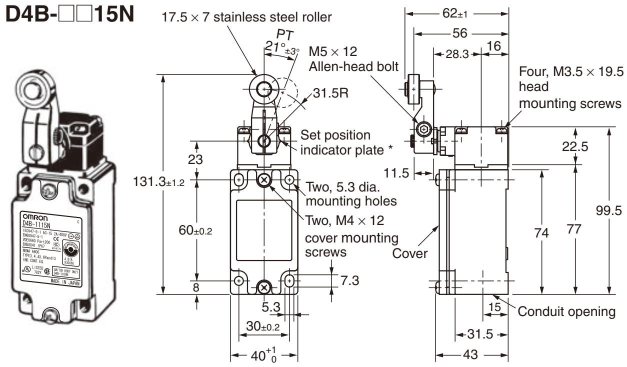
D4B-□□11N



* The lever can be set to any desired position by turning the operating position indicator.

Roller Lever (Stainless Steel Roller)

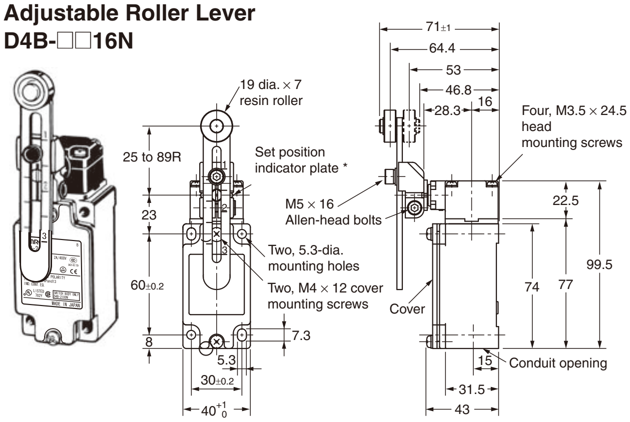
D4B-□□15N



* The lever can be set to any desired position by turning the operating position indicator.

Adjustable Roller Lever

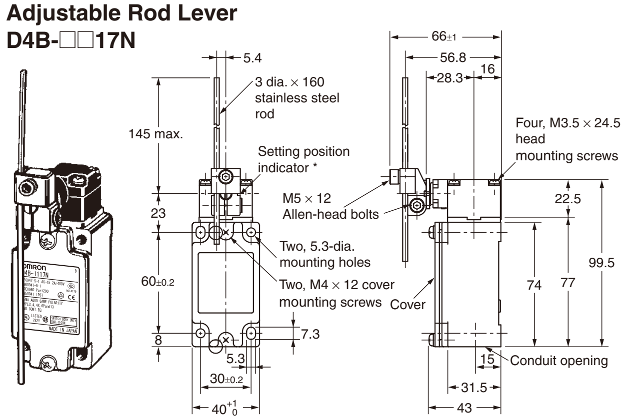
D4B-□□16N



* The lever can be set to any desired position by turning the operating position indicator.

Adjustable Rod Lever

D4B-□□17N



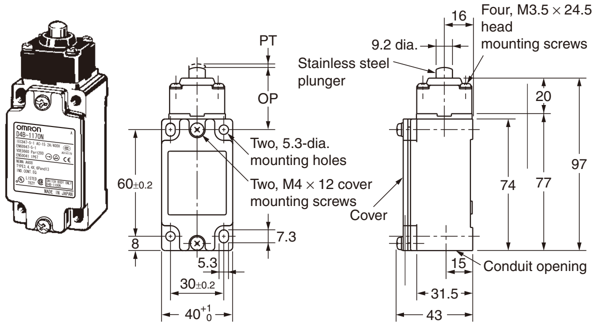
* The lever can be set to any desired position by turning the operating position indicator.

Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

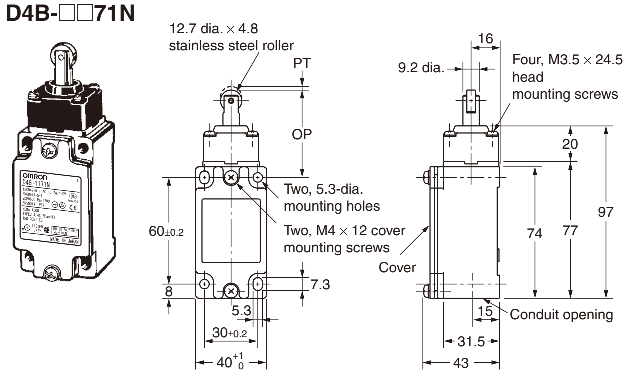
Operating characteristics	Model	D4B-□□11N	D4B-□□15N	D4B-□□16N *1	D4B-□□17N *2
Operating force	OF max.	9.41N	9.41N	9.41N	2.12N
Release force	RF min.	1.47N	1.47N	1.47N	0.29N
Pretravel	PT	21°±3°	21°±3°	21°±3°	21°±3°
	PT (2nd) *3 *5	(45°)	(45°)	(45°)	(45°)
Overtravel	OT min.	50°	50°	50°	50°
Movement differential	MD max. *4	12°	12°	12°	12°
Direct opening travel	DOT min. *3 *6	35°	35°	35°	35°
	*4 *6	55°	55°	55°	55°
Direct opening force	DOF min. *6	19.61N	19.61N	19.61N	19.61N
Total travel	TT *5	(75°)	(75°)	(75°)	(75°)

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC contacts. Check contact operation.
*1. The operating characteristics of these Switches were measured with the roller level set at 31.5 mm.
*2. The operating characteristics of these Switches were measured with the rod level set at 140 mm.
*3. Only for slow-action models.
*4. Only for snap-action models.
*5. Reference values.
*6. Must be provided to ensure safe operation.

Top Plunger
D4B-□□70N



Top Roller Plunger
D4B-□□71N



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

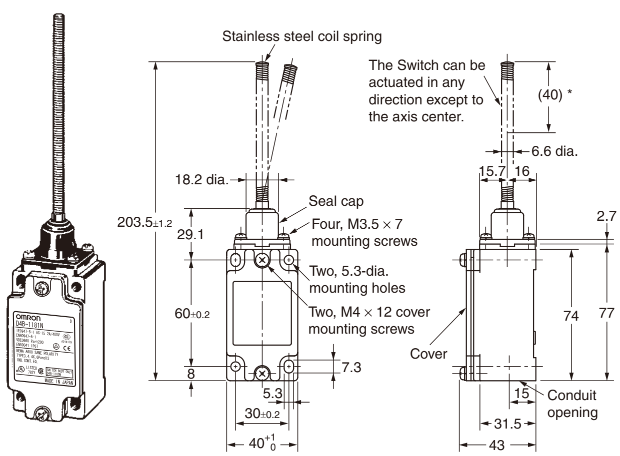
Operating characteristics	Model	D4B-□□70N	D4B-□□71N
Operating force	**OF max.**	18.63 N	18.63 N
Release force	**RF min.**	1.96 N	1.96 N
Pretravel	**PT max.**	2 mm	2 mm
	PT (2nd) *1 *3	(3 mm)	(3 mm)
Overtravel	**OT min.**	5 mm	5 mm
Movement differential	**MD max. *2**	1 mm	1 mm
Direct opening travel	**DOT min. *4**	3.2 mm	3.2 mm
Direct opening force	**DOF min. *4**	49.03 N	49.03N
Total travel	**TT *3**	(7 mm)	(7 mm)
Free position	**FP max.**	38 mm	51 mm
Operating position	**OP**	35±1 mm	48±1 mm

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC contacts. Check contact operation.

*1. Only for slow-action models.
*2. Only for snap-action models.
*3. Reference values.
*4. Must be provided to ensure safe operation.

Coil Spring (Non-directional)
D4B-□□81N

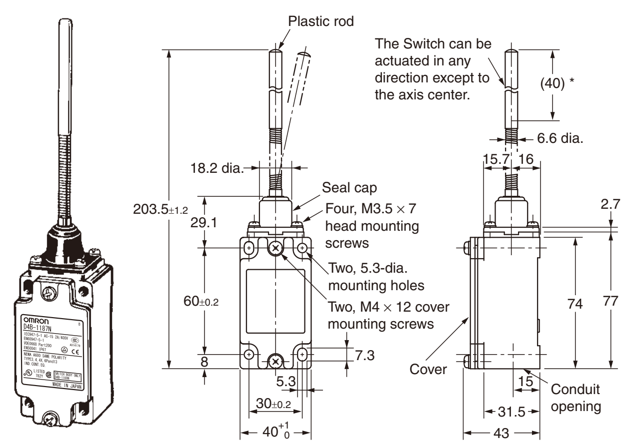
Mechanically speaking, these models are general limit switches and not safety limit switches.



* Be sure to adjust the dog to within 40 mm from the top end of the coil spring.

Plastic Rod (Non-directional)
D4B-□□87N

Mechanically speaking, these models are general limit switches and not safety limit switches.



* Be sure to adjust the dog to within 40 mm from the top end of the plastic rod.

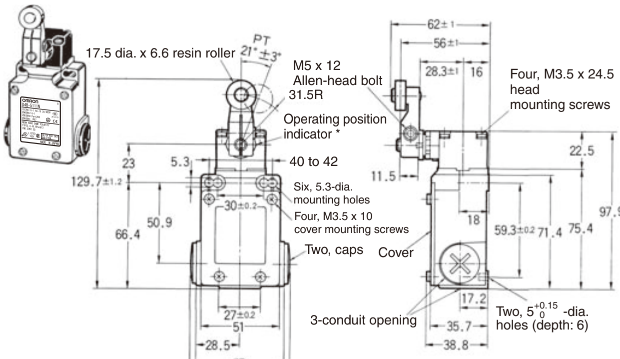
Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

Operating characteristics	Model	D4B-□□81N	D4B-□□87N
Operating force	**OF max.**	1.47 N	1.47 N
Pretravel	**PT max.**	15°	15°

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC contacts. Check contact operation.

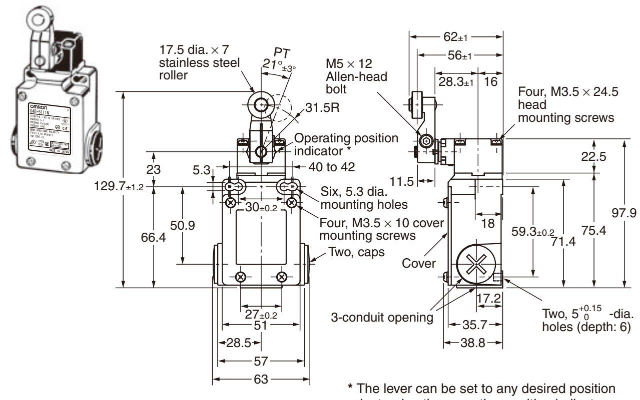
3-conduit Switches

Roller Lever
D4B-□□11N



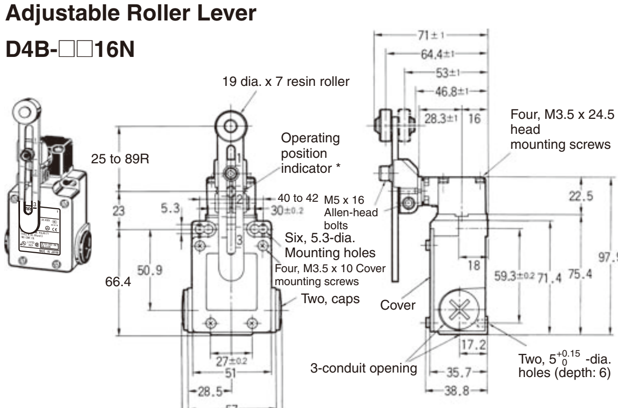
* The lever can be set to any desired position by turning the operating position indicator.

Roller Lever
D4B-□□15N



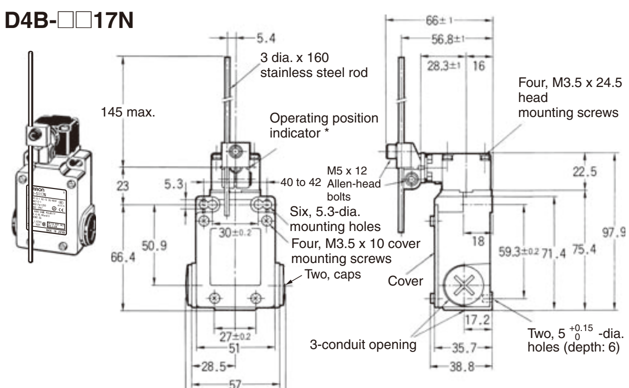
* The lever can be set to any desired position by turning the operating position indicator.

Adjustable Roller Lever
D4B-□□16N



* The lever can be set to any desired position by turning the operating position indicator.

Adjustable Rod Lever
D4B-□□17N



* The lever can be set to any desired position by turning the operating position indicator.

Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

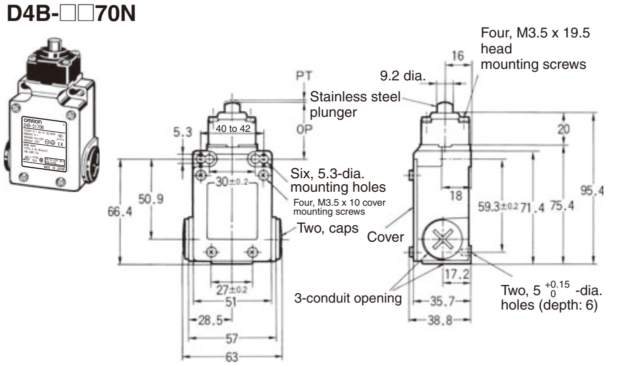
Operating characteristics	Model	D4B-□□11N	D4B-□□15N	D4B-□□16N *1	D4B-□□17N *2
Operating force	**OF max.**	9.41 N	9.41 N	9.41 N	2.12 N
Release force	**RF min.**	1.47 N	1.47 N	1.47 N	0.29 N
Pretravel	**PT**	21°±3°	21°±3°	21°±3°	21°±3°
	PT (2nd) *3 *5	(45°)	(45°)	(45°)	(45°)
Overtravel	**OT min.**	50°	50°	50°	50°
Movement differential	**MD max. *4**	12°	12°	12°	12°
Direct opening travel	**DOT min. *3 *6**	35°	35°	35°	35°
	***4 *6**	55°	55°	55°	55°
Direct opening force	**DOF min. *6**	19.61 N	19.61 N	19.61 N	19.61 N
Total travel	**TT *5**	(75°)	(75°)	(75°)	(75°)

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC contacts. Check contact operation.

*1. The operating characteristics of these Switches were measured with the roller level set at 31.5 mm.
*2. The operating characteristics of these Switches were measured with the rod level set at 140 mm.
*3. Only for slow-action models.
*4. Only for snap-action models.
*5. Reference values.
*6. Must be provided to ensure safe operation.

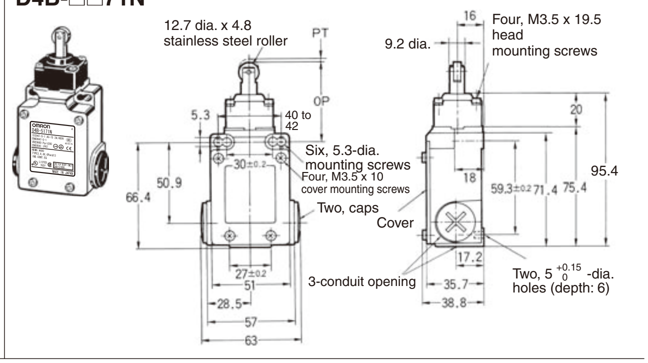
Top Plunger

D4B-□□70N



Top Roller Plunger

D4B-□□71N



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

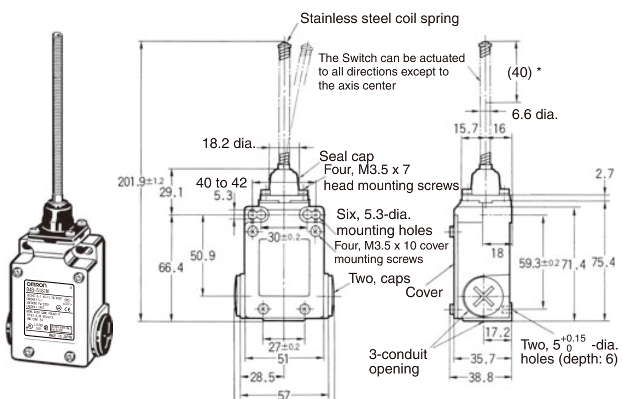
Operating characteristics	Model	D4B-□□70N	D4B-□□71N
Operating force	**OF max.**	18.63 N	18.63 N
Release force	**RF min.**	1.96 N	1.96 N
Pretravel	**PT max.**	2 mm	2 mm
	PT (2nd) *1 *3	(3 mm)	(3 mm)
Overtravel	**OT min.**	5 mm	5 mm
Movement differential	**MD max. *2**	1 mm	1 mm
Direct opening travel	**DOT min. *4**	3.2 mm	3.2 mm
Direct opening force	**DOF min. *4**	49.03 N	49.03N
Total travel	**TT *3**	(7 mm)	(7 mm)
Free position	**FP max.**	38 mm	51 mm
Operating position	**OP**	35±1 mm	48±1 mm

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC contacts. Check contact operation.

*1. Only for slow-action models.
*2. Only for snap-action models.
*3. Reference values.
*4. Must be provided to ensure safe operation.

Coil Spring

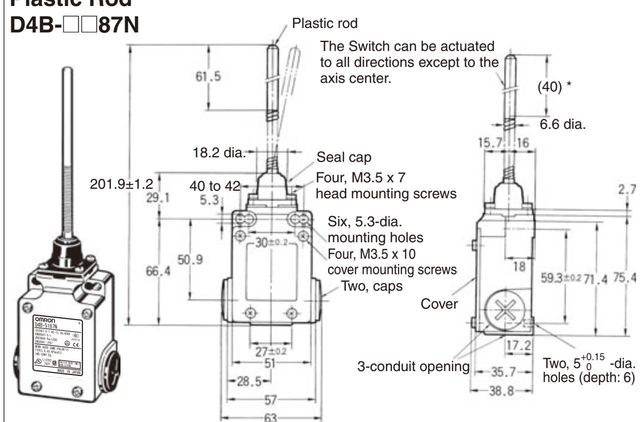
D4B-□□81N



* Set the spring so that the dog comes in contact at a point 40 mm from the tip.

Plastic Rod

D4B-□□87N



* Set the spring so that the dog comes in contact at a point 40 mm from the tip.

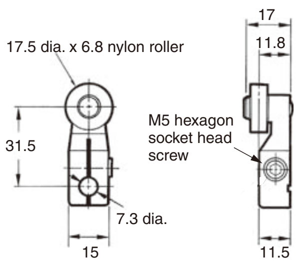
Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

Operating characteristics	Model	D4B-□□81N	D4B-□□87N
Operating force	**OF max.**	1.47 N	1.47 N
Pretravel	**PT max.**	15°	15°

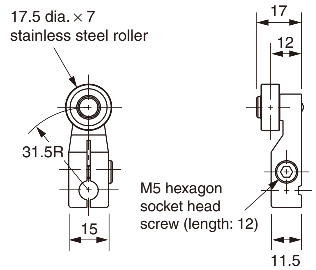
Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC contacts. Check contact operation.

Levers (Applicable for Roller Lever Models only)

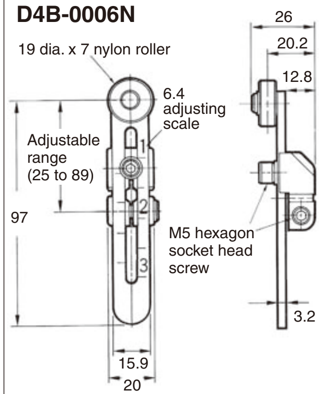
Roller Lever
D4B-0001N



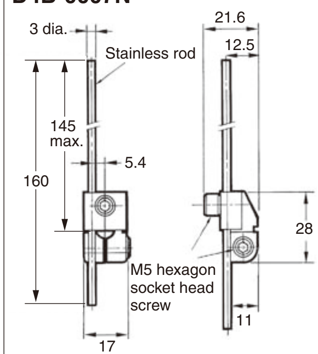
Roller Lever (Stainless Steel Roller)
D4B-0005N



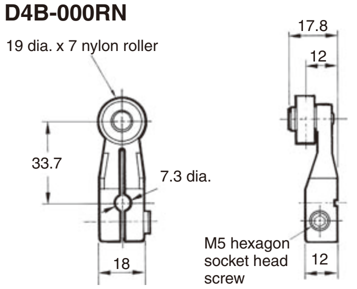
Adjustable Roller Lever
D4B-0006N



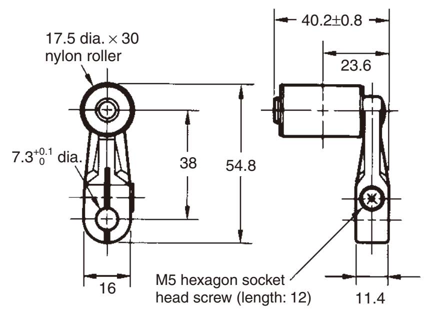
Adjustable Rod Lever
D4B-0007N



Roller Lever (Compatible with Previous D4B Model)
D4B-000RN

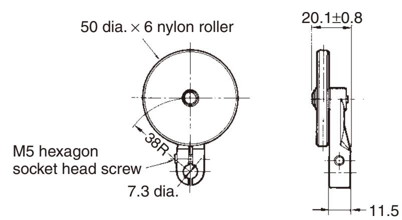


Roller Lever
WL-1A118



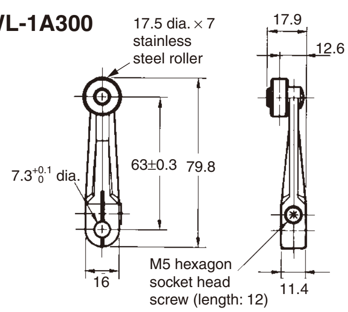
Note: Reverse the indicator plate when mounting.

Roller Lever
WL-1A106



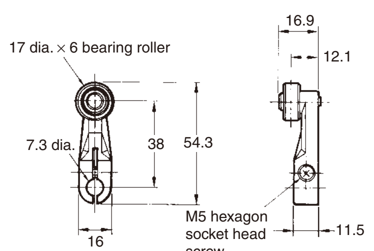
Note: Reverse the indicator plate when mounting.

Roller Lever
WL-1A300



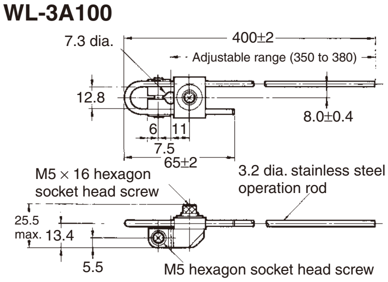
Note: Reverse the indicator plate when mounting.

Roller Lever
WL-1A400



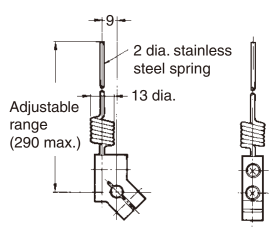
Note: Reverse the indicator plate when mounting.

Adjustable Rod Lever
WL-3A100



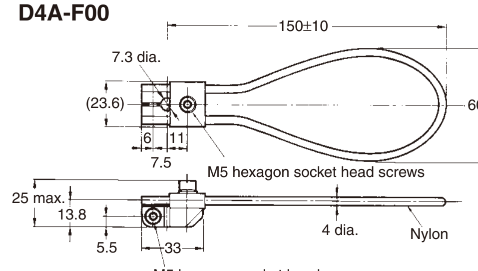
Note: Reverse the indicator plate when mounting.

Spring Rod Lever
WL-4A201



Note: Reverse the indicator plate when mounting.

Resin Loop Lever
D4A-F00



Note: Reverse the indicator plate when mounting.

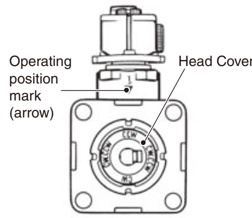
Note: 1. Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
2. Safety Limit Switch specifications are satisfied with D4B-□□□□N Levers only (example: D4B-0001N).
The D4B-0006N Adjustable Roller Lever and D4B-0007N Adjustable Rod Lever, however, cannot be used. Do not order them for a Side Rotary Operating Head.

Application Precaution

Changing the Operating Direction

Switches with Roller Levers

The operating direction of the lever can be easily changed without using any tools. It can be set to clockwise operation (CW) or counterclockwise (CCW) operation.
Use the procedure given at the right to change the operating direction.



Operating section (on back of Head)	Operating procedure
(see figure above)	**1.** Remove the four Head set screws and remove the Head from the Switch Box.
	2. Turn the bottom of the Head toward you, press in the Head Cover shown in the diagram at the left, and turn the Cover clockwise or counterclockwise. **Note:** The factory setting is for “CW.CCW.”
	3. The “CW” setting is for clockwise operation and the “CCW” setting is for counterclockwise operation. Set the Cover to the desired position.

Safety Precautions

Refer to the *“Precautions for All Switches”* and *“Precautions for All Safety Limit Switches”.*

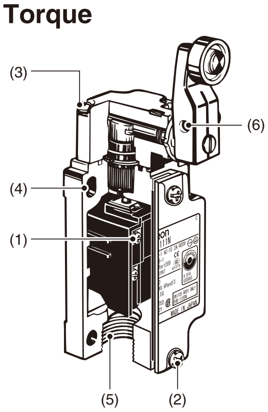
Precautions for Safe Use

- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of oil or water. Doing so may result in oil or water entering the Switch interior. (The IP67 degree of protection specification for the Switch refers to water penetration while the Switch is submersed in water for a specified period of time.)
- Always attach the cover after completing wiring and before using the Switch. Also, do not turn ON the Switch with the cover open. Doing so may result in electric shock.

Precautions for Correct Use

Appropriate Tightening Torque

Be sure to tighten each screw of the D4B-□N properly, otherwise the D4B-□N may malfunction.



	Type	Appropriate tightening torque
1	M3.5 terminal screw	0.59 to 0.78 N·m
2	Cover mounting screw *	1.18 to 1.37 N·m
3	Head mounting screw	0.78 to 0.88 N·m
4	M5 body mounting screw	4.90 to 5.88 N·m
5	Connector	1.77 to 2.16 N·m
6	Lever Mounting Screws (Roller Levers)	4.90 to 5.88 N·m
---	Cap screw (for three-conduit models)	1.27 to 1.67 N·m

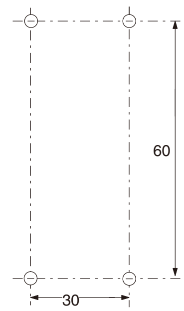
* Apply a tightening torque of 0.78 to 0.88 N·m to three-conduit models.

Mounting

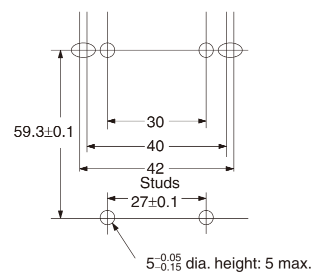
Use four M5 screws with washers to mount the standard model. Be sure to apply the proper torque to tighten each screw. The 3-conduit models can be mounted more securely by using the four screws plus two $5^{-0.05}_{-0.15}$ mm diameter studs, each of which has a maximum height of 4.8 mm as shown below.

Mounting Dimensions (M5)

Standard Model



3-conduit Model



Changes in Actuator Mounting Position

- To change the angle of the lever, loosen the Allen-head bolts on the side of the lever.
- The operating position indicator plate has protruding parts which engage with the lever, thus allowing changes to the lever position by 90°.
- The back of the operating position indicator plate has no protruding parts. If this plate is turned over and attached, any angle within a 360° range can be set. Do not turn over the plate, however, when using the D4B-□N as a switch with a certified direct opening mechanism. For an SUVA- or BIA-certified application, make sure that the lever engages with the operating position indicator plate securely so that the lever will not slip.

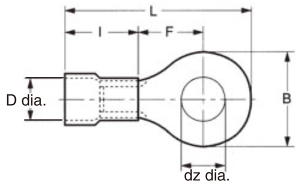
Changes in Head Mounting Position

By removing the screws on the four corners of the head, the head can be reset in any of four directions. Make sure that no foreign materials will penetrate through the head.

Wiring

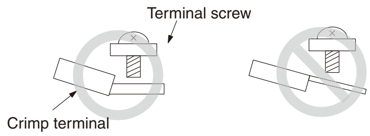
Do not connect the bare lead wires directly to the terminals but be sure to connect each of them by using an insulation tube and M3.5 round crimp terminals and tighten each terminal screw within the specified torque range.
The proper lead wire is 20 to 14 AWG (0.5 to 2.5 mm^2) in size.

dz dia.:	3.7 mm
D dia.:	4.5 mm
B:	7.0 mm
L:	20.2 mm
F:	7.7 mm
I:	9.0 mm

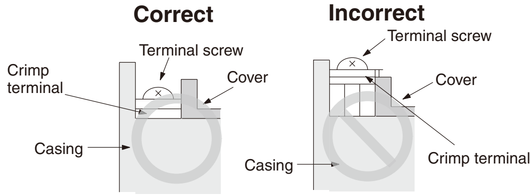


Make sure that all crimp terminals come into contact with the casing or cover as shown below, otherwise the cover may not be mounted properly or the D4B-□N may malfunction.

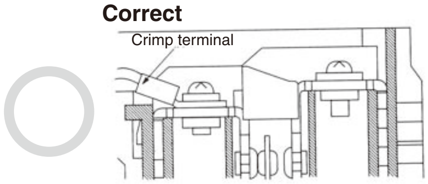
Correct **Incorrect**



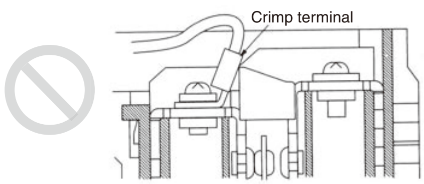
Correct **Incorrect**



Correct



Incorrect



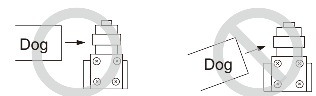
Conduit Opening

- Make sure that each connector is tightened within the specified torque range.
  The casing may be damaged if the connector is tightened excessively.
- If the 1/2-14NPT is used, cover the cable and conduit end with sealing tape in order to ensure IP67.
- The Pg13.5 connector must be Nippon Flex's ABS-08Pg13.5 or ABS-12 Pg13.5.
- Use an OMRON SC-series Connector (sold separately) that is suited to the cable in diameter.
- Properly attach the provided conduit cap to the unused conduit opening and securely tighten the cap screw within the specified torque when wiring the D4B-□N.

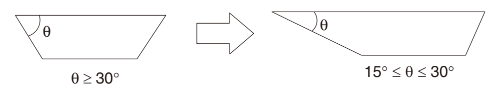
Others

- The load for the actuator (roller) of the Switch must be imposed on the actuator in the horizontal direction, otherwise the actuator or the rotating axis may be deformed or damaged.

Correct **Incorrect**



- When using a long lever model like the D4B-□□16N or D4B-□□17N, the Switch may telegraph. To avoid telegraphing, take the following precautions.
  1. Set the lever to operate in one direction.
  2. Modify the rear end of the dog to an angle of 15° to 30° as shown below or to a secondary-degree curve.



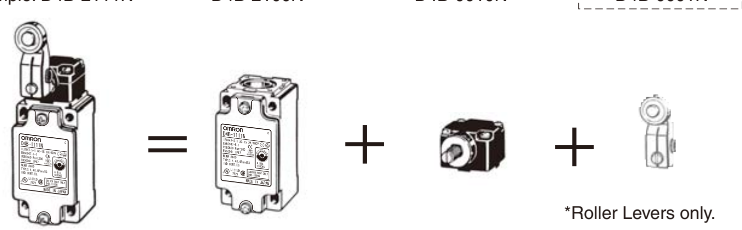
  3. Modify the circuit so as not to detect the wrong operating signals.

Ordering Method

The D4B-□N uses a block mounting method. Switches can be ordered either as sets or as individual parts. If a set is ordered, the Switch will be shipped with all parts assembled.

Note: For Switches with Roller Levers, do not order just the Head and Lever, or just the Switch Box and Lever.

			Individual model numbers				
Set model number	=	Switch Box	+	Head	+	Lever*
Example: D4B-2111N	=	D4B-2100N	+	D4B-0010N	+	D4B-0001N



*Roller Levers only.

Precautions for All Safety Limit Switches

Note: Refer to the "*Safety Precautions*" section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

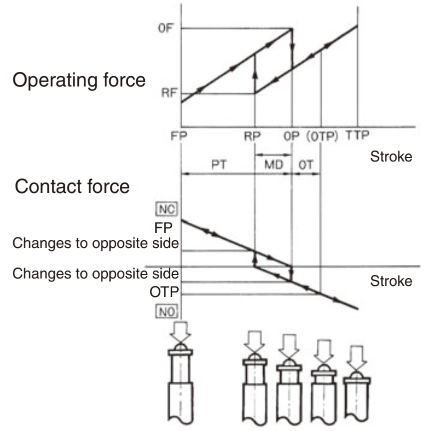
- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch box is protected from dust or water penetration, the head is not protected from minute foreign matter or water penetration. Ensure that minute foreign matter and water do not penetrate the head. Failure to do so may result in accelerated wear, Switch damage, or malfunctioning.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch as a stopper.
- Do not use the Switch in a startup circuit. Use it instead for a safety confirmation signal.
- Check the Switches before use and inspect regularly, replacing them when necessary. If a Switch is kept pressed for an extended period of time, the components may deteriorate quickly, and the Switch may not release.
- To protect the Switch from damage due to short-circuits, be sure to connect a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current in series with the Switch. When complying with EN certified ratings, use a 10 A IEC 60269-compliant gI or gG fuse.
- Do not drop the Switch. Doing so may prevent it from functioning to its full capacity.
- Do not disassemble or modify the Switch. Doing so may prevent it from operating correctly.

Precautions for Correct Use

Mechanical Characteristics

Operating Force, Stroke, and Contact Characteristics

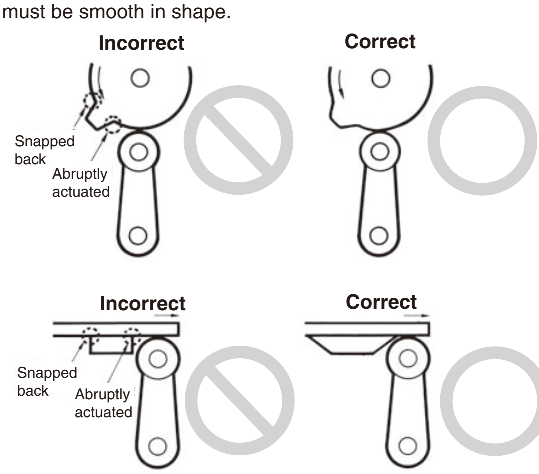
- The following graph indicates the relationship between operating force and stroke or stroke and contact force. In order to operate the Limit Switch with high reliability, it is necessary to use the Limit Switch within an appropriate contact force range. If the Limit Switch is used in the normally closed condition, the dog must be installed so that the actuator will return to the FP when the actuator is actuated by the object. If the Limit Switch is used in the normally open condition, the actuator must be pressed to 80% to 100% of the OT (i.e., 60% to 80% of the TT) and any slight fluctuation must be absorbed by the actuator.
- If the full stroke is set close to the OP or RP, contact instability may result. If the full stroke is set to the TTP, the actuator or switch may become damaged due to the inertia of the dog. In that case, adjust the stroke with the mounting panel or the dog. Refer to page C-2, *Dog Design*, page C-3, *Stroke Settings vs. Dog Movement Distance*, and page C-3, *Dog Surface* for details.
- The following graph shows an example of changes in contact force according to the stroke. The contact force near the OP or RP is unstable, and the Limit Switch cannot maintain high reliability. Furthermore, the Limit Switch cannot withstand strong vibration or shock.



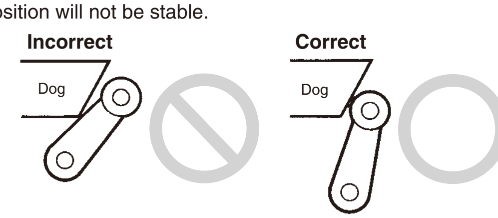
- If the Limit Switch is used so that the actuator is constantly pressed, it will fail quickly and reset faults may occur. Inspect the Limit Switch periodically and replace it as required.

Operation

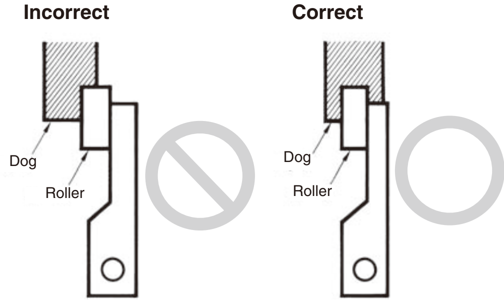
- Carefully determine the proper cam or dog so that the actuator will not abruptly snap back, thus causing shock. In order to operate the Limit Switch at a comparatively high speed, use a cam or dog with a long enough stroke that keeps the Limit Switch turned ON for a sufficient time so that the relay or valve will be sufficiently energized.
- The operating method, the shape of the dog or cam, the operating frequency, and the travel after operation have a large influence on the durability and operating accuracy of the Limit Switch. The cam must be smooth in shape.



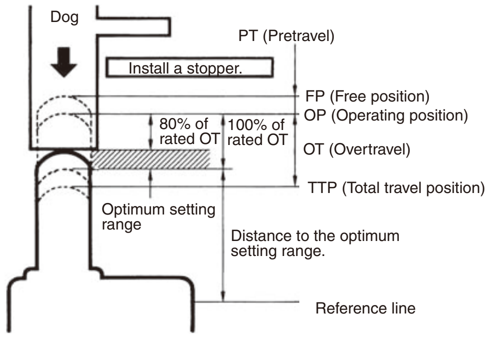
- Appropriate force must be imposed on the actuator by the cam or another object in both rotary operation and linear operation. If the object touches the lever as shown below, the operating position will not be stable.



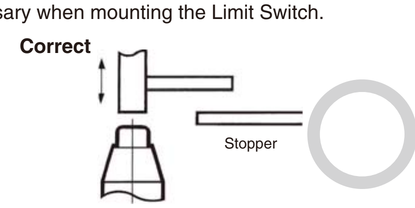
- Unbalanced force must not be imposed on the actuator. Otherwise, wear and tear on the actuator may result.



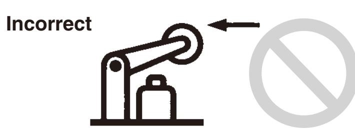
- Make sure that the actuator does not exceed the OT (overtravel) range, otherwise the Limit Switch may malfunction. When mounting the Limit Switch, be sure to adjust the Limit Switch carefully while considering the whole movement of the actuator.



- The Limit Switch may soon malfunction if the OT is excessive. Therefore, adjustments and careful consideration of the position of the Limit Switch and the expected OT of the actuator are necessary when mounting the Limit Switch.



- Be sure to use the Limit Switch according to the characteristics of the actuator.
  If a roller arm lever actuator is used, do not attempt to actuate the Limit Switch in the direction shown below.



- Do not modify the actuator to change the OP.
- In the case of a long actuator of an adjustable roller lever type, the following countermeasures against lever shaking are recommended.

1. Make the rear edge of the object smooth with an angle of 15° to 30° or make it in the shape of a quadratic curve.
2. Design the circuit so that no error signal will be generated.
3. Use or set a switch that is actuated in one direction only. (Also, set the switch for operation in one direction only.)

Operating Environment

- These Switches are for indoor applications.
  The Switches may fail if they are used outdoors.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperatures or humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switches in the following locations.
  - Locations subject to severe temperature changes
  - Locations subject to high temperatures or condensation
  - Locations subject to severe vibration
  - Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - Locations where the Switch may come into contact with thinner or detergents
  - Locations where explosive or flammable gases are present

Switch Contacts

Switch contacts can be used with both standard loads and microloads, but once a contact has been used to switch a standard load, it cannot be used for a load of a smaller capacity.
Doing so may result in roughening of the contact surface and contact reliability may be lost.

Storing Switches

Do not store the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to, excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Dog Design

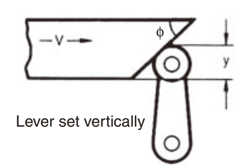
Operating Speed, Dog Angle, and Relationship with Actuator

Before designing a dog, carefully consider the operating speed and angle of the dog and their relationship with the shape of the actuator. The optimum operating speed (V) of a standard dog at an angle of 30° to 45° is 0.5 m/s maximum.

Roller Lever Models

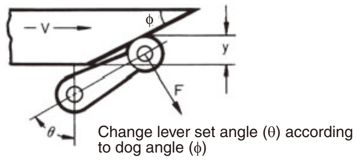
1. Non-overtravel Dog

Dog speed: 0.5 m/s max. (Standard Speed)



ϕ	V max. (m/s)	y
30°	0.4	0.8 (TT) 80% of totaltravel
45°	0.25	
60°	0.1	
60° to 90°	0.05 (low speed)	

Dog speed: 0.5 m/s ≤ V ≤ 2 m/s (High Speed)

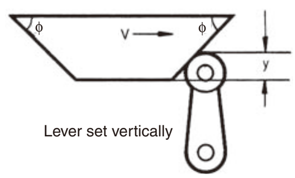


θ	ϕ	V max. (m/s)	y
45°	45°	0.5	0.5 to 0.8 (TT)
50°	40°	0.6	
60° to 55°	30° to 35°	1.3	0.5 to 0.7 (TT)
75° to 65°	15° to 25°	2	

Note: The above y values indicate the ratio ranges based on TT (total travel). Therefore, the optimum pressing distance of the dog is between 50% and 80% (or 50% and 70%).

2. Overtravel Dog

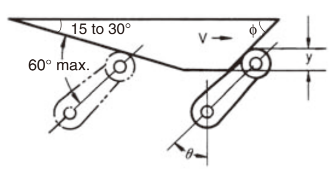
Dog speed: 0.5 m/s max.



ϕ	V max. (m/s)	y
30°	0.4	0.8 (TT) 80% of total travel
45°	0.25	
60°	0.1	
60° to 90°	0.05 (low speed)	

Dog speed: 0.5 m/s min.

If the speed of the overtravel dog is comparatively high, make the rear edge of the object smooth at an angle of 15° to 30° or make it in the shape of a quadratic curve. Then lever shaking will be reduced.



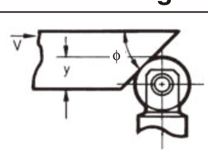
θ	ϕ	V max. (m/s)	y
45°	45°	0.5	0.5 to 0.8 (TT)
50°	40°	0.6	
60° to 55°	30° to 35°	1.3	0.5 to 0.7 (TT)
75° to 65°	15° to 25°	2	

Note: The above y values indicate the ratio ranges based on TT (total travel). Therefore, the optimum pressing distance of the dog is between 50% and 80% (or 50% and 70%).

Plunger Models

If the dog overrides the actuator, the front and rear of the dog may be the same in shape, provided that the dog is not designed to be separated from the actuator abruptly.

Roller Plunger

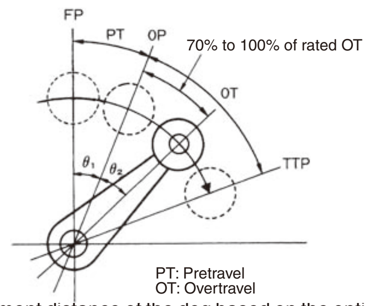


ϕ	V max. (m/s)	y
30°	0.25	0.6 to 0.8 (TT)
20°	0.5	0.5 to 0.7 (TT)

Stroke Settings vs. Dog Movement Distance

- The following provides information on stroke settings based on the movement distance of the dog instead of the actuator angle.
  The following is the optimum stroke of the Limit Switch.

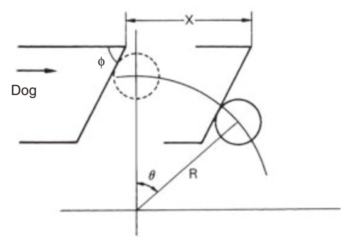
  Optimum stroke: PT + {Rated OT x (0.7 to 1.0)}
  The angle converted from the above: $\theta_1 + \theta_2$



- The movement distance of the dog based on the optimum stroke is expressed by the following formula.

  Movement distance of dog

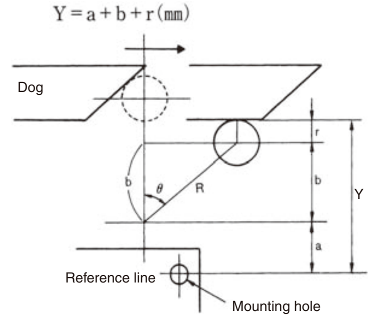
$$X = R\sin\theta + \frac{R(1-\cos\theta)}{\tan\phi} \ (\mathrm{mm})$$



ϕ: Dog angle
θ: Optimum stroke angle
R: Actuator length
X: Dog movement distance

- The distance between the reference line and the bottom of the dog based on the optimum stroke is expressed by the following formula.

$$Y = a + b + r \ (\mathrm{mm})$$



a: Distance between reference line and actuator fulcrum
b: R cosθ
r: Roller radius
Y: Distance between reference line and bottom of dog

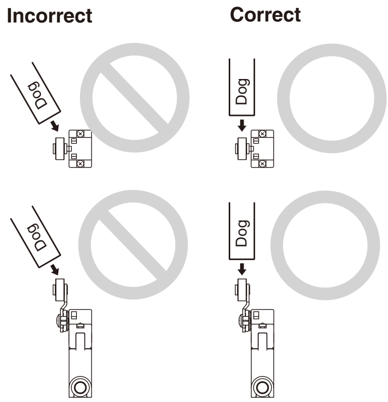
Dog Surface

- The surface of dog touching the actuator should be 6.3 S in quality and hardened at approximately HV450.
  For smooth operation of the actuator, apply molybdenum disulfide grease to the actuator and the dog touching the actuator.

Others

- When using the Limit Switch with a long lever or long rod lever, make sure that the lever is in the downward direction.

- With a roller actuator, the dog must touch the actuator at a right angle. The actuator or roller may deform or break if the dog touches the actuator (roller) at an oblique angle.



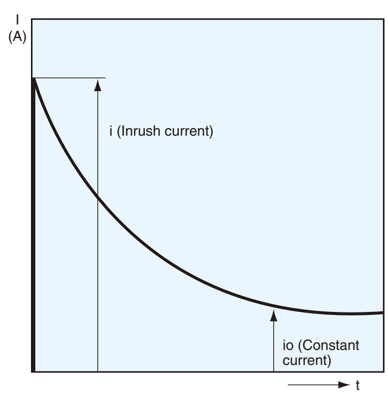
- Do not remove the Head. The Switch may fail.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly.
If the terminal is wired incorrectly, the Switch will not function.
Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

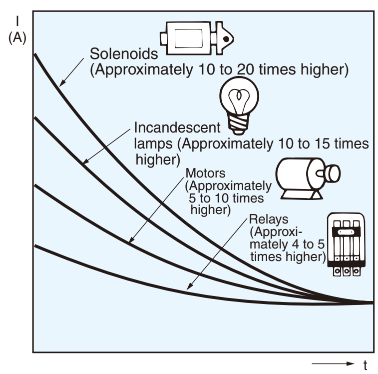
  Inductive load: A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)

  Lamp load: An inrush current 10 times higher than the normal current

  Motor load: An inrush current 6 times higher than the normal current

  1. Ambient temperature: 5°C to 35°C
  2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

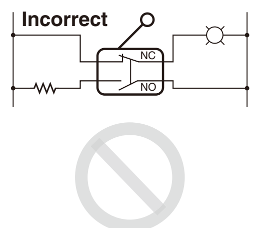
Electrical Conditions

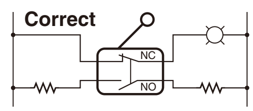
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

Connections

- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

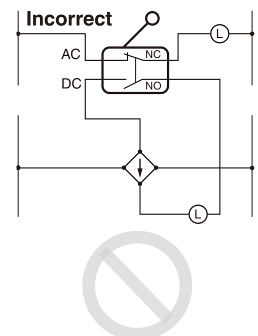
Power Connection Examples
(Connection of Different Polarities)



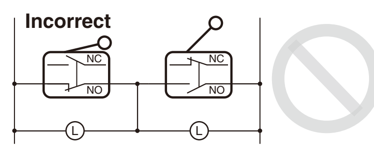


Connect the load to the same polarities.

Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

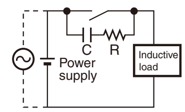
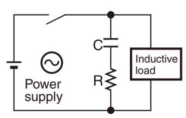
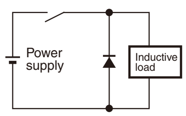
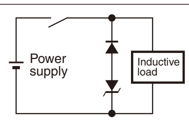
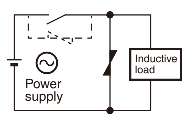


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

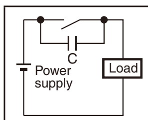
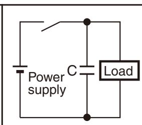
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

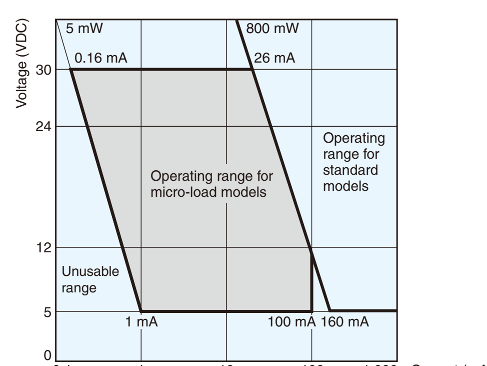
Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

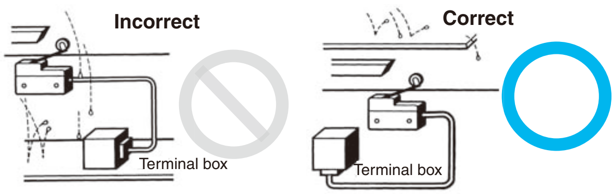
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, $\lambda_{60} = 0.5\times10^{-6}$/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

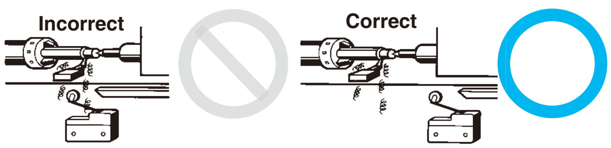


Operating Environment

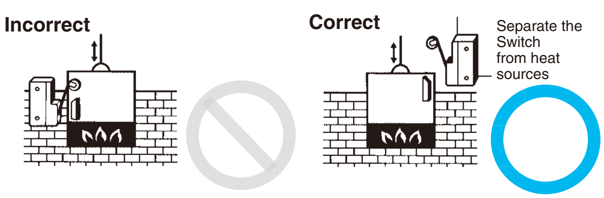
- The Switches are designed for use indoors.
  Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



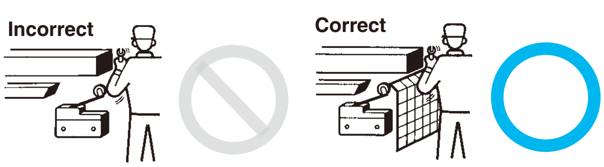
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges.
  The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog.
  If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



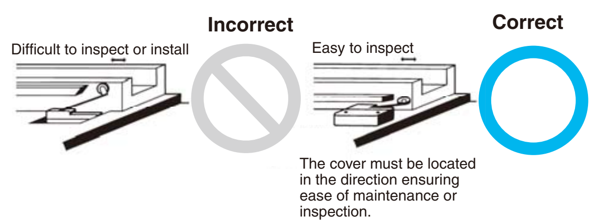
- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.



- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

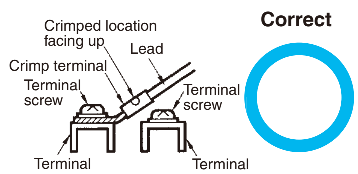
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

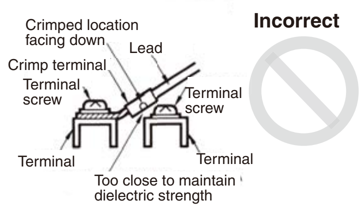
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

Safety Limit Switch
D4N

Upgraded Safety Limit Switches Based on the Popular D4D, Providing a Full Lineup Conforming to International Standards

Note: Contact your sales representative for details on models with safety standard certification.

■ Lineup includes three contact models with 2NC/1NO and 3NC contact forms in addition to the previous contact forms 1NC/1NO, and 2NC. Models with MBB contacts are also available.
■ M12-connector models are available, saving on labor and simplifying replacement.
■ Standardized gold-clad contacts provide high contact reliability. Can be used with both standard loads and microloads.
■ Conforms to EN115, EN81-1, and EN81-2 (slow-action models only).
■ Lineup includes both slow-action and snap-action models with Zb contacts.
■ Certified standards: UL, EN (TÜV), and CCC

⚠ Be sure to read the *"Safety Precautions"* on page 18 and the *"Precautions for All Safety Limit Switches"* .

Model Number Structure

Model Number Legend

D4N-□□□□
(1) (2) (3)

1. Conduit size
1: Pg13.5 (1-conduit)
2: G1/2 (1-conduit)
3: 1/2-14NPT (1-conduit)
4: M20 (1-conduit)
5: Pg13.5 (2-conduit)
6: G1/2 (2-conduit)
7: 1/2-14NPT (2-conduit)
8: M20 (2-conduit)
9: M12 connector (1-conduit)

2. Built-in Switch
1: 1NC/1NO (snap-action)
2: 2NC (snap-action)
A: 1NC/1NO (slow-action)
B: 2NC (slow-action)
C: 2NC/1NO (slow-action)
D: 3NC (slow-action)
E: 1NC/1NO (MBB contact) (slow-action)
F: 2NC/1NO (MBB contact) (slow-action)

3. Head and Actuator
20: Roller lever (resin lever, resin roller)
22: Roller lever (metal lever, resin roller)
25: Roller lever (metal lever, metal roller)
26: Roller lever (metal lever, bearing roller)
2G: Adjustable roller lever, form lock (metal lever, resin roller)
2H: Adjustable roller lever, form lock (metal lever, rubber roller)
31: Top Plunger
32: Top Roller Plunger
62: One-way roller arm lever (horizontal)
72: One-way roller arm lever (vertical)
80: Cat whisker
87: Plastic rod
RE: Fork lever lock (right operation)
LE: Fork lever lock (left operation)

Ordering Information

List of Models

Switches with Two Contacts (with Direct Opening Mechanism)

Actuator	Conduit size		Built-in switch mechanism: 1NC/1NO (Snap-action) Model	Direct opening	2NC (Snap-action) Model	Direct opening	1NC/1NO (Slow-action) Model	Direct opening	2NC (Slow-action) Model	Direct opening
Roller lever (resin lever, resin roller)	1-conduit	Pg13.5	D4N-1120		D4N-1220		D4N-1A20		D4N-1B20	
		G1/2	D4N-2120		D4N-2220		D4N-2A20		D4N-2B20	
		1/2-14NPT	D4N-3120		D4N-3220		D4N-3A20		D4N-3B20	
		M20	D4N-4120		D4N-4220		D4N-4A20		D4N-4B20	
		M12 connector	D4N-9120		D4N-9220		D4N-9A20		D4N-9B20	
	2-conduit	Pg13.5	D4N-5120		D4N-5220		D4N-5A20		D4N-5B20	
		G1/2	D4N-6120		D4N-6220		D4N-6A20		D4N-6B20	
		M20	D4N-8120		D4N-8220		D4N-8A20		D4N-8B20	
Roller lever (metal lever, resin roller)	1-conduit	Pg13.5	D4N-1122		D4N-1222		D4N-1A22		D4N-1B22	
		G1/2	D4N-2122		D4N-2222		D4N-2A22		D4N-2B22	
		1/2-14NPT	D4N-3122		D4N-3222		D4N-3A22		D4N-3B22	
		M20	D4N-4122		D4N-4222		D4N-4A22		D4N-4B22	
		M12 connector	D4N-9122		D4N-9222		D4N-9A22		D4N-9B22	
	2-conduit	Pg13.5	D4N-5122		D4N-5222		D4N-5A22		D4N-5B22	
		G1/2	D4N-6122		D4N-6222		D4N-6A22		D4N-6B22	
		M20	D4N-8122		D4N-8222		D4N-8A22		D4N-8B22	
Roller lever (metal lever, metal roller)	1-conduit	Pg13.5	D4N-1125		D4N-1225		D4N-1A25		D4N-1B25	
		G1/2	D4N-2125		D4N-2225		D4N-2A25		D4N-2B25	
		1/2-14NPT	D4N-3125		D4N-3225		D4N-3A25		D4N-3B25	
		M20	D4N-4125		D4N-4225		D4N-4A25		D4N-4B25	
		M12 connector	D4N-9125		D4N-9225		D4N-9A25		D4N-9B25	
Roller lever (metal lever, bearing roller)	1-conduit	Pg13.5	D4N-1126		D4N-1226		D4N-1A26		D4N-1B26	
		G1/2	D4N-2126		D4N-2226		D4N-2A26		D4N-2B26	
		1/2-14NPT	D4N-3126		D4N-3226		D4N-3A26		D4N-3B26	
		M20	D4N-4126		D4N-4226		D4N-4A26		D4N-4B26	
		M12 connector	D4N-9126		D4N-9226		D4N-9A26		D4N-9B26	
Plunger	1-conduit	Pg13.5	D4N-1131		D4N-1231		D4N-1A31		D4N-1B31	
		G1/2	D4N-2131		D4N-2231		D4N-2A31		D4N-2B31	
		1/2-14NPT	D4N-3131		D4N-3231		D4N-3A31		D4N-3B31	
		M20	D4N-4131		D4N-4231		D4N-4A31		D4N-4B31	
		M12 connector	D4N-9131		D4N-9231		D4N-9A31		D4N-9B31	
	2-conduit	Pg13.5	D4N-5131		D4N-5231		D4N-5A31		D4N-5B31	
		G1/2	D4N-6131		D4N-6231		D4N-6A31		D4N-6B31	
		M20	D4N-8131		D4N-8231		D4N-8A31		D4N-8B31	
Roller plunger	1-conduit	Pg13.5	D4N-1132		D4N-1232		D4N-1A32		D4N-1B32	
		G1/2	D4N-2132		D4N-2232		D4N-2A32		D4N-2B32	
		1/2-14NPT	D4N-3132		D4N-3232		D4N-3A32		D4N-3B32	
		M20	D4N-4132		D4N-4232		D4N-4A32		D4N-4B32	
		M12 connector	D4N-9132		D4N-9232		D4N-9A32		D4N-9B32	
	2-conduit	Pg13.5	D4N-5132		D4N-5232		D4N-5A32		D4N-5B32	
		G1/2	D4N-6132		D4N-6232		D4N-6A32		D4N-6B32	
		M20	D4N-8132		D4N-8232		D4N-8A32		D4N-8B32	
One-way roller arm lever (horizontal)	1-conduit	Pg13.5	D4N-1162		D4N-1262		D4N-1A62		D4N-1B62	
		G1/2	D4N-2162		D4N-2262		D4N-2A62		D4N-2B62	
		1/2-14NPT	D4N-3162		D4N-3262		D4N-3A62		D4N-3B62	
		M20	D4N-4162		D4N-4262		D4N-4A62		D4N-4B62	
		M12 connector	D4N-9162		D4N-9262		D4N-9A62		D4N-9B62	
	2-conduit	Pg13.5	D4N-5162		D4N-5262		D4N-5A62		D4N-5B62	
		G1/2	D4N-6162		D4N-6262		D4N-6A62		D4N-6B62	
		M20	D4N-8162		D4N-8262		D4N-8A62		D4N-8B62	
One-way roller arm lever (vertical)	1-conduit	Pg13.5	D4N-1172		D4N-1272		D4N-1A72		D4N-1B72	
		G1/2	D4N-2172		D4N-2272		D4N-2A72		D4N-2B72	
		1/2-14NPT	D4N-3172		D4N-3272		D4N-3A72		D4N-3B72	
		M20	D4N-4172		D4N-4272		D4N-4A72		D4N-4B72	
		M12 connector	D4N-9172		D4N-9272		D4N-9A72		D4N-9B72	
	2-conduit	Pg13.5	D4N-5172		D4N-5272		D4N-5A72		D4N-5B72	
		G1/2	D4N-6172		D4N-6272		D4N-6A72		D4N-6B72	
		M20	D4N-8172		D4N-8272		D4N-8A72		D4N-8B72	
Adjustable roller lever, form lock (metal lever, resin roller)	1-conduit	Pg13.5	D4N-112G		D4N-122G		D4N-1A2G		D4N-1B2G	
		G1/2	D4N-212G		D4N-222G		D4N-2A2G		D4N-2B2G	
		1/2-14NPT	D4N-312G		D4N-322G		D4N-3A2G		D4N-3B2G	
		M20	D4N-412G		D4N-422G		D4N-4A2G		D4N-4B2G	
		M12 connector	D4N-912G		D4N-922G		D4N-9A2G		D4N-9B2G	
	2-conduit	G1/2	D4N-612G		D4N-622G		D4N-6A2G		D4N-6B2G	
		M20	D4N-812G		D4N-822G		D4N-8A2G		D4N-8B2G	
Adjustable roller lever, form lock (metal lever, rubber roller)	1-conduit	Pg13.5	D4N-112H		D4N-122H		D4N-1A2H		D4N-1B2H	
		G1/2	D4N-212H		D4N-222H		D4N-2A2H		D4N-2B2H	
		1/2-14NPT	D4N-312H		D4N-322H		D4N-3A2H		D4N-3B2H	
		M20	D4N-412H		D4N-422H		D4N-4A2H		D4N-4B2H	
		M12 connector	D4N-912H		D4N-922H		D4N-9A2H		D4N-9B2H	
	2-conduit	G1/2	D4N-612H		D4N-622H		D4N-6A2H		D4N-6B2H	
		M20	D4N-812H		D4N-822H		D4N-8A2H		D4N-8B2H	

Note: It is recommended that M20 be used for Switches to be exported to Europe and 1/2-14NPT be used for Switches to be exported to North American countries.

Switches with Three Contacts and MBB Contacts (with Direct Opening Mechanism)

Actuator	Conduit size		Built-in switch mechanism							
			2NC/1NO (Slow-action)		3NC (Slow-action)		1NC/1NO MBB (Slow-action)		2NC/1NO MBB (Slow-action)	
			Model	Direct opening	Model	Direct opening	Model	Direct opening	Model	Direct opening
Roller lever (resin lever, resin roller)	1-conduit	Pg13.5	D4N-1C20	⊖	D4N-1D20	⊖	D4N-1E20	⊖	D4N-1F20	⊖
		G1/2	D4N-2C20		D4N-2D20		D4N-2E20		D4N-2F20	
		1/2-14NPT	D4N-3C20		D4N-3D20		D4N-3E20		D4N-3F20	
		M20	D4N-4C20		D4N-4D20		D4N-4E20		D4N-4F20	
		M12 connector	---		---		D4N-9E20		---	
	2-conduit	Pg13.5	D4N-5C20	⊖	D4N-5D20	⊖	D4N-5E20	⊖	D4N-5F20	⊖
		G1/2	D4N-6C20		D4N-6D20		D4N-6E20		D4N-6F20	
		M20	D4N-8C20		D4N-8D20		D4N-8E20		D4N-8F20	
Roller lever (metal lever, resin roller)	1-conduit	Pg13.5	D4N-1C22	⊖	D4N-1D22	⊖	D4N-1E22	⊖	D4N-1F22	⊖
		G1/2	D4N-2C22		D4N-2D22		D4N-2E22		D4N-2F22	
		1/2-14NPT	D4N-3C22		D4N-3D22		D4N-3E22		D4N-3F22	
		M20	D4N-4C22		D4N-4D22		D4N-4E22		D4N-4F22	
		M12 connector	---		---		D4N-9E22		---	
	2-conduit	Pg13.5	D4N-5C22	⊖	D4N-5D22	⊖	D4N-5E22	⊖	D4N-5F22	⊖
		G1/2	D4N-6C22		D4N-6D22		D4N-6E22		D4N-6F22	
		M20	D4N-8C22		D4N-8D22		D4N-8E22		D4N-8F22	
Roller lever (metal lever, metal roller)	1-conduit	Pg13.5	D4N-1C25	⊖	D4N-1D25	⊖	D4N-1E25	⊖	D4N-1F25	⊖
		G1/2	D4N-2C25		D4N-2D25		D4N-2E25		D4N-2F25	
		1/2-14NPT	D4N-3C25		D4N-3D25		D4N-3E25		D4N-3F25	
		M20	D4N-4C25		D4N-4D25		D4N-4E25		D4N-4F25	
		M12 connector	---		---		D4N-9E25		---	
Roller lever (metal lever, bearing roller)	1-conduit	Pg13.5	D4N-1C26	⊖	D4N-1D26	⊖	D4N-1E26	⊖	D4N-1F26	⊖
		G1/2	D4N-2C26		D4N-2D26		D4N-2E26		D4N-2F26	
		1/2-14NPT	D4N-3C26		D4N-3D26		D4N-3E26		D4N-3F26	
		M20	D4N-4C26		D4N-4D26		D4N-4E26		D4N-4F26	
		M12 connector	---		---		D4N-9E26		---	
Plunger	1-conduit	Pg13.5	D4N-1C31	⊖	D4N-1D31	⊖	D4N-1E31	⊖	D4N-1F31	⊖
		G1/2	D4N-2C31		D4N-2D31		D4N-2E31		D4N-2F31	
		1/2-14NPT	D4N-3C31		D4N-3D31		D4N-3E31		D4N-3F31	
		M20	D4N-4C31		D4N-4D31		D4N-4E31		D4N-4F31	
		M12 connector	---		---		D4N-9E31		---	
	2-conduit	Pg13.5	D4N-5C31	⊖	D4N-5D31	⊖	D4N-5E31	⊖	D4N-5F31	⊖
		G1/2	D4N-6C31		D4N-6D31		D4N-6E31		D4N-6F31	
		M20	D4N-8C31		D4N-8D31		D4N-8E31		D4N-8F31	
Roller plunger	1-conduit	Pg13.5	D4N-1C32	⊖	D4N-1D32	⊖	D4N-1E32	⊖	D4N-1F32	⊖
		G1/2	D4N-2C32		D4N-2D32		D4N-2E32		D4N-2F32	
		1/2-14NPT	D4N-3C32		D4N-3D32		D4N-3E32		D4N-3F32	
		M20	D4N-4C32		D4N-4D32		D4N-4E32		D4N-4F32	
		M12 connector	---		---		D4N-9E32		---	
	2-conduit	Pg13.5	D4N-5C32	⊖	D4N-5D32	⊖	D4N-5E32	⊖	D4N-5F32	⊖
		G1/2	D4N-6C32		D4N-6D32		D4N-6E32		D4N-6F32	
		M20	D4N-8C32		D4N-8D32		D4N-8E32		D4N-8F32	
One-way roller arm lever (horizontal)	1-conduit	Pg13.5	D4N-1C62	⊖	D4N-1D62	⊖	D4N-1E62	⊖	D4N-1F62	⊖
		G1/2	D4N-2C62		D4N-2D62		D4N-2E62		D4N-2F62	
		1/2-14NPT	D4N-3C62		D4N-3D62		D4N-3E62		D4N-3F62	
		M20	D4N-4C62		D4N-4D62		D4N-4E62		D4N-4F62	
		M12 connector	---		---		D4N-9E62		---	
	2-conduit	Pg13.5	D4N-5C62	⊖	D4N-5D62	⊖	D4N-5E62	⊖	D4N-5F62	⊖
		G1/2	D4N-6C62		D4N-6D62		D4N-6E62		D4N-6F62	
		M20	D4N-8C62		D4N-8D62		D4N-8E62		D4N-8F62	
One-way roller arm lever (vertical)	1-conduit	Pg13.5	D4N-1C72	⊖	D4N-1D72	⊖	D4N-1E72	⊖	D4N-1F72	⊖
		G1/2	D4N-2C72		D4N-2D72		D4N-2E72		D4N-2F72	
		1/2-14NPT	D4N-3C72		D4N-3D72		D4N-3E72		D4N-3F72	
		M20	D4N-4C72		D4N-4D72		D4N-4E72		D4N-4F72	
		M12 connector	---		---		D4N-9E72		---	
	2-conduit	Pg13.5	D4N-5C72	⊖	D4N-5D72	⊖	D4N-5E72	⊖	D4N-5F72	⊖
		G1/2	D4N-6C72		D4N-6D72		D4N-6E72		D4N-6F72	
		M20	D4N-8C72		D4N-8D72		D4N-8E72		D4N-8F72	
Adjustable roller lever, form lock (metal lever, resin roller)	1-conduit	Pg13.5	D4N-1C2G	⊖	D4N-1D2G	⊖	D4N-1E2G	⊖	D4N-1F2G	⊖
		G1/2	D4N-2C2G		D4N-2D2G		D4N-2E2G		D4N-2F2G	
		1/2-14NPT	D4N-3C2G		D4N-3D2G		D4N-3E2G		D4N-3F2G	
		M20	D4N-4C2G		D4N-4D2G		D4N-4E2G		D4N-4F2G	
		M12 connector	---		---		D4N-9E2G		---	
	2-conduit	G1/2	D4N-6C2G	⊖	D4N-6D2G	⊖	D4N-6E2G	⊖	D4N-6F2G	⊖
		M20	D4N-8C2G		D4N-8D2G		D4N-8E2G		D4N-8F2G	
Adjustable roller lever, form lock (metal lever, rubber roller)	1-conduit	Pg13.5	D4N-1C2H	⊖	D4N-1D2H	⊖	D4N-1E2H	⊖	D4N-1F2H	⊖
		G1/2	D4N-2C2H		D4N-2D2H		D4N-2E2H		D4N-2F2H	
		1/2-14NPT	D4N-3C2H		D4N-3D2H		D4N-3E2H		D4N-3F2H	
		M20	D4N-4C2H		D4N-4D2H		D4N-4E2H		D4N-4F2H	
		M12 connector	---		---		D4N-9E2H		---	
	2-conduit	G1/2	D4N-6C2H	⊖	D4N-6D2H	⊖	D4N-6E2H	⊖	D4N-6F2H	⊖
		M20	D4N-8C2H		D4N-8D2H		D4N-8E2H		D4N-8F2H	

Note: It is recommended that M20 be used for Switches to be exported to Europe and 1/2-14NPT be used for Switches to be exported to North American countries.

General-purpose Switches with Two Contacts

Actuator	Conduit size		Built-in switch mechanism							
			1NC/1NO (Snap-action)		2NC (Snap-action)		1NC/1NO (Slow-action)		2NC (Slow-action)	
			Model	Direct opening	Model	Direct opening	Model	Direct opening	Model	Direct opening
Fork lever lock (right operation)	1-conduit	G1/2	---	---	---	---	D4N-2ARE	---	D4N-2BRE	---
		1/2-14NPT					D4N-3ARE		D4N-3BRE	
		M20					D4N-4ARE		D4N-4BRE	
	2-conduit	G1/2		---		---	D4N-6ARE	---	D4N-6BRE	---
		M20					D4N-8ARE		D4N-8BRE	
Fork lever lock (left operation)	1-conduit	G1/2		---		---	D4N-2ALE	---	D4N-2BLE	---
		1/2-14NPT					D4N-3ALE		D4N-3BLE	
		M20					D4N-4ALE		D4N-4BLE	
	2-conduit	G1/2		---		---	D4N-6ALE	---	D4N-6BLE	---
		M20					D4N-8ALE		D4N-8BLE	
Cat whisker	1-conduit	G1/2	D4N-2180	---	D4N-2280	---	---	---	D4N-2B80	---
		1/2-14NPT	D4N-3180		D4N-3280				D4N-3B80	
		M20	D4N-4180		D4N-4280				D4N-4B80	
	2-conduit	G1/2	D4N-6180	---	D4N-6280	---		---	D4N-6B80	---
		M20	D4N-8180		D4N-8280				D4N-8B80	
Plastic rod	1-conduit	G1/2	D4N-2187	---	D4N-2287	---		---	D4N-2B87	---
		1/2-14NPT	D4N-3187		D4N-3287				D4N-3B87	
		M20	D4N-4187		D4N-4287				D4N-4B87	
	2-conduit	G1/2	D4N-6187	---	D4N-6287	---		---	D4N-6B87	---
		M20	D4N-8187		D4N-8287				D4N-8B87	

Note: 1. It is recommended that M20 be used for Switches to be exported to Europe and 1/2-14NPT be used for Switches to be exported to North American countries.
2. Mechanically speaking, these models are basic limit switches.

General-purpose Switches with Three Contacts and MBB Contacts

Actuator	Conduit size		Built-in switch mechanism							
			2NC/1NO (Slow-action)		3NC (Slow-action)		1NC/1NO MBB (Slow-action)		2NC/1NO MBB (Slow-action)	
			Model	Direct opening	Model	Direct opening	Model	Direct opening	Model	Direct opening
Fork lever lock (right operation)	1-conduit	G1/2	D4N-2CRE	---	D4N-2DRE	---	D4N-2ERE	---	D4N-2FRE	---
		1/2-14NPT	D4N-3CRE		D4N-3DRE		D4N-3ERE		D4N-3FRE	
		M20	D4N-4CRE		D4N-4DRE		D4N-4ERE		D4N-4FRE	
	2-conduit	G1/2	D4N-6CRE	---	D4N-6DRE	---	D4N-6ERE	---	D4N-6FRE	---
		M20	D4N-8CRE		D4N-8DRE		D4N-8ERE		D4N-8FRE	
Fork lever lock (left operation)	1-conduit	G1/2	D4N-2CLE	---	D4N-2DLE	---	D4N-2ELE	---	D4N-2FLE	---
		1/2-14NPT	D4N-3CLE		D4N-3DLE		D4N-3ELE		D4N-3FLE	
		M20	D4N-4CLE		D4N-4DLE		D4N-4ELE		D4N-4FLE	
	2-conduit	G1/2	D4N-6CLE	---	D4N-6DLE	---	D4N-6ELE	---	D4N-6FLE	---
		M20	D4N-8CLE		D4N-8DLE		D4N-8ELE		D4N-8FLE	
Cat whisker	1-conduit	G1/2	---	---	D4N-2D80	---	---	---	---	---
		1/2-14NPT			D4N-3D80					
		M20			D4N-4D80					
	2-conduit	G1/2		---	D4N-6D80	---		---		---
		M20			D4N-8D80					
Plastic rod	1-conduit	G1/2		---	D4N-2D87	---		---		---
		1/2-14NPT			D4N-3D87					
		M20			D4N-4D87					
	2-conduit	G1/2		---	D4N-6D87	---		---		---
		M20			D4N-8D87					

Note: 1. It is recommended that M20 be used for Switches to be exported to Europe and 1/2-14NPT be used for Switches to be exported to North American countries.
2. Mechanically speaking, these models are basic limit switches.

Specifications

Standards and EC Directives

Conforms to the following EC Directives:

- Machinery Directive
- Low Voltage Directive
- EN50047
- EN60204-1
- EN1088
- GS-ET-15

Certified Standards

Certification body	Standard	File No.
TÜV Product Service	EN60947-5-1 (certified direct opening)	*1
UL *2	UL508, CSA C22.2 No.14	E76675
CQC (CCC) *3	GB14048.5	2004010305105973

*1. Consult your OMRON representative for details.
*2. Certification for CSA C22.2 No. 14 is authorized by the UL mark.
*3. Ask your OMRON representative for information on certified models.

Certified Standard Ratings

TÜV (EN60947-5-1), CCC (GB14048.5)

Item / Utilization category	AC-15	DC-13
Rated operating current (I_e)	3 A	0.27 A
Rated operating voltage (U_e)	240 V	250 V

Note: Use a 10 A fuse type gI or gG that conforms to IEC269 as a short-circuit protection device. This fuse is not built into the Switch.

UL/CSA (UL508, CSA C22.2 No. 14)

A300

Rated voltage	Carry current	Current (A)		Volt-amperes (VA)	
		Make	Break	Make	Break
120 VAC	10 A	60	6	7,200	720
240 VAC		30	3		

Q300

Rated voltage	Carry current	Current (A)		Volt-amperes (VA)	
		Make	Break	Make	Break
125 VDC	2.5 A	0.55	0.55	69	69
250 VDC		0.27	0.27		

Characteristics

Degree of protection *1		IP67 (EN60947-5-1)
Durability *2	**Mechanical**	15,000,000 operations min. *5
	Electrical	500,000 operations min. (3 A resistive load at 250 VAC) *3 300,000 operations min. (10 A resistive load at 250 VAC)
Operating speed		1 to 500 mm/s (D4N-1120)
Operating frequency		30 operations/minute max.
Contact resistance		25 mΩ max.
Minimum applicable load *4		1 mA resistive load at 5 VDC (N-level reference value)
Rated insulation voltage (U_i)		300 V
Rated frequency		50/60 Hz
Protection against electric shock		Class II (double insulation)
Pollution degree (operating environment)		3 (EN60947-5-1)
Impulse withstand voltage (EN60947-5-1)	**Between terminals of same polarity**	2.5 kV
	Between terminals of different polarity	4 kV
	Between each terminal and non-current carrying metallic parts	6 kV
Insulation resistance		100 MΩ min.
Contact gap		Snap-action: 2 × 0.5 mm min. Slow-action: 2 × 2 mm min.
Vibration resistance	**Malfunction**	10 to 55 Hz, 0.75 mm single amplitude
Shock resistance	**Destruction**	1,000 m/s^2 min.
	Malfunction	300 m/s^2 min.
Conditional short-circuit current		100 A (EN60947-5-1)
Conventional free air thermal current (I_{th})		10 A (EN60947-5-1)
Ambient operating temperature		−30 to 70°C (with no icing)
Ambient operating humidity		95% max.
Weight		Approx. 82 g (D4N-1120) Approx. 99 g (D4N-5120)

Note: 1. The above values are initial values.
2. Once a contact has been used to switch a standard load, it cannot be used for a load of a smaller capacity. Doing so may result in roughening of the contact surface and contact reliability may be lost.

*1. The degree of protection is tested using the method specified by the standard (EN60947-5-1). Confirm that sealing properties are sufficient for the operating conditions and environment beforehand. Although the switch box is protected from dust or water penetration, do not use the D4N in places where foreign material such as dust, dirt, oil, water, or chemicals may penetrate through the head. Otherwise, accelerated wear, Switch damage or malfunctioning may occur.
*2. The durability is for an ambient temperature of 5 to 35°C and an ambient humidity of 40% to 70%. For more details, consult your OMRON representative.
*3. Do not pass the 3 A, 250 VAC load through more than 2 circuits.
*4. This value will vary with the switching frequency, environment, and reliability level. Confirm that correct operation is possible with the actual load beforehand.
*5. The mechanical durability of fork lever lock models is 10,000,000 operations min.

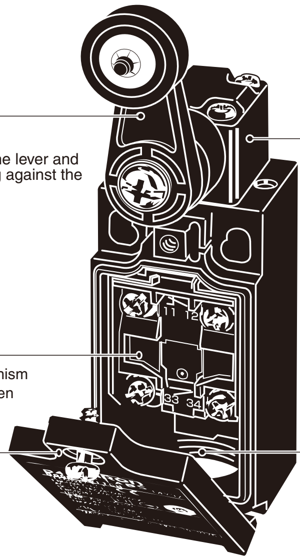
Structure and Nomenclature

Structure

Safety-oriented Lever Setting (Form-lock construction)
Grooves which engage the lever are cut in the lever and rotary shaft to prevent the lever from slipping against the rotary shaft.
There are resin-lever and metal-lever types.

Built-in Switch
The built-in switch has a direct opening mechanism that forcibly separates the NC contact even when there is contact deposit.

Cover
The cover, with a hinge on its lower part, can be opened by removing the screw of the cover, which ensures ease of maintenance and wiring.



Head
The direction of the switch head can be varied to any of the four directions. (Roller plunger models can be mounted in either of two directions at a 90° angle.)

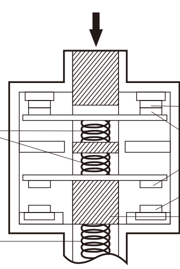
Conduit Opening
A wide variety of conduits is available.

Size Box	1-conduit	2-conduit
Pg13.5	Yes	Yes
G1/2	Yes	Yes
1/2-14NPT	Yes	Yes
M20	Yes	Yes
M12 connector	Yes	---

Note: M12 connector types are not available for Switches with three contacts.

Direct Opening Mechanism

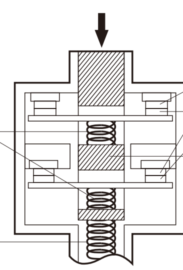
1NC/1NO Contact (Slow-action)



Conforms to EN60947-5-1 Direct Opening Operation ⊖

(Only the NC contact side has a direct opening mechanism.)
When contact welding occurs, the contacts are separated from each other by the plunger being pushed in.

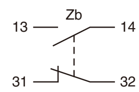
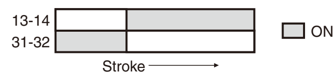
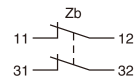
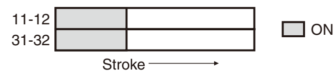
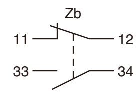
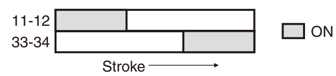
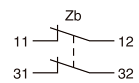
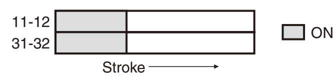
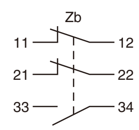
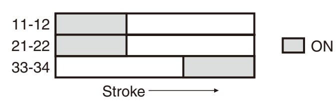
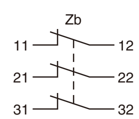
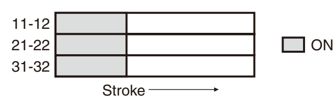
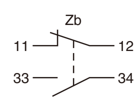
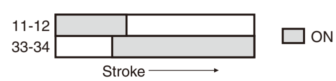
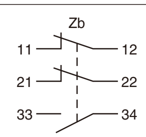
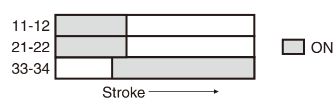
2NC Contact (Slow-action)



Conforms to EN60947-5-1 Direct Opening Operation ⊖

(Both NC contacts have a direct opening mechanism.)

Contact Form

Model	Contact	Contact form	Operating pattern	Remarks
D4N-□1□	1NC/1NO (Snap-action)			Only NC contacts 31-32 have a certified direct opening mechanism. The terminals 13-14 and 31-32 can be used as unlike poles.
D4N-□2□	2NC (Snap-action)			Only NC contacts 11-12 and 31-32 have a certified direct opening mechanism. The terminals 11-12 and 31-32 can be used as unlike poles.
D4N-□A□	1NC/1NO (Slow-action)			Only NC contacts 11-12 have a certified direct opening mechanism. The terminals 11-12 and 33-34 can be used as unlike poles.
D4N-□B□	2NC (Slow-action)			Only NC contacts 11-12 and 31-32 have a certified direct opening mechanism. The terminals 11-12 and 31-32 can be used as unlike poles.
D4N-□C□	2NC/1NO (Slow-action)			Only NC contacts 11-12 and 21-22 have a certified direct opening mechanism. The terminals 11-12, 21-22, and 33-34 can be used as unlike poles.
D4N-□D□	3NC (Slow-action)			Only NC contacts 11-12, 21-22, and 31-32 have a certified direct opening mechanism. The terminals 11-12, 21-22, and 31-32 can be used as unlike poles.
D4N-□E□	1NC/1NO MBB * (Slow-action)			Only NC contacts 11-12 have a certified direct opening mechanism. The terminals 11-12 and 33-34 can be used as unlike poles.
D4N-□F□	2NC/1NO MBB * (Slow-action)			Only NC contacts 11-12 and 21-22 have a certified direct opening mechanism. The terminals 11-12, 21-22 and 33-34 can be used as unlike poles.

Note: Terminals are numbered according to EN50013 and the contact forms are according to IEC947-5-1.
* MBB (Make Before Break) contacts have an overlapping structure, so that before the normally closed contact (NC) opens, the normally open contact (NO) closes.

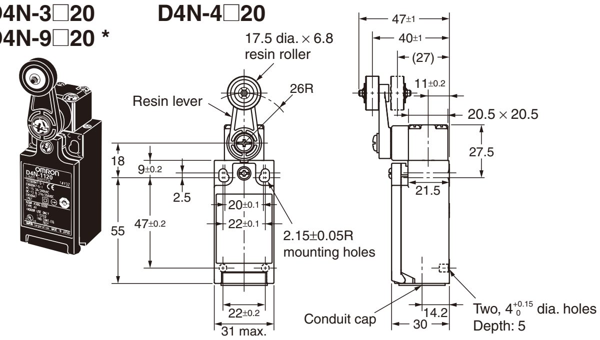
Dimensions and Operating Characteristics

(Unit: mm)

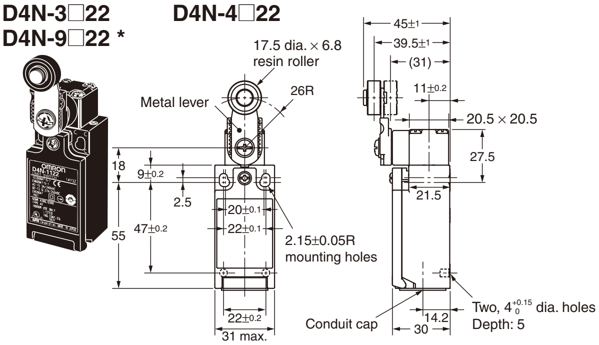
Switches

1-conduit Models

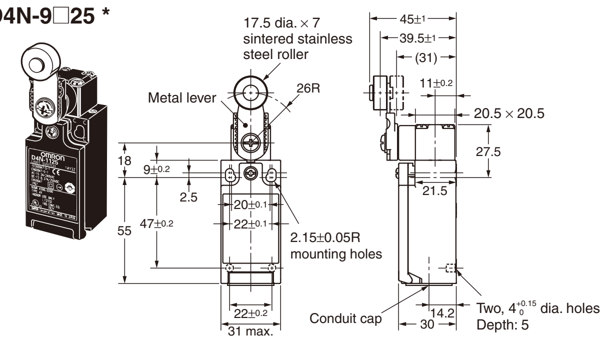
Roller Lever (Resin Lever, Resin Roller)
D4N-1□20 D4N-2□20
D4N-3□20 D4N-4□20
D4N-9□20 *



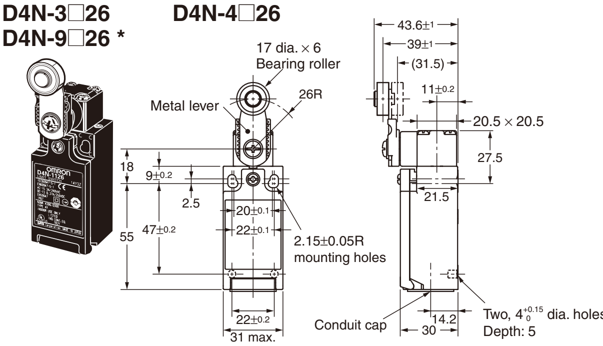
Roller Lever (Metal Lever, Resin Roller)
D4N-1□22 D4N-2□22
D4N-3□22 D4N-4□22
D4N-9□22 *



Roller Lever (Metal Lever, Metal Roller)
D4N-1□25 D4N-2□25
D4N-3□25 D4N-4□25
D4N-9□25 *



Roller Lever (Metal Lever, Bearing Roller)
D4N-1□26 D4N-2□26
D4N-3□26 D4N-4□26
D4N-9□26 *



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
* Refer to page 12 for details on M12 connectors.

Snap-action (1NC/1NO) (2NC), Slow-action (2NC) (3NC)

Operating characteristics	Model	D4N-□120 D4N-□220 D4N-□B20 D4N-□D20	D4N-□122 D4N-□222 D4N-□B22 D4N-□D22	D4N-□125 D4N-□225 D4N-□B25 D4N-□D25	D4N-□126 D4N-□226 D4N-□B26 D4N-□D26
Operating force	OF max.	5.0 N			
Release force	RF min.	0.5 N			
Pretravel	PT	18° to 27°			
Overtravel	OT min.	40°			
Movement differential	MD max. *1	14°			
Operating position	OP	---			
Total travel	TT *2	(80°)			
Direct opening travel	DOT min. *3	50°			
Direct opening force	DOF min. *3	20 N			

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC, 2NC/1NO, and 3NC contacts. Check contact operation.
*1. Only for snap-action models.
*2. Reference value.
*3. For safe use, always make sure that the minimum values or greater are provided.

Slow-action (1NC/1NO) (2NC/1NO)

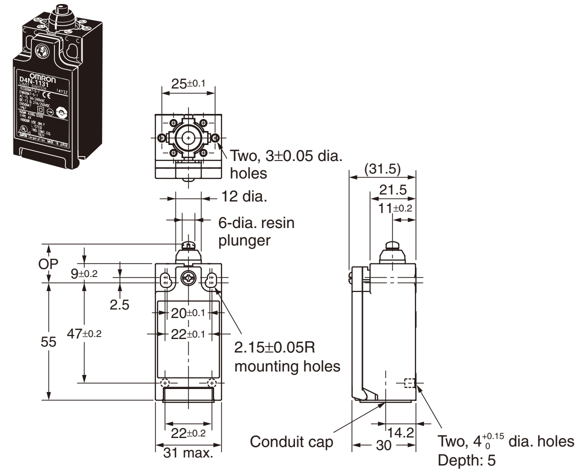
Operating characteristics	Model	D4N-□A20 D4N-□C20 D4N-□E20 D4N-□F20	D4N-□A22 D4N-□C22 D4N-□E22 D4N-□F22	D4N-□A25 D4N-□C25 D4N-□E25 D4N-□F25	D4N-□A26 D4N-□C26 D4N-□E26 D4N-□F26
Operating force	OF max.	5.0 N			
Release force	RF min.	0.5 N			
	PT *1	18° to 27°			
	PT (2nd) *2	(44°)			
	PT *3	27.5° to 36.5°			
	PT (2nd) *4	(18°)			
Overtravel	OT min.	40°			
Operating position	OP	---			
Total travel	TT *5	(80°)			
Direct opening travel	DOT min. *6	50°			
Direct opening force	DOF min. *6	20 N			

*1. These PT values are possible when the NC contacts are open (OFF).
*2. These PT values are possible when the NO contacts are closed (ON).
*3. Only for MBB models.
*4. Reference values for MBB models only.
*5. Reference values.
*6. For safe use, always make sure that the minimum values or greater are provided.

1-conduit Models

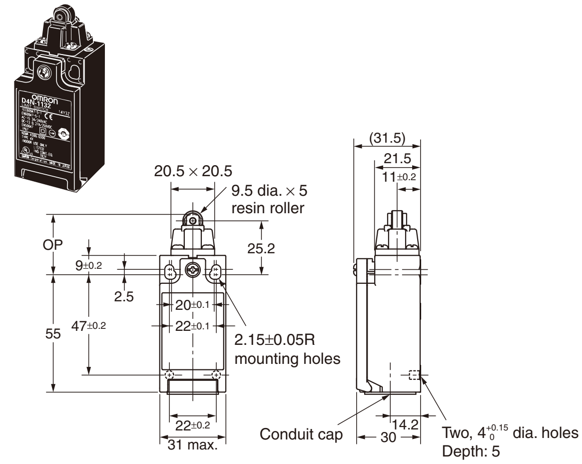
Plunger

D4N-1□31 **D4N-2□31**
D4N-3□31 **D4N-4□31**
D4N-9□31 *



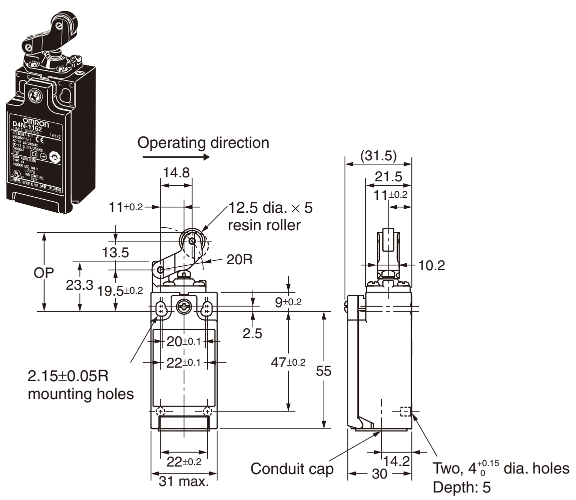
Roller Plunger

D4N-1□32 **D4N-2□32**
D4N-3□32 **D4N-4□32**
D4N-9□32 *



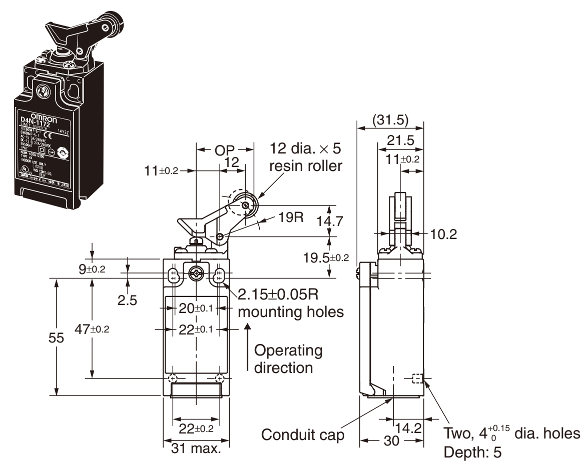
One-way Roller Arm Lever (Horizontal)

D4N-1□62 **D4N-2□62**
D4N-3□62 **D4N-4□62**
D4N-9□62 *



One-way Roller Arm Lever (Vertical)

D4N-1□72 **D4N-2□72**
D4N-3□72 **D4N-4□72**
D4N-9□72 *



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
* Refer to page 12 for details on M12 connectors.

Snap-action (1NC/1NO) (2NC), Slow-action (2NC) (3NC)

Operating characteristics	Model	D4N-□131 D4N-□231 D4N-□B31 D4N-□D31	D4N-□132 D4N-□232 D4N-□B32 D4N-□D32	D4N-□162 D4N-□262 D4N-□B62 D4N-□D62	D4N-□172 D4N-□272 D4N-□B72 D4N-□D72
Operating force	OF max.	6.5 N	6.5 N	5.0 N	5.0 N
Release force	RF min.	1.5 N	1.5 N	0.8 N	0.8 N
Pretravel	PT max.	2 mm	2 mm	4 mm	4 mm
Overtravel	OT min.	4 mm	4 mm	5 mm	5 mm
Movement differential	MD max. *1	1 mm	1 mm	1.5 mm	1.5 mm
Operating position	OP	18.2 ±0.5 mm	28.6 ±0.8 mm	37 ±0.8 mm	27 ±0.8 mm
Total travel	TT *2	(6 mm)	(6 mm)	(9 mm)	(9 mm)
Direct opening travel	DOT min. *3	3.2 mm	3.2 mm	5.8 mm	4.8 mm
Direct opening force	DOF min. *3	20 N	20 N	20 N	20 N

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC, 2NC/1NO, and 3NC contacts. Check contact operation.

*1. Only for snap-action models.
*2. Reference value.
*3. For safe use, always make sure that the minimum values or greater are provided.

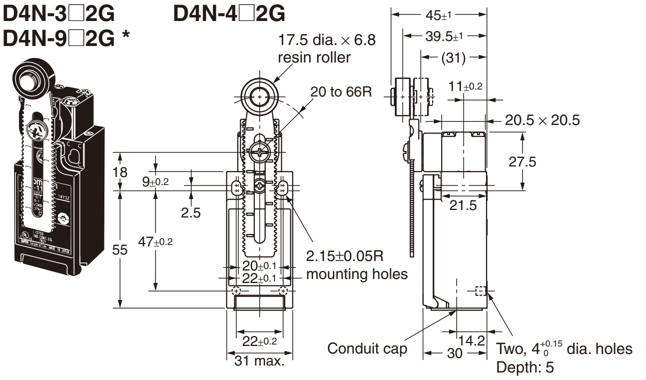
Slow-action (1NC/1NO) (2NC/1NO)

Operating characteristics	Model	D4N-□A31 D4N-□C31 D4N-□E31 D4N-□F31	D4N-□A32 D4N-□C32 D4N-□E32 D4N-□F32	D4N-□A62 D4N-□C62 D4N-□E62 D4N-□F62	D4N-□A72 D4N-□C72 D4N-□E72 D4N-□F72
Operating force	OF max.	6.5 N	6.5 N	5.0 N	5.0 N
Release force	RF min.	1.5 N	1.5 N	0.8 N	0.8 N
Pretravel	PT max. *1	2 mm	2 mm	4 mm	4 mm
	PT (2nd) *2	(2.9 mm)	(2.9 mm)	(5.2 mm)	(4.3 mm)
	PT max. *3	2.8 mm	2.8 mm	4 mm	4 mm
	PT (2nd) *4	(1 mm)	(1 mm)	(1.5 mm)	(1.5 mm)
Overtravel	OT min.	4 mm	4 mm	5 mm	5 mm
Operating position	OP	18.2 ±0.5 mm	28.6 ±0.8 mm	37 ±0.8 mm	27 ±0.8 mm
	OP *5	17.4 ±0.5 mm	28 ±0.8 mm	36 ±0.8 mm	26.1 ±0.8 mm
Total travel	TT *6	(6 mm)	(6 mm)	(9 mm)	(9 mm)
Direct opening travel	DOT min. *7	3.2 mm	3.2 mm	5.8 mm	4.8 mm
Direct opening force	DOF min. *7	20 N	20 N	20 N	20 N

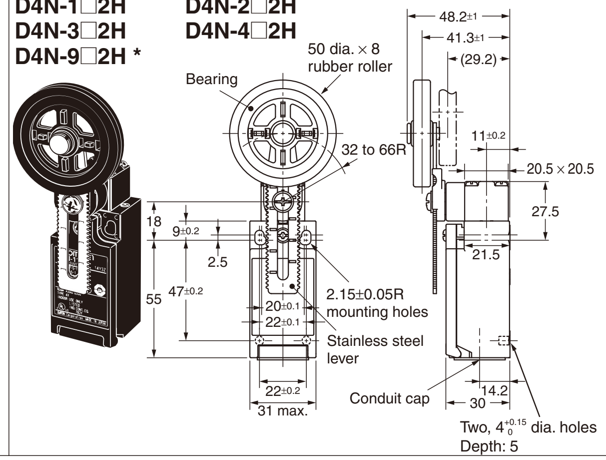
*1. These PT values are possible when the NC contacts are open (OFF).
*2. These PT values are possible when the NO contacts are closed (ON).
*3. Only for MBB models.
*4. Reference values for MBB models.
*5. Only for MBB models.
*6. Reference value.
*7. For safe use, always make sure that the minimum values or greater are provided.

1-conduit Models

Adjustable Roller Lever, Form Lock (with Metal Lever, Resin Roller)
D4N-1□2G D4N-2□2G
D4N-3□2G D4N-4□2G
D4N-9□2G *



Adjustable Roller Lever, Form Lock (with Metal Lever, Rubber Roller)
D4N-1□2H D4N-2□2H
D4N-3□2H D4N-4□2H
D4N-9□2H *



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
* Refer to following diagrams for details on M12 connectors.

Snap-action (1NC/1NO) (2NC), Slow-action (2NC) (3NC)

Operating characteristics	Model	D4N-□12H D4N-□22H D4N-□B2H D4N-□D2H	D4N-□12G D4N-□22G D4N-□B2G D4N-□D2G *1
Operating force	OF max.	4.5 N	
Release force	RF min.	0.4 N	
Pretravel	PT	18° to 27°	
Overtravel	OT min.	40°	
Movement differential	MD max. *2	14°	
Operating position	OP	---	
Total travel	TT *3	(80°)	
Direct opening travel	DOT min. *4	50°	
Direct opening force	DOF min. *4	20 N	

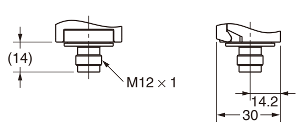
Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC, 2NC/1NO, and 3NC contacts. Check contact operation.
*1. The operating characteristics of these Switches were measured with the roller lever set at 32 mm.
*2. Only for snap-action models.
*3. Reference value.
*4. For safe use, always make sure that the minimum values or greater are provided.

Slow-action (1NC/1NO) (2NC/1NO)

Operating characteristics	Model	D4N-□A2H D4N-□C2H D4N-□E2H D4N-□F2H	D4N-□A2G D4N-□C2G D4N-□E2G D4N-□F2G *1
Operating force	OF max.	4.5 N	
Release force	RF min.	0.4 N	
Pretravel	PT *2	18° to 27°	
	PT (2nd) *3	(44°)	
	PT *4	27.5° to 36.5°	
	PT (2nd) *5	(18°)	
Overtravel	OT min.	40°	
Operating position	OP	---	
Total travel	TT *6	(80°)	
Direct opening travel	DOT min.	50°	
Direct opening force	DOF min. *7	20 N	

*1. The operating characteristics of these Switches were measured with the roller lever set at 32 mm.
*2. This PT value is possible when the NC contacts are open (OFF).
*3. This PT value is possible when the NO contacts are closed (ON).
*4. Only for MBB models.
*5. Reference value for MBB models only.
*6. Reference value.
*7. For safe use, always make sure that the minimum values or greater are provided.

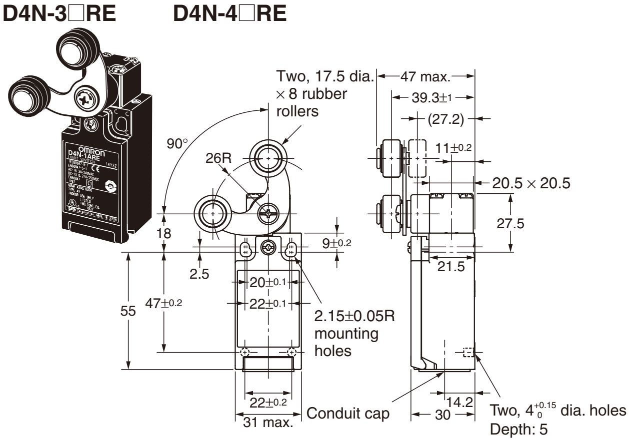
1-conduit M12 Connector
D4N-9□□□



1-conduit Models

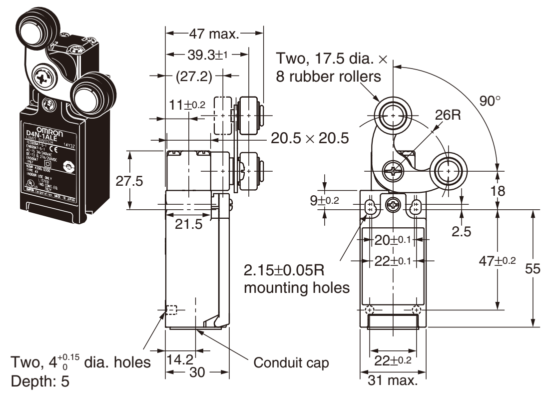
Fork Lever Lock (Right Operation)

D4N-1□RE D4N-2□RE
D4N-3□RE D4N-4□RE



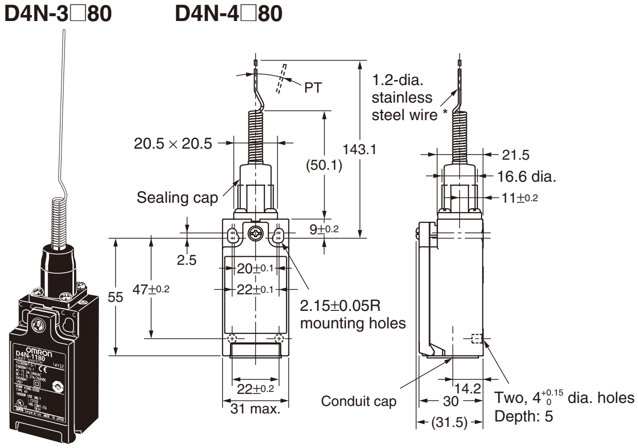
Fork Lever Lock (Left Operation)

D4N-1□LE D4N-2□LE
D4N-3□LE D4N-4□LE



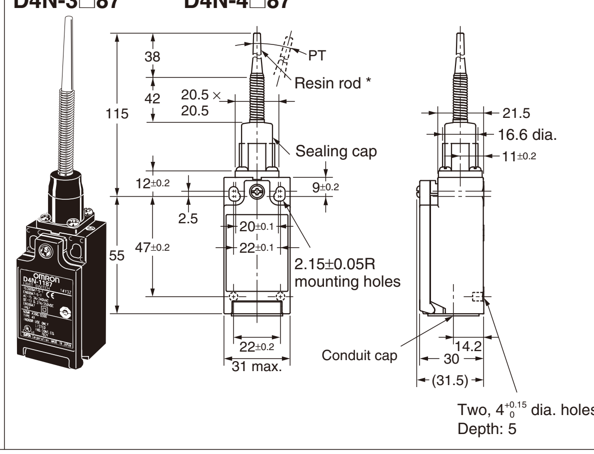
Cat Whisker

D4N-1□80 D4N-2□80
D4N-3□80 D4N-4□80



Plastic Rod

D4N-1□87 D4N-2□87
D4N-3□87 D4N-4□87



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
* The usable range for stainless steel wires and resin rods is 35 mm max. from the end with a total travel of 70 mm max.

Slow-action (1NC/1NO) (2NC/1NO) (2NC) (3NC)

Model / Operating characteristics	D4N-□□RE	D4N-□□LE
Force necessary to reverse the direction of the lever: max.	6.4 N	6.4 N
Movement until the lever reverses	55 ±10°	55 ±10°
Movement until switch operation (NC)	(6.5°) (MBB: 10°)	(6.5°) (MBB: 10°)
Movement until switch operation (NO)	(18.5°) (MBB: 5°)	(18.5°) (MBB: 5°)

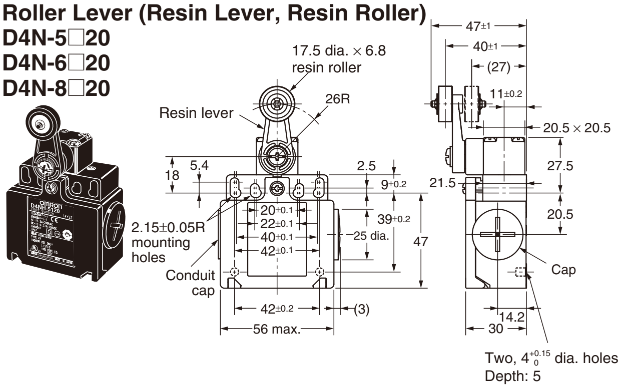
Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC, 2NC/1NO, and 3NC contacts. Check contact operation.

Snap-action (1NC/1NO) (2NC), Slow-action (2NC) (3NC)

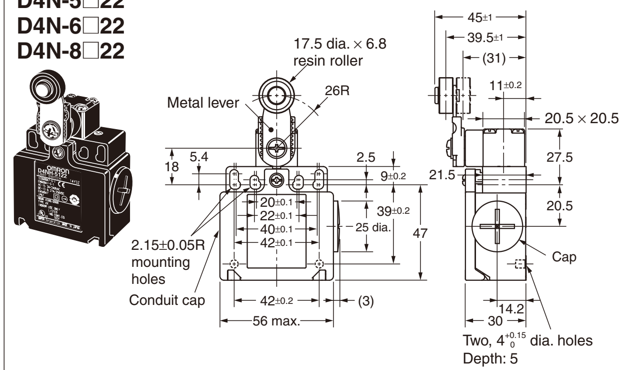
Model / Operating characteristics		D4N-□□80	D4N-□□87
Operating force	**OF max.**	1.5 N	1.5 N
Pretravel	**PT max.**	15°	15°

2-conduit Models

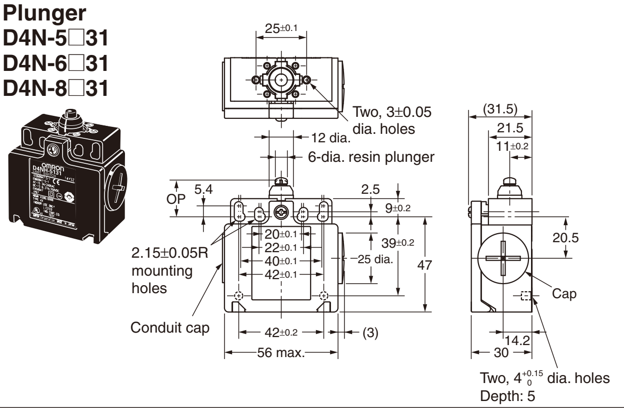
Roller Lever (Resin Lever, Resin Roller)
D4N-5□20
D4N-6□20
D4N-8□20



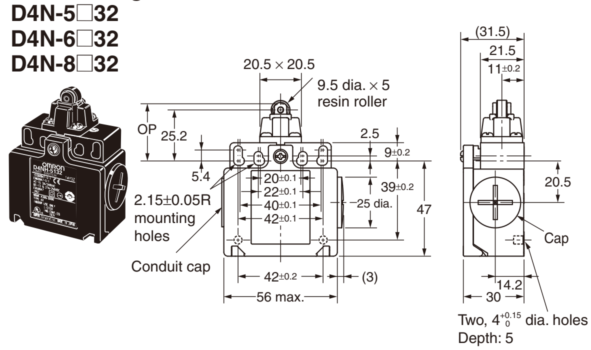
Roller Lever (Metal Lever, Resin Roller)
D4N-5□22
D4N-6□22
D4N-8□22



Plunger
D4N-5□31
D4N-6□31
D4N-8□31



Roller Plunger
D4N-5□32
D4N-6□32
D4N-8□32



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

Snap-action (1NC/1NO) (2NC), Slow-action (2NC) (3NC)

Operating characteristics	Model	D4N-□120 D4N-□220 D4N-□B20 D4N-□D20	D4N-□122 D4N-□222 D4N-□B22 D4N-□D22	D4N-□131 D4N-□231 D4N-□B31 D4N-□D31	D4N-□132 D4N-□232 D4N-□B32 D4N-□D32
Operating force	OF max.	5 N	5 N	6.5 N	6.5 N
Release force	RF min.	0.5 N	0.5 N	1.5 N	1.5 N
Pretravel	PT	18° to 27°	18° to 27°	2 mm	2 mm
Overtravel	OT min.	40°	40°	4 mm	4 mm
Movement differential	MD max. *1	14°	14°	1 mm	1 mm
Operating position	OP	---	---	18 ±0.5 mm	28.2 ±0.8 mm
Total travel	TT *2	(80°)	(80°)	(6 mm)	(6 mm)
Direct opening travel	DOT min. *3	50°	50°	3.2 mm	3.2 mm
Direct opening force	DOF min. *3	20 N	20 N	20 N	20 N

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC, 2NC/1NO, and 3NC contacts. Check contact operation.

*1. Only for snap-action models.
*2. Reference value.
*3. For safe use, always make sure that the minimum values or greater are provided.

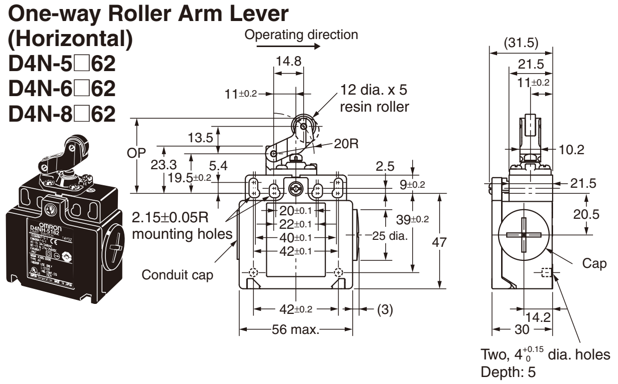
Slow-action (1NC/1NO) (2NC/1NO)

Operating characteristics	Model	D4N-□A20 D4N-□C20 D4N-□E20 D4N-□F20	D4N-□A22 D4N-□C22 D4N-□E22 D4N-□F22	D4N-□A31 D4N-□C31 D4N-□E31 D4N-□F31	D4N-□A32 D4N-□C32 D4N-□E32 D4N-□F32
Operating force	OF max.	5 N	5 N	6.5 N	6.5 N
Release force	RF min.	0.5 N	0.5 N	1.5 N	1.5 N
Pretravel	PT *1	18° to 27°	18° to 27°	2 mm	2 mm
	PT (2nd) *2	(44°)	(44°)	(2.9 mm)	(2.9 mm)
	PT *3	27.5° to 36.5°	27.5° to 36.5°	2.8 mm	2.8 mm
	PT (2nd) *4	(18°)	(18°)	(1 mm)	(1 mm)
Overtravel	OT min.	40°	40°	4 mm	4 mm
Operating position	OP	---	---	18 ±0.5 mm	28.2 ±0.8 mm
	OP *5	---	---	17.4 ±0.5 mm	28 ±0.8 mm
Total travel	TT *6	(80°)	(80°)	(6 mm)	(6 mm)
Direct opening travel	DOT min. *7	50°	50°	3.2 mm	3.2 mm
Direct opening force	DOF min. *7	20 N	20 N	20 N	20 N

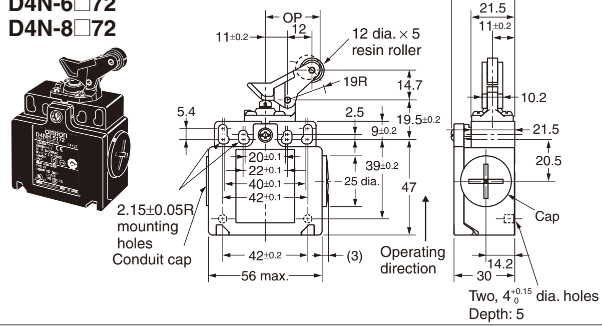
*1. This PT value is possible when the NC contacts are open (OFF).
*2. This PT value is possible when the NO contacts are closed (ON).
*3. Only for MBB models.
*4. Reference value for MBB models.
*5. Only for MBB models.
*6. Reference value.
*7. For safe use, always make sure that the minimum values or greater are provided.

2-conduit Models

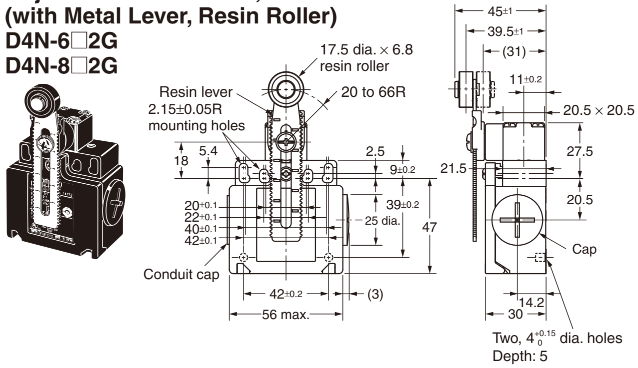
One-way Roller Arm Lever (Horizontal)
D4N-5□62
D4N-6□62
D4N-8□62



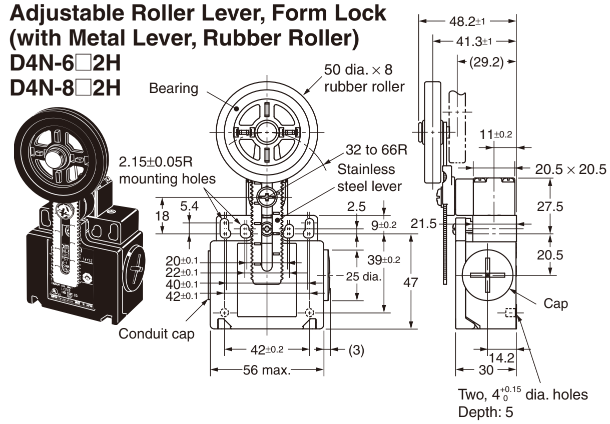
One-way Roller Arm Lever (Vertical)
D4N-5□72
D4N-6□72
D4N-8□72



Adjustable Roller Lever, Form Lock (with Metal Lever, Resin Roller)
D4N-6□2G
D4N-8□2G



Adjustable Roller Lever, Form Lock (with Metal Lever, Rubber Roller)
D4N-6□2H
D4N-8□2H



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

Snap-action (1NC/1NO) (2NC), Slow-action (2NC) (3NC)

Operating characteristics		Model: D4N-□162 D4N-□262 D4N-□B62 D4N-□D62	D4N-□172 D4N-□272 D4N-□B72 D4N-□D72	D4N-□12G D4N-□22G D4N-□B2G D4N-□D2G *1	D4N-□12H D4N-□22H D4N-□B2H D4N-□D2H *2
Operating force	OF max.	5.0 N	5.0 N	4.5 N	4.5 N
Release force	RF min.	0.8 N	0.8 N	0.4 N	0.4 N
Pretravel	PT max.	4 mm	4 mm	18° to 27°	18° to 27°
Overtravel	OT min.	5 mm	5 mm	40°	40°
Movement differential	MD max. *3	1.5 mm	1.5 mm	14°	14°
Operating position	OP	37 ±0.8 mm	27 ±0.8 mm	---	---
Total travel	TT *4	(9 mm)	(9 mm)	(70°)	(70°)
Direct opening travel	DOT min. *5	5.8 mm	4.8 mm	50°	50°
Direct opening force	DOF min. *5	20 N	20 N	20 N	20 N

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC, 2NC/1NO, and 3NC contacts. Check contact operation.
*1. The operating characteristics of these Switches were measured with the roller lever set at 30 mm.
*2. The operating characteristics of these Switches were measured with the roller lever set at 31 mm.
*3. Only for snap-action models.
*4. Reference value.
*5. For safe use, always make sure that the minimum values or greater are provided.

Slow-action (1NC/1NO) (2NC/1NO)

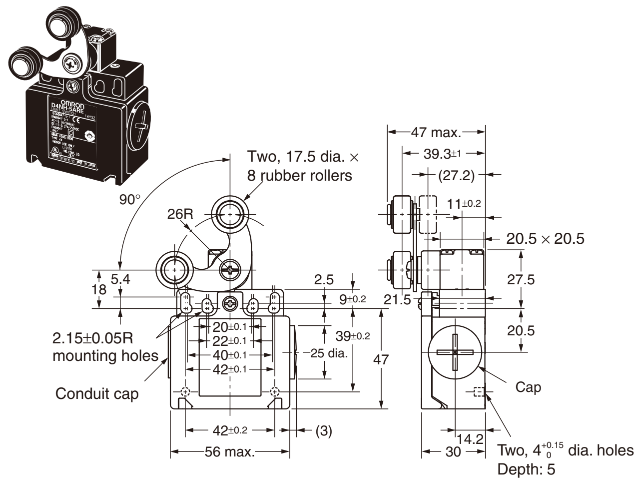
Operating characteristics		Model: D4N-□A62 D4N-□C62 D4N-□E62 D4N-□F62	D4N-□A72 D4N-□C72 D4N-□E72 D4N-□F72	D4N-□A2G D4N-□C2G D4N-□E2G D4N-□F2G *1	D4N-□A2H D4N-□C2H D4N-□E2H D4N-□F2H *2
Operating force	OF max.	5.0 N	5.0 N	4.5 N	4.5 N
Release force	RF min.	0.8 N	0.8 N	0.4 N	0.4 N
Pretravel	PT max. *3	4 mm	4 mm	18° to 27°	18° to 27°
	PT (2nd) *4	(5.2 mm)	(4.3 mm)	(44°)	(44°)
	PT max. *5	4 mm	4 mm	27.5° to 36.5°	27.5° to 36.5°
	PT (2nd) *6	(1.5 mm)	(1.5 mm)	(18°)	(18°)
Overtravel	OT min.	5 mm	5 mm	40°	40°
Operating position	OP	37 ±0.8 mm	27 ±0.8 mm	---	---
	OP *7	36 ±0.8 mm	26.1 ±0.8 mm	---	---
Total travel	TT *8	(9 mm)	(9 mm)	(70°)	(70°)
Direct opening travel	DOT min. *9	5.8 mm	4.8 mm	50°	50°
Direct opening force	DOF min. *9	20 N	20 N	20 N	20 N

*1. The operating characteristics of these Switches were measured with the roller lever set at 30 mm.
*2. The operating characteristics of these Switches were measured with the roller lever set at 31 mm.
*3. This PT value is possible when the NC contacts are open (OFF).
*4. This PT value is possible when the NO contacts are closed (ON).
*5. Only for MBB models.
*6. Reference value for MBB models only.
*7. Only for MBB models.
*8. Reference value.
*9. For safe use, always make sure that the minimum values or greater are provided.

2-conduit Models

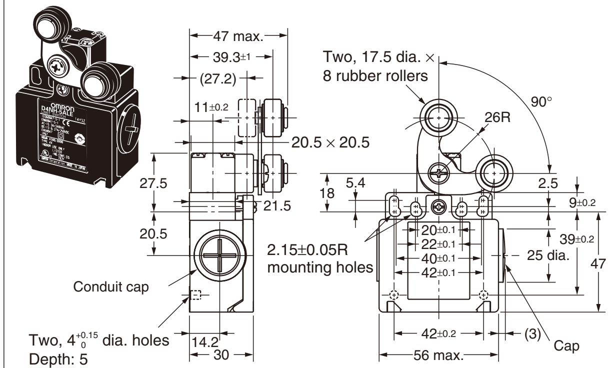
Fork Lever Lock (Right Operation)

D4N-5□RE D4N-6□RE
D4N-7□RE D4N-8□RE



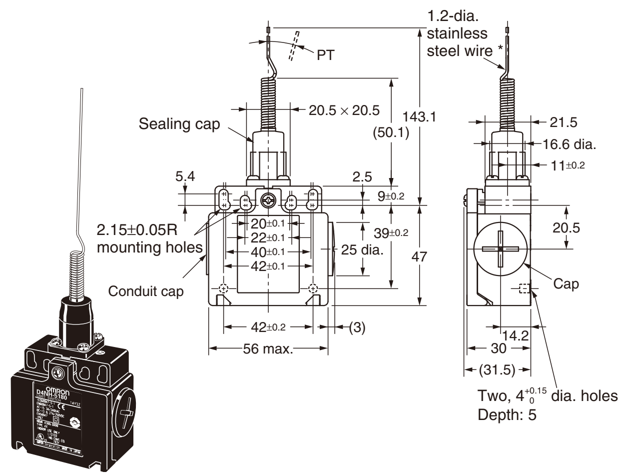
Fork Lever Lock (Left Operation)

D4N-5□LE D4N-6□LE
D4N-7□LE D4N-8□LE



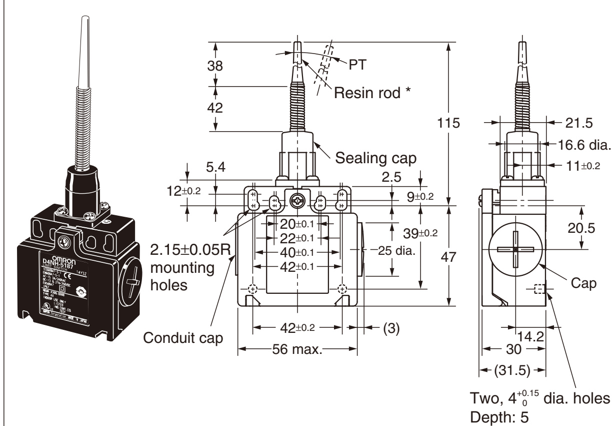
Cat Whisker

D4N-5□80 D4N-6□80
D4N-7□80 D4N-8□80



Plastic Rod

D4N-5□87 D4N-6□87
D4N-7□87 D4N-8□87



Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
* The usable range for stainless steel wires and resin rods is 35 mm max. from the end with a total travel of 70 mm max.

Slow-action (1NC/1NO) (2NC), Slow-action (2NC) (3NC)

Model / Operating characteristics	D4N-□□RE	D4N-□□LE
Force necessary to reverse the direction of the lever: max.	6.4 N	6.4 N
Movement until the lever reverses	55 ±10°	55 ±10°
Movement until switch operation (NC)	(6.5°)	(6.5°) (MBB: 10°)
Movement until switch operation (NO)	(18.5°)	(18.5°) (MBB: 5°)

Note: Variation occurs in the simultaneity of contact opening/closing operations of 2NC, 2NC/1NO, and 3NC contacts. Check contact operation.

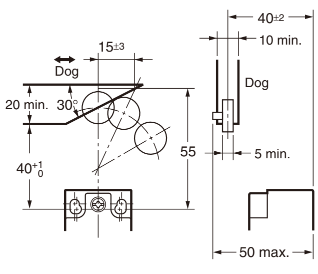
Snap-action (1NC/1NO), Slow-action (2NC) (3NC)

Model / Operating characteristics		D4N-□□80	D4N-□□87
Operating force	**OF max.**	1.5 N	1.5 N
Pretravel	**PT max.**	15°	15°

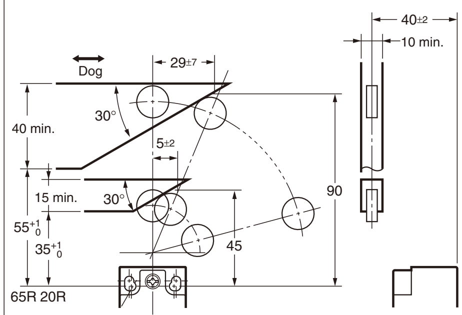
Levers

Refer to the following for the angles and positions of the watchdogs (source: EN50047.)

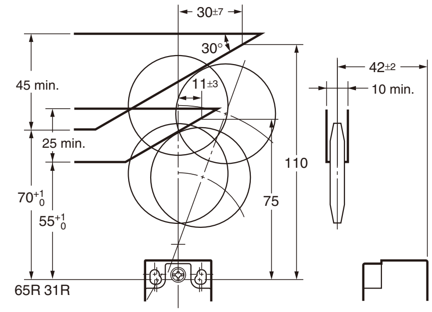
Roller Lever
(D4N-□□20)



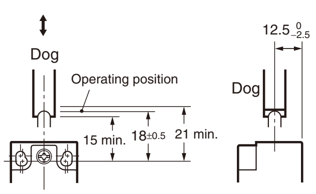
Adjustable Roller Lever, Form Lock
(with Metal Lever, Resin Roller)
(D4N-□□2G) (Reference Values)



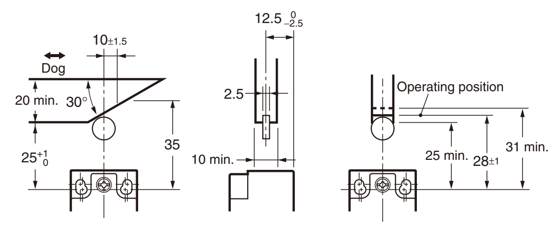
Adjustable Roller Lever, Form Lock
(with Metal Lever, Rubber Roller)
(D4N-□□2H) (Reference Values)



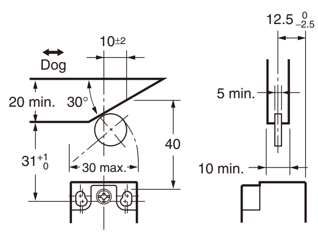
Sealed Plunger
(D4N-□□31)



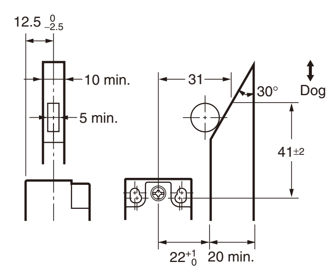
Roller Plunger
(D4N-□□32)



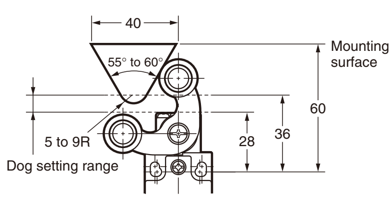
One-way Roller Arm Lever
(Horizontal)
(D4N-□□62)



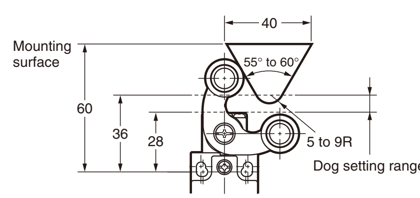
One-way Roller Arm Lever
(Vertical) (Reference Values)
(D4N-□□72)



Fork Lever Lock
(Right Operation)
(D4N-□□RE)



Fork Lever Lock
(Left Operation)
(D4N-□□LE)



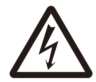
Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

Safety Precautions

Refer to the *"Precautions for All Switches"* and *"Precautions for All Safety Limit Switches".*

⚠ CAUTION

Electric shock may occasionally occur.
Do not use metal connectors or metal conduits.



Precautions for Safe Use

- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of oil or water. Doing so may result in oil or water entering the Switch interior. (The IP67 degree of protection specification for the Switch refers to water penetration while the Switch is submersed in water for a specified period of time.)
- Always attach the cover after completing wiring and before using the Switch. Also, do not turn ON the Switch with the cover open. Doing so may result in electric shock.
- Do not switch circuits for two or more standard loads (250 VAC, 3 A) at the same time. Doing so may adversely affect insulation performance.

Precautions for Correct Use

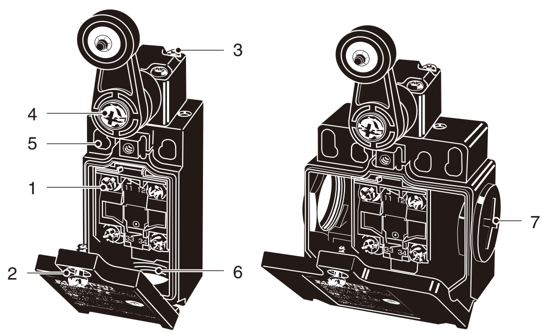
The Switch contacts can be used with either standard loads or microloads. Once the contacts have been used to switch a load, however, they cannot be used to switch smaller loads. The contact surfaces will become rough once they have been used and contact reliability for smaller loads may be reduced.

Mounting Method

Appropriate Tightening Torque

Tighten each of the screws to the specified torque. Loose screws may result in malfunction of the Switch within a short time.

1	**Terminal screw**	0.6 to 0.8 N·m
2	**Cover mounting screw**	0.5 to 0.7 N·m
3	**Head mounting screw**	0.5 to 0.6 N·m
4	**Lever mounting screw**	1.6 to 1.8 N·m
5	**Body mounting screw**	0.5 to 0.7 N·m
6	**Connector, M12 adaptor**	1.8 to 2.2 N·m (except 1/2-14NPT)
		1.4 to 1.8 N·m (for 1/2-14NPT)
7	**Cap screw**	1.3 to 1.7 N·m

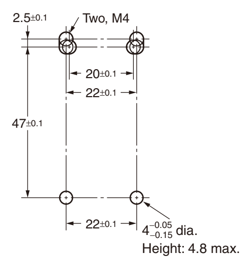


Switch Mounting

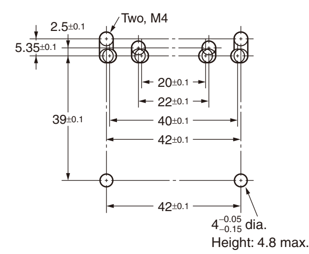
- Mount the Switch using M4 screws and washers and tighten the screws to the specified torque.
- For safety, use screws that cannot be easily removed, or use an equivalent measure to ensure that the Switch is secure.
- As shown below, two studs with a maximum height of 4.8 mm and a diameter of $4^{-0.05}_{-0.15}$ mm can be provided, the studs inserted into the holes on the bottom of the Switch, and the Switch secured at four locations to increase the mounting strength.

Switch Mounting Holes

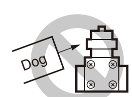
One-conduit Type



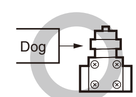
Two-conduit Type



- Make sure that the dog contacts the actuator at a right angle. Applying a load to the switch actuator (roller) on a slant may result in deformation or damage of the actuator or rotary shaft.



Incorrect



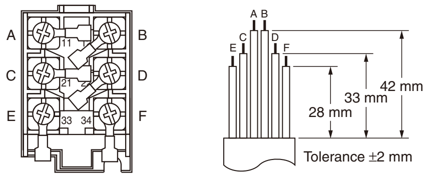
Correct

Wiring

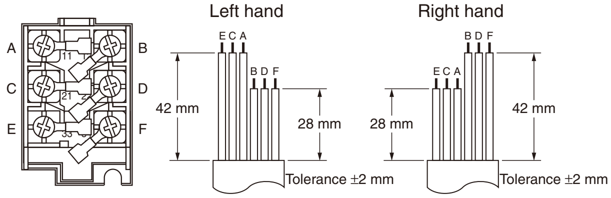
Wiring

- When connecting to the terminals via insulating tube and M3.5 crimp terminals, arrange the crimp terminals as shown below so that they do not rise up onto the case or the cover.
  Applicable lead wire size: AWG20 to AWG18 (0.5 to 0.75 mm^2).
  Use lead wires of an appropriate length, as shown below. Not doing so may result in excess length causing the cover to rise and not fit properly.

One-conduit Type (3 Poles)



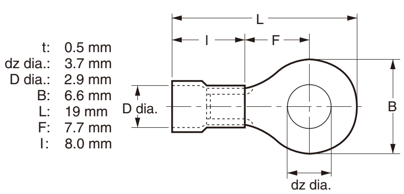
Two-conduit Type (3 Poles)

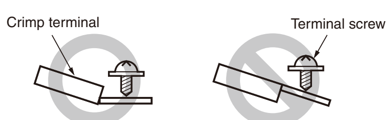


- Do not push crimp terminals into gaps in the case interior. Doing so may cause damage or deformation of the case.
- Use crimp terminals not more than 0.5 mm in thickness. Otherwise, they will interfere with other components inside the case.

[Reference] The crimp terminals shown below are not more than 0.5 mm thick.

Manufacturer	Type
J.S.T. Mfg. Co.	FN0.5-3.7 (F Type)
	N0.5-3.7 (Straight Type)



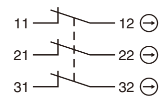


Contact Arrangement

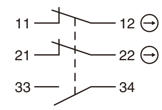
- The contact arrangements are shown below.

Screw Terminal Type

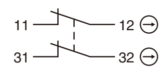
D4N-□D□□ (3NC)



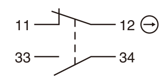
D4N-□C□□ (2NC/1NO)
D4N-□F□□ (2NC/1NO (MBB))



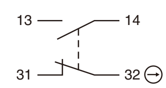
D4N-□B□□ (2NC)
D4N-□2□□ (2NC (SNAP))



D4N-□A□□ (1NC/1NO)
D4N-□E□□ (1NC/1NO (MBB))

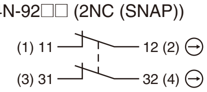


D4N-□1□□ (1NC/1NO (SNAP))

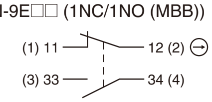


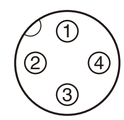
Connector Type

D4N-9B□□ (2NC)
D4N-92□□ (2NC (SNAP))



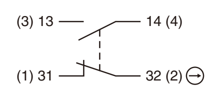
D4N-9A□□ (1NC/1NO)
D4N-9E□□ (1NC/1NO (MBB))





Pin No. (Terminal No.)

D4N-91□□ (1NC/1NO (SNAP))



- Applicable socket: XS2F (OMRON).
- Refer to the *Connector Catalog* for details on socket pin numbers and lead wire colors.

Socket Tightening (Connector Type)

- Turn the socket connector screws by hand and tighten until no space remains between the socket and the plug.
- Make sure that the socket connector is tightened securely. Otherwise, the rated degree of protection (IP67) may not be maintained and vibration may loosen the socket connector.

Conduit Opening

- Connect a recommended connector to the opening of the conduit and tighten the connector to the specified torque. The case may be damaged if an excessive tightening torque is applied.
- When using 1/2-14NPT, wind sealing tape around the joint between the connector and conduit opening so that the enclosure will conform to IP67.
- Use a cable with a suitable diameter for the connector.
- Attach and tighten a conduit cap to the unused conduit opening when wiring. Tighten the conduit cap to the specified torque. The conduit cap is provided with the Switch (2-conduit types).

Changing the Lever

The lever mounting screws can be used to set the lever position to any position in a 360° angle at 7.5° increments. Grooves are incised on the lever and rotary shaft that engage to prevent the lever from slipping against the rotary shaft. The screws on adjustable roller lever models can also loosened to change the length of the lever.
Remove the screws from the front of the lever before mounting the lever in reverse (front/back), and set the level so that operation will be completed before exceeding a range of 180° on the horizontal.

Recommended Connectors

Use connectors with screws not exceeding 9 mm, otherwise the screws will protrude into the case interior, interfering with other components in the case.
The connectors listed in the following table have connectors with thread sections not exceeding 9 mm.
Use the recommended connectors to ensure conformance to IP67.

Size	Manufacturer	Model	Applicable cable diameter
G1/2	LAPP	ST-PF1/2 5380-1002	6.0 to 12.0 mm
Pg13.5	LAPP	ST-13.5 5301-5030	6.0 to 12.0 mm
M20	LAPP	ST-M20 × 1.5 5311-1020	7.0 to 13.0 mm
1/2-14NPT	LAPP	ST-NPT1/2 5301-6030	6.0 to 12.0 mm

Use LAPP connectors together with seal packing (JPK-16, GP-13.5, or GPM20), and tighten to the specified tightening torque. Seal packing is sold separately.

- LAPP is a German manufacturer.
- Before using a 2-conduit 1/2-14NPT type, attach the provided changing adaptor to the Switch and then connect the recommended connector.

Others

- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.
- Make sure that foreign particles do not enter the head when removing the screws from the four corners to change the head position in any of the four directions.
- Use the following recommended countermeasures to prevent telegraphing when using adjustable or long levers.
  1. Make the rear edge of the dog smooth with an angle of 15° to 30° or make it in the shape of a quadratic curve.
  2. Design the circuit so that no error signal will be generated.

Production Discontinuation

Following the release of the D4N, production of the D4D-N was discontinued.

Date of Production Discontinuation

Production of the D4D-N Series was discontinued as of the end of March 2006.

Recommended Substitute Product

Sales of the D4N series commenced in January 2004.

Product Substitution

1. Dimensions

The D4D-N and D4N use the same mounting method, and mounting hole. The multi-contact structure and the extra 4 mm in length, however, are different.

2. Terminal Numbers

For the 2-contact slow-action model, the terminals 21, 22, 23, and 24 on the D4D-N are 31, 32, 33, and 34 on the D4N.

3. Recommended Terminals

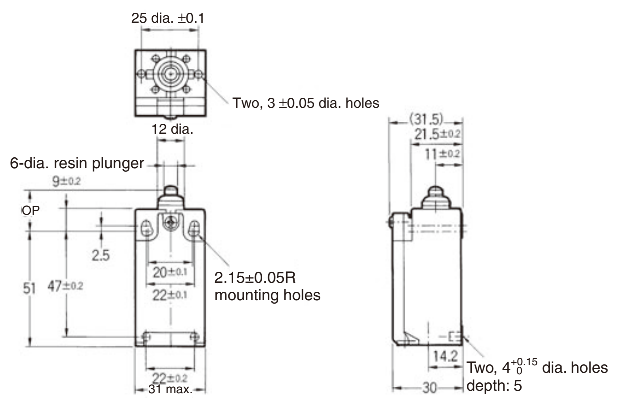
If the recommended terminals are not used, the Switch may not be compatible. Make sure that the Switch is compatible with the terminals.

Comparison with Discontinued Products

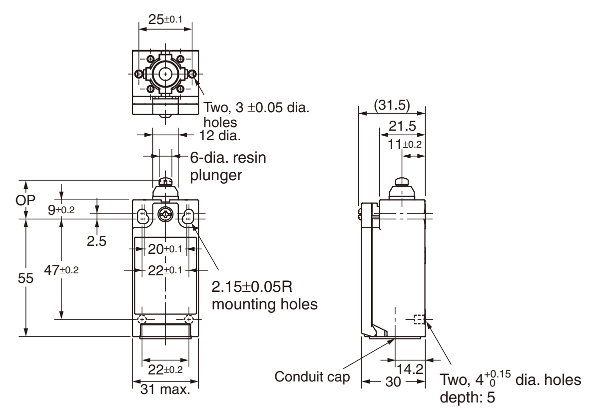
Item Model	D4N
Switch color	Very similar
Dimensions	Very similar
Wiring/connection	Significantly different
Mounting method	Completely compatible
Ratings/performance	Very similar
Operating characteristics	Very similar
Operating method	Completely compatible

Dimensions (Unit: mm)

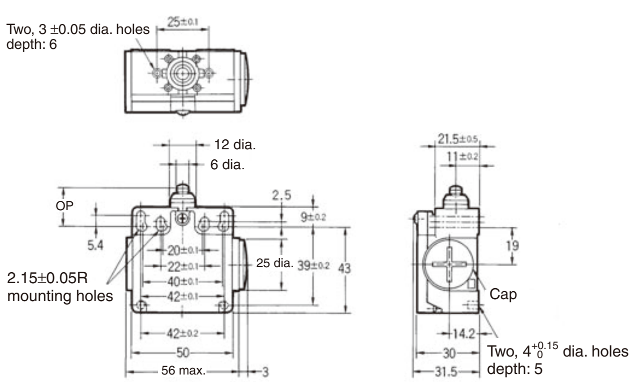
Discontinued Product (1-conduit Plunger-type D4D-N)



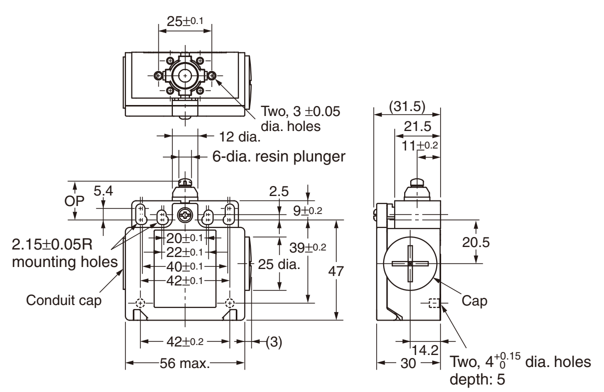
Recommended Substitute Product (1-conduit Plunger-type D4N)



Discontinued product (2-conduit Plunger-type D4D-N)



Recommended Substitute Product (2-conduit Plunger-type D4N)



List of Recommended Substitute Products

: The actuator on the D4D-N is a non-safety type. The D4N is recommended for safety applications (form lock type). Be sure to mount it correctly.

: M screws are recommended to comply with European standards. Therefore, the M20 type is recommended as a substitute when the Pg13.5 conduit-type is not available in a D4N model.

Safety Limit Switches

Discontinued product	Recommended substitute product	Discontinued product	Recommended substitute product	Discontinued product	Recommended substitute product
D4D-1120N	D4N-1120	D4D-1520N	D4N-1A20	D4D-1A20N	D4N-1B20
D4D-2120N	D4N-2120	D4D-2520N	D4N-2A20	D4D-2A20N	D4N-2B20
D4D-3120N	D4N-3120	D4D-3520N	D4N-3A20	D4D-3A20N	D4N-3B20
D4D-5120N	D4N-5120	D4D-5520N	D4N-5A20	D4D-5A20N	D4N-5B20
D4D-6120N	D4N-6120	D4D-6520N	D4N-6A20	D4D-6A20N	D4N-6B20
D4D-1122N	D4N-1122	D4D-1522N	D4N-1A22	D4D-1A22N	D4N-1B22
D4D-2122N	D4N-2122	D4D-2522N	D4N-2A22	D4D-2A22N	D4N-2B22
D4D-3122N	D4N-3122	D4D-3522N	D4N-3A22	D4D-3A22N	D4N-3B22
D4D-5122N	D4N-5122	D4D-5522N	D4N-5A22	D4D-5A22N	D4N-5B22
D4D-6122N	D4N-6122	D4D-6522N	D4N-6A22	D4D-6A22N	D4N-6B22
D4D-1125N	D4N-1125	D4D-1525N	D4N-1A25	D4D-1A25N	D4N-1B25
D4D-2125N	D4N-2125	D4D-2525N	D4N-2A25	D4D-2A25N	D4N-2B25
D4D-3125N	D4N-3125	D4D-3525N	D4N-3A25	D4D-3A25N	D4N-3B25
D4D-1131N	D4N-1131	D4D-1531N	D4N-1A31	D4D-1A31N	D4N-1B31
D4D-2131N	D4N-2131	D4D-2531N	D4N-2A31	D4D-2A31N	D4N-2B31
D4D-3131N	D4N-3131	D4D-3531N	D4N-3A31	D4D-3A31N	D4N-3B31
D4D-5131N	D4N-5131	D4D-5531N	D4N-5A31	D4D-5A31N	D4N-5B31
D4D-6131N	D4N-6131	D4D-6531N	D4N-6A31	D4D-6A31N	D4N-6B31
D4D-1132N	D4N-1132	D4D-1532N	D4N-1A32	D4D-1A32N	D4N-1B32
D4D-2132N	D4N-2132	D4D-2532N	D4N-2A32	D4D-2A32N	D4N-2B32
D4D-3132N	D4N-3132	D4D-3532N	D4N-3A32	D4D-3A32N	D4N-3B32
D4D-5132N	D4N-5132	D4D-5532N	D4N-5A32	D4D-5A32N	D4N-5B32
D4D-6132N	D4N-6132	D4D-6532N	D4N-6A32	D4D-6A32N	D4N-6B32
D4D-1162N	D4N-1162	D4D-1562N	D4N-1A62	D4D-1A62N	D4N-1B62
D4D-2162N	D4N-2162	D4D-2562N	D4N-2A62	D4D-2A62N	D4N-2B62
D4D-3162N	D4N-3162	D4D-3562N	D4N-3A62	D4D-3A62N	D4N-3B62
D4D-5162N	D4N-5162	D4D-5562N	D4N-5A62	D4D-5A62N	D4N-5B62
D4D-6162N	D4N-6162	D4D-6562N	D4N-6A62	D4D-6A62N	D4N-6B62
D4D-1172N	D4N-1172	D4D-1572N	D4N-1A72	D4D-1A72N	D4N-1B72
D4D-2172N	D4N-2172	D4D-2572N	D4N-2A72	D4D-2A72N	D4N-2B72
D4D-3172N	D4N-3172	D4D-3572N	D4N-3A72	D4D-3A72N	D4N-3B72
D4D-5172N	D4N-5172	D4D-5572N	D4N-5A72	D4D-5A72N	D4N-5B72
D4D-6172N	D4N-6172	D4D-6572N	D4N-6A72	D4D-6A72N	D4N-6B72
D4D-112HN	D4N-112H	D4D-152HN	D4N-1A2H	D4D-1A2HN	D4N-1B2H
D4D-212HN	D4N-212H	D4D-252HN	D4N-2A2H	D4D-2A2HN	D4N-2B2H
D4D-312HN	D4N-312H	D4D-352HN	D4N-3A2H	D4D-3A2HN	D4N-3B2H

General-purpose Limit Switches

Discontinued product	Recommended substitute product
D4D-1121N	D4N-112G
D4D-2121N	D4N-212G
D4D-3121N	D4N-312G
D4D-5121N	D4N-512G
D4D-6121N	D4N-612G
D4D-1127N	D4N-112H
D4D-2127N	D4N-212H
D4D-3127N	D4N-312H
D4D-5127N	D4N-512H
D4D-6127N	D4N-612H
D4D-1180N	D4N-4180
D4D-2180N	D4N-2180
D4D-3180N	D4N-3180
D4D-5180N	D4N-8180
D4D-6180N	D4N-6180
D4D-1187N	D4N-4187
D4D-2187N	D4N-2187
D4D-3187N	D4N-3187
D4D-5187N	D4N-8187
D4D-6187N	D4N-6187

Discontinued product	Recommended substitute product
D4D-15REN	D4N-1ARE
D4D-25REN	D4N-2ARE
D4D-35REN	D4N-3ARE
D4D-55REN	D4N-5ARE
D4D-65REN	D4N-6ARE
D4D-15LEN	D4N-1ALE
D4D-25LEN	D4N-2ALE
D4D-35LEN	D4N-3ALE
D4D-55LEN	D4N-5ALE
D4D-65LEN	D4N-6ALE
D4D-1521N	D4N-1A2G
D4D-2521N	D4N-2A2G
D4D-3521N	D4N-3A2G
D4D-5521N	D4N-5A2G
D4D-6521N	D4N-6A2G
D4D-1527N	D4N-1A2H
D4D-2527N	D4N-2A2H
D4D-3527N	D4N-3A2H
D4D-5527N	D4N-5A2H
D4D-6527N	D4N-6A2H

Discontinued product	Recommended substitute product
D4D-1AREN	D4N-1BRE
D4D-2AREN	D4N-2BRE
D4D-3AREN	D4N-3BRE
D4D-5AREN	D4N-5BRE
D4D-6AREN	D4N-6BRE
D4D-1ALEN	D4N-1BLE
D4D-2ALEN	D4N-2BLE
D4D-3ALEN	D4N-3BLE
D4D-5ALEN	D4N-5BLE
D4D-6ALEN	D4N-6BLE
D4D-1A21N	D4N-1B2G
D4D-2A21N	D4N-2B2G
D4D-3A21N	D4N-3B2G
D4D-5A21N	D4N-5B2G
D4D-6A21N	D4N-6B2G
D4D-1A27N	D4N-1B2H
D4D-2A27N	D4N-2B2H
D4D-3A27N	D4N-3B2H
D4D-5A27N	D4N-5B2H
D4D-6A27N	D4N-6B2H
D4D-1A80N	D4N-4B80
D4D-2A80N	D4N-2B80
D4D-3A80N	D4N-3B80
D4D-5A80N	D4N-8B80
D4D-6A80N	D4N-6B80
D4D-1A87N	D4N-4B87
D4D-2A87N	D4N-2B87
D4D-3A87N	D4N-3B87
D4D-5A87N	D4N-8B87
D4D-6A87N	D4N-6B87

Precautions for All Safety Limit Switches

Note: Refer to the "*Safety Precautions*" section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

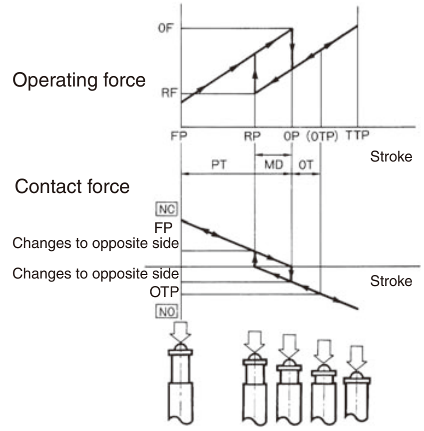
- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch box is protected from dust or water penetration, the head is not protected from minute foreign matter or water penetration. Ensure that minute foreign matter and water do not penetrate the head. Failure to do so may result in accelerated wear, Switch damage, or malfunctioning.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch as a stopper.
- Do not use the Switch in a startup circuit. Use it instead for a safety confirmation signal.
- Check the Switches before use and inspect regularly, replacing them when necessary. If a Switch is kept pressed for an extended period of time, the components may deteriorate quickly, and the Switch may not release.
- To protect the Switch from damage due to short-circuits, be sure to connect a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current in series with the Switch. When complying with EN certified ratings, use a 10 A IEC 60269-compliant gI or gG fuse.
- Do not drop the Switch. Doing so may prevent it from functioning to its full capacity.
- Do not disassemble or modify the Switch. Doing so may prevent it from operating correctly.

Precautions for Correct Use

Mechanical Characteristics

Operating Force, Stroke, and Contact Characteristics

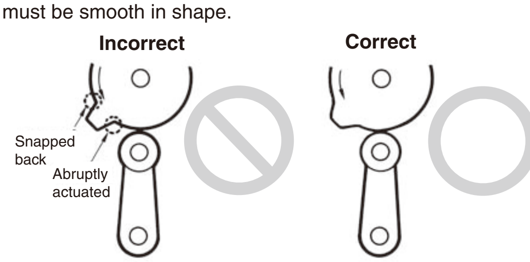
- The following graph indicates the relationship between operating force and stroke or stroke and contact force. In order to operate the Limit Switch with high reliability, it is necessary to use the Limit Switch within an appropriate contact force range. If the Limit Switch is used in the normally closed condition, the dog must be installed so that the actuator will return to the FP when the actuator is actuated by the object. If the Limit Switch is used in the normally open condition, the actuator must be pressed to 80% to 100% of the OT (i.e., 60% to 80% of the TT) and any slight fluctuation must be absorbed by the actuator.
- If the full stroke is set close to the OP or RP, contact instability may result. If the full stroke is set to the TTP, the actuator or switch may become damaged due to the inertia of the dog. In that case, adjust the stroke with the mounting panel or the dog. Refer to page C-2, *Dog Design*, page C-3, *Stroke Settings vs. Dog Movement Distance*, and page C-3, *Dog Surface* for details.
- The following graph shows an example of changes in contact force according to the stroke. The contact force near the OP or RP is unstable, and the Limit Switch cannot maintain high reliability. Furthermore, the Limit Switch cannot withstand strong vibration or shock.

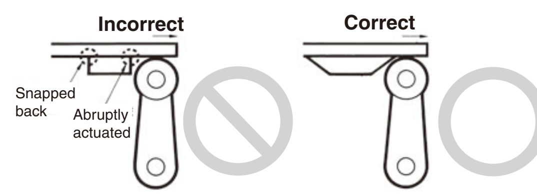


- If the Limit Switch is used so that the actuator is constantly pressed, it will fail quickly and reset faults may occur. Inspect the Limit Switch periodically and replace it as required.

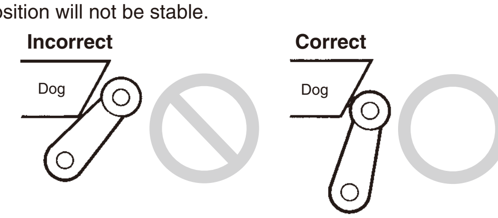
Operation

- Carefully determine the proper cam or dog so that the actuator will not abruptly snap back, thus causing shock. In order to operate the Limit Switch at a comparatively high speed, use a cam or dog with a long enough stroke that keeps the Limit Switch turned ON for a sufficient time so that the relay or valve will be sufficiently energized.
- The operating method, the shape of the dog or cam, the operating frequency, and the travel after operation have a large influence on the durability and operating accuracy of the Limit Switch. The cam must be smooth in shape.



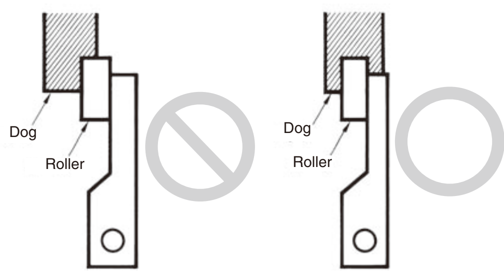


- Appropriate force must be imposed on the actuator by the cam or another object in both rotary operation and linear operation. If the object touches the lever as shown below, the operating position will not be stable.

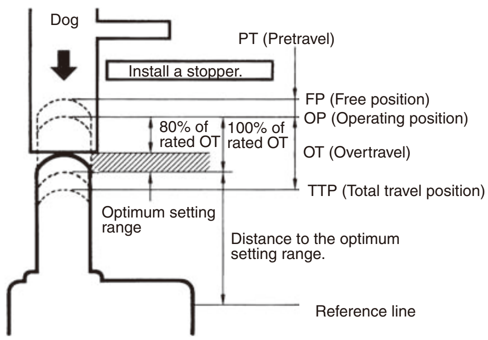


- Unbalanced force must not be imposed on the actuator. Otherwise, wear and tear on the actuator may result.

Incorrect **Correct**

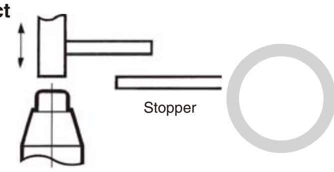


- Make sure that the actuator does not exceed the OT (overtravel) range, otherwise the Limit Switch may malfunction. When mounting the Limit Switch, be sure to adjust the Limit Switch carefully while considering the whole movement of the actuator.



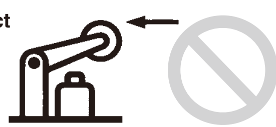
- The Limit Switch may soon malfunction if the OT is excessive. Therefore, adjustments and careful consideration of the position of the Limit Switch and the expected OT of the actuator are necessary when mounting the Limit Switch.

Correct



- Be sure to use the Limit Switch according to the characteristics of the actuator.
  If a roller arm lever actuator is used, do not attempt to actuate the Limit Switch in the direction shown below.

Incorrect



- Do not modify the actuator to change the OP.
- In the case of a long actuator of an adjustable roller lever type, the following countermeasures against lever shaking are recommended.

1. Make the rear edge of the object smooth with an angle of 15° to 30° or make it in the shape of a quadratic curve.
2. Design the circuit so that no error signal will be generated.
3. Use or set a switch that is actuated in one direction only. (Also, set the switch for operation in one direction only.)

Operating Environment

- These Switches are for indoor applications.
  The Switches may fail if they are used outdoors.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperatures or humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switches in the following locations.
  - Locations subject to severe temperature changes
  - Locations subject to high temperatures or condensation
  - Locations subject to severe vibration
  - Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - Locations where the Switch may come into contact with thinner or detergents
  - Locations where explosive or flammable gases are present

Switch Contacts

Switch contacts can be used with both standard loads and microloads, but once a contact has been used to switch a standard load, it cannot be used for a load of a smaller capacity.
Doing so may result in roughening of the contact surface and contact reliability may be lost.

Storing Switches

Do not store the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to, excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Dog Design

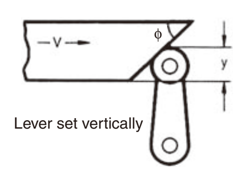
Operating Speed, Dog Angle, and Relationship with Actuator

Before designing a dog, carefully consider the operating speed and angle of the dog and their relationship with the shape of the actuator. The optimum operating speed (V) of a standard dog at an angle of 30° to 45° is 0.5 m/s maximum.

Roller Lever Models

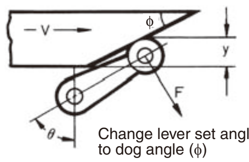
1. Non-overtravel Dog

Dog speed: 0.5 m/s max. (Standard Speed)



ϕ	V max. (m/s)	y
30°	0.4	0.8 (TT) 80% of totaltravel
45°	0.25	
60°	0.1	
60° to 90°	0.05 (low speed)	

Dog speed: 0.5 m/s ≤ V ≤ 2 m/s (High Speed)



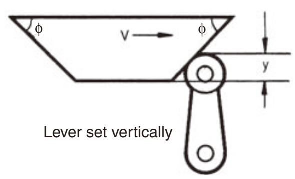
Change lever set angle (θ) according to dog angle (φ)

θ	φ	V max. (m/s)	y
45°	45°	0.5	0.5 to 0.8 (TT)
50°	40°	0.6	
60° to 55°	30° to 35°	1.3	0.5 to 0.7 (TT)
75° to 65°	15° to 25°	2	

Note: The above y values indicate the ratio ranges based on TT (total travel). Therefore, the optimum pressing distance of the dog is between 50% and 80% (or 50% and 70%).

2. Overtravel Dog

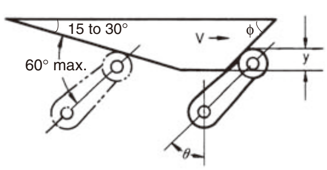
Dog speed: 0.5 m/s max.



φ	V max. (m/s)	y
30°	0.4	0.8 (TT) 80% of total travel
45°	0.25	
60°	0.1	
60° to 90°	0.05 (low speed)	

Dog speed: 0.5 m/s min.

If the speed of the overtravel dog is comparatively high, make the rear edge of the object smooth at an angle of 15° to 30° or make it in the shape of a quadratic curve. Then lever shaking will be reduced.



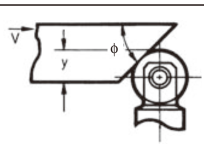
θ	φ	V max. (m/s)	y
45°	45°	0.5	0.5 to 0.8 (TT)
50°	40°	0.6	
60° to 55°	30° to 35°	1.3	0.5 to 0.7 (TT)
75° to 65°	15° to 25°	2	

Note: The above y values indicate the ratio ranges based on TT (total travel). Therefore, the optimum pressing distance of the dog is between 50% and 80% (or 50% and 70%).

Plunger Models

If the dog overrides the actuator, the front and rear of the dog may be the same in shape, provided that the dog is not designed to be separated from the actuator abruptly.

Roller Plunger

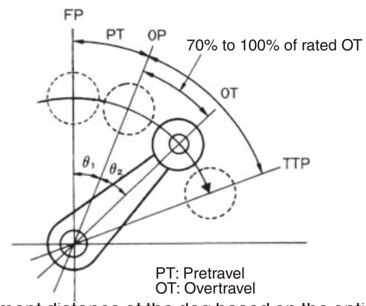


φ	V max. (m/s)	y
30°	0.25	0.6 to 0.8 (TT)
20°	0.5	0.5 to 0.7 (TT)

Stroke Settings vs. Dog Movement Distance

- The following provides information on stroke settings based on the movement distance of the dog instead of the actuator angle.
  The following is the optimum stroke of the Limit Switch.

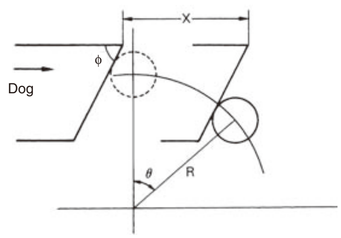
  Optimum stroke: PT + {Rated OT x (0.7 to 1.0)}
  The angle converted from the above: $\theta_1 + \theta_2$



- The movement distance of the dog based on the optimum stroke is expressed by the following formula.

  Movement distance of dog

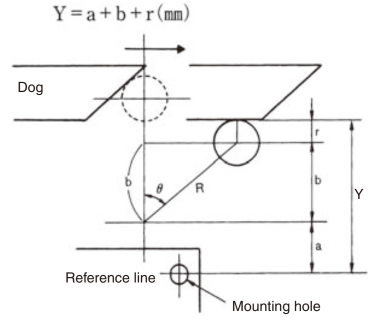
$$X = R\sin\theta + \frac{R(1-\cos\theta)}{\tan\phi} \ (\mathrm{mm})$$



φ: Dog angle
θ: Optimum stroke angle
R: Actuator length
X: Dog movement distance

- The distance between the reference line and the bottom of the dog based on the optimum stroke is expressed by the following formula.

$$Y = a + b + r \ (\mathrm{mm})$$



a: Distance between reference line and actuator fulcrum
b: R cosθ
r: Roller radius
Y: Distance between reference line and bottom of dog

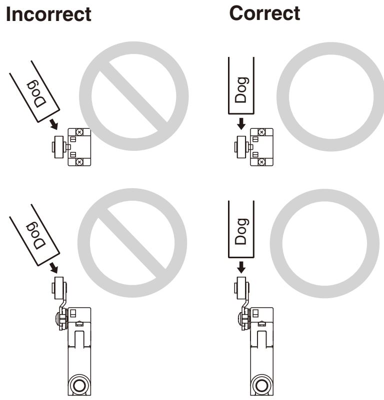
Dog Surface

- The surface of dog touching the actuator should be 6.3 S in quality and hardened at approximately HV450.
  For smooth operation of the actuator, apply molybdenum disulfide grease to the actuator and the dog touching the actuator.

Others

- When using the Limit Switch with a long lever or long rod lever, make sure that the lever is in the downward direction.

- With a roller actuator, the dog must touch the actuator at a right angle. The actuator or roller may deform or break if the dog touches the actuator (roller) at an oblique angle.



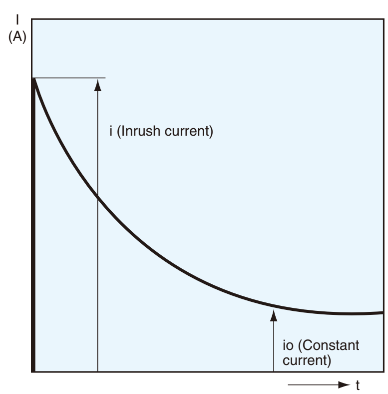
- Do not remove the Head. The Switch may fail.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly.
If the terminal is wired incorrectly, the Switch will not function.
Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

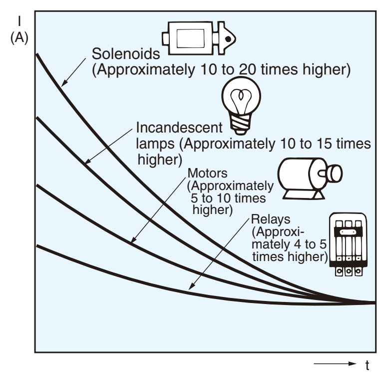
  Inductive load: A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)

  Lamp load: An inrush current 10 times higher than the normal current

  Motor load: An inrush current 6 times higher than the normal current

  1. Ambient temperature: 5°C to 35°C
  2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

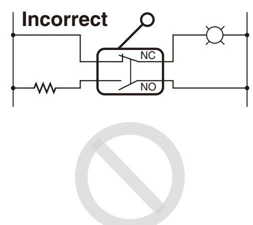
Electrical Conditions

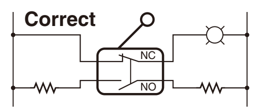
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

Connections

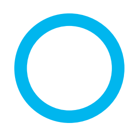
- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

Power Connection Examples
(Connection of Different Polarities)

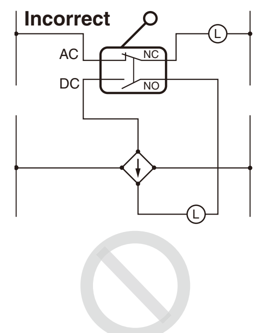




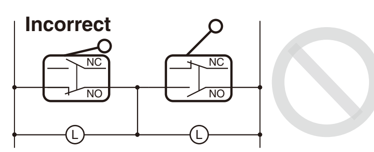
Connect the load to the same polarities.



Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

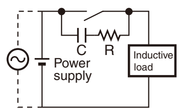
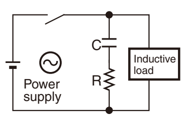
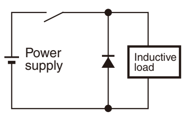
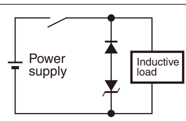
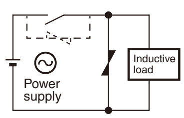


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

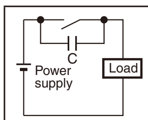
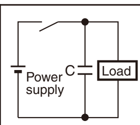
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 µF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

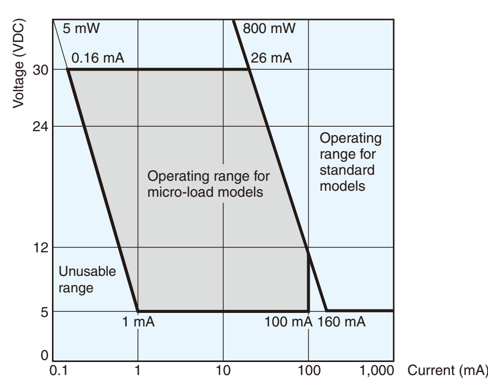
Do not use the following types of contact protection circuit.

 This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.	 This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

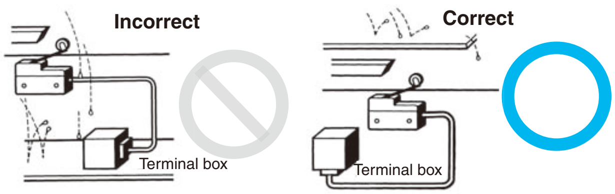
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, $\lambda_{60} = 0.5 \times 10^{-6}$/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

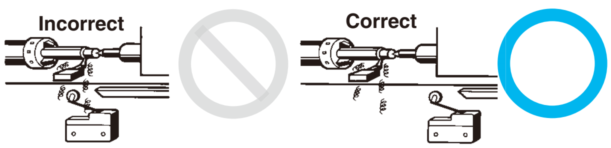


Operating Environment

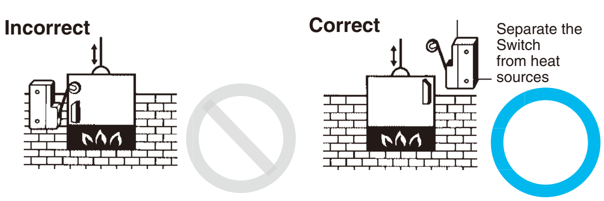
- The Switches are designed for use indoors. Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



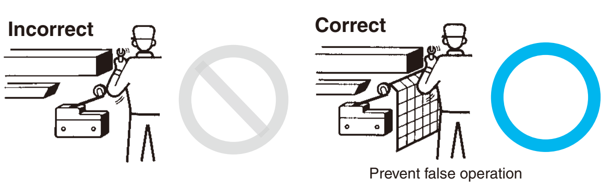
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges. The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog. If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



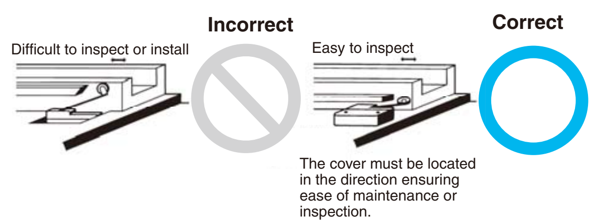
- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.



- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

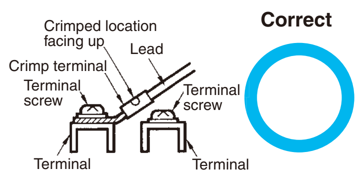
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

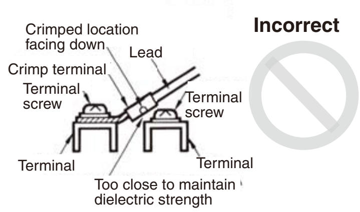
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

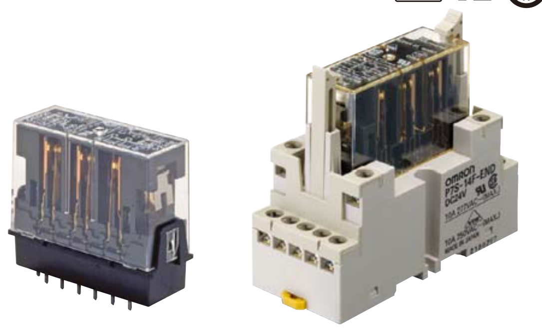
OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Relays with Forcibly Guided Contacts
G7S

Relays Conforming to EN Standard



- Relays with forcibly guided contacts (EN50205 Class A, certified by VDE).
- Supports the CE marking of machinery (Machinery Directive).
- Helps avoid hazardous machine status when used as part of an interlocking circuit.
- Track-mounting and Back-mounting Sockets are available.

⚠ Be sure to read the *"Safety Precautions"* on page 5 and the *"Precautions for All Relays with Forcibly Guided Contacts"*.

Model Number Structure

Model Number Legend

G7S-□A□B
1 2

1. **NO Contact Poles**
   4: 4PST-NO
   3: 3PST-NO
2. **NC Contact Poles**
   2: DPST-NC
   3: 3PST-NC

Ordering Information

Relays with Forcibly Guided Contacts

Type	Poles	Contact configuration	Rated voltage	Model
Standard	6 poles	4PST-NO, DPST-NC	24 VDC	**G7S-4A2B**
		3PST-NO, 3PST-NC		**G7S-3A3B**

Sockets

Type		Rated voltage	Model
Track-mounting	Common for track mounting and screw mounting	24 VDC	**P7S-14F-END**
Back-mounting	PCB terminals	---	**P7S-14P-E**

Specifications

Ratings

Coil

Item / Rated voltage	Rated current (mA)	Coil resistance (Ω)	Must operate voltage (V)	Must release voltage (V)	Max. voltage (V)	Power consumption (W)
24 VDC	30	800	80% max.	10% min.	110%	Approx. 0.8

Note: 1. The rated current and coil resistance are measured at a coil temperature of 23°C with tolerances of ±15%.
2. Performance characteristics are based on a coil temperature of 23°C.
3. The maximum voltage is based on an ambient operating temperature of 23°C maximum.

Contacts

Item / Load	Resistive load	Inductive load (cos ϕ = 0.4, L/R = 7 ms)
Rated load	240 VAC: 3 A, 24 VDC: 3 A	240 VAC: 3 A, 24 VDC: 1 A
Rated carry current	6 A	
Maximum switching voltage	250 VAC, 24 VDC	
Maximum switching current	6 A	

Characteristics of Sockets

Model	Continuous current	Dielectric strength	Insulation resistance
P7S-14□	10 A	2,000 VAC for 1 min. between terminals	1,000 MΩ min. *

Note: Use the P7S-14F-END in the ambient humidity range of 35 to 85%.
* The insulation resistance was measured with a 500-VDC megohmmeter at the same locations as the dielectric strength was measured.

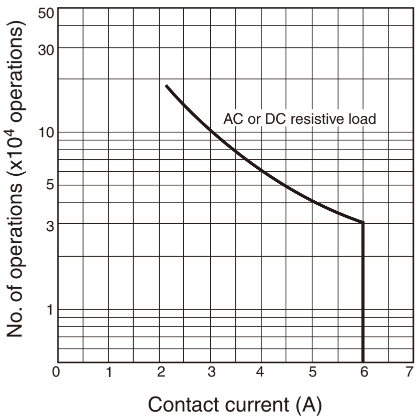
Characteristics

Contact resistance *1		100 mΩ max.
Operating time *2		50 ms max.
Release time *2		50 ms max.
Maximum operating frequency	**Mechanical**	18,000 operations/h
	Rated load	1,800 operations/h
Insulation resistance *3		100 MΩ min.
Dielectric strength		2,500 VAC, 50/60 Hz for 1 min. (1,500 VAC between contacts of same polarity)
Vibration resistance	**Destruction**	10 to 55 to 10 Hz, 0.75-mm single amplitude (1.5-mm double amplitude)
	Malfunction	10 to 55 to 10 Hz, 0.375-mm single amplitude (0.75-mm double amplitude)
Shock resistance	**Destruction**	1,000 m/s^2
	Malfunction	100 m/s^2
Durability *4	**Mechanical**	10,000,000 operations min. (at approx. 18,000 operations/h)
	Electrical	100,000 operations min. (at the rated load and approx. 1,800 operations/h)
Failure rate (P level) (reference value *5)		5 VDC, 1 mA
Ambient operating temperature		–25 to 70°C (with no icing or condensation)
Ambient operating humidity		5% to 85%
Weight		Approx. 65 g

Note: The above values are initial values.
*1. Measurement conditions: 5 VDC, 10 mA, voltage drops.
*2. Measurement conditions: Rated voltage operation
Ambient operating temperature: 23°C
Contact bounce time is not included.
*3. The insulation resistance was measured with a 500-VDC megohmmeter at the same locations as the dielectric strength was measured.
*4. The durability is for an ambient temperature of 15 to 35°C and an ambient humidity of 25% to 75%.
*5. The failure rate is based on an operating frequency of 60 operations/min.

Engineering Data

Durability Curve (Rated Resistive Load)

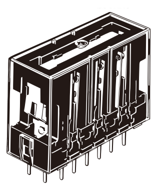


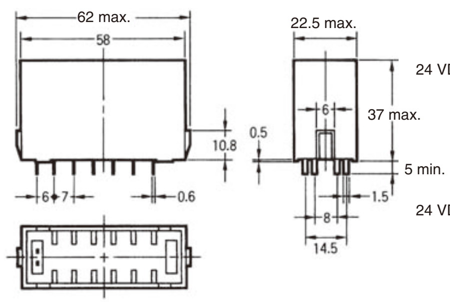
Dimensions

(Unit: mm)

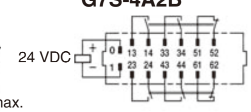
Relays with Forcibly Guided Contacts

G7S-4A2B
G7S-3A3B

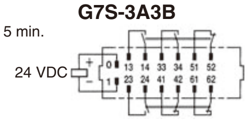




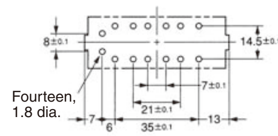
Terminal Arrangement/Internal Connection Diagram (Bottom View)
G7S-4A2B



G7S-3A3B



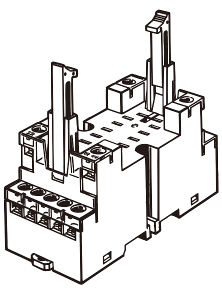
Mounting Hole Dimensions

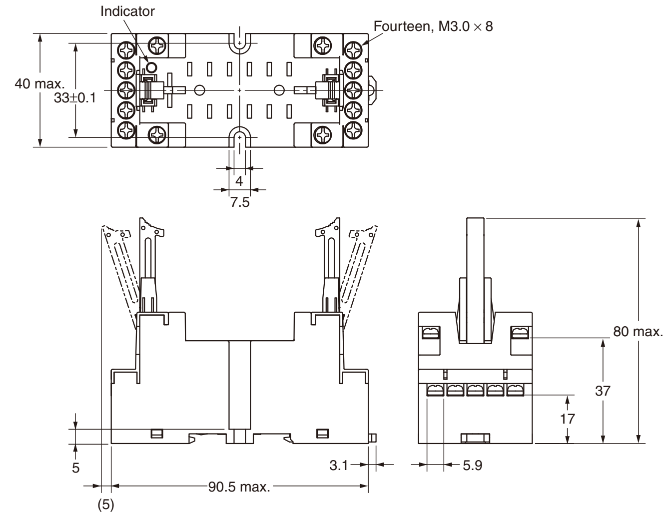


Sockets

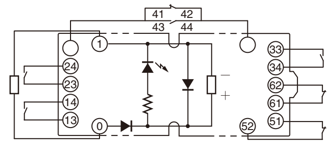
Track-mounting Socket

P7S-14F-END

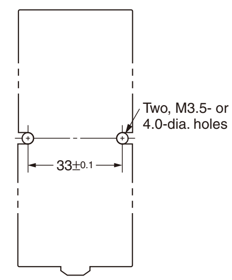




Terminal Arrangement/Internal Connection Diagram (Top View)

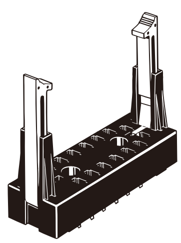


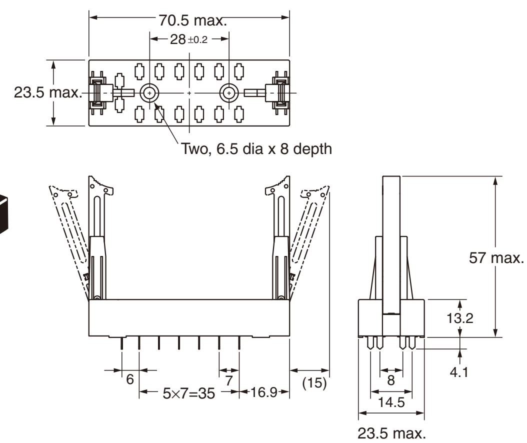
Mounting Hole Dimensions



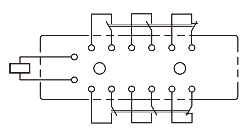
Back-mounting Socket (PCB Terminals)

P7S-14P-E

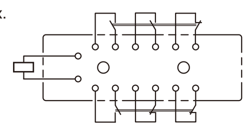




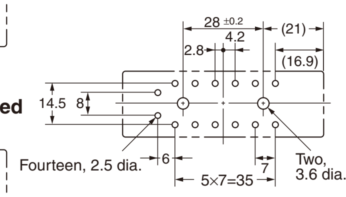
Terminal Arrangement/Internal Connection Diagram (Bottom View) With G7S-4A2B mounted



With G7S-3A3B mounted



Mounting Hole Dimensions



Certified Standards

- EN Standards, VDE Certified
  EN61810-1 (Electromechanical non-specified time all-or-nothing relays)
  EN50205 (Relays with forcibly guided (linked) contacts)
- UL standard UL508 Industrial Control Devices
- CSA standard CSA C22.2 No. 14 Industrial Control Devices

Forcibly Guided Contacts (from EN50205)

If an NO contact becomes welded, all NC contacts will maintain a minimum distance of 0.5 mm when the coil is not energized. Likewise if an NC contact becomes welded, all NO contacts will maintain a minimum distance of 0.5 mm when the coil is energized.

Safety Precautions

Refer to the *"Precautions for All Relays"* and *"Precautions for All Relays with Forcibly Guided Contacts".*

Precautions for Correct Use

Wiring

- Use one of the following wires to connect to the P7S-14F-END.
  Stranded wire: 0.75 to 1.5 mm^2
  Solid wire: 1.0 to 1.5 mm^2
- Tighten each screw of the P7S-14F-END to a torque of 0.78 to 0.98 N·m.
- Refer to the internal connections diagram of the G9S Safety Relay Unit for an application example of the G7S.
- Wire the terminals correctly with no mistakes in coil polarity, otherwise the G7S will not operate.

Cleaning

The G7S is not of enclosed construction. Therefore, do not wash the G7S with water or detergent.

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)

To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).

Refer to the *Safety Components Technical Guide* (Cat No. Y107).

The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

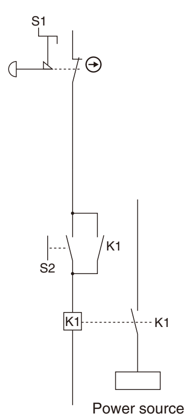
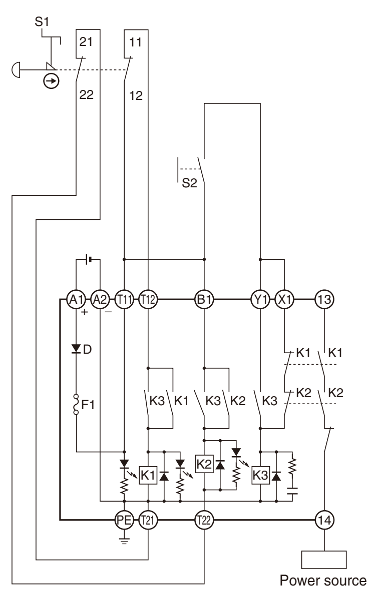


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.

When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)

The G7SA, G7S and G7S-□-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-□-E, however, do not display the CE Marking according to the concepts in the guidelines.

VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-□-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

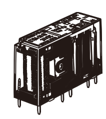
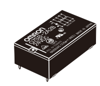
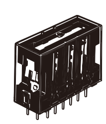
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	**Flux protection**	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

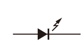
② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED 	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

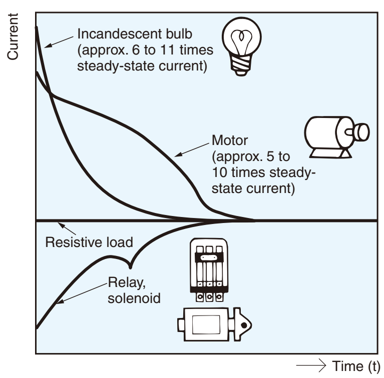
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

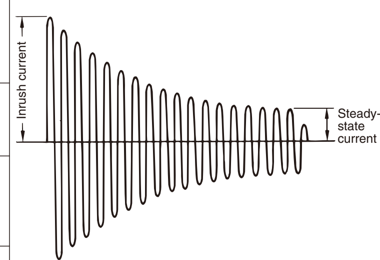
Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	

❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

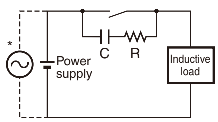
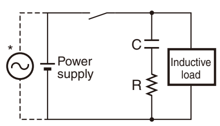
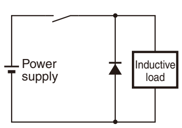
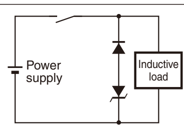
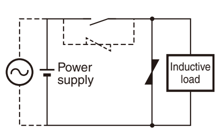
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

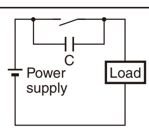
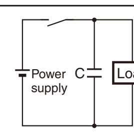
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

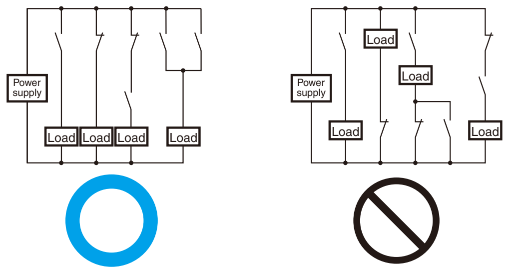
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

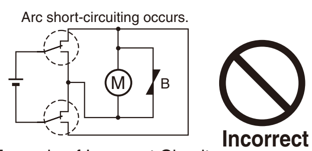
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



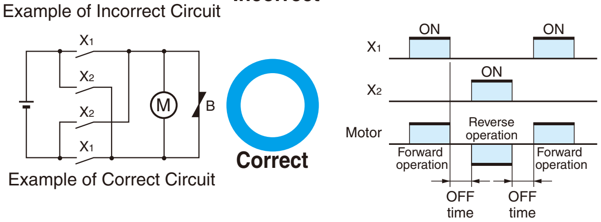
a. Correct Connection   b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



Example of Incorrect Circuit



Example of Correct Circuit

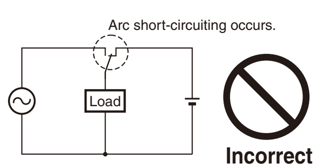
❸-①-8 Power Supply Double Break with Multi-pole Relays

If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

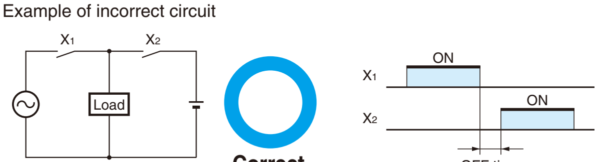
❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.

Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



Example of incorrect circuit

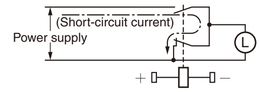


Example of correct circuit

❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.

Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.

The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.

Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.

This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).

This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

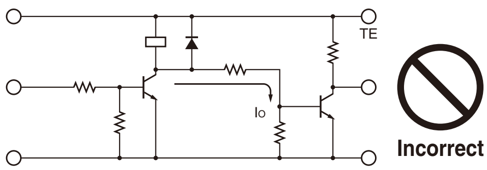
❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.
As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.
Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

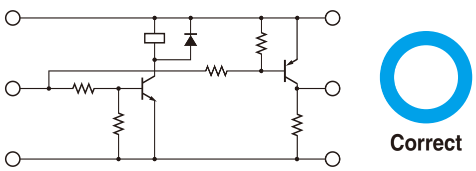
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

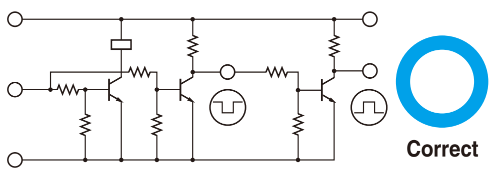
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value

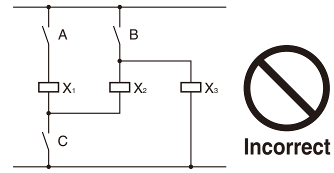


❸-②-7 Using with Infrequent Switching

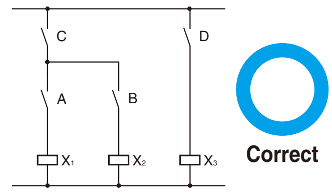
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.
The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.
The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



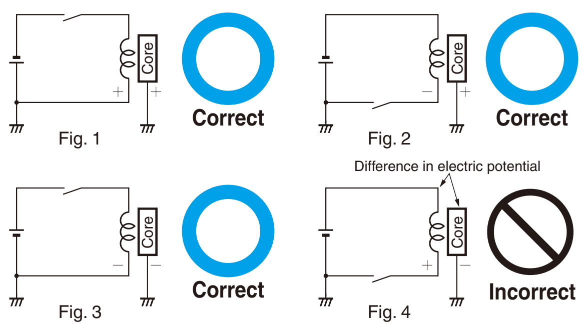
The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)
(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)
(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

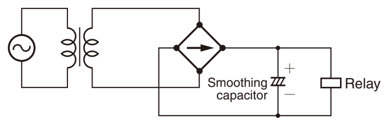


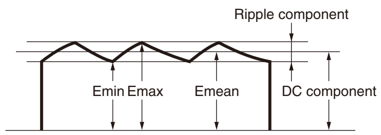
❸-②-10 Individual Specifications for Must-operate/release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.





$$\text{Ripple percentage }\% = \frac{E_{max} - E_{min}}{E_{mean}} \times 100\%$$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON.
Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil

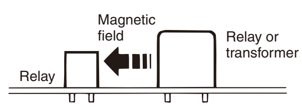
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock

Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields

Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads

Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust

Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

❺ Relay Mounting Operations

① Plug-in Relays

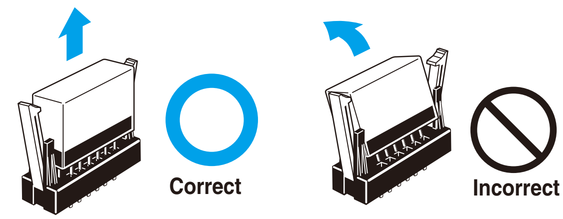
❺-①-1 Panel-mounting Sockets

1. Socket Mounting Screws
When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach.
Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.

2. Lead Wire Screw Connections
Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
Conversely, excessive tightening can strip the threads.

❺-①-2 Relay Removal Direction

Insert and remove Relays from the socket perpendicular to the socket surface.

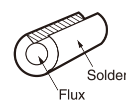


If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering

Solder General-purpose Relays manually following the precautions described below.

1. Smooth the tip of the solder gun and then begin the soldering.
- Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
- Soldering iron: Rated at 30 to 60 W
- Tip temperature: 280 to 300°C
- Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.

3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning

Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals

Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals

Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations

Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing

G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

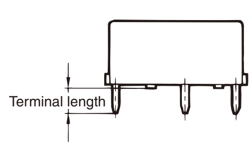
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material	Epoxy		Phenol
Item	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

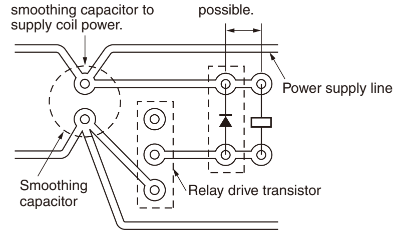
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② **Noise from Contacts**

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ **High-frequency Patterns**

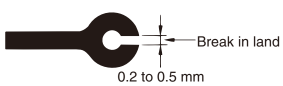
As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

Correct Examples	
Incorrect Examples	

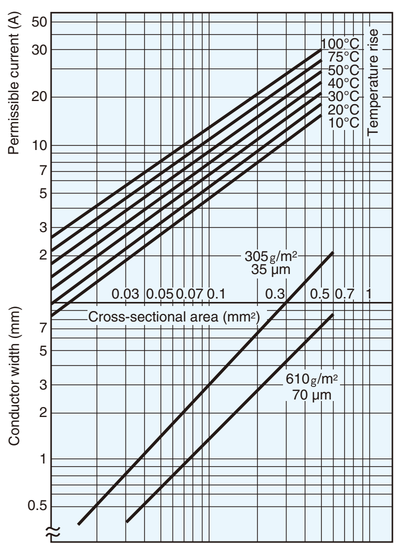
2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.



❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 µm and 70 µm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

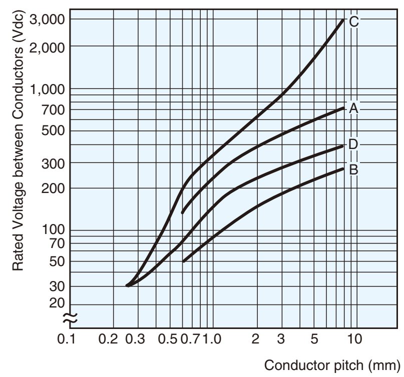
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

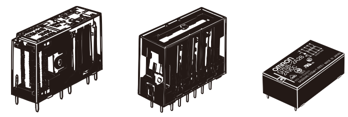
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

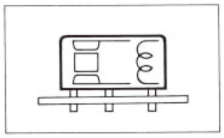
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

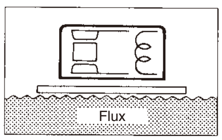
Placement



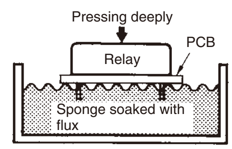
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay. The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials. For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive. Apply the flux sparingly and evenly to prevent penetration into the Relay. When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



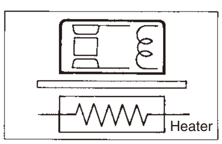
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

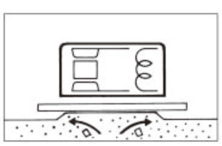
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

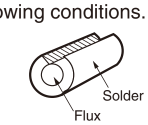
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

Applicability of Manual Soldering

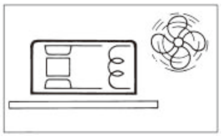
G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5

Cooling



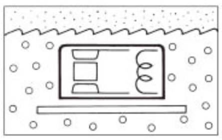
1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6

Cleaning



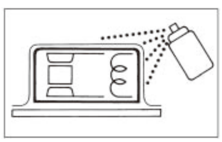
Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7

Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed. Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

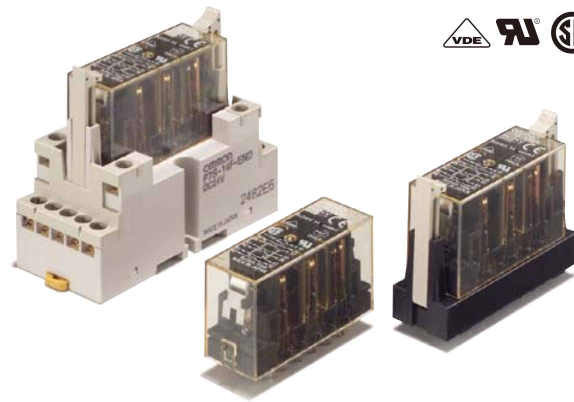
In the interest of product improvement, specifications are subject to change without notice.

Relays with Forcibly Guided Contacts

G7S-☐-E

Lineup Now Includes 10-A Models

- Relays with forcibly guided contacts (EN50205 Class A, certified by VDE).
- Supports the CE marking of machinery (Machinery Directive).
- Helps avoid hazardous machine status when used as part of an interlocking circuit.
- Track-mounting and Back-mounting Sockets are available.



⚠ Be sure to read the *"Safety Precautions"* on page 4 and the *"Precautions for All Relays with Forcibly Guided Contacts"*.

Model Number Structure

Model Number Legend

G7S-☐A☐B-E
1 2

1. NO Contact Poles
4: 4PST-NO
3: 3PST-NO

2. NC Contact Poles
2: DPST-NC
3: 3PST-NC

Ordering Information

Relays with Forcibly Guided Contacts

Type	Poles	Contact configuration	Rated voltage	Model
Standard	6 poles	4PST-NO, DPST-NC	24 VDC	**G7S-4A2B-E**
		3PST-NO, 3PST-NC		**G7S-3A3B-E**

Sockets

Type		Rated voltage	Model
Track-mounting	Common for track mounting and screw mounting	24 VDC	**P7S-14F-END**
Back-mounting	PCB terminals	---	**P7S-14P-E**

Specifications

Ratings

Coil

Item / Rated voltage	Rated current (mA)	Coil resistance (Ω)	Must operate voltage (V)	Must release voltage (V)	Max. voltage (V)	Power consumption (W)
24 VDC	30	800	80% max.	10% min.	110%	Approx. 0.8

Note: 1. The rated current and coil resistance are measured at a coil temperature of 23°C with tolerances of ±15%.
2. Performance characteristics are based on a coil temperature of 23°C.
3. The maximum voltage is based on an ambient operating temperature of 23°C maximum.

Contacts

Item	Load	Resistive load	Inductive load *
Rated load	NO contact	10 A at 250 VAC 10 A at 30 VDC	AC-15: 5 A at 240 VAC DC-13: 2 A at 24 VDC
	NC contact	6 A at 250 VAC 6 A at 30 VDC	AC-15: 3 A at 240 VAC DC-13: 2 A at 24 VDC
Rated carry current	NO contact	10 A	
	NC contact	6 A	
Maximum switching voltage		250 VAC, 30 VDC	
Maximum switching current	NO contact	10 A	
	NC contact	6 A	

* In the above table, cosϕ = 0.3 for AC-15 inductive loads and L/R = 96 ms for DC-13 inductive loads.

Characteristics of Sockets

Model	Continuous current	Dielectric strength	Insulation resistance
P7S-14□	10 A	2000 VAC for 1 min. between terminals	1000 MΩ min. *

Note: Use the P7S-14F-END in the ambient humidity range of 35 to 85%.
* Measurement conditions: Measurement of the same points as for the dielectric strength at 500 VDC.

Characteristics

Contact resistance *1		100 mΩ max.
Operating time *2		50 ms max.
Release time *2		50 ms max.
Maximum operating frequency	Mechanical	18,000 operations/h
	Rated load	1,800 operations/h
Insulation resistance *3		100 MΩ min.
Dielectric strength *4 *5		Between coil and contacts: Between coil and pole 3 or coil and pole 4: 4,000 VAC, 50/60 Hz for 1 min Other than the above:2,500 VAC, 50/60 Hz for 1 min Between different poles: Between pole 1, 3, or 5 and pole 2, 4, or 6: 4,000 VAC, 50/60 Hz for 1 min Other than the above:2,500 VAC, 50/60 Hz for 1 min Between contacts of same polarity:1,500 VAC, 50/60 Hz for 1 min
Vibration resistance	Destruction	10 to 55 to 10 Hz, 0.75-mm single amplitude (1.5-mm double amplitude)
	Malfunction	10 to 55 to 10 Hz, 0.375-mm single amplitude (0.75-mm double amplitude)
Shock resistance	Destruction	1,000 m/s^2
	Malfunction	100 m/s^2
Durability *6	Mechanical	10,000,000 operations min. (at approx. 18,000 operations/h)
	Electrical	100,000 operations min. (at the rated load and approx. 1,800 operations/h)
Failure rate (P level) (reference value *7)		5 VDC, 1 mA
Ambient operating temperature		–25 to 70°C (with no icing or condensation)
Ambient operating humidity		5% to 85%
Weight		Approx. 65 g

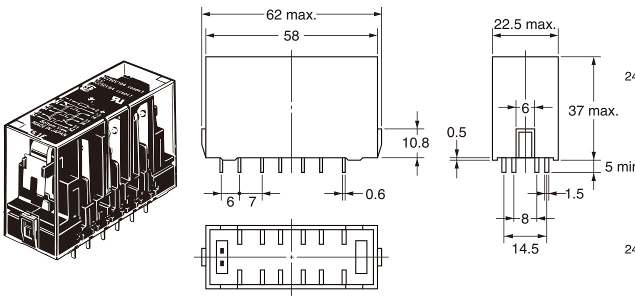
Note: The above values are initial values.
*1. Measurement conditions: 5 VDC, 10 mA, voltage drop method.
*2. Measurement conditions: Rated voltage operation
Ambient operating temperature: 23°C
Contact bounce time is not included.
*3. The insulation resistance was measured with a 500-VDC megohmmeter at the same locations as the dielectric strength was measured.
*4. When using a P7S Socket, the dielectric strength between coil and contacts and between different poles is 2,000 VAC, 50/60 Hz for 1 min.
*5. The coil refers to terminals 0-1, pole 1 refers to terminals 13–14, pole 2 refers to terminals 23–24, pole 3 refers to terminals 33–34, pole 4 refers to terminals 41–42 or 43–44, pole 5 refers to terminals 51–52, and pole 6 refers to terminals 61–62.
*6. The durability is for an ambient temperature of 15 to 35°C and an ambient humidity of 25% to 75%.
*7. The failure rate is based on an operating frequency of 60 operations/min.

Dimensions

(Unit: mm)

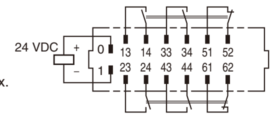
Relays with Forcibly Guided Contacts

G7S-4A2B-E
G7S-3A3B-E

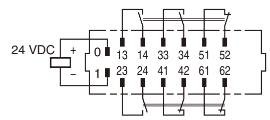


Terminal Arrangement/Internal Connection Diagram (Bottom View)

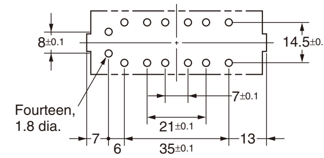
G7S-4A2B-E



G7S-3A3B-E

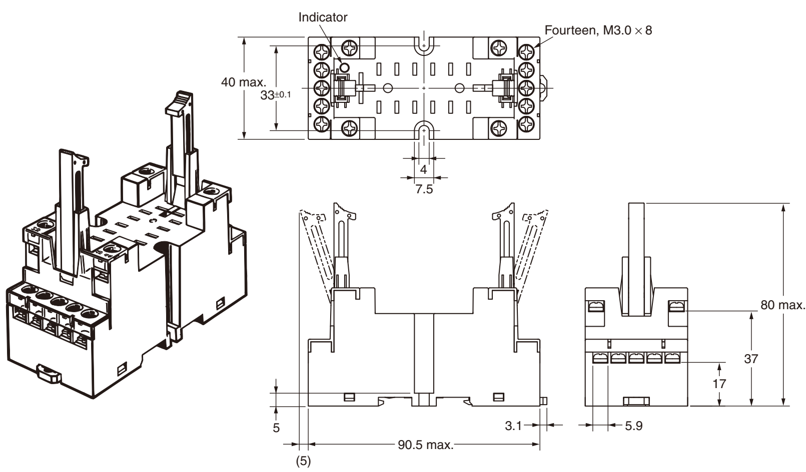


Mounting Hole Dimensions

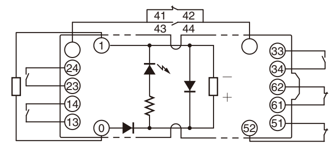


Sockets

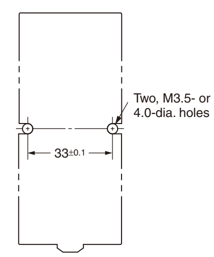
Track-mounting Socket
P7S-14F-END



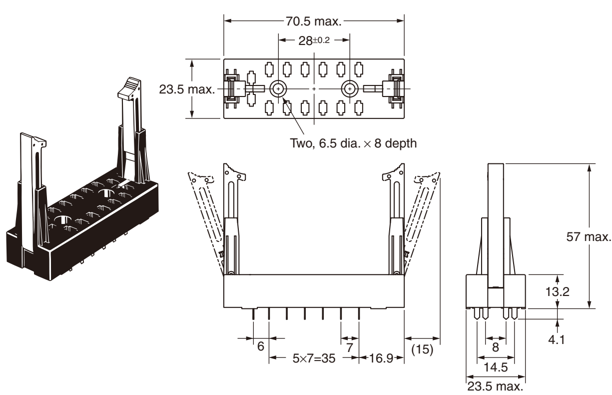
Terminal Arrangement/Internal Connection Diagram (Top View)



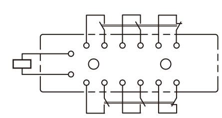
Mounting Hole Dimensions



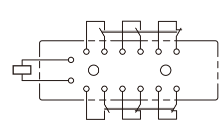
Back-mounting Socket (PCB Terminals)
P7S-14P-E



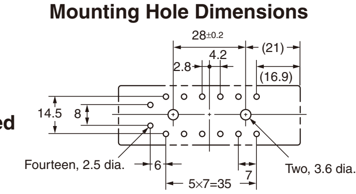
Terminal Arrangement/Internal Connection Diagram (Bottom View)
With G7S-4A2B-E mounted



With G7S-3A3B-E mounted



Mounting Hole Dimensions



Certified Standards

- EN standards, VDE certified
  EN61810-1 (Electromechanical non-specified time all-or-nothing relays)
  EN60255-23 (Contact performance)
  EN50205 (Relays with forcibly guided (linked) contacts)
- UL standards: UL508 (Industrial Control Equipment)
- CSA standards: CSA C22.2 No.14 (Industrial Control Equipment)

Forcibly Guided Contacts (from EN50205)

If an NO contact becomes welded, all NC contacts will maintain a minimum distance of 0.5 mm when the coil is not energized. Likewise if an NC contact becomes welded, all NO contacts will maintain a minimum distance of 0.5 mm when the coil is energized.

Safety Precautions

Refer to the *"Precautions for All Relays"* and *"Precautions for All Relays with Forcibly Guided Contacts".*

⚠ CAUTION

Do not pass currents of 6 A or more when using this product in combination with the P7S-14F/14P/14A Socket. Doing so may result in fire. Use this product in combination with the P7S-14F-END/14P-E.

Precautions for Correct Use

Wiring

- Use one of the following wires to connect to the P7S-14F-END.
  Stranded wire: 0.75 to 1.5 mm^2
  Solid wire: 1.0 to 1.5 mm^2
- Tighten each screw of the P7S-14F-END to a torque of 0.78 to 0.98 N·m.
- Wire the terminals correctly with no mistakes in coil polarity, otherwise the G7S will not operate.

Cleaning

The G7S is not of enclosed construction. Therefore, do not wash the G7S with water or detergent.

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)
To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).
Refer to the *Safety Components Technical Guide* (Cat No. Y107).
The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

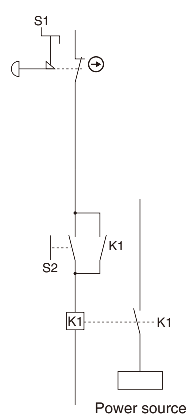
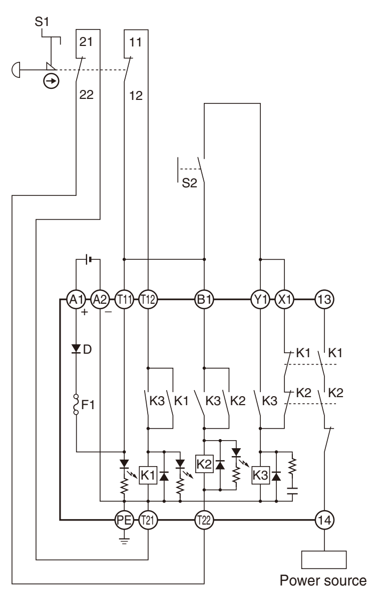


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)
The G7SA, G7S and G7S-□-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-□-E, however, do not display the CE Marking according to the concepts in the guidelines.
VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-□-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

No.	Area	No.	Classification	No.	Item	Page
❹	Operating and Storage Environments			1 2 3 4 5 6 7 8	Operating, Storage, and Transport Operating Atmosphere Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas) Adhesion of Water, Chemicals, Solvent, and Oil Vibration and Shock External Magnetic Fields External Loads Adhesion of Magnetic Dust	C-9 to C-10
❺	Relay Mounting Operations	①	Plug-in Relays	1 2 3	Panel-mounting Sockets Relay Removal Direction Terminal Soldering	C-10
		②	Printed Circuit Board Relays	1	Ultrasonic Cleaning	
		③	Common Items	1 2 3 4	Removing the Case and Cutting Terminals Deformed Terminals Replacing Relays and Performing Wiring Operations Coating and Packing	
❻	Handling Relays			1 2	Vibration and Shock Dropped Products	C-11
❼	Relays for Printed Circuit Boards (PCBs)			1 2 3 4 5 6 7 8 9 10	Selecting PCBs, (1) PCB Materials Selecting PCBs, (2) PCB Thickness Selecting PCBs, (3) Terminal Hole and Land Diameters Mounting Space ① Ambient Temperature ② Mutual Magnetic Interference Pattern Design for Noise Countermeasures ① Noise from Coils ② Noise from Contacts ③ High-frequency Patterns Shape of Lands Pattern Conductor Width and Thickness Conductor Pitch Securing the PCB Automatic Mounting of PCB Relays	C-11 to C-14
❽	Troubleshooting					C-15

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

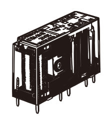
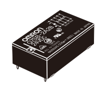
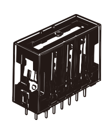
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item				Atmosphere conditions	
Mounting structure	**Type of protection**	**Features**	**Representative model**	**Dust and dirt**	**Corrosive gases**
PCB-mounted Relay	**Flux protection**	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

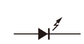
② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED 	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

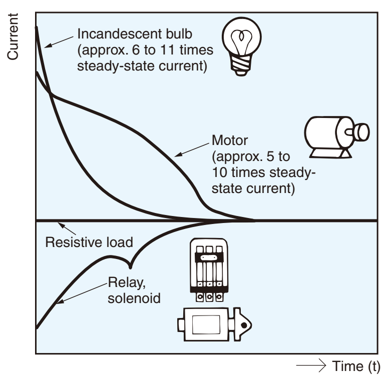
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

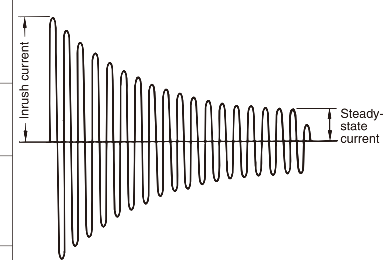
Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	

❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

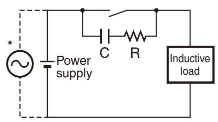
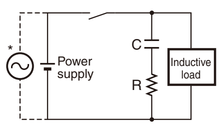
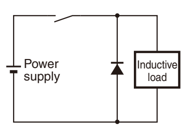
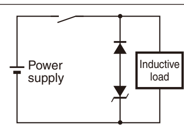
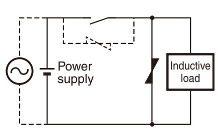
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

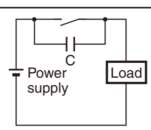
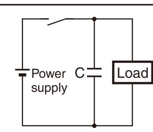
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

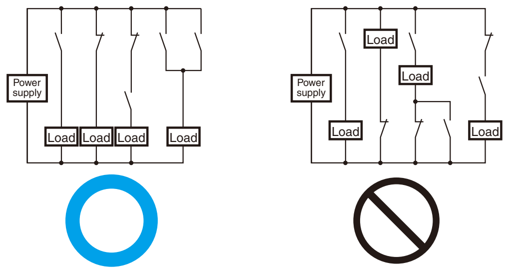
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

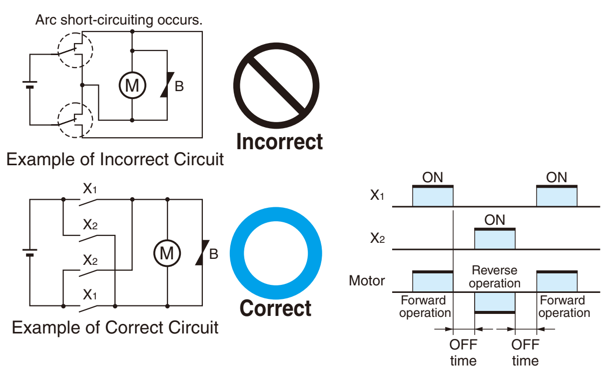
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



a. Correct Connection   b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



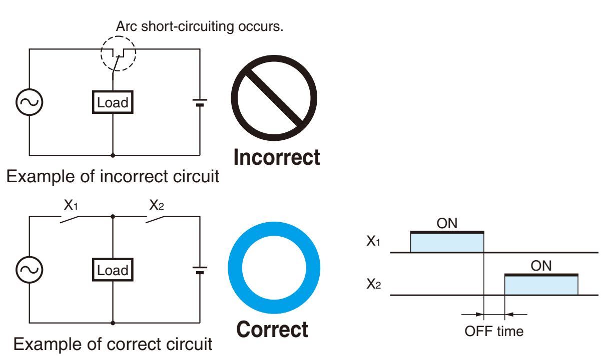
❸-①-8 Power Supply Double Break with Multi-pole Relays

If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.

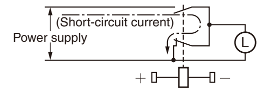
Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.

Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.

The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.

Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.

This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).

This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

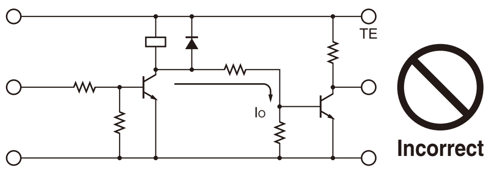
❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.
As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.
Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

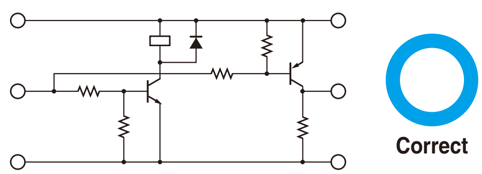
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

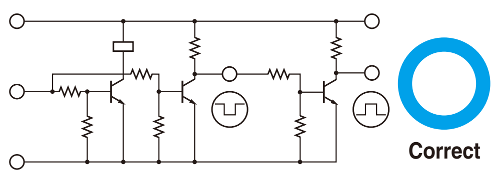
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value

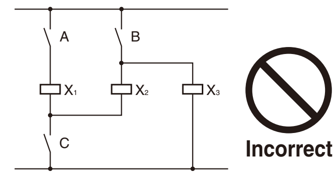


❸-②-7 Using with Infrequent Switching

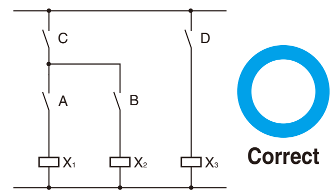
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.
The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.
The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



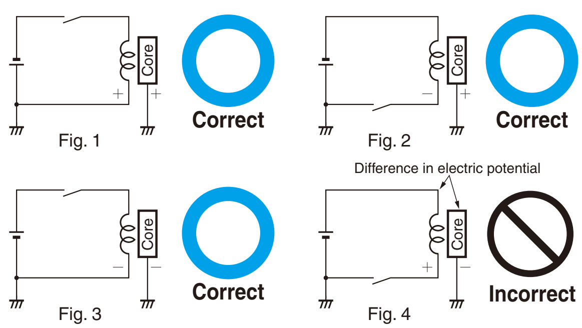
The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)
(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)
(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

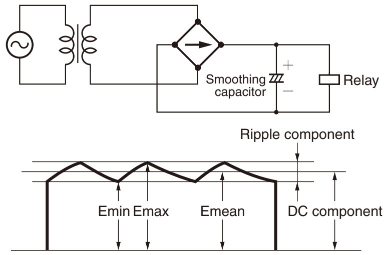


❸-②-10 Individual Specifications for Must-operate/ release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



Ripple percentage %= $\frac{Emax-Emin}{Emean} \times 100\%$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON. Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil

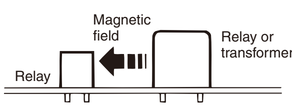
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock

Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields

Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads

Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust

Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

❺ Relay Mounting Operations

① Plug-in Relays

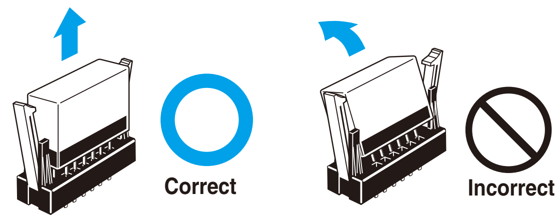
❺-①-1 Panel-mounting Sockets

1. Socket Mounting Screws
When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach.
Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.

2. Lead Wire Screw Connections
Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
Conversely, excessive tightening can strip the threads.

❺-①-2 Relay Removal Direction

Insert and remove Relays from the socket perpendicular to the socket surface.

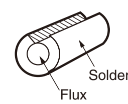


If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering

Solder General-purpose Relays manually following the precautions described below.

1. Smooth the tip of the solder gun and then begin the soldering.
- Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
- Soldering iron: Rated at 30 to 60 W
- Tip temperature: 280 to 300°C
- Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.

3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning

Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals

Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals

Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations

Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing

G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

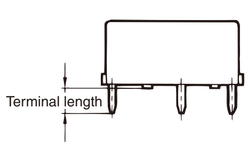
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material / Item	Epoxy: Glass epoxy (GE)	Epoxy: Paper epoxy (PE)	Phenol: Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm): Nominal value	Terminal hole diameter (mm): Tolerance	Minimum land diameter (mm)
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

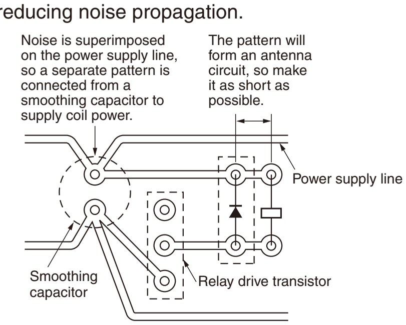
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② **Noise from Contacts**

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ **High-frequency Patterns**

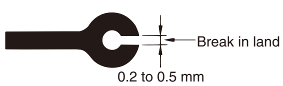
As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

Correct Examples	
Incorrect Examples	

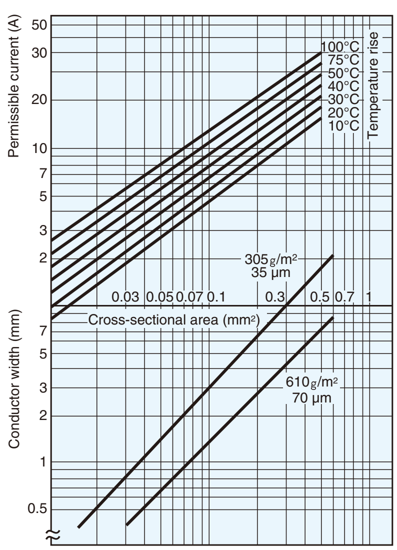
2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.



❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 µm and 70 µm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

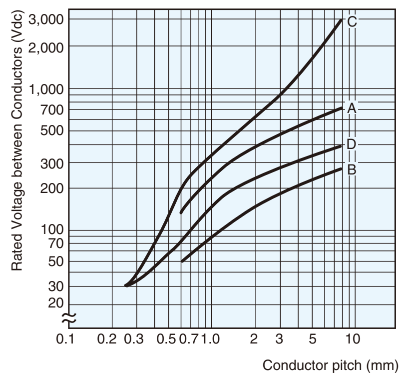
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

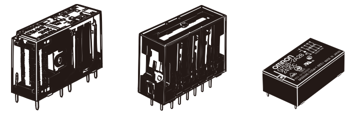
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

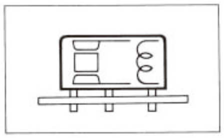
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

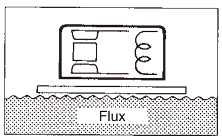
Placement



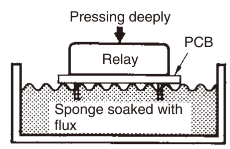
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay. The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials. For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive. Apply the flux sparingly and evenly to prevent penetration into the Relay. When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



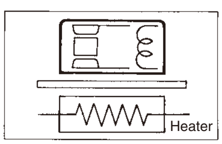
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

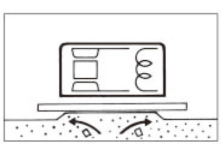
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

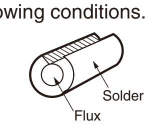
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.
2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.



Applicability of Manual Soldering

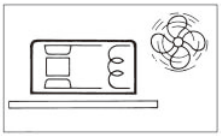
G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5

Cooling



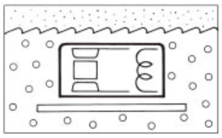
1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6

Cleaning



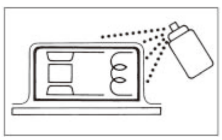
Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7

Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed.
   Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company
http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Relays with Forcibly Guided Contacts

G7SA

Compact, Slim Relays Conforming to EN Standards

- Relays with forcibly guided contacts (EN50205 Class A, certified by VDE).
- Supports the CE marking of machinery (Machinery Directive).
- Helps avoid hazardous machine status when used as part of an interlocking circuit.
- Four-pole and six-pole Relays are available.
- The Relay's terminal arrangement simplifies PWB pattern design.
- Reinforced insulation between inputs and outputs. Reinforced insulation between some poles of different polarity.

⚠ Be sure to read the *"Safety Precautions"* on page 6 and the *"Precautions for All Relays with Forcibly Guided Contacts"*.

Model Number Structure

Model Number Legend

G7SA-□A□B
1 2

1. NO Contact Poles
2: DPST-NO
3: 3PST-NO
4: 4PST-NO
5: 5PST-NO

2. NC Contact Poles
1: SPST-NC
2: DPST-NC
3: 3PST-NC

Ordering Information

Relays with Forcibly Guided Contacts

Type	Sealing	Poles	Contact configuration	Rated voltage *	Model
Standard	Flux-tight	4 poles	3PST-NO, SPST-NC	24 VDC	**G7SA-3A1B**
			DPST-NO, DPST-NC		**G7SA-2A2B**
		6 poles	5PST-NO, SPST-NC		**G7SA-5A1B**
			4PST-NO, DPST-NC		**G7SA-4A2B**
			3PST-NO, 3PST-NC		**G7SA-3A3B**

* Consult your OMRON representative for details on rated voltages of 12 VDC and 48 VDC.

Sockets

Type		LED indicator	Poles	Rated voltage	Model
Track-mounting	Track mounting and screw mounting possible	No	4 poles	---	**P7SA-10F**
			6 poles		**P7SA-14F**
		Yes	4 poles	24 VDC	**P7SA-10F-ND**
			6 poles		**P7SA-14F-ND**
Back-mounting	PCB terminals	No	4 poles	---	**P7SA-10P**
			6 poles		**P7SA-14P**

Specifications

Ratings

Coil

Item / Rated voltage	Rated current (mA)	Coil resistance (Ω)	Must operate voltage (V)	Must release voltage (V)	Max. voltage (V)	Power consumption (mW)
24 VDC	4 poles: 15 6 poles: 20.8	4 poles: 1,600 6 poles: 1,152	75% max.	10% min.	110%	4 poles: Approx. 360 6 poles: Approx. 500

Note: **1.** The rated current and coil resistance are measured at a coil temperature of 23°C with tolerances of ±15%.
2. Performance characteristics are based on a coil temperature of 23°C.
3. The maximum voltage is based on an ambient operating temperature of 23°C maximum.

Contacts

Item / Load	Resistive load
Rated load	6 A at 250 VAC, 6 A at 30 VDC
Rated carry current	6 A
Max. switching voltage	250 VAC, 125 VDC
Max. switching current	6 A

Characteristics of Sockets

Model	Continuous current	Dielectric strength	Insulation resistance
P7SA-1□	6 A *1	2,500 VAC for 1 min. between poles	1,000 MΩ min. *2

Note: Use the P7SA-1□F-ND in the ambient temperature range of −20 to 70°C.
Use the P7SA-1□F and P7SA-1□F-ND in the ambient humidity range of 45 to 85%.
*1. When operating the P7SA-1□F at a temperature between 55 and 85°C, reduce the continuous current (6 A at 55°C or less) by 0.1 A for each degree above 55°C.
When operating the P7SA-1□F-ND at a temperature between 50 and 70°C, reduce the continuous current (6 A at 50°C or less) by 0.3 A for each degree above 50°C.
*2. Measurement conditions: Measurement of the same points as for the dielectric strength at 500 VDC.

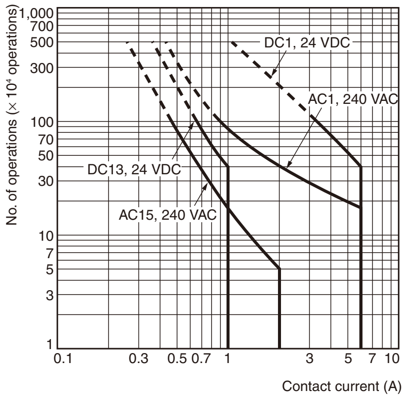
Characteristics

Contact resistance *1		100 mΩ max.
Operating time *2		20 ms max.
Response time *3		10 ms max.
Release time *2		20 ms max.
Maximum operating frequency	Mechanical	36,000 operations/h
	Rated load	1,800 operations/h
Insulation resistance *4		1,000 MΩ min.
Dielectric strength *5 *6		Between coil contacts/different poles (except for poles 3–4 in 4-pole Relays and poles 3–5, 4–6, and 5–6 in 6-pole Relays): 4,000 VAC, 50/60 Hz for 1 min. Between different poles (poles 3–4 in 4-pole Relays and poles 3–5, 4–6, and 5–6 in 6-pole Relays): 2,500 VAC, 50/60 Hz for 1 min. Between contacts of same polarity: 1,500 VAC, 50/60 Hz for 1 min.
Vibration resistance		10 to 55 to 10 Hz, 0.75-mm single amplitude (1.5-mm double amplitude)
Shock resistance	Destruction	1,000 m/s^2
	Malfunction	100 m/s^2
Durability *7	Mechanical	10,000,000 operations min. (at approx. 36,000 operations/h)
	Electrical	100,000 operations min. (at the rated load and approx. 1,800 operations/h)
Failure rate (P level) (reference value *8)		5 VDC, 1 mA
Ambient operating temperature *9		−40 to 85°C (with no icing or condensation)
Ambient operating humidity		5% to 85%
Weight		4 poles: Approx. 22 g 6 poles: Approx. 25 g

Note: The above values are initial values.
*1. The contact resistance was measured with 1 A at 5 VDC using the voltage-drop method.
*2. These times were measured at the rated voltage and an ambient temperature of 23°C. Contact bounce time is not included.
*3. The response time is the time it takes for the normally open contacts to open after the coil voltage is turned OFF. Contact bounce time is included. Measurement conditions: Rated voltage operation, Ambient temperature: 23°C
*4. The insulation resistance was measured with a 500-VDC megohmmeter at the same locations as the dielectric strength was measured.
*5. Pole 3 refers to terminals 31–32 or 33–34, pole 4 refers to terminals 43–44, pole 5 refers to terminals 53–54, and pole 6 refers to terminals 63–64.
*6. When using a P7SA Socket, the dielectric strength between coil contacts/different poles is 2,500 VAC, 50/60 Hz for 1 min.
*7. The durability is for an ambient temperature of 15 to 35°C and an ambient humidity of 25% to 75%.
*8. The failure rate is based on an operating frequency of 300 operations/min.
*9. When operating at a temperature between 70 and 85°C, reduce the rated carry current (6 A at 70°C or less) by 0.1 A for each degree above 70°C.

Engineering Data

Durability Curve

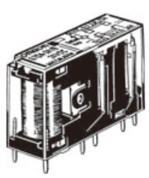


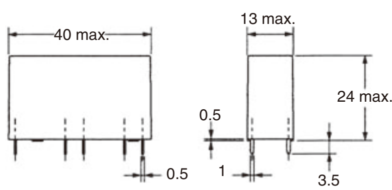
Dimensions

(Unit: mm)

Relays with Forcibly Guided Contacts

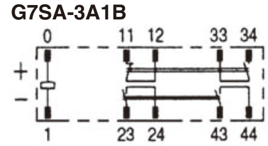
G7SA-3A1B
G7SA-2A2B



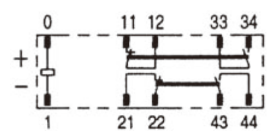


Terminal Arrangement/ Internal Connection Diagram (Bottom View)

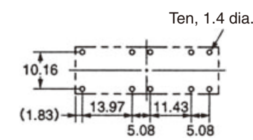
G7SA-3A1B



G7SA-2A2B



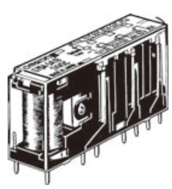
Printed Circuit Board Design Diagram (Bottom View)
(±0.1 tolerance)

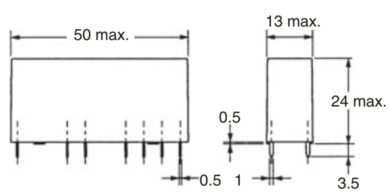


Note: 1. Terminals 23-24, 33-34, and 43-44 are normally open. Terminals 11-12 and 21-22 are normally closed.

2. The colors of the cards inside the Relays are as follows: G7SA-3A1B: Blue and G7SA-2A2B: White.

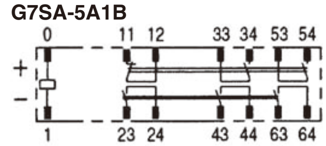
G7SA-5A1B
G7SA-4A2B
G7SA-3A3B



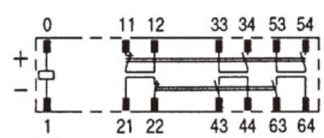


Terminal Arrangement/ Internal Connection Diagram (Bottom View)

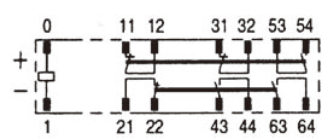
G7SA-5A1B



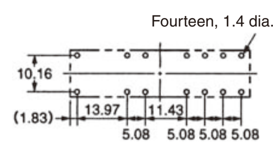
G7SA-4A2B



G7SA-3A3B



Printed Circuit Board Design Diagram (Bottom View)
(±0.1 tolerance)



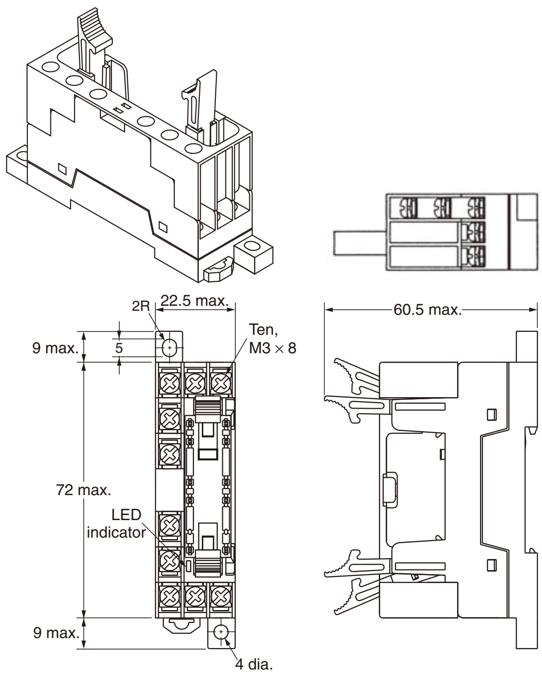
Note: 1. Terminals 23-24, 33-34, 43-44, 53-54, and 63-64 are normally open. Terminals 11-12, 21-22, and 31-32 are normally closed.

2. The colors of the cards inside the Relays are as follows: G7SA-5A1B: Blue, G7SA-4A2B: White, and G7SA-3A3B: Yellow.

Sockets

Track-mounting Socket

P7SA-10F, P7SA-10F-ND

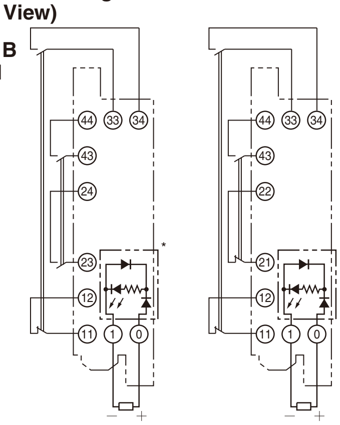


Note 1: The socket is shown with the finger cover removed.
2: Only the -ND Sockets have LED indicators (orange)

Terminal Arrangement/Internal Connection Diagram (Top View)

G7SA-3A1B Mounted

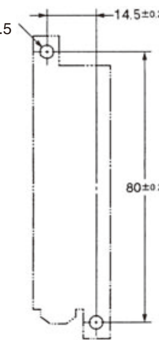
G7SA-2A2B Mounted



* This display circuit is available only for "-ND" models.

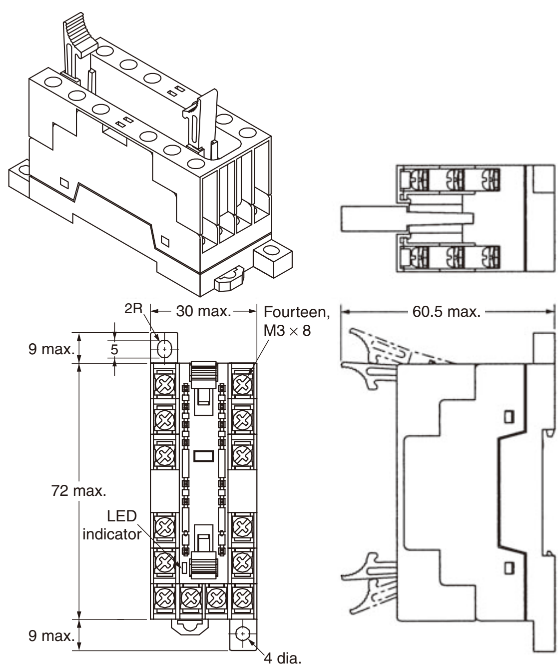
Note: Terminals 23-24, 33-34, and 43-44 are normally open. Terminals 11-12 and 21-22 are normally closed.

Mounting Hole Placement Diagram (Top View)



Track-mounting Socket

P7SA-14F, P7SA-14F-ND



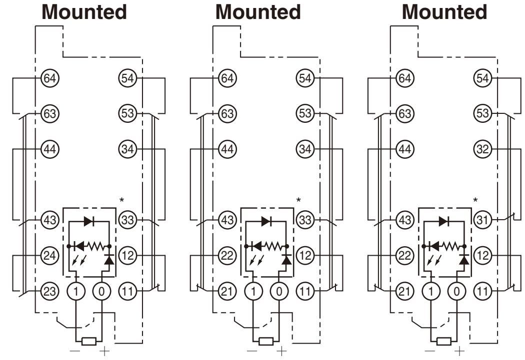
Note 1: The socket is shown with the finger cover removed.
2: Only the -ND Sockets have LED indicators (orange).

Terminal Arrangement/Internal Connection Diagram (Top View)

G7SA-5A1B Mounted

G7SA-4A2B Mounted

G7SA-3A3B Mounted



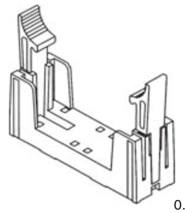
Mounting Hole Placement Diagram (Top View)

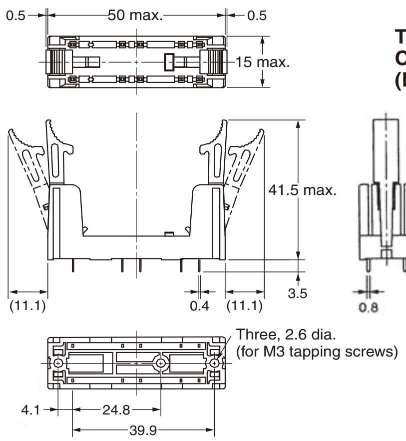
* This display circuit is available only for "-ND" models.

Note: Terminals 23-24, 33-34, 43-44, 53-54, and 63-64 are normally open. Terminals 11-12, 21-22, and 31-32 are normally closed.

Back-mounting Socket (for PCB)

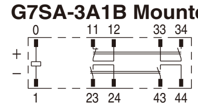
P7SA-10P



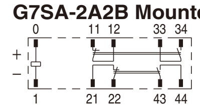


Terminal Arrangement/Internal Connection Diagram (Bottom View)

G7SA-3A1B Mounted

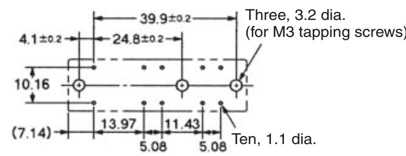


G7SA-2A2B Mounted



Mounting Hole Placement (Bottom View)

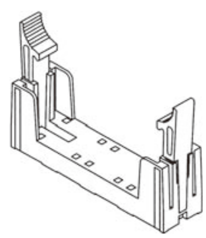
(±0.1 tolerance)

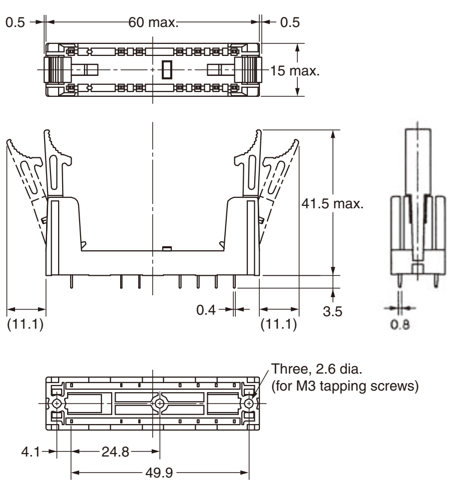


Note: Terminals 23-24, 33-34, and 43-44 are normally open. Terminals 11-12 and 21-22 are normally closed.

Back-mounting Socket (for PCB)

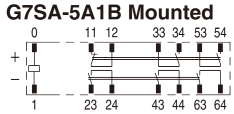
P7SA-14P



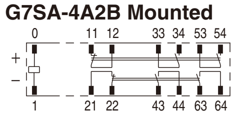


Terminal Arrangement/Internal Connection Diagram (Bottom View)

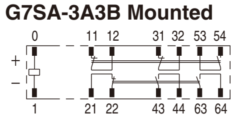
G7SA-5A1B Mounted



G7SA-4A2B Mounted

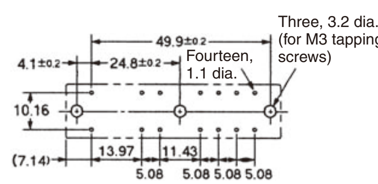


G7SA-3A3B Mounted



Mounting Hole Placement (Bottom View)

(±0.1 tolerance)



Note: Terminals 23-24, 33-34, 43-44, 53-54, and 63-64 are normally open. Terminals 11-12, 21-22, and 31-32 are normally closed.

Certified Standards

G7SA

- EN Standards, VDE Certified
  EN61810-1 (Electromechanical non-specified time all-or-nothing relays)
  EN50205 (Relays with forcibly guided (linked) contacts)
- UL standard UL508 Industrial Control Devices
- CSA standard CSA C22.2 No. 14 Industrial Control Devices

Forcibly Guided Contacts (from EN50205)

If an NO contact becomes welded, all NC contacts will maintain a minimum distance of 0.5 mm when the coil is not energized. Likewise if an NC contact becomes welded, all NO contacts will maintain a minimum distance of 0.5 mm when the coil is energized.

Safety Precautions

Refer to the *"Precautions for All Relays"* and *"Precautions for All Relays with Forcibly Guided Contacts".*

Precautions for Correct Use

Wiring

- Use one of the following wires to connect to the P7SA-10F/10F-ND/14F/14F-ND.
  Stranded wire: 0.75 to 1.5 mm^2
  Solid wire: 1.0 to 1.5 mm^2
- Tighten each screw of the P7SA-10F/10F-ND/14F/14F-ND to a torque of 0.78 to 0.98 N·m.
- Wire the terminals correctly with no mistakes in coil polarity, otherwise the G7SA will not operate.

Cleaning

The G7SA is not of enclosed construction. Therefore, do not wash the G7SA with water or detergent.

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)
To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).
Refer to the *Safety Components Technical Guide* (Cat No. Y107).
The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

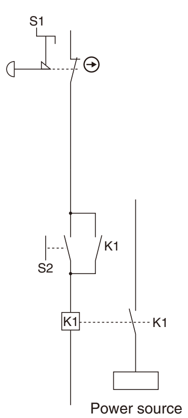
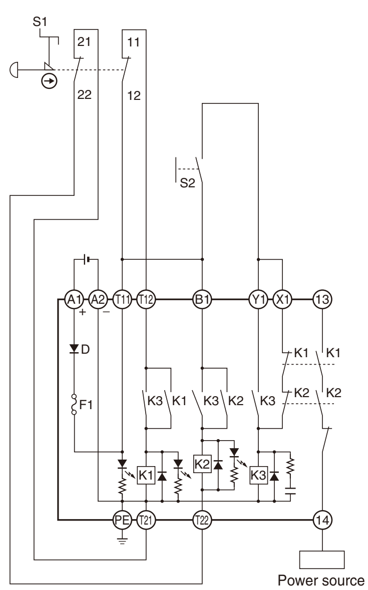


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)
The G7SA, G7S and G7S-□-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-□-E, however, do not display the CE Marking according to the concepts in the guidelines.
VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-□-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

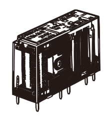
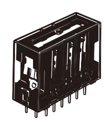
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	Flux protection	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

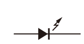
② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED 	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

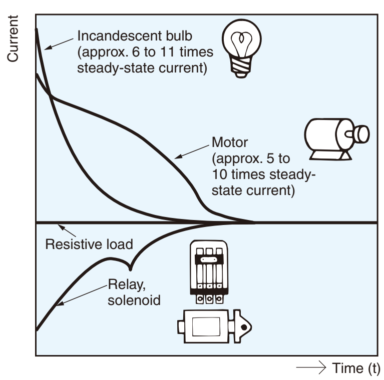
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

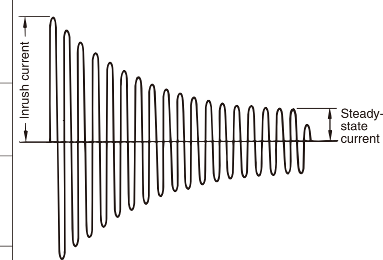
If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	



❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

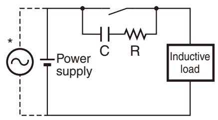
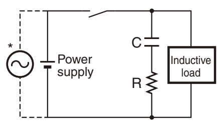
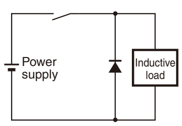
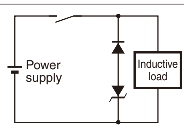
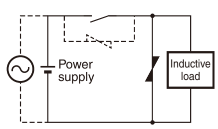
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

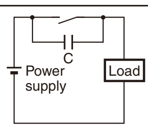
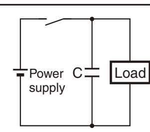
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current		Features and remarks	Element selection
		AC	DC		
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

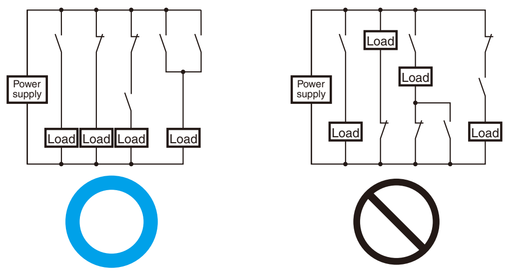
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

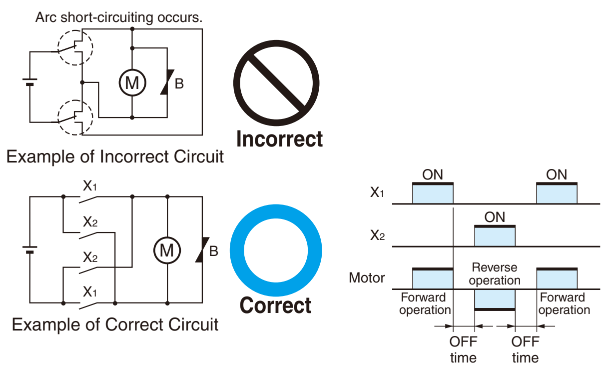
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



a. Correct Connection b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



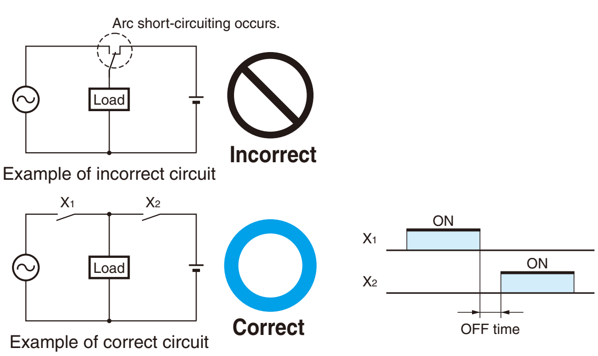
❸-①-8 Power Supply Double Break with Multi-pole Relays

If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.

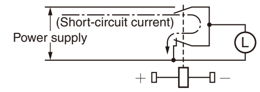
Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.

Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.

The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.

Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.

This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).

This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

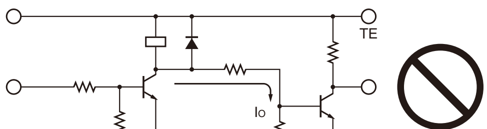
❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.
As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.
Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

❸-②-6 Leakage Current to Relay Coils

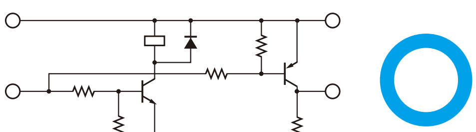
Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

Example: Circuit with Leakage Current Occurring



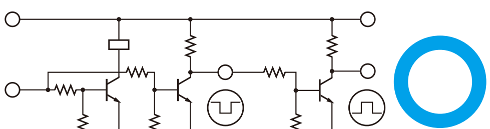
Incorrect

Corrective Example 1



Correct

Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value



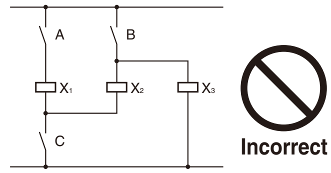
Correct

❸-②-7 Using with Infrequent Switching

For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.
The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

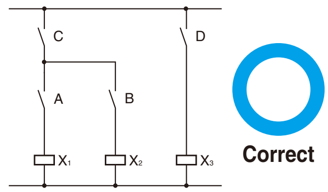
❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.
The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X1, X2, and X3 to operate, and then contacts B and C are opened, a series circuit is created from A to X1 to X2 to X3. This causes the Relay to hum or to not release.



Incorrect

The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.

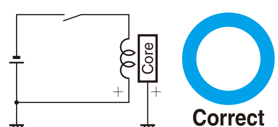


Correct

❸-②-9 Connecting Relay Grounds

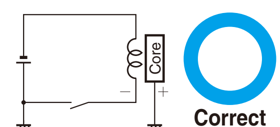
Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)
(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)
(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)



Correct

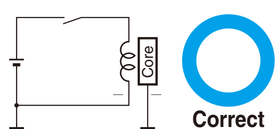
Fig. 1



Correct

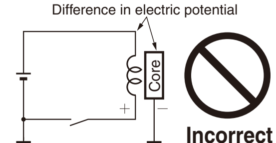
Fig. 2

Difference in electric potential



Correct

Fig. 3



Incorrect

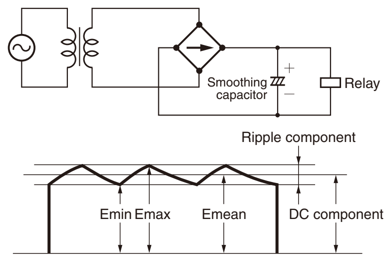
Fig. 4

❸-②-10 Individual Specifications for Must-operate/release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



$$\text{Ripple percentage }\% = \frac{\text{Emax}-\text{Emin}}{\text{Emean}} \times 100\%$$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON.
Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil

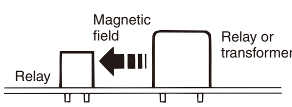
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock

Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields

Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads

Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

❹-8 Adhesion of Magnetic Dust

Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

❺ Relay Mounting Operations

① Plug-in Relays

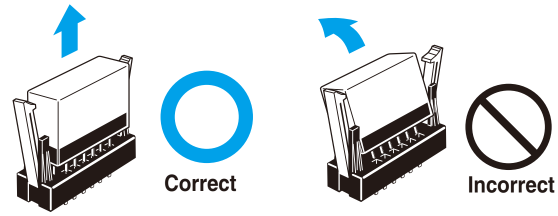
❺-①-1 Panel-mounting Sockets

1. Socket Mounting Screws
When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach.
Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.

2. Lead Wire Screw Connections
Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
Conversely, excessive tightening can strip the threads.

❺-①-2 Relay Removal Direction

Insert and remove Relays from the socket perpendicular to the socket surface.

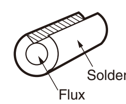


If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering

Solder General-purpose Relays manually following the precautions described below.

1. Smooth the tip of the solder gun and then begin the soldering.
- Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
- Soldering iron: Rated at 30 to 60 W
- Tip temperature: 280 to 300°C
- Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.

3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning

Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals

Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals

Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations

Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing

G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

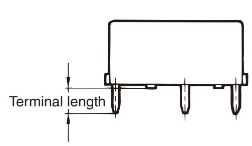
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material	Epoxy		Phenol
Item	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

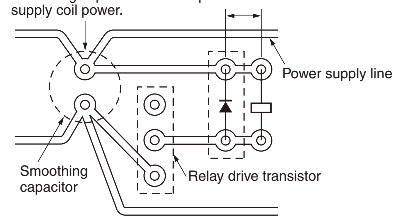
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② **Noise from Contacts**

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ **High-frequency Patterns**

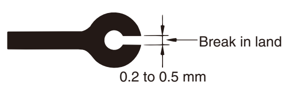
As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

Correct Examples	
Incorrect Examples	

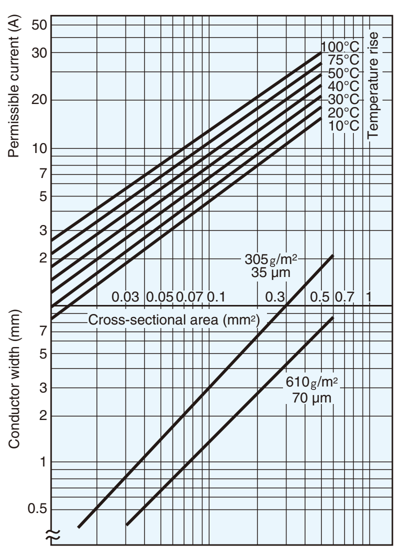
2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.



❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 µm and 70 µm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

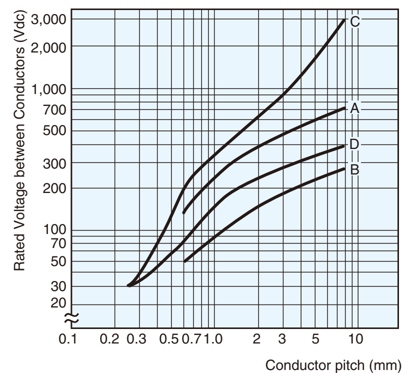
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

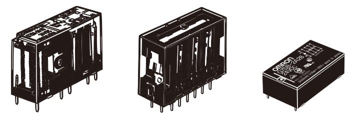
Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

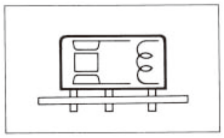
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

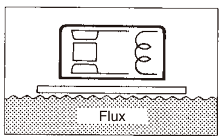
Placement



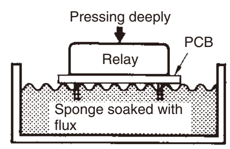
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay. The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials. For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive. Apply the flux sparingly and evenly to prevent penetration into the Relay. When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



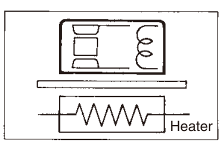
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

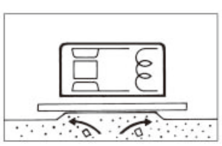
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

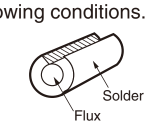
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

Applicability of Manual Soldering

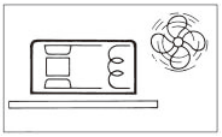
G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5

Cooling



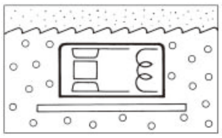
1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6

Cleaning



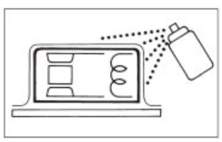
Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7

Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed.
   Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

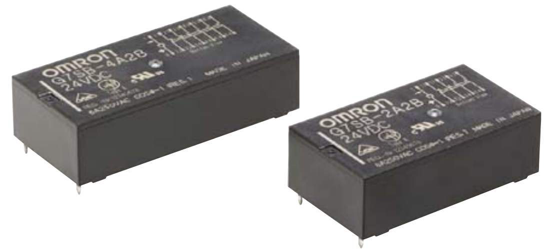
2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

Relays with Forcibly Guided Contacts
G7SB

Low Profile Relays with Low Power Consumption



- Relays with forcibly guided contacts (EN50205 Class A, certified by VDE).
- Low profile - only 14.5 mm.
- Coil power consumption is 360 mW for 4 pole model or 500 mW for 6 pole model.
- Four-pole and six-pole Relays are available.
- The Relay's terminal arrangement simplifies PWB pattern design.
- Reinforced insulation.

⚠ Be sure to read the *"Safety Precautions"* on page 4 and the *"Precautions for All Relays with Forcibly Guided Contacts"*.

Model Number Structure

Model Number Legend

G7SB-□A□B
1 2

1. NO Contact Poles
2: DPST-NO
3: 3PST-NO
4: 4PST-NO
5: 5PST-NO

2. NC Contact Poles
1: SPST-NC
2: DPST-NC

Ordering Information

Relays with Forcibly Guided Contacts

Type	Sealing	Poles	Contact configuration	Rated voltage *	Model
Standard	Flux-tight	4 poles	3PST-NO, SPST-NC	24 VDC	**G7SB-3A1B**
			DPST-NO, DPST-NC		**G7SB-2A2B**
		6 poles	5PST-NO, SPST-NC		**G7SB-5A1B**
			4PST-NO, DPST-NC		**G7SB-4A2B**

* Consult your OMRON representative for details on rated voltages of 12 VDC, 18 VDC and 21 VDC.

Specifications

Ratings

Coil

Item / Rated voltage	Rated current (mA)	Coil resistance (Ω)	Must operate voltage (V)	Must release voltage (V)	Max. voltage (V)	Power consumption (mW)
24 VDC	4 poles: 15 6 poles: 20.8	4 poles: 1,600 6 poles: 1,152	75% max.	10% min.	110%	4 poles: Approx. 360 6 poles: Approx. 500

Note: 1. The rated current and coil resistance are measured at a coil temperature of 23°C with tolerances of ±15%.
2. Performance characteristics are based on a coil temperature of 23°C.
3. The value given for the maximum voltage is for voltages applied Instantaneously to the Relay coil (at an ambient temperature of 23°C) and not continuously.

Contacts

Item / Load	Resistive load
Rated load	6 A at 250 VAC, 6 A at 30 VDC
Rated carry current	6 A
Max. switching voltage	250 VAC, 125 VDC
Max. switching current	6 A

Characteristics

Contact resistance *1		100 mΩ max.
Operating time *2		20 ms max.
Response time *3		10 ms max.
Release time *2		20 ms max.
Maximum operating frequency	**Mechanical**	36,000 operations/h
	Rated load	1,800 operations/h
Insulation resistance *4		1,000 MΩ min. (at 500 VDC)
Dielectric strength *5		Between coil contacts/different poles: 3,000 VAC, 50/60 Hz for 1 min. Between poles 1–2, 2–3, and 3–4: 3,000 VAC, 50/60 Hz for 1 min. Between poles 4–5 and 5–6 (in 6-pole relays): 2,500 VAC, 50/60 Hz for 1 min. Between contacts of same polarity: 1,500 VAC, 50/60 Hz for 1 min.
Vibration resistance		10 to 55 Hz, 0.75-mm single amplitude (1.5-mm double amplitude)
Shock resistance	**Destruction**	1,000 m/s^2
	Malfunction	100 m/s^2
Durability *6	**Mechanical**	10,000,000 operations min. (at approx. 36,000 operations/h)
	Electrical	100,000 operations min. (at the rated load and approx. 1,800 operations/h)
Failure rate (P level) (reference value *7)		5 VDC, 1 mA
Ambient operating temperature *8		–40 to 85°C (with no icing or condensation)
Ambient operating humidity		5% to 85%
Weight		4 poles: Approx. 25 g 6 poles: Approx. 29 g

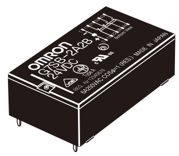
Note: The above values are initial values.
*1. The contact resistance was measured with 1 A at 5 VDC using the voltage-drop method.
*2. These times were measured at the rated voltage and an ambient temperature of 23°C. Contact bounce time is not included.
*3. The response time is the time it takes for the normally open contacts to open after the coil voltage is turned OFF. Contact bounce time is included. Measurement conditions: Rated voltage operation, Ambient temperature: 23°C
*4. The insulation resistance was measured with a 500-VDC megohmmeter at the same locations as the dielectric strength was measured.
*5. Pole 3 refers to terminals 33–34, pole 4 refers to terminals 43–44, pole 5 refers to terminals 53–54, and pole 6 refers to terminals 63–64.
*6. The durability is for an ambient temperature of 15 to 35°C and an ambient humidity of 25% to 75%.
*7. The failure rate is based on an operating frequency of 300 operations/min.
*8. When operating at a temperature between 70 and 85°C, reduce the rated carry current (6 A at 70°C or less) by 0.1 A for each degree above 70°C.

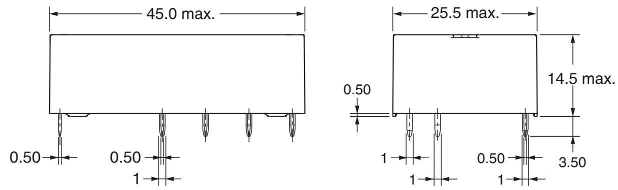
Dimensions

(Unit: mm)

Relays with Forcibly Guided Contacts

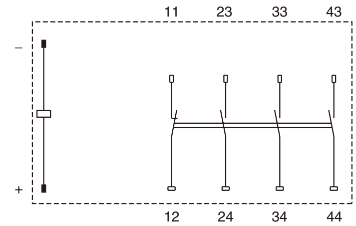
G7SB-3A1B
G7SB-2A2B



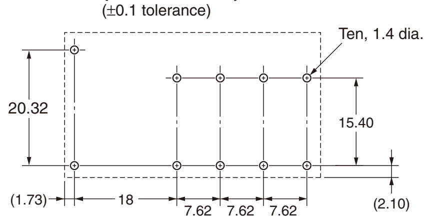


Terminal Arrangement/ Internal Connection Diagram (Bottom View)

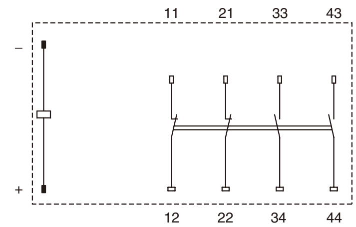
G7SB-3A1B



Printed Circuit Board Design Diagram (Bottom View)
(±0.1 tolerance)

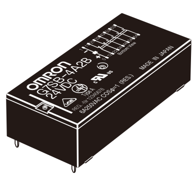


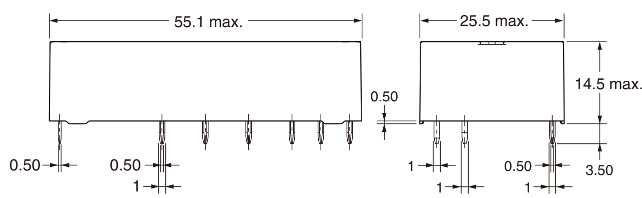
G7SB-2A2B



Note: Terminals 23-24, 33-34, and 43-44 are normally open. Terminals 11-12 and 21-22 are normally closed.

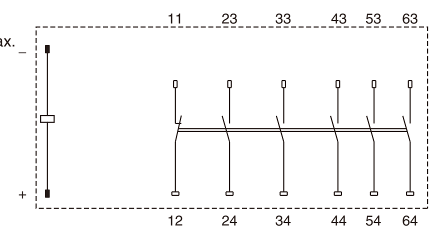
G7SB-5A1B
G7SB-4A2B



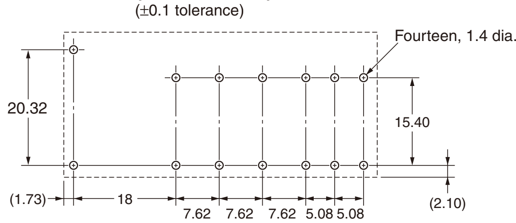


Terminal Arrangement/ Internal Connection Diagram (Bottom View)

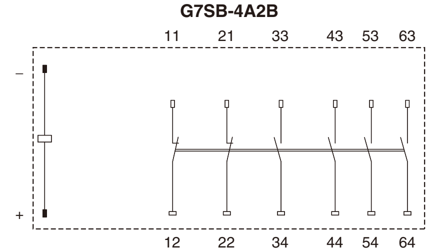
G7SB-5A1B



Printed Circuit Board Design Diagram (Bottom View)
(±0.1 tolerance)



G7SB-4A2B



Note: Terminals 23-24, 33-34, 43-44, 53-54, and 63-64 are normally open. Terminals 11-12 and 21-22 are normally closed.

Certified Standards

G7SB
- EN Standards, VDE Certified
  EN61810-1 (Electromechanical non-specified time all-or-nothing relays)
  EN50205 (Relays with forcibly guided (linked) contacts)
- UL standard UL508 Industrial Control Devices
- CSA standard CSA C22.2 No. 14 Industrial Control Devices

Forcibly Guided Contacts (from EN50205)

If an NO contact becomes welded, all NC contacts will maintain a minimum distance of 0.5 mm when the coil is not energized. Likewise if an NC contact becomes welded, all NO contacts will maintain a minimum distance of 0.5 mm when the coil is energized.

Safety Precautions

Refer to the *"Precautions for All Relays"* and *"Precautions for All Relays with Forcibly Guided Contacts"*.

Precautions for Safe Use

Connections

The coil terminals have polarity (+/–). Operation will not be possible if the polarity is reversed.

Washing

The G7SB does not have a sealed structure. Do not wash G7SB Relays.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)
To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2). Refer to the *Safety Components Technical Guide*.
The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

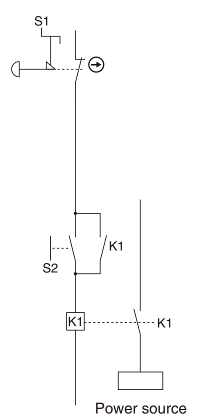
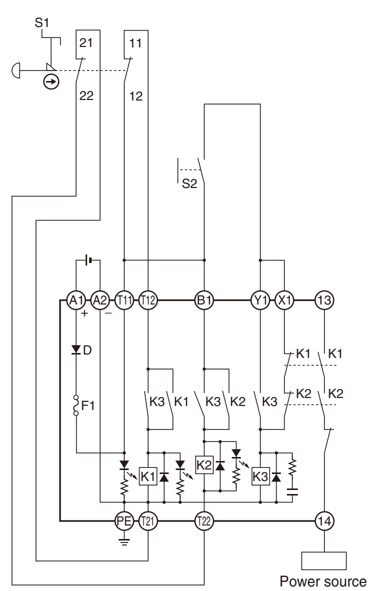


Fig 2



Durability of Contact Outputs

The durability of the Relays with Forcibly Guided Contacts varies considerably depending on switching conditions. Always confirm the usage conditions by testing the Relay with Forcibly Guided Contacts in an actual application, and use the Relay with Forcibly Guided Contacts only for the number of switching operations that its performance allows.
Restarting a safety circuit like the one incorporating the Relay with Forcibly Guided Contacts in Fig. 2 may not be possible if the switching capacity is exceeded. If this occurs, replace the relevant relays immediately. If a Relay with Forcibly Guided Contacts is used after performance has deteriorated, it may result in reduced safety.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)
The G7SB has been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components.
The G7SB, however, does not display the CE Marking according to the concepts in the guidelines.
VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SB.
Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays with Forcibly Guided Contacts

Refer to the "*Safety Precautions*" section for each Relay for specific precautions applicable to each Relay.

Precautions for Correct Use

Mounting

The Relays with Forcibly Guided Contacts can be mounted in any direction.

Relays with Forcibly Guided Contacts

While the Relay with Forcibly Guided Contacts has the previously described forcibly guided contact structure, it is basically the same as an ordinary relay in other respects. Rather than serving to prevent malfunctions, the forcibly guided contact structure enables another circuit to detect the condition following a contact weld or other malfunction. Accordingly, when a contact weld occurs in a Relay with Forcibly Guided Contacts, depending on the circuit configuration, the power may not be interrupted, leaving the Relay in a potentially dangerous condition (as shown in Fig. 1.)
To configure the power control circuit to interrupt the power when a contact weld or other malfunction occurs, and to prevent restarting until the problem has been eliminated, add another Relay with Forcibly Guided Contacts or similar Relay in combination to provide redundancy and a self-monitoring function to the circuit (as shown in Fig. 2).
Refer to the *Safety Components Technical Guide* (Cat No. Y107).
The G9S/G9SA/G9SB Safety Relay Unit, which combines Relays such as the Relay with Forcibly Guided Contacts in order to provide the above-described functions, is available for this purpose. By connecting a contactor with appropriate input and output to the Safety Relay Unit, the circuit can be equipped with redundancy and a self-monitoring function.

Fig 1

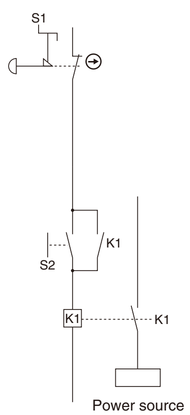
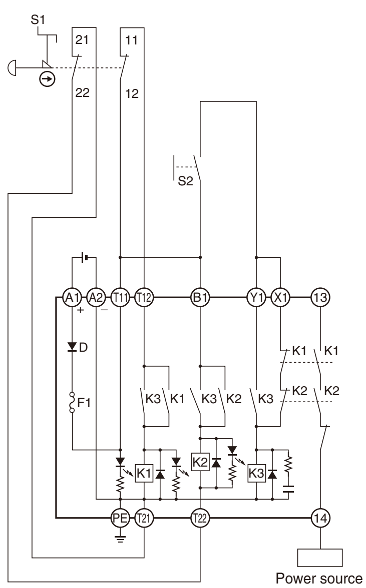


Fig 2



Durability of Contact Outputs

Relay with Forcibly Guided Contact durability depends greatly on the switching condition. Confirm the actual conditions of operation in which the Relay will be used in order to make sure the permissible number of switching operations.
When the accumulated number of operation exceeds its permissible range, it can cause failure of reset of safety control circuit. In such case, please replace the Relay immediately. If the Relay is used continuously without replacing, then it can lead to loss of safety function.

CE Marking

(Source: *Guidelines on the Application of Council Directive 73/23/EEC*)
The G7SA, G7S and G7S-□-E have been recognized by the VDE for meeting the Low Voltage Directive according to EN requirements for relays and relays with forcibly guided contacts. The Low Voltage Directive, however, contains no clauses that specify handling methods for components, and interpretations vary among test sites and manufacturers. To solve this problem, the European Commission has created guidelines for the application of the Low Voltage Directive in EU. These guidelines present concepts for applying the Low Voltage Directive to components. The G7SA, G7S and G7S-□-E, however, do not display the CE Marking according to the concepts in the guidelines.
VDE recognition, however, has been obtained, so there should be no problems in obtaining the CE Marking for machines that use the G7SA, G7S or G7S-□-E. Use the manufacturer's compliance declaration to prove standard conformance.

Contents of the Guidelines

The *Guidelines on the Application of Council Directive 73/23/EEC* apply to components. Relays with PWB terminals are not covered by the Low Voltage Directive.

Precautions for All Relays

Refer to the *Safety Precautions* section for each Relay for specific precautions applicable to that Relay.

Precautions for Safe Use

These precautions are required to ensure safe operation.

- Do not touch the charged Relay terminal area or the charged socket terminal area while the power is turned ON. Doing so may result in electric shock.
- Do not use a Relay for a load that exceeds the Relay's switching capacity or other contact ratings. Doing so will reduce the specified performance, causing insulation failure, contact welding, and contact failure, and the Relay itself may be damaged or burnt.
- Do not drop or disassemble Relays.
  Doing so may reduce Relay characteristics and may result in damage, electric shock, or burning.
- Relay durability depends greatly on the switching conditions. Confirm operation under the actual conditions in which the Relay will be used. Make sure the number of switching operations is within the permissible range. If a Relay is used after performance has deteriorated, it may result in insulation failure between circuits and burning of the Relay itself.
- Do not apply overvoltages or incorrect voltages to coils, or incorrectly wire the terminals. Doing so may prevent the Relay from functioning properly, may affect external circuits connected to the Relay, and may cause the Relay itself to be damaged or burnt.
- Do not use Relays where flammable gases or explosive gases may be present. Doing so may cause combustion or explosion due to Relay heating or arcing during switching.
- Perform wiring and soldering operations correctly and according to the instructions contained in *Precautions for Correct Use* given below. If a Relay is used with faulty wiring or soldering, it may cause burning due to abnormal heating when the power is turned ON.

Precautions for Correct Use

Contents

No.	Area	No.	Classification	No.	Item	Page
❹	Operating and Storage Environments			1 2 3 4 5 6 7 8	Operating, Storage, and Transport Operating Atmosphere Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas) Adhesion of Water, Chemicals, Solvent, and Oil Vibration and Shock External Magnetic Fields External Loads Adhesion of Magnetic Dust	C-9 to C-10
❺	Relay Mounting Operations	①	Plug-in Relays	1 2 3	Panel-mounting Sockets Relay Removal Direction Terminal Soldering	C-10
		②	Printed Circuit Board Relays	1	Ultrasonic Cleaning	
		③	Common Items	1 2 3 4	Removing the Case and Cutting Terminals Deformed Terminals Replacing Relays and Performing Wiring Operations Coating and Packing	
❻	Handling Relays			1 2	Vibration and Shock Dropped Products	C-11
❼	Relays for Printed Circuit Boards (PCBs)			1 2 3 4 5 6 7 8 9 10	Selecting PCBs, (1) PCB Materials Selecting PCBs, (2) PCB Thickness Selecting PCBs, (3) Terminal Hole and Land Diameters Mounting Space ① Ambient Temperature ② Mutual Magnetic Interference Pattern Design for Noise Countermeasures ① Noise from Coils ② Noise from Contacts ③ High-frequency Patterns Shape of Lands Pattern Conductor Width and Thickness Conductor Pitch Securing the PCB Automatic Mounting of PCB Relays	C-11 to C-14
❽	Troubleshooting					C-15

❶ Using Relays

- When actually using Relays, unanticipated failures may occur. It is therefore essential to test the operation is as wide of range as possible.
- Unless otherwise specified in this catalog for a particular rating or performance value, all values are based on JIS C5442 standard test conditions (temperature: 15 to 35°C, relative humidity: 25% to 75%, air pressure: 86 to 106 kPa). When checking operation in the actual application, do not merely test the Relay under the load conditions, but test it under the same conditions as in the actual operating environment and using the actual operating conditions.
- The reference data provided in this catalog represent actual measured values taken from samples of the production line and shown in diagrams. They are reference values only.
- Ratings and performance values given in this catalog are for individual tests and do not indicate ratings or performance values under composite conditions.

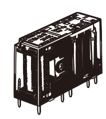
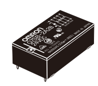
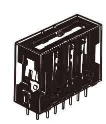
❷ Selecting Relays

① Mounting Structure and Type of Protection

❷-①-1 Type of Protection

If a Relay is selected that does not have the appropriate type of protection for the atmosphere and the mounting conditions, it may cause problems, such as contact failure.
Refer to the type of protection classifications shown in the following table and select a Relay suitable to the atmosphere in which it is to be used.

Classification by Type of Protection

Item: Mounting structure	Item: Type of protection	Features	Representative model	Atmosphere conditions: Dust and dirt	Atmosphere conditions: Corrosive gases
PCB-mounted Relay	**Flux protection**	Structure that helps prevent flux from entering Relays during soldering	G7SA 	Some protection (No large dust or dirt particles inside Relay.)	No protection
			G7SB 		
	Unsealed	Structure that protects against contact with foreign material by means of enclosure in a case (designed for manual soldering)	G7S 		

❷-①-2 Combining Relays and Sockets

Use OMRON Relays in combination with specified OMRON Sockets. If the Relays are used with sockets from other manufacturers, it may cause problems, such as abnormal heating at the mating point due to differences in power capacity and mating properties.

❷-①-3 Using Relays in Atmospheres Subject to Dust

If a Relay is used in an atmosphere subject to dust, dust will enter the Relay, become lodged between contacts, and cause the circuit to fail to close. Moreover, if conductive material such as wire clippings enter the Relay, it will cause contact failure and short-circuiting.
Implement measures to protect against dust as required by the application.

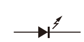
② Drive Circuits

❷-②-1 Providing Power Continuously for Long Periods

If power is continuously provided to the coil for a long period, deterioration of coil insulation will be accelerated due to heating of the coil. Also see 3-2-7 Using with Infrequent Switching.

❷-②-2 Operation Checks for Inspection and Maintenance

If a socket with an operation indicator is used, Relay status during operation can be shown by means of the indicator, thereby facilitating inspection and maintenance.

Type	Description	Examples of applicable models
Built-in indicator	LED 	G7S G7SA

Note: The built-in indicator shows that power is being provided to the coil. The indicator is not based on contact operation.

③ Loads

❷-③-1 Contact Ratings

Contact ratings are generally shown for resistance loads and inductive loads.

❷-③-2 Using Relays with a Microload

Check the failure rate in the performance tables for individual products.

❸ Circuit Design

① Load Circuits

❸-①-1 Load Switching

In actual Relay operation, the switching capacity, electrical durability, and applicable load will vary greatly with the type of load, the ambient conditions, and the switching conditions. Confirm operation under the actual conditions in which the Relay will be used.

① Resistive Loads and Inductive Loads

The switching power for an inductive load will be lower than the switching power for a resistive load due to the influence of the electromagnetic energy stored in the inductive load.

② Switching Voltage (Contact Voltage)

The switching power will be lower with DC loads than it will with AC loads. Applying voltage or current between the contacts exceeding the maximum values will result in the following:

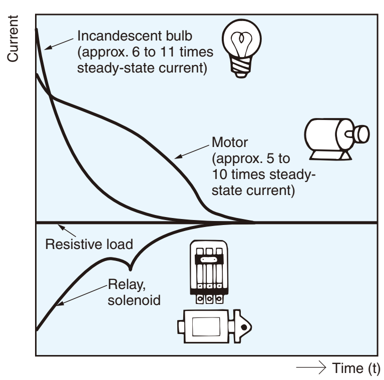
1. The carbon generated by load switching will accumulate around the contacts and cause deterioration of insulation.
2. Contact deposits and locking will cause contacts to malfunction.

③ Switching Current (Contact Current)

Current applied to contacts when they are open or closed will have a large effect on the contacts. For example, when the load is a motor or a lamp, the larger the inrush current, the greater the amount of contact exhaustion and contact transfer will be, leading to deposits, locking, and other factors causing the contacts to malfunction. (Typical examples illustrating the relationship between load and inrush current are given below.)

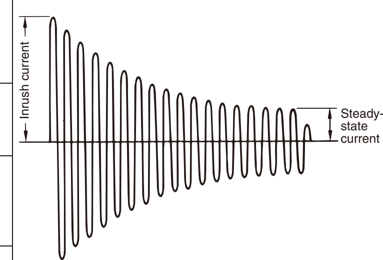
If a current greater than the rated current is applied and the load is from a DC power supply, the connection and shorting of arcing contacts will result in the loss of switching capability.

DC Loads and Inrush Current



AC Loads and Inrush Current

Type of load	Ratio of inrush current to steady-state current	Waveform
Solenoid	Approx. 10	
Incandescent bulb	Approx. 10 to 15	
Motor	Approx. 5 to 10	
Relay	Approx. 2 to 3	
Capacitor	Approx. 20 to 50	
Resistive load	1	



❸-①-2 Electrical Durability

Electrical durability will greatly depend on factors such as the coil drive circuit, type of load, switching frequency, switching phase, and ambient atmosphere. Therefore be sure to check operation in the actual application.

Coil drive circuit	Rated voltage applied to coil using instantaneous ON/OFF
Type of load	Rated load
Switching frequency	According to individual ratings
Switching phase (for AC load)	Random ON, OFF
Ambient atmosphere	According to JIS C5442 standard test conditions

❸-①-3 Failure Rates

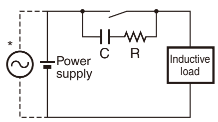
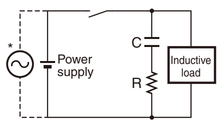
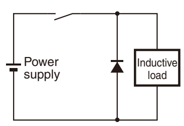
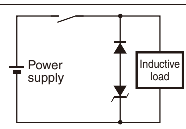
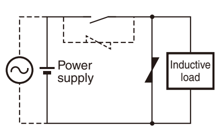
The failure rates provided in this catalog are determined through tests performed under specified conditions. The values are reference values only. The values will depend on the operating frequency, the ambient atmosphere, and the expected level of reliability of the Relay. Be sure to check relay suitability under actual load conditions.

❸-①-4 Contact Protection Circuits

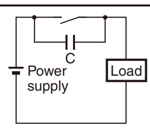
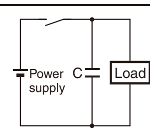
Using a contact protection circuit is effective in increasing contact durability and minimizing the production of carbides and nitric acid. The following table shows typical examples of contact protection circuits. Use them as guidelines for circuit design.

1. Depending on factors such as the nature of the load and the Relay characteristics, the effects may not occur at all or adverse effects may result. Therefore be sure to check operation under the actual load conditions.
2. When a contact protection circuit is used, it may cause the release time (breaking time) to be increased. Therefore be sure to check operation under the actual load conditions.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Relay for an AC voltage. When the contacts are open, current flows to the inductive load via CR.	Use the following as guides for C and R values: C: 0.5 to 1 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics and variations in characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity). If there is any question about the ability to cut off arcing of the contacts in applications with high DC voltages, it may be more effective to connect the capacitor and resistor across the contacts, rather than across the load. Perform testing with the actual equipment to determine this.
		Yes	Yes	The release time of the contacts will be increased if the load is a Relay or solenoid.	
Diode		No	Yes	The electromagnetic energy stored in the inductive load reaches the inductive load as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current. A diode having a reverse breakdown voltage two or three times that of the supply voltage can be used in an electronic circuit where the circuit voltage is not particularly high.
Diode + Zener diode		No	Yes	This circuit effectively shortens the release time in applications where the release time of a diode circuit is too slow.	The breakdown voltage of the Zener diode should be about the same as the supply voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the release time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	The cutoff voltage Vc must satisfy the following conditions. For AC, it must be multiplied by $\sqrt{2}$. Vc > (Supply voltage × 1.5) If Vc is set too high, its effectiveness will be reduced because it will fail to cut off high voltages.

Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

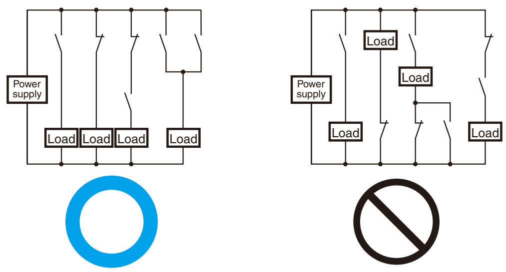
Note: Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

❸-①-5 Countermeasures for Surge from External Circuits

Install contact protection circuits, such as surge absorbers, at locations where there is a possibility of surges exceeding the Relay withstand voltage due to factors such as lightning. If a voltage exceeding the Relay withstand voltage value is applied, it will cause line and insulation deterioration between coils and contacts and between contacts of the same polarity.

❸-①-6 Connecting Loads for Multi-pole Relays

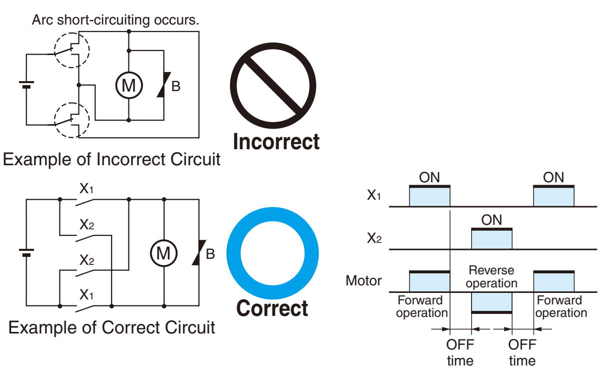
Connect multi-pole Relay loads according to diagram "a" below to avoid creating differences in electric potential in the circuits. If a multi-pole Relay is used with an electric potential difference in the circuit, it will cause short-circuiting due to arcing between contacts, damaging the Relays and peripheral devices.



a. Correct Connection b. Incorrect Connection

❸-①-7 Motor Forward/Reverse Switching

Switching a motor between forward and reverse operation creates an electric potential difference in the circuit, so a time lag (OFF time) must be set up using multiple Relays.



Example of Incorrect Circuit

Example of Correct Circuit

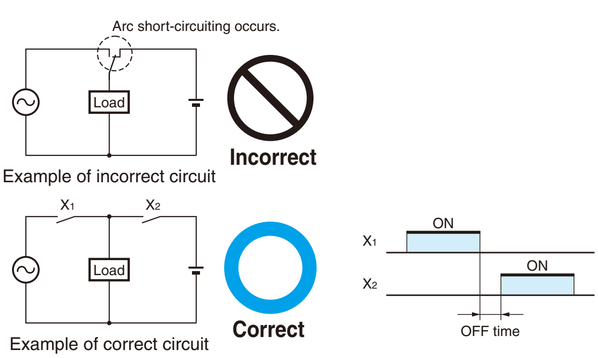
❸-①-8 Power Supply Double Break with Multi-pole Relays

If a double break circuit for the power supply is constructed using multi-pole Relays, take factors into account when selecting models: Relay structure, creepage distance, clearance between unlike poles, and the existence of arc barriers. Also, after making the selection, check operation in the actual application. If an inappropriate model is selected, short-circuiting will occur between unlike poles even when the load is within the rated values, particularly due to arcing when power is turned OFF. This can cause burning and damage to peripheral devices.

❸-①-9 Short-circuiting Due to Arcing between NO and NC Contacts in SPDT Relays

With Relays that have NO and NC contacts, short-circuiting between contacts will result due to arcing if the space between the NO and NC contacts is too small or if a large current is switched.

Do not construct a circuit in such a way that overcurrent and burning occur if the NO, NC, and SPDT contacts are short-circuited.



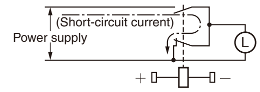
Example of incorrect circuit

Example of correct circuit

❸-①-10 Using SPST-NO/SPST-NC Contact Relays as an SPDT Relay

Do not construct a circuit so that overcurrent and burning occur if the NO, NC and SPDT contacts are short-circuited.

Also, with SPST-NO/SPST-NC Relays, a short-circuit current may flow for forward/reverse motor operation.



❸-①-11 Connecting Loads of Differing Capacities

Do not have a single Relay simultaneously switching a large load and a microload.

The purity of the contacts used for microload switching will be lost as a result of the contact spattering that occurs during large load switching, and this may give rise to contact failure during microload switching.

② Input Circuits

❸-②-1 Maximum Allowable Voltage

The coil's maximum allowable voltage is determined by the coil temperature increase and the heat withstand temperature of the insulation material. (If the heat withstand temperature is exceeded, it will cause coil burning and layer shorting.) There are also important restrictions imposed to prevent problems such as thermal changes and deterioration of the insulation, damage to other control devices, injury to humans, and fires, so be careful not to exceed the specified values provided in this catalog.

❸-②-2 Voltage Applied to Coils

Apply only the rated voltage to coils. The Relays will operate at the must-operate voltage or greater, but the rated voltage must be applied to the coils in order to obtain the specified performance.

❸-②-3 Changes in Must-operate Voltage Due to Coil Temperature

It may not be possible to satisfy this catalog values for must-operate voltages during a hot start or when the ambient temperature exceeds 23°C, so be sure to check operation under the actual application conditions.

Coil resistance is increased by a rise in temperature causing the must-operate voltage to increase. The resistance thermal coefficient of a copper wire is approximately 0.4% per 1°C, and the coil resistance also increases at this percentage.

This catalog values for the must-operate voltage and must-release voltage are given for a coil temperature of 23°C.

❸-②-4 Applied Voltage Waveform for Input Voltage

As a rule, power supply waveforms are based on the rectangular (square) waveforms, and do not operate in such a way that the voltage applied to the coil slowly rises and falls. Also, do not use them to detect voltage or current limit values (i.e., using them for turning ON or OFF at the moment a voltage or current limit is reached).

This kind of circuit causes faulty sequence operations. For example, the simultaneous operability of contacts may not be dependable (for multi-pole Relays, time variations must occur in contact operations), and the must-operate voltage varies with each operation. In addition, the operation and release times are lengthened, causing durability to drop and contact welding. Be sure to use an instantaneous ON/OFF.

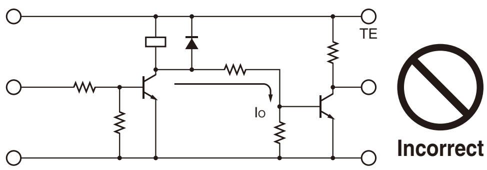
❸-②-5 Preventing Surges when the Coil Is Turned OFF

Counter electromotive force generated from a coil when the coil is turned OFF causes damage to semiconductor elements and faulty operation.
As a countermeasure, install surge absorbing circuits at both ends of the coil. When surge absorbing circuits have been installed, the Relay release time will be lengthened, so be sure to check operation using the actual circuits.
External surges must be taken into account for the repetitive peak reverse voltage and the DC reverse voltage, and a diode with sufficient capacity used. Also, ensure that the diode has an average rectified current that is greater than the coil current.
Do not use under conditions in which a surge is included in the power supply, such as when an inductive load is connected in parallel to the coil. Doing so will cause damage to the installed (or built-in) coil surge absorbing diode.

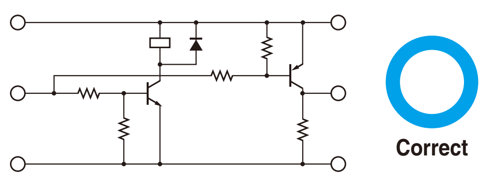
❸-②-6 Leakage Current to Relay Coils

Do not allow leakage current to flow to Relay coils. Construct a corrective circuit as shown in examples 1 and 2 below.

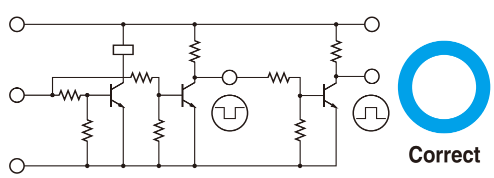
Example: Circuit with Leakage Current Occurring



Corrective Example 1



Corrective Example 2:
When an Output Value Is Required in the Same Phase as the Input Value

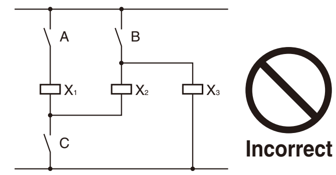


❸-②-7 Using with Infrequent Switching

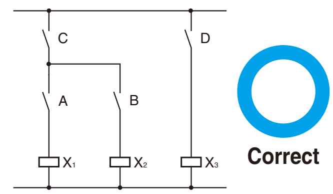
For operations using a microload and infrequent switching, periodically perform continuity tests on the contacts. When switching is not executed for contacts for long periods of time, it causes contact instability due to factors such as the formation of film on contact surfaces.
The frequency with which the inspections are needed will depend on factors such as the operating environment and the type of load.

❸-②-8 Configuring Sequence Circuits

When configuring a sequence circuit, care must be taken to ensure that abnormal operation does not occur due to faults such as sneak current.
The following diagram shows an example of sneak current. After contacts A, B, and C are closed causing Relays X_1, X_2, and X_3 to operate, and then contacts B and C are opened, a series circuit is created from A to X_1 to X_2 to X_3. This causes the Relay to hum or to not release.



The following diagram shows an example of a circuit that corrects the above problem. Also, in a DC circuit, the sneak current can be prevented by means of a diode.



❸-②-9 Connecting Relay Grounds

Do not connect a ground when using a Relay at high temperatures or high humidity. Depending on the grounding method, electrolytic corrosion may occur, causing the wire to the coil to sever. If the Relay must be grounded, use the method shown in the following diagrams.

(1) Ground the positive side of the power supply. (Fig. 1 and Fig. 2)
(2) If grounding the positive side of the power supply is not possible and the negative side must be grounded, connect a switch at the positive side so that the coil is connected to the negative side. (Fig. 3)
(3) Do not ground the negative side and connect a switch to the negative side.
This will cause electrolytic corrosion to occur. (Fig. 4)

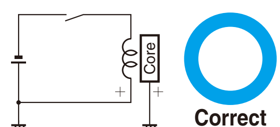


Fig. 1

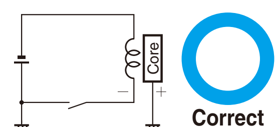


Fig. 2

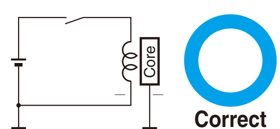


Fig. 3

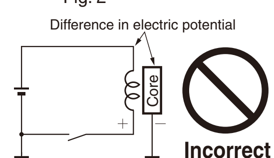


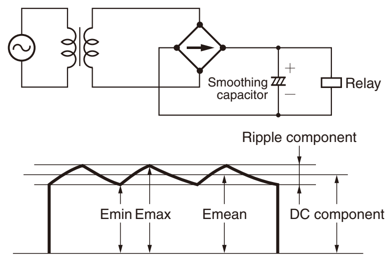
Fig. 4

❸-②-10 Individual Specifications for Must-operate/release Voltages and Operate/Release Times

If it is necessary to know the individual specifications of characteristics, such as must-operate voltages, must-release voltages, operate times, and release times, please contact your OMRON representative.

❸-②-11 Using DC-operated Relays (1) Input Power Supply Ripple

For a DC-operated Relay power supply, use a power supply with a maximum ripple percentage of 5%. An increase in the ripple percentage will cause humming.



Ripple percentage %= $\frac{Emax-Emin}{Emean} \times 100\%$

E max.= Maximum value of ripple component
E min.= Minimum value of ripple component
E mean= Mean value of DC component

❸-②-12 Using DC-operated Relays (2) Coil Polarity

To make the correct connections, first check the individual terminal numbers and applied power supply polarities provided in this catalog. If the polarity is connected in reverse for the coil power supply when Relays with surge suppressor diodes or Relays with operation indicators are used, it can cause problems such as Relay malfunctioning, damage to diodes, or failure of indicators. Also, for Relays with diodes, it can cause damage to devices in the circuit due to short-circuiting.
Polarized Relays that use a permanent magnet in a magnetic circuit will not operate if the power supply to the coil is connected in reverse.

❸-②-13 Using DC-operated Relays (3) Coil Voltage Insufficiency

If insufficient voltage is applied to the coil, either the Relay will not operate or operation will be unstable. This will cause problems such as a drop in the electrical durability of the contacts and contact welding.
In particular, when a load with a large surge current, such as a large motor, is used, the voltage applied to the coil may drop when a large inrush current occurs to operate the load as the power is turned ON. Also, if a Relay is operated while the voltage is insufficient, it will cause the Relay to malfunction even at vibration and shock values below the specifications specified in the specification sheets and this catalog. Therefore, be sure to apply the rated voltage to the coil.

③ Mounting Design

❸-③-1 Lead Wire Diameters

Lead wire diameters are determined by the size of the load current. As a standard, use lead wires at least the size of the cross-sectional areas shown in the following table. If the lead wire is too thin, it may cause burning due to abnormal heating of the wire.

Permissible current (A)	Cross-sectional area (mm^2)
6	0.75
10	1.25
15	2
20	3.5

❸-③-2 When Sockets are Used

Check Relay and socket ratings, and use devices at the lower end of the ratings. Relay and socket rated values may vary, and using devices at the high end of the ratings can result in abnormal heating and burning at connections.

❸-③-3 Mounting Direction

Depending on the model, a particular mounting direction may be specified. Check this catalog and then mount the device in the correct direction.

❸-③-4 When Devices Such as Microcomputers are in Proximity

If a device that is susceptible to external noise, such as a microcomputer, is located nearby, take noise countermeasures into consideration when designing the pattern and circuits. If Relays are driven using a device such as a microcomputer, and a large current is switched by Relay contacts, noise generated by arcing can cause the microcomputer to malfunction.

❹ Operating and Storage Environments

❹-1 Operating, Storage, and Transport

During operation, storage, and transport, avoid direct sunlight and maintain room temperature, humidity, and pressure.

- If Relays are used or stored for a long period of time in an atmosphere of high temperature and humidity, oxidation and sulphurization films will form on contact surfaces, causing problems such as contact failure.
- If the ambient temperature is suddenly changed in an atmosphere of high temperature and humidity, condensation will develop inside of the Relay. This condensation may cause insulation failure and deterioration of insulation due to tracking (an electric phenomenon) on the surface of the insulation material.
  Also, in an atmosphere of high humidity, with load switching accompanied by a comparatively large arc discharge, a dark green corrosive product may be generated inside of the Relay. To prevent this, it is recommended that Relays be used in at low humidity.
- If Relays are to be used after having been stored for a long period, first inspect the power transmission before use. Even if Relays are stored without being used at all, contact instability and obstruction may occur due to factors such as chemical changes to contact surfaces, and terminal soldering characteristics may be degraded.

❹-2 Operating Atmosphere

- Do not use Relays in an atmosphere containing flammable or explosive gas. Arcs and heating resulting from Relay switching may cause fire or explosion.
- Do not use Relays in an atmosphere containing dust. The dust will get inside the Relays and cause contact failure.

❹-3 Using Relays in an Atmosphere Containing Corrosive Gas (Silicon, Sulfuric, or Organic Gas)

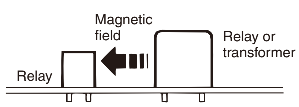
Do not use Relays in a location where silicon gas, sulfuric gas (SO_2 or H_2S), or organic gas is present.
If Relays are stored or used for a long period of time in an atmosphere of sulfuric gas or organic gas, contact surfaces may become corroded and cause contact instability and obstruction, and terminal soldering characteristics may be degraded.
Also, if Relays are stored or used for a long period of time in an atmosphere of silicon gas, a silicon film will form on contact surfaces, causing contact failure.
The effects of corrosive gas can be reduced by the processing shown in the following table.

Item	Processing
Outer case, housing	Seal structure using packing.
PCB, copper plating	Apply coating.
Connectors	Apply gold plating or rhodium plating.

❹-4 Adhesion of Water, Chemicals, Solvent, and Oil
Do not use or store Relays in an atmosphere exposed to water, chemicals, solvent, or oil. If Relays are exposed to water or chemicals, it can cause rusting, corrosion, resin deterioration, and burning due to tracking. Also, if they are exposed to solvents such as thinner or gasoline, it can erase markings and cause components to deteriorate.
If oil adheres to the transparent case (polycarbonate), it can cause the case to cloud up or crack.

❹-5 Vibration and Shock
Do not allow Relays to be subjected to vibration or shock that exceeds the rated values.
If abnormal vibration or shock is received, it will not only cause malfunctioning but faulty operation due to deformation of components in Relays, damage, etc. Mount Relays in locations and using methods that will not let them be affected by devices (such as motors) that generate vibration so that Relays are not subjected to abnormal vibration.

❹-6 External Magnetic Fields
Do not use Relays in a location where an external magnetic field of 800 A/m or greater is present.
If they are used in a location with a strong magnetic field, it will cause malfunctioning.
Also, strong magnetic field may cause the arc discharge between contacts during switching to be bent or may cause tracking or insulation failure.



❹-7 External Loads
Do not use or store Relays in such a way that they are subjected to external loads. The original performance capabilities of the Relays cannot be maintained if they are subjected to an external load.

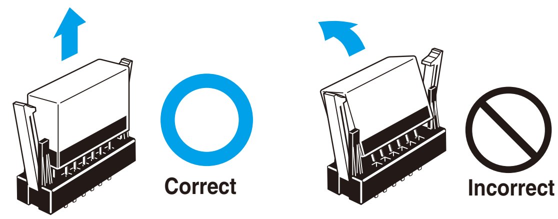
❹-8 Adhesion of Magnetic Dust
Do not use Relays in an atmosphere containing a large amount of magnetic dust. Relay performance cannot be maintained if magnetic dust adheres to the case.

❺ Relay Mounting Operations

① Plug-in Relays

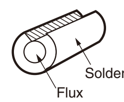
❺-①-1 Panel-mounting Sockets
1. Socket Mounting Screws
   When mounting a panel-mounting socket to the mounting holes, make sure that the screws are tightened securely.
   If there is any looseness in the socket mounting screws, vibration and shock can cause the socket, Relays, and lead wire to detach.
   Panel-mounting sockets that can be snapped on to a 35-mm DIN Track are also available.
2. Lead Wire Screw Connections
   Tighten lead wire screws to a torque of 0.78 to 0.98 N·m (P7SA and P7S).
   If the screws connecting a panel-mounting socket are not sufficiently tightened, the lead wire can become detached and abnormal heating or fire can be caused by the contact failure.
   Conversely, excessive tightening can strip the threads.

❺-①-2 Relay Removal Direction
Insert and remove Relays from the socket perpendicular to the socket surface.



If they are inserted or removed at an angle, Relay terminals may be bent and may not make proper contact with the socket.

❺-①-3 Terminal Soldering
Solder General-purpose Relays manually following the precautions described below.
1. Smooth the tip of the solder gun and then begin the soldering.
   - Solder: JIS Z3282, H60A or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.
2. Use a non-corrosive rosin-based flux suitable for the Relay's structural materials.
   For flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.
3. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

When soldering Relay terminals, be careful not to allow materials such as solder, flux, and solvent to adhere to areas outside of the terminals.
If this occurs, solder, flux, or solvent can penetrate inside of the Relays and cause degrading of the insulation and contact failure.

② Printed Circuit Board Relays

❺-②-1 Ultrasonic Cleaning
Do not use ultrasonic cleaning for Relays that are not designed for it. Resonance from the ultrasonic waves used in ultrasonic cleaning can cause damage to a Relay's internal components, including sticking of contacts and disconnection of coils.

③ Common Items

❺-③-1 Removing the Case and Cutting Terminals
Absolutely do not remove the case and cut terminals. Doing so will cause the Relay's original performance capabilities to be lost.

❺-③-2 Deformed Terminals
Do not attempt to repair and use a terminal that has been deformed. Doing so will cause excessive force to be applied to the Relay, and the Relay's original performance capabilities will be lost.

❺-③-3 Replacing Relays and Performing Wiring Operations
Before replacing a Relay or performing a wiring operation, first turn OFF the power to the coil and the load and check to make sure that the operation will be safe.

❺-③-4 Coating and Packing
G7S, G7SA and G7SB Relays are not fully sealed, so do not use a coating or packing resin.

❻ Handling Relays

❻-1 Vibration and Shock

Relays are precision components. Regardless of whether or not they are mounted, do not exceed the rated values for vibration and shock. The vibration and shock values are determined individually for each Relay, so check the individual Relay specifications in this catalog.
If a Relay is subjected to abnormal vibration or shock, its original performance capabilities will be lost.

❻-2 Dropped Products

Do not use a product that has been dropped, or that has been taken apart. Not only may its characteristics not be satisfied, but it may be susceptible to damage or burning.

❼ Relays for Printed Circuit Boards (PCBs)

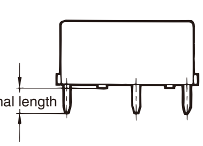
❼-1 Selecting PCBs
(1) PCB Materials

PCBs are classified into those made of epoxy and those made of phenol. The following table lists the characteristics of these PCBs. Select one, taking into account the application and cost. Epoxy PCBs are recommended for mounting Relays to prevent the solder from cracking.

Material	Epoxy		Phenol
Item	Glass epoxy (GE)	Paper epoxy (PE)	Paper phenol (PP)
Electrical characteristics	• High insulation resistance. • Insulation resistance hardly affected by moisture absorption.	Characteristics between glass epoxy and phenol	New PCBs are highly insulation-resistive but easily affected by moisture absorption.
Mechanical characteristics	• The dimensions are not easily affected by temperature or humidity. • Suitable for through-hole or multi-layer PCBs.	Characteristics between glass epoxy and phenol	• The dimensions are easily affected by temperature or humidity. • Not suitable for through-hole PCBs.
Relative cost	High	Moderate	Low
Applications	Applications that require high reliability.	Characteristics between glass epoxy and paper phenol	Applications in comparatively good environments with low-density wiring.

❼-2 Selecting PCBs
(2) PCB Thickness

The PCB may warp due to the size, mounting method, or ambient operating temperature of the PCB or the weight of components mounted to the PCB. Should warping occur, the internal mechanism of the Relay on the PCB will be deformed and the Relay may not provide its full capability. Determine the thickness of the PCB by taking the material of the PCB into consideration.
In general, PCB thickness should be 0.8, 1.2, 1.6, or 2.0 mm. Taking Relay terminal length into consideration, the optimum thickness is 1.6 mm.



❼-3 Selecting PCBs
(3) Terminal Hole and Land Diameters

Refer to the following table to select the terminal hole and land diameters based on the Relay mounting dimensions. The land diameter may be smaller if the land is processed with through-hole plating.

Terminal hole diameter (mm)		Minimum land diameter (mm)
Nominal value	Tolerance	
0.6	±0.1	1.5
0.8		1.8
1.0		2.0
1.2		2.5
1.3		2.5
1.5		3.0
1.6		3.0
2.0		3.0

❼-4 Mounting Space

① Ambient Temperature

When mounting a Relay, check this catalog for the specified amount of mounting space for that Relay, and be sure to allow at least that much space.
When two or more Relays are mounted, their interaction may generate excessive heat. In addition, if multiple PCBs with Relays are mounted to a rack, the temperature may rise excessively. When mounting Relays, leave enough space so that heat will not build up, and so that the Relays' ambient temperature remains within the specified operating temperature range.

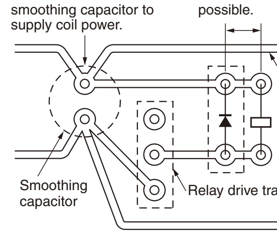
② Mutual Magnetic Interference

When two or more Relays are mounted, Relay characteristics may be changed by interference from the magnetic fields generated by the individual Relays. Be sure to conduct tests using the actual devices.

❼-5 Pattern Design for Noise Countermeasures

① Noise from Coils

When the coil is turned OFF, reverse power is generated to both ends of the coil and a noise spike occurs. As a countermeasure, connect a surge absorbing diode. The diagram below shows an example of a circuit for reducing noise propagation.



② Noise from Contacts

Noise may be transmitted to the electronic circuit when switching a load, such as a motor or transistor, that generates a surge at the contacts. When designing patterns, take the following three points into consideration.

1. Do not place a signal transmission pattern near the contact pattern.
2. Shorten the length of patterns that may be sources of noise.
3. Block noise from electronic circuits by means such as constructing ground patterns.

③ High-frequency Patterns

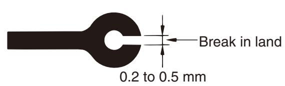
As the manipulated frequency is increased, pattern mutual interference also increases. Therefore, take noise countermeasures into consideration when designing high-frequency pattern and land shapes.

❼-6 Shape of Lands

1. The land section should be on the center line of the copper-foil pattern, so that the soldered fillets become uniform.

Correct Examples	
Incorrect Examples	

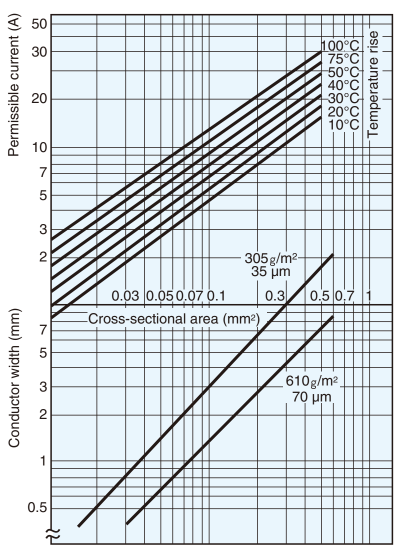
2. A break in the circular land area will prevent molten solder from filling holes reserved for components which must be soldered manually after the automatic soldering of the PCB is complete.



❼-7 Pattern Conductor Width and Thickness

The following thicknesses of copper foil are standard: 35 μm and 70 μm. The conductor width is determined by the current flow and allowable temperature rise. Refer to the chart below as a simple guideline.

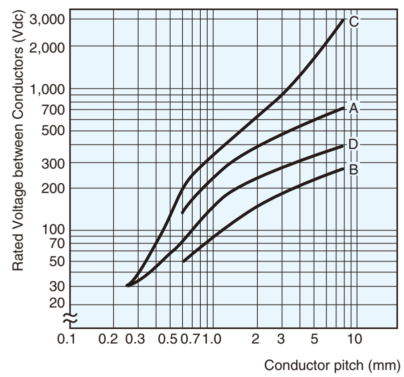
Conductor Width and Permissible Current (According to IEC Pub326-3)



❼-8 Conductor Pitch

The conductor pitch on a PCB is determined by the insulation characteristics between conductors and the environmental conditions under which the PCB is to be used. Refer to the following graph. If the PCB must conform to safety organization standards (such as UL, CSA, or IEC), however, priority must be given to fulfilling their requirements. Also, multi-layer PCBs can be used as a means of increasing the conductor pitch.

Voltage between Conductors vs. Conductor Pitch (According to IEC Pub326-3)



A = Without coating at altitude of 3,000 m max.
B = Without coating at altitude of 3,000 m or higher but lower than 15,000 m
C = With coating at altitude of 3,000 m max.
D = With coating at altitude of 3,000 m or higher

❼-9 Securing the PCB

Although the PCB itself is not normally a source of vibration or shock, it may prolong vibration or shock by resonating with external vibration or shock.

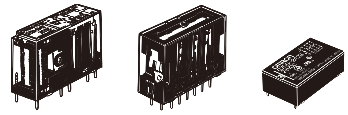
Securely fix the PCB, paying attention to the following points.

Mounting method	Process
Rack mounting	No gap between rack's guide and PCB
Screw mounting	• Securely tighten screw. Place heavy components such as Relays on part of PCB near where screws are to be used. • Attach rubber washers to screws when mounting components that are affected by shock (such as audio devices.)

❼-10Automatic Mounting of PCB Relays

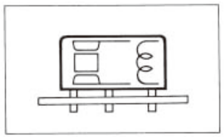
① Through-hole PCBs

When mounting a Relay to a PCB, take the following points into consideration for each process. There are also certain mounting precautions for individual Relays, so refer to the individual Relay precautions as well.



Process 1

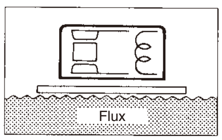
Placement



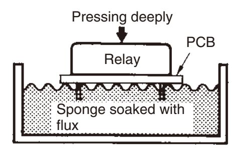
1. Do not bend any terminals of the Relay to use it as a self-clinching Relay.
   The initial performance characteristics of the Relay will be lost.
2. Execute PCB processing correctly according to the PCB process diagrams.

Process 2

Flux Application



1. The G7S has no protection against flux penetration, so absolutely do not use the method shown in the diagram on the right, in which a sponge is soaked with flux and the PCB pressed down on the sponge. If this method is used for the G7S, it will cause the flux to penetrate into the Relay. Be careful even with the flux-resistant G7SA or G7SB, because flux can penetrate into the Relay if it is pressed too deeply into the sponge.
2. The flux must be a non-corrosive rosin-based flux suitable for the Relay's structural materials.
   For the flux solvent, use an alcohol-based solvent, which tends to be less chemically reactive.
   Apply the flux sparingly and evenly to prevent penetration into the Relay.
   When dipping the Relay terminals into liquid flux, be sure to adjust the flux level, so that the upper surface of the PCB is not flooded with flux.
3. Make sure that flux does not adhere anywhere outside of the Relay terminals. If flux adheres to an area such as the bottom surface of the Relay, it will cause the insulation to deteriorate.



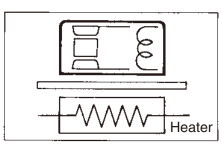
Example of incorrect method

Applicability of Dipping Method

G7S	G7SA	G7SB
NO	YES (Must be checked when spray flexor is used.)	

Process 3

Preheating



1. Preheating is required to create the optimum conditions for soldering.
2. The following conditions apply for preheating.

Temperature	100°C max.
Time	1 min max.

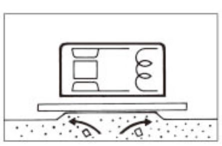
3. Do not use a Relay if it has been left at a high temperature for a long period of time due to a circumstance such as equipment failure. These conditions will cause the Relay's initial characteristics to change.

Applicability of Preheating

G7S	G7SA	G7SB
NO	YES	

Process 4

Soldering



Automatic soldering

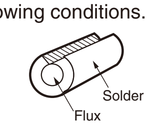
1. Flow soldering is recommended to assure a uniform solder joint.
   - Solder: JIS Z3282 or H63A
   - Solder temperature and soldering time: Approx. 250°C (DWS: Approx. 260°C)
   - Solder time: 5 s max. (DWS: Approx. 2 s for first time and approx. 3 s for second time)
   - Adjust the level of the molten solder so that the PCB is not flooded with solder.

Applicability of Automatic Soldering

G7S	G7SA	G7SB
NO	YES	

Manual soldering

1. Smooth the solder with the tip of the iron, and then perform the soldering under the following conditions.
   - Solder: JIS Z3282, H60A, or H63A (containing rosin-based flux)
   - Soldering iron: Rated at 30 to 60 W
   - Tip temperature: 280 to 300°C
   - Soldering time: Approx. 3 s max.



2. As shown in the above illustration, solder is available with a cut section to prevent flux from splattering.

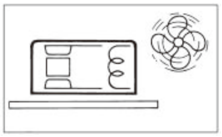
Applicability of Manual Soldering

G7S	G7SA	G7SB
YES	YES	

Continued next page.

Note: For lead-free solder, perform the soldering under conditions that conform to the applicable specifications.

Process 5
Cooling

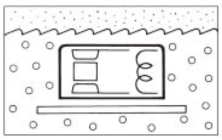


1. Upon completion of automatic soldering, use a fan or other device to forcibly cool the PCB. This helps prevent the Relay and other components from deteriorating from the residual heat of soldering.
2. Fully sealed relays are washable. Do not, however, put fully sealed relays in a cold cleaning solvent immediately after soldering or the seals may be dameged.

Cooling

G7SA	G7SB
Required	

Process 6
Cleaning

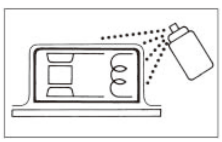


Refer to the following table to select the cleaning method and solvent.

Cleaning Method

G7S	G7SA	G7SB
Neither boiling cleaning nor immersion cleaning is possible. Clean only the back of the PCB with a brush.		

Process 7
Coating



1. With the G7S, G7SA or G7SB coating will penetrate inside Relays and damage the contacts. Therefore either do not apply coating at all or apply the coating first, before mounting the Relays.
2. Be very careful in selecting the coating material. Depending on the type of coating selected, it may damage the Relay case and chemically dissolve the seals, causing them to lose their sealing capability.
3. Do not secure the entire Relay in resin, or the Relay's characteristics will be changed.
   Do not exceed the maximum value for the coating's ambient operating temperature.

❽ Troubleshooting

The following table can be used for troubleshooting when Relay operation is not normal. Refer to this table when checking the circuit and other items.
If checking the circuit reveals no abnormality, and it appears that the fault is caused by a Relay, contact your OMRON representative. (Do not disassemble the Relay. Doing so will make it impossible to identify the cause of the problem.)
A Relay is composed of various mechanical parts, including a coil, contacts, and iron core. Among these, problems occur most often with the contacts, and next often with the coil.
These problems, however, mostly occur as a result of external factors such as methods and conditions of operation, and can generally be prevented by means of careful consideration before operation and by selecting the correct Relays.
The following table shows the main faults that may occur, their probable causes, and suggested countermeasures to correct them.

Fault	Probable cause	Countermeasures
(1) Operation fault	**1.** Incorrect coil rated voltage selected **2.** Faulty wiring **3.** Input signal not received **4.** Power supply voltage drop **5.** Circuit voltage drop (Be careful in particular of high-current devices operated nearby or wired at a distance.) **6.** Rise in operating voltage along with rise in ambient operating temperature (especially for DC) **7.** Coil disconnection	**1.** Select the correct rated voltage. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the power supply voltage. **5.** Check the circuit voltage. **6.** Test individual Relay operation. **7.** • For coil burning, see fault (3). • For disconnection due to electrical corrosion, check the polarity being applied to the coil voltage.
(2) Release fault	**1.** Input signal OFF fault **2.** Voltage is applied to the coil by a sneak current **3.** Residual voltage by a combination circuit such as a semiconductor circuit **4.** Release delay due to parallel connection of coil and capacitor **5.** Contact welding	**1.** Check the voltage between coil terminals. **2.** Check the voltage between coil terminals. **3.** Check the voltage between coil terminals. **4.** Check the voltage between coil terminals. **5.** For contact welding, see fault (4).
(3) Coil burning	**1.** Unsuitable voltage applied to coil **2.** Incorrect rated voltage selected **3.** Short-circuit between coil layers	**1.** Check the voltage between coil terminals. **2.** Select the correct rated voltage. **3.** Recheck the operating atmosphere.
(4) Contact welding	**1.** Excessive device load connected (insufficient contact capacity) **2.** Excessive switching frequency **3.** Short-circuiting of load circuit **4.** Abnormal contact switching due to humming **5.** Expected service life of contacts reached	**1.** Check the load capacity. **2.** Check the number of switches. **3.** Check the load circuits. **4.** For humming, see fault (7). **5.** Check the contact ratings.
(5) Contact failure	**1.** Oxidation of contact surfaces **2.** Contact abrasion and aging **3.** Terminal and contact displacement due to faulty handling	**1.** • Recheck the operating atmosphere. • Select the correct Relay. **2.** The expected service life of the contacts has been reached. **3.** Be careful of vibration, shock, and soldering operations.
(6) Abnormal contact consumption	**1.** Unsuitable Relay selection **2.** Insufficient consideration of device load (especially motor, solenoid, and lamp loads) **3.** No contact protection circuit **4.** Insufficient withstand voltage between adjacent contacts	**1.** Select the correct Relay. **2.** Select the correct devices. **3.** Add a circuit such as a spark quenching circuit. **4.** Select the correct Relay.
(7) Humming	**1.** Insufficient voltage applied to coil **2.** Excessive power supply ripple (DC) **3.** Incorrect coil rated voltage selected **4.** Slow rise in input voltage **5.** Abrasion in iron core **6.** Foreign material between moveable iron piece and iron core	**1.** Check the voltage between coil terminals. **2.** Check the ripple percentage. **3.** Select the correct rated voltage. **4.** Make supplemental changes to circuit. **5.** The expected service life has been reached. **6.** Remove the foreign material.

⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.4

OMRON Corporation
Industrial Automation Company

In the interest of product improvement, specifications are subject to change without notice.

http://www.ia.omron.com/

Guard Lock Safety-door Switch

D4BL

Release Protective Cover Locks Using Controller Signals or Pushbutton Switches after the Cutting Tool Stops Moving Due to Inertia

Note: Contact your sales representative for details on models with safety standard certification.

- A mechanical lock is applied automatically when the Operation Key is inserted. A high level of safety is achieved using a mechanism where the lock is only released when voltage is applied to the solenoid.
- Conforms to EN (TÜV) standards corresponding to the CE marking.
- Certified by UL, CSA and CCC standards.
- The Switch contact is opened by a direct opening mechanism (NC contacts only) when the protective cover is opened. Direct opening mechanism that is EN-certified is indicated by ⊖ on the Switch.
- Auxiliary release key ensures easy maintenance and unlocks the door in the case of a power failure.
- Tough aluminum die-cast body incorporating a switch box with degree of protection satisfying IP67, UL, and CSA TYPE6P, 13.
- Equipped with a horizontal and vertical conduit opening.
- Models incorporating easy-to-see indicators for monitoring and those using an adjustable Operation Key for a swinging door are available.
- The mounting direction of the head can be changed to allow the Operation Key to be inserted from four directions.

⚠ Be sure to read the *"Safety Precautions"* on page 13 and the *"Precautions for All Safety Door Switches"*.

Model Number Structure

Model Number Legend

Switch

D4BL -□□□□ -□
1 2 3 4 5

1. **Conduit Size (2-conduit)**
   1: PG13.5
   2: G1/2
   3: 1/2-14NPT
2. **Built-in Switch (with Safety Switch and Lock Monitor Switch Contacts)**
   C: 1NC/1NO (slow-action) + 1NC (slow-action)
   D: 2NC (slow-action) + 1NC (slow-action)
3. **Head Mounting Direction**
   R: Four mounting directions possible (right-side mounting at shipping)
4. **Door Lock and Release (Auxiliary Release Key is Incorporated by All Models)**
   A: Mechanical lock/24 VDC solenoid release
   B: Mechanical lock/110 VAC solenoid release
   G: 24 VDC Solenoid lock/Mechanical release
5. **Indicator**
   Blank: Without indicator
   A: 10 to 115 VAC or VDC driving (with orange and green LED indicator unit)

Operation Key

D4BL - K□
1

1. **Operation Key Type**
   1: Horizontal mounting
   2: Vertical mounting
   3: Adjustable mounting (Horizontal)

Switch

D4BL -2GRD-AT
1 2 3 4 5 6

1. **Conduit Size (2-conduit)**
   2: G1/2
2. **Built-in Switch**
   G: 2NC (slow-action) + 2NC (slow-action)
3. **Head Mounting Direction**
   R: Four mounting directions possible (right-side mounting at shipping)
4. **Door Lock and Release**
   D: Mechanical lock/24 VDC solenoid release
5. **Indicator lamp**
   A: Equipped with an orange/green LED display unit
6. **Release key**
   T: No release key

Operation Key

D4BL - K□
1

1. **Operation Key Type**
   1: Horizontal mounting
   2: Vertical mounting
   3: Adjustable mounting (Horizontal)

Ordering Information

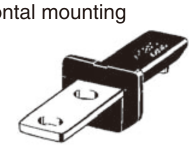
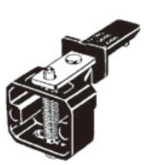
List of Models

Switches (Operation Keys are sold separately.)

: Models with certified direct opening contacts.

Lock method	Conduit size	Voltage for solenoid	Without indicator 1NC/1NO+ 1NC (Slow-action)	With LED indicator 1NC/1NO+ 1NC (Slow-action)	Without indicator 2NC+ 1NC (Slow-action)	With LED indicator 2NC+ 1NC (Slow-action)
Mechanical lock	PG13.5	24 VDC	D4BL-1CRA	D4BL-1CRA-A	D4BL-1DRA	D4BL-1DRA-A
		110 VAC	D4BL-1CRB	D4BL-1CRB-A	D4BL-1DRB	D4BL-1DRB-A
	G1/2	24 VDC	D4BL-2CRA	D4BL-2CRA-A	D4BL-2DRA	D4BL-2DRA-A
		110 VAC	D4BL-2CRB	D4BL-2CRB-A	D4BL-2DRB	D4BL-2DRB-A
	1/2-14NPT	24 VDC	D4BL-3CRA	D4BL-3CRA-A	D4BL-3DRA	D4BL-3DRA-A
		110 VAC	D4BL-3CRB	D4BL-3CRB-A	D4BL-3DRB	D4BL-3DRB-A
Solenoid lock	Pg 13.5	24 VDC	D4BL-1CRG	D4BL-1CRG-A	D4BL-1DRG	D4BL-1DRG-A
	G1/2	24 VDC	D4BL-2CRG	D4BL-2CRG-A	D4BL-2DRG	D4BL-2DRG-A
	1/2-14NPT	24 VDC	D4BL-3CRG	D4BL-3CRG-A	D4BL-3DRG	D4BL-3DRG-A

Operation Keys

Mounting type	Model
Horizontal mounting 	D4BL-K1
Vertical mounting 	D4BL-K2
Adjustable mounting 	D4BL-K3

Specifications

Standards and EC Directives

Conforms to the following EC Directives:

- Machinery Directive
- Low Voltage Directive
- EN1088

Certified Standards

Certification body	Standard	File No.
TÜV Rheinland	EN60947-5-1 (certified direct opening) GS-ET-19	R9451050
UL	UL508	E76675
CSA	CSA C22.2, No.14	LR45746
CQC (CCC)	GB14048.5	2003010305073836

Certified Standard Ratings

TÜV (EN60947-5-1), CCC (GB14048.5)

Item / Type	Standard model	Indicator model
Utilization category	AC-15	AC-15
Rated operating current (I_e)	3 A	6 A
Rated operating voltage (U_e)	250 V	115 V

Note: Use a 10 A fuse type gI or gG that conforms to IEC60269 as a short-circuit protection device.

UL/CSA (UL508, CSA C22.2 No. 14)

A300

Rated voltage	Carry current	Current (A)		Volt-amperes (VA)	
		Make	Break	Make	Break
120 VAC	10 A	60	6	7,200	720
240 VAC		30	3		

Note: The UL/CSA certified rating for products with indicators (-A) is 6 A/115 VAC.

Characteristics

Degree of protection *1		IP67 (EN60947-5-1)
Durability *2	**Mechanical**	1,000,000 operations min.
	Electrical	500,000 operations min. (10 A resistive load at 250 VAC)
Operating speed		0.05 to 0.5 m/s
Operating frequency		30 operations/minute max.
Direct opening force *3		19.61 N min. (EN60947-5-1)
Direct opening travel *3		20 mm min. (EN60947-5-1)
Holding force		700 N min. (GS-ET-19)
Contact resistance		50 mΩ max.
Rated insulation voltage (U_i)		300 V (EN60947-5-1)
Rated frequency		50/60 Hz
Protection against electric shock		Class I (with ground terminal)
Pollution degree (operating environment)		3 (EN60947-5-1)
Impulse withstand voltage (EN60947-5-1)	**Between terminals of same polarity**	4 kV
	Between terminals of different polarity	
	Between each terminal and ground	
	Between solenoid and ground	2.5 kV
Insulation resistance		100 MΩ min. (at 500 VDC)
Contact gap		2 × 2 mm min.
Vibration resistance	**Malfunction**	10 to 55 Hz, 0.35 mm single amplitude
Shock resistance	**Destruction**	1,000 m/s^2 min.
	Malfunction	300 m/s^2 min.
Conditional short-circuit current		100 A (EN60947-5-1)
Conventional enclosed thermal current (I_{the})		10 A (EN60947-5-1)
Ambient operating temperature		–10 to 55°C (with no icing)
Ambient operating humidity		95% max.
Weight		Approx. 800 g

Note: The above values are initial values.

*1. The degree of protection is tested using the method specified by the standard (EN60947-5-1). Confirm that sealing properties are sufficient for the operating conditions and environment beforehand. Although the switch box is protected from dust, oil or water penetration, do not use the D4BL in places where dust, oil, water, or chemicals may enter through the key hole on the head, otherwise Switch damage or malfunctioning may occur.

*2. The durability is for an ambient temperature of 5 to 35°C and an ambient humidity of 40% to 70%.

*3. These figures are minimum requirements for safe operation.

Solenoid Coil Characteristics

Item / Type	24 VDC mechanical lock models	110 VAC mechanical lock models	24 VDC solenoid lock models
Rated operating voltage	24 VDC $^{+10\%}_{-15\%}$ (100% ED)	110 VAC ±10% (50/60 Hz)	24 VDC $^{+10\%}_{-15\%}$ (100% ED)
Current consumption	Approx. 300 mA	Approx. 98 mA	Approx. 300 mA
Insulation class	Class F (130°C or less)		

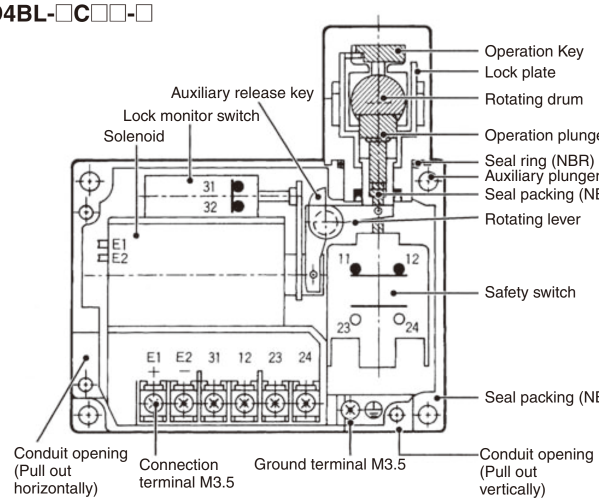
Indicator Characteristics

Rated voltage	10 to 115 VAC/VDC
Current leakage	Approx. 1 mA
Color (LED)	Orange, green

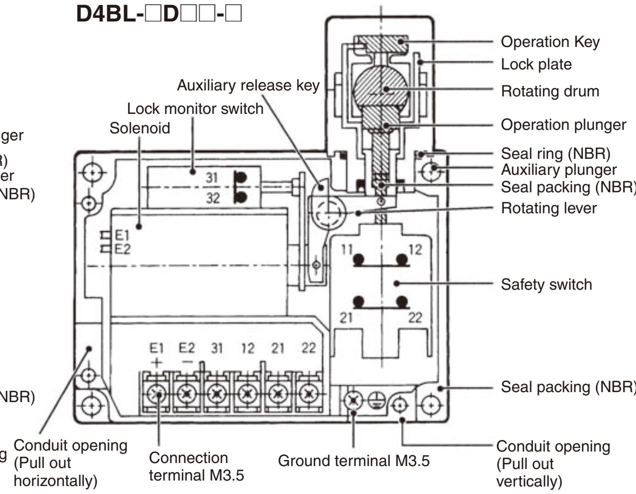
Structure and Nomenclature

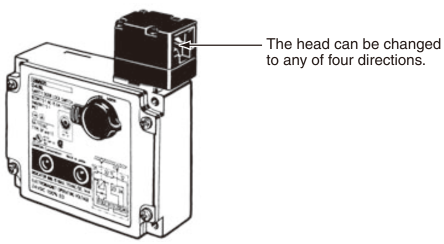
Structure

D4BL-□C□□-□

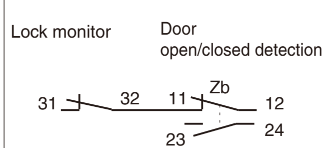
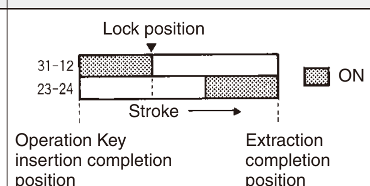
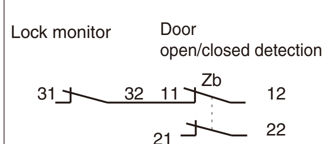
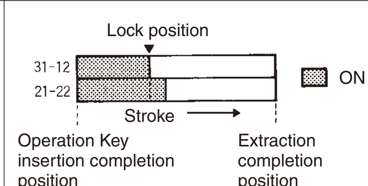


D4BL-□D□□-□



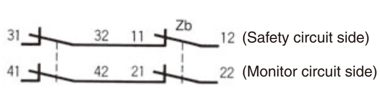


Contact Form (Diagrams Show State with Key Inserted and Lock Engaged)

Model	Contact (door open/ closed detection and lock monitor)	Contact form		Operating pattern	Remarks
		Lock monitor	Door open/ closed detection		
D4BL-□C□□-□	1NC/1NO+1NC	Lock monitor / Door open/closed detection 			Only NC contacts 11-12 and 31-32 have a certified direct opening mechanism. The terminals 11-12 and 23-24 can be used as unlike poles.
D4BL-□D□□-□	2NC+1NC	Lock monitor / Door open/closed detection 			NC contacts 11-12, 21-22, and 31-32 have a certified direct opening mechanism. The terminals 11-12 and 21-22 can be used as unlike poles.

Note: The EN-certified direct opening mechanism is indicated by ⊖ on the Switch.

Contact Form 2NC + 2NC

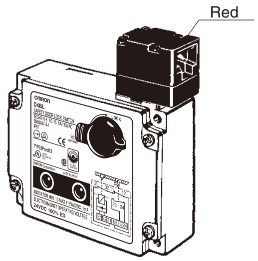


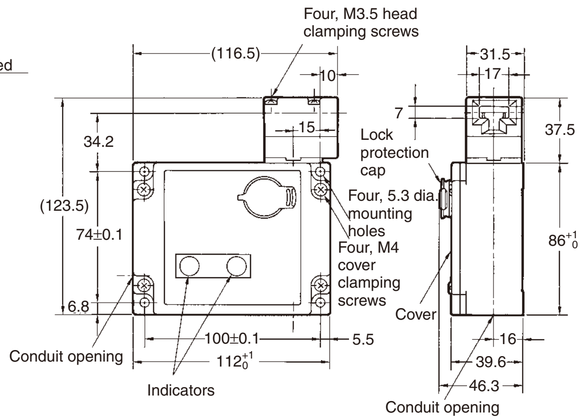
Dimensions and Operating Characteristics

(Unit: mm)

Switches

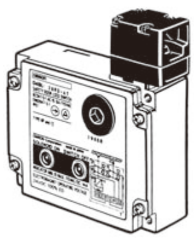
D4BL-□□□□-□

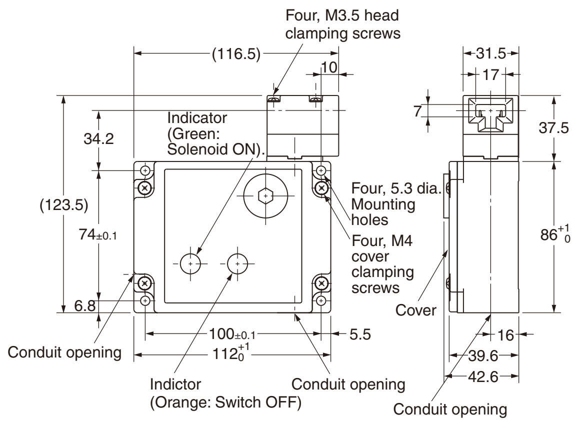




Operating Characteristics / Model	D4BL-□□□□
Key insertion force **Key extraction force**	19.61 N max. 19.61 N max.
Movement before being locked	15 mm max.
Total travel	23 mm min.

D4BL-2GRD-AT



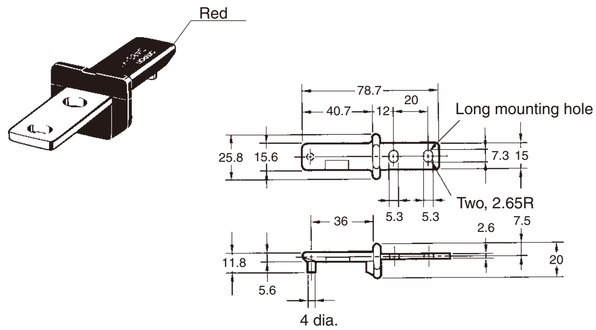


Operating Characteristics / Model	D4BL-2GRD-AT
Key insertion force **Key extraction force**	19.61 N max. 19.61 N max.
Movement before being locked	15 mm max.
Total travel	23 mm min.

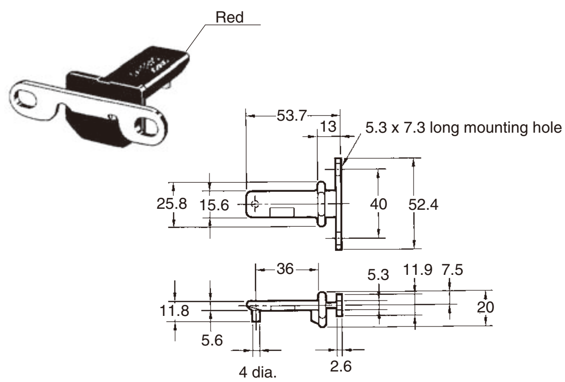
Note: 1. Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
2. There are fluctuations in the contact ON/OFF timing for 2NC contacts. Confirm performance before application.

Operation Keys

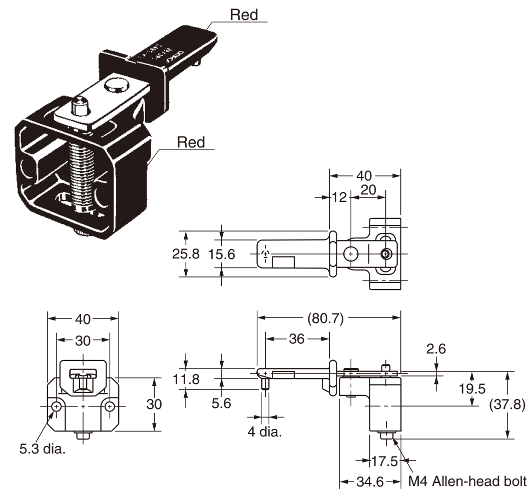
D4BL-K1



D4BL-K2

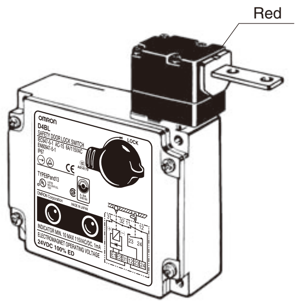


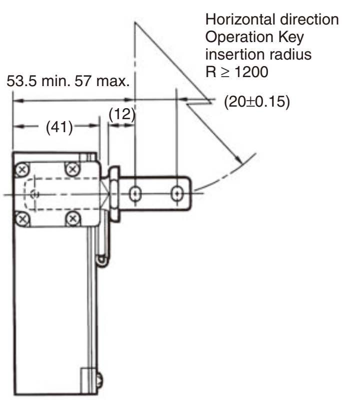
D4BL-K3

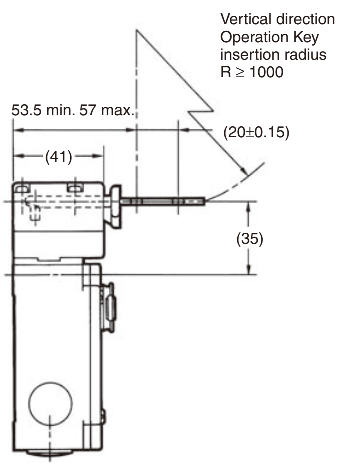


With Operation Key Inserted

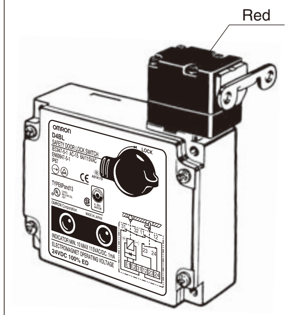
D4BL + D4BL-K1

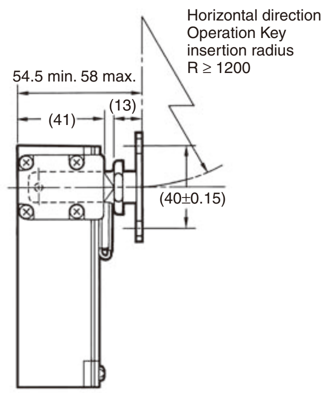


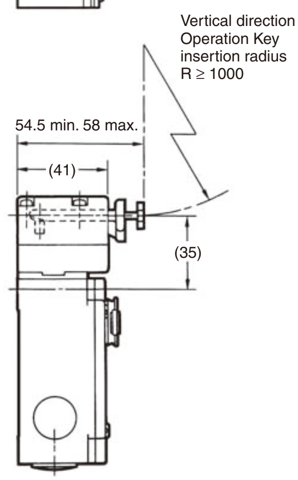




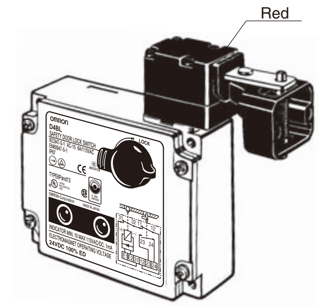
D4BL + D4BL-K2

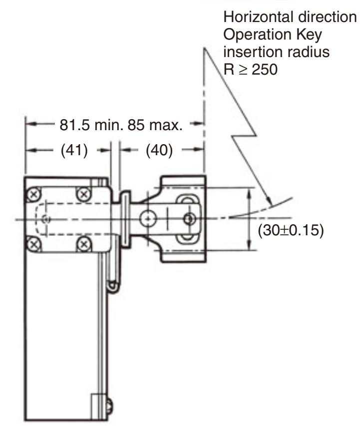


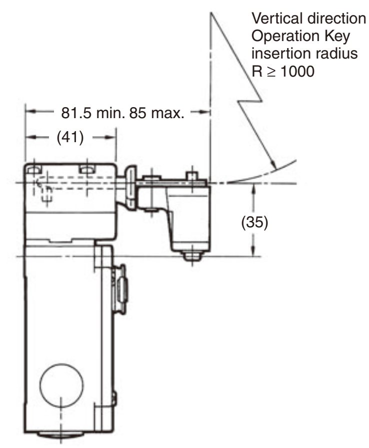




D4BL + D4BL-K3

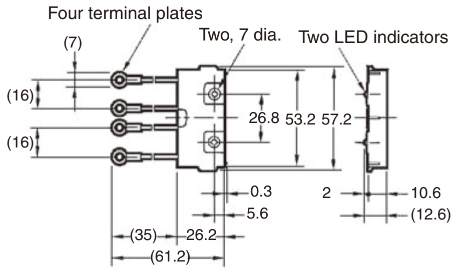






Note: 1. Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
2. In the above diagrams, the Operation Key is inserted from the front.

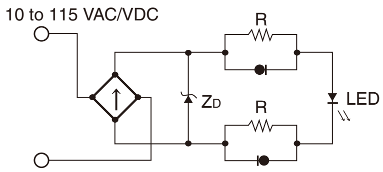
Indicator Unit



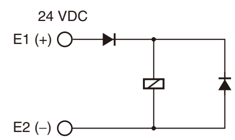
Connections

Internal Circuit Diagram

Indicator



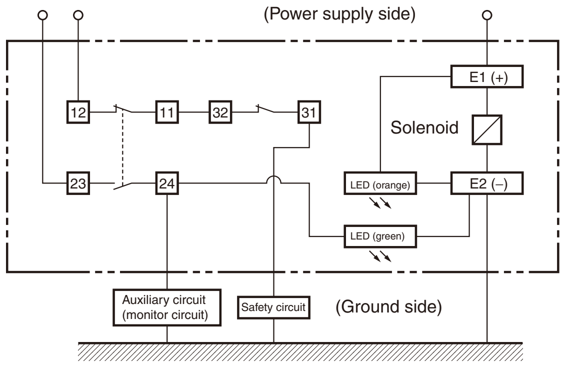
Solenoid



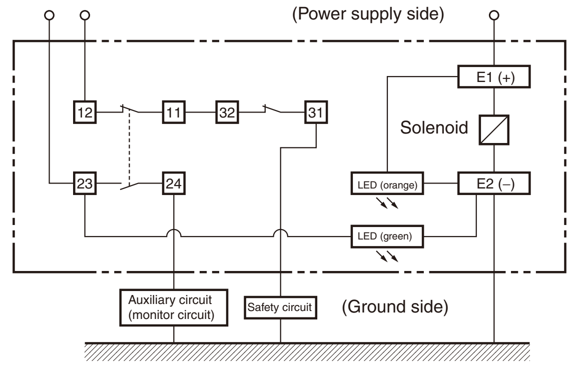
Circuit Connection Example

- Terminals 11 and 32 are connected internally and so connect terminals 12 and 31 for safety-circuit input. (GS-ET-19).
- When using indicators, connect them to the auxiliary circuit side (monitor circuit) or in parallel between E1 and E2 as shown below.
- Do not connect the indicators in parallel with the direct opening contact. If the indicators are broken, a short-circuit current may flow, causing equipment to malfunction.
- The 24 VDC solenoid terminals have polarity. Confirm the polarity before wiring.

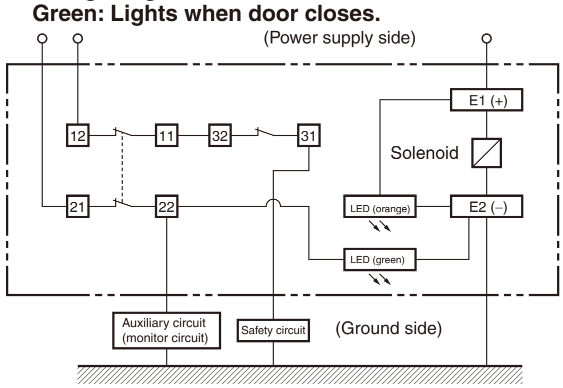
1. Orange: Lights when the solenoid turns ON.
Green: Lights when the door opens.



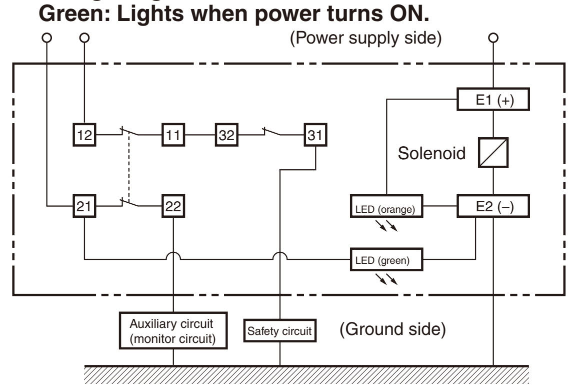
2. Orange: Lights when the solenoid turns ON.
Green: Lights when power turns ON.



3. Orange: Lights when the solenoid turns ON.
Green: Lights when door closes.

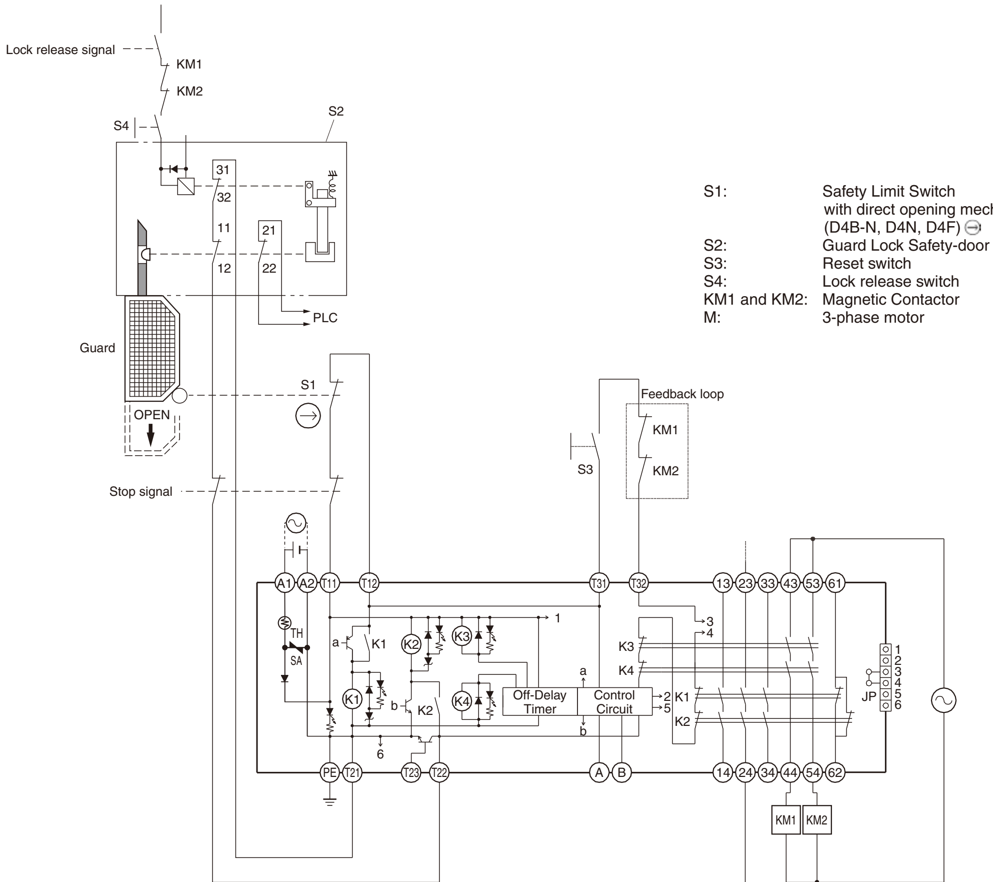


4. Orange: Lights when the solenoid turns ON.
Green: Lights when power turns ON.

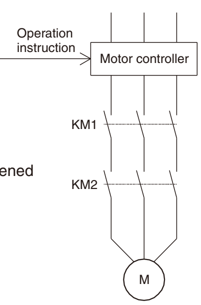


Connection Example with OMRON's G9SA Safety Relay Unit

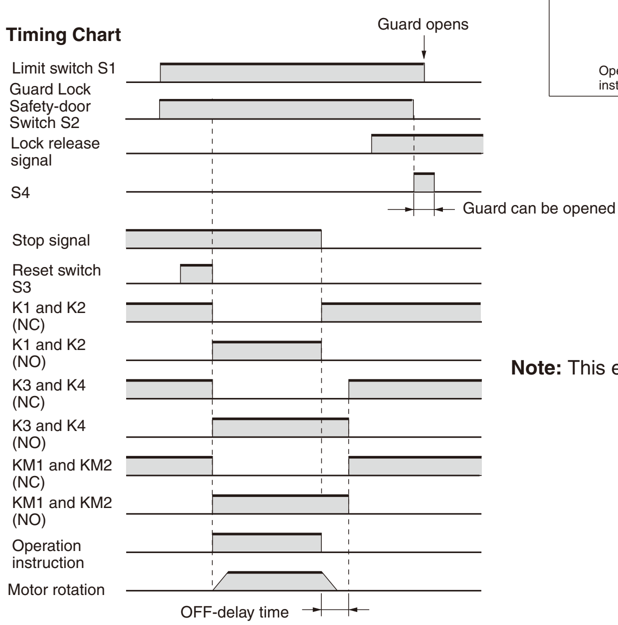
G9SA-321-T□ (24 VAC/VDC) + D4BL-□D□A-□, -□D□B-□ (Mechanical Lock Type) Circuit Diagram (Manual Reset)



S1: Safety Limit Switch with direct opening mechanism (D4B-N, D4N, D4F)
S2: Guard Lock Safety-door Switch
S3: Reset switch
S4: Lock release switch
KM1 and KM2: Magnetic Contactor
M: 3-phase motor

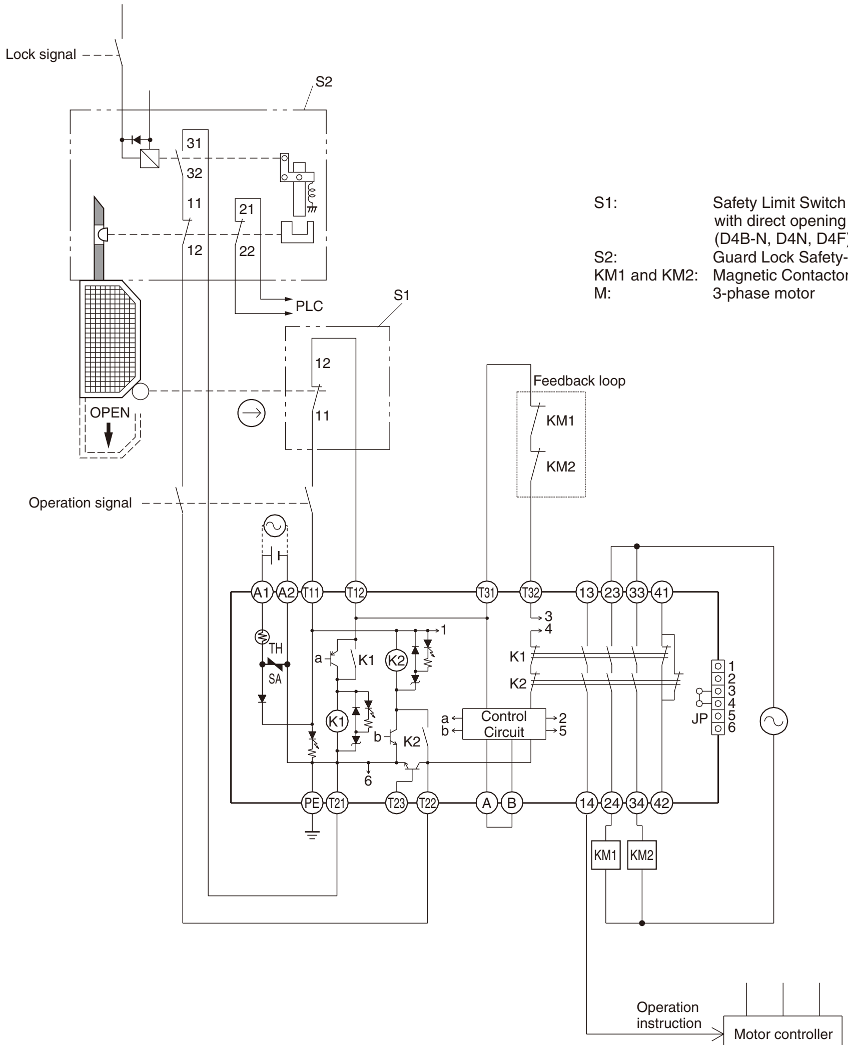


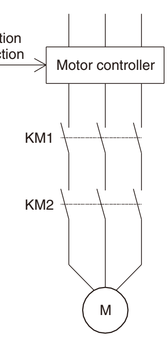
Timing Chart



Note: This example circuit is for Category 3.

G9SA-301 (24 VAC/VDC) + D4BL-□D□G-□ (Solenoid Lock Type) Circuit Diagram (Auto-reset)





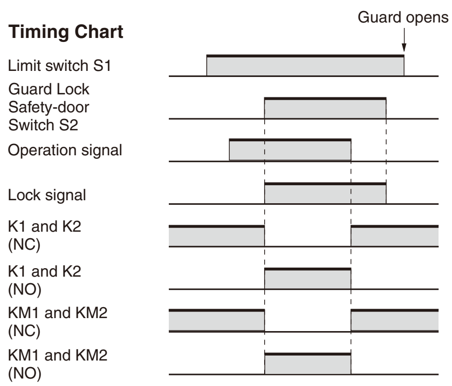
S1: Safety Limit Switch with direct opening mechanism (D4B-N, D4N, D4F)

S2: Guard Lock Safety-door Switch

KM1 and KM2: Magnetic Contactor

M: 3-phase motor

Timing Chart



Note: 1. This example circuit is for Category 4.

2. The lock can be released at any time. Therefore, do not use a model with a solenoid lock in applications where the operator may be exposed to danger when the guard opens. Use a model with a mechanical lock.

Safety Precautions

Refer to the *"Precautions for All Switches"* and *"Precautions for All Safety Door Switches"*.

⚠ DANGER

Injury may occasionally occur. Always check to make sure that the safety functions operate correctly before using the machine. The safety functions may not operate correctly because of wiring mistakes, setting mistakes, or Switch malfunction, causing some machines to continue operating in situations where they should be stopped.

Injury may occasionally occur. If the machine is used with the release key in the UNLOCK position, the electromagnetic lock may not operate, causing some machines to continue operating in situations where they should be stopped. Be sure to put the release key in the LOCK position before using the machine. Also, check the condition of the lock and safety circuits.

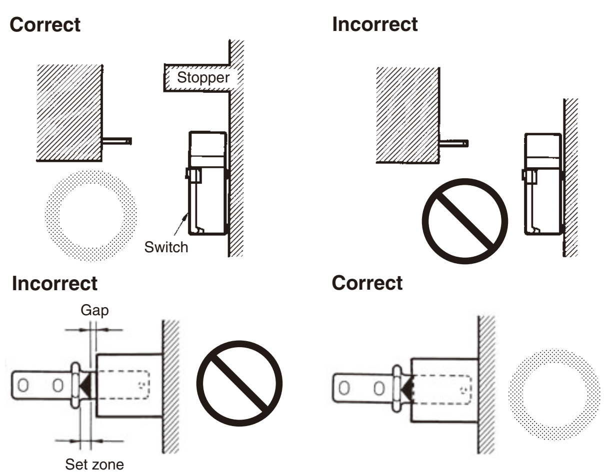
Injury may occasionally occur. When the electromagnetic lock function or Switch function is damaged, some machines may continue operating in situations where they should be stopped. Do not use the electromagnetic lock function of the Switch in place of a door lock. Always provide a lock separate from the Switch, attach a warning seal to prevent people from using excessive force to open the door when it is locked, or provide an indicator lamp to show the locked/unlocked status of the door.

Precautions for Safe Use

- Do not use the Switch submersed in oil or water or in locations continuously subject to splashes of oil or water. Doing so may result in oil or water entering the Switch. (The IP67 degree of protection of the Switch specifies the amount of water penetration after the Switch is submerged in water for a certain period of time.)
- Always attach the cover after completing wiring and before using the Switch. Also, do not turn ON the Switch with the cover open. Doing so may result in electric shock.
- Make sure the Switch is mounted securely to prevent it from falling off. Otherwise injury may result.

Stopper Installation

Do not use a Switch as a stopper. Be sure to install a stopper as shown in the following illustration when mounting the Switch so that the Operation Key is within 0.5 to 5 mm of the set zone.
Do not subject the Switch to a shock that exceeds the Switch's shock resistance of 1,000 m/s^2.



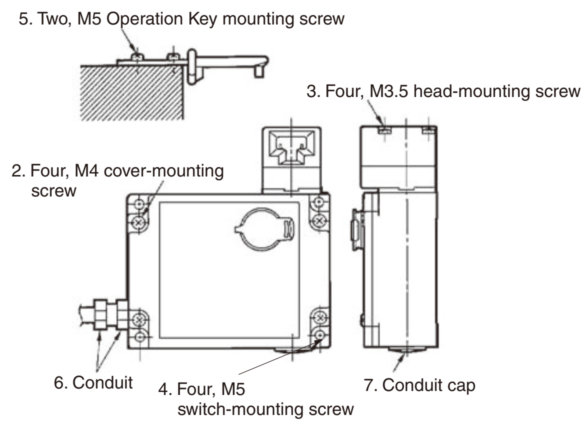
Precautions for Correct Use

Appropriate Tightening Torque

Loose screws may result in malfunction. Tighten the screws to the specified torques.

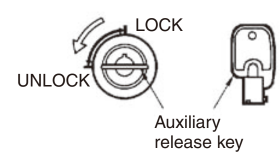
No.	Type	Appropriate tightening torque
1	M3.5 terminal screw (including terminal screw)	0.59 to 0.78 N·m
2	Cover mounting screw	1.18 to 1.37 N·m
3	Head mounting screw	0.78 to 0.98 N·m
4	M5 body mounting screw *	4.90 to 5.88 N·m
5	Operation Key mounting screw	2.35 to 2.75 N·m
6	Connector	1.77 to 2.16 N·m
7	Cap screw	1.27 to 1.67 N·m

* Use M5 screws. Apply a torque of 4.90 to 5.88 N·m for an Allen-head bolt. For a pan head screw, apply a torque of 2.35 to 2.75 N·m



Auxiliary Release Key

- The auxiliary release key is used to unlock the D4BL in case of emergency or in case the power supply to the D4BL fails.
- Use the enclosed Release Key to change the lock from LOCK to UNLOCK so that the lock will be released and the door can be opened. (Applies only to mechanical locks.)



- Whenever the lock has been changed to UNLOCK, always return it to LOCK before using the Switch.
- Do not use the auxiliary release key to start or stop machines.
- Make sure that the auxiliary release key is kept with the person in charge.
- To prevent the auxiliary release key from being handled carelessly by unauthorized people, seal the auxiliary release key with sealing wax and the provided seal cap to ensure IP67.
- Before attaching the cover to the D4BL, make sure that the auxiliary release key position is set to LOCK.

Solenoid Lock Models

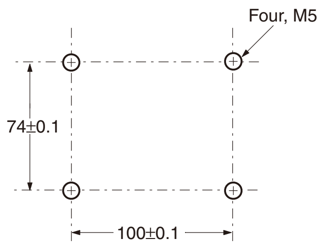
The solenoid lock locks the door only when power is supplied to the solenoid. Therefore, the door will be unlocked if the power supply to the solenoid stops. Therefore, do not use solenoid lock models for machines that may be operating and dangerous even after the machine stops operating.

Switch and Operation Key Mounting

Use four M5 screws and washers to mount the Switch and Operation Key, and tighten the screws to a suitable torque.
To ensure safety, use screws that cannot be easily removed or another means to prevent the Switch and Operation Key from easily being removed.

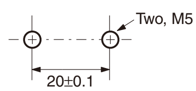
Mounting Dimensions

Switch Mounting Dimensions

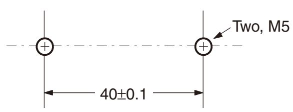


Operation Key Mounting Holes

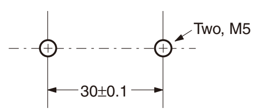
D4BL-K1



D4BL-K2



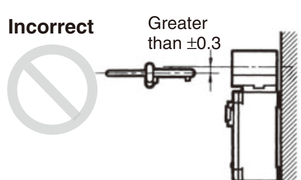
D4BL-K3



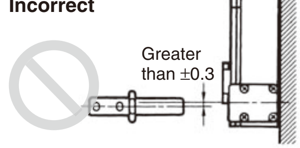
Operation Key

- The D4BL is provided with a shock-absorbing damper to protect the D4BL from damage that may result from dropping the D4BL during transportation. Be sure to remove the damper after mounting the D4BL.
- The mounting tolerance of the Operation Key is ±0.3 mm vertically or horizontally. Be sure to mount the D4BL correctly without misalignment, otherwise the D4BL may soon break or wear out.
- Observe the specified insertion radius for the Operation Key and insert it in a direction perpendicular to the key hole.

Incorrect



Incorrect

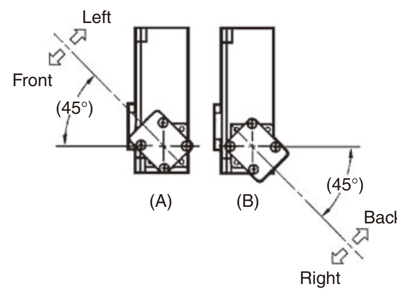


- The Operation Key for the D4BL is different from the one for the D4BS.

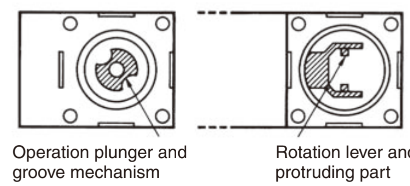
Head Direction

- The head can be mounted in four directions by loosening the four screws holding the head. To remove the head, turn the head at the surface mating with the Switch body by 45° as shown in figures (A) and (B) below.
  To change the direction of the head, make sure that the protruding part of the rotating lever engages with the groove of the plunger. Then turn the head clockwise or counterclockwise to the desired direction. At that time, make sure that the groove of the plunger is located under the rotating lever. If the direction of the head is not set when the plunger is rotated by 45°, the groove of the plunger presses the rotating lever. The head, plunger, or the built-in switch may be damaged as a result.

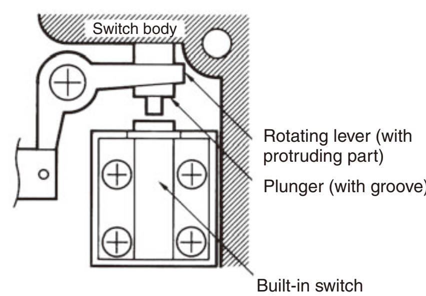
Head Direction Changes



Head Bottom View **Switch Top View**



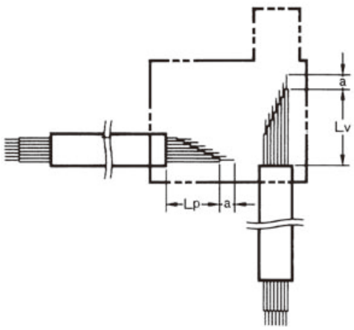
Normal Positions of Rotating Lever and Plunger



- Be sure to check the mechanical lock and solenoid release functions when mounting the D4BL.
- If the head direction is changed, recheck the tightening torque of each screw. Make sure that no foreign materials will enter through the key hole on the head.

Processing and Connecting Cable/ Conduit

- The following procedures are recommended for mounting and wiring the indicator unit securely.
- To ensure IP67, use OMRON's SC-□M and Nippon Flex's ABS-08Pg13.5 and ABS-12 Pg13.5 Connectors.
- Recommended cable: UL2464-type cable that is AWG20 to AWG18 (0.5 to 1.0 mm^2) in size and has seven conductors
- If the 1/2-14NPT is used, cover the cable and conduit end with sealing tape to ensure IP67. Tighten the connector to a torque of 1.77 to 2.16 N·m.
- Connect the indicator unit after connecting the seven-conductor cable.

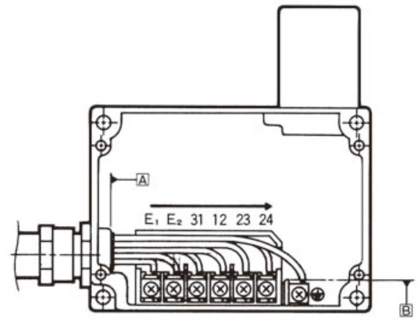


Terminal no.	Lp (mm)	Lv (mm)	a (mm)
E_1	30±2	80±2	8±1
E_2	35±2	75±2	
31	45±2	60±2	
12	55±2	50±2	
23 (21)	65±2	45±2	
24 (22)	70±2	35±2	
⏚	90±2	50±2	

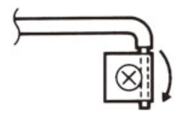
- Properly attach and securely tighten the provided conduit cap to the unused conduit opening to the suitable tightening torque when wiring the D4BL.

Cable Connection Example

1. Connect the wires to the terminals in the order shown below for wiring efficiency.

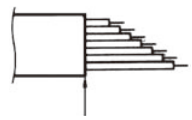


Tighten each wired terminal clockwise to a torque of 0.59 to 0.78 N·m.



Twist the wire two or three times and make sure that no bare wire exists outside the terminal when tightening the terminal.

2. The insulation sheath of the seven-conductor cable must come into contact with the wall of the conduit mouth, side A or side B.



Insulation sheath edge

Others

Do not touch the solenoid because the solenoid radiates heat while power is being supplied.

Precautions for All Safety Door Switches

Note: Refer to the *Safety Precautions* section for each Switch for specific precautions applicable to each Switch.

⚠ CAUTION

Do not insert the Operation Key when the door is open.
The machine may operate, possibly causing injury.

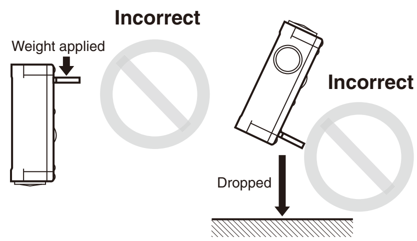
Precautions for Safe Use

- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch body is protected from the ingress of dust or water, avoid the ingress of foreign substance through the key hole on the head. Otherwise, accelerated wear, breaking, or malfunction may result.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch in a starting circuit. (Use the Switch for safety confirmation signal purposes.)
- Connect a fuse in series with the Switch to protect it from short-circuit damage. The value of the breaking current of the fuse must be calculated by multiplying the rated current by 150% to 200%.
  When using the Switch for an EN rating, use a 10 A fuse of type gI or gG that complies with IEC 60269.
- Mount the Operation Key so that it will not come into contact with persons in the area when the door is opened and closed. Injury may result.
- Do not drop the Switch. Doing so may prevent the Switch from functioning to its full capability.
- Do not under any circumstances disassemble or modify the Switch. Doing so may cause malfunction.

Precautions for Correct Use

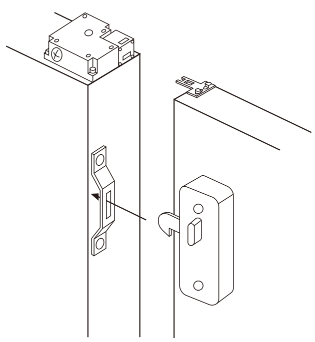
Operation Key

- Use only the designated Operation Key. The Head has been designed so that operation is not possible with a screwdriver or other tools. Using anything other than the designated Operation Key may damage the Switch or affect machine safety.
- Do not operate the Switch with anything other than the special OMRON Operation Key, otherwise the Switch may break or the safety of the system may not be maintained.
- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.



Securing the Door

If the closed door (with the Operation Key inserted) pulls the Operation Key past the operating/lock position (i.e., the set zone) because of, for example, the door's own weight, machine vibration, or the door cushion rubber, the Switch may be damaged.
Also, with a magnetic lock, it may not be possible to unlock the Switch if there is weight placed on the Operation Key. Secure the door with a stopper so that the Operation Key remains within the set zone.



Operating Environment

- Safety Door Switches are designed for use indoors. Using a Switch outdoors may damage it.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperature or high humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switch in the following locations:
  - Locations subject to severe temperature changes
  - Locations subject to high temperatures or condensation
  - Locations subject to severe vibration
  - Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - Locations where the Switch may come into contact with thinner or detergents
  - Locations where explosive or flammable gases are present

Storing Switches

Do not store Switches in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

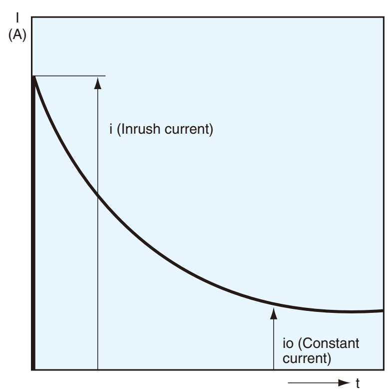
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly. If the terminal is wired incorrectly, the Switch will not function. Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

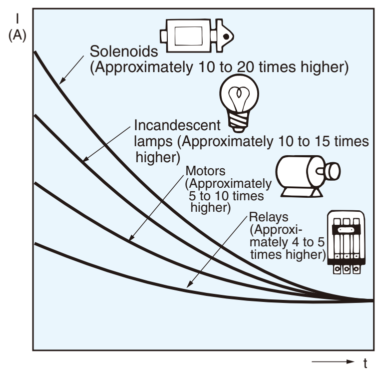
  Inductive load: A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)

  Lamp load: An inrush current 10 times higher than the normal current

  Motor load: An inrush current 6 times higher than the normal current

  1. Ambient temperature: 5°C to 35°C
  2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

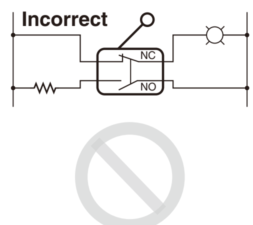
Electrical Conditions

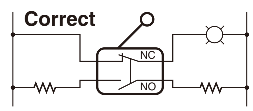
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

Connections

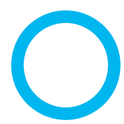
- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

Power Connection Examples
(Connection of Different Polarities)

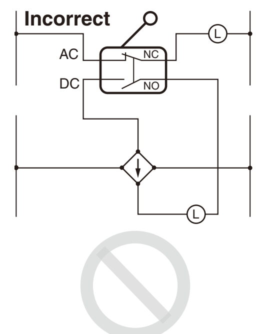




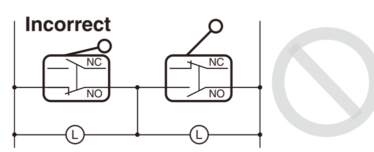
Connect the load to the same polarities.



Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

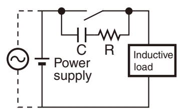
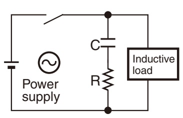
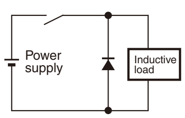
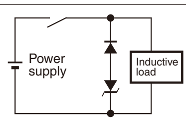
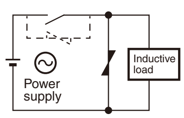


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

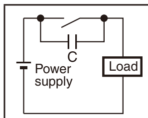
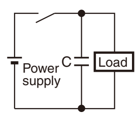
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current		Features and remarks	Element selection
		AC	DC		
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

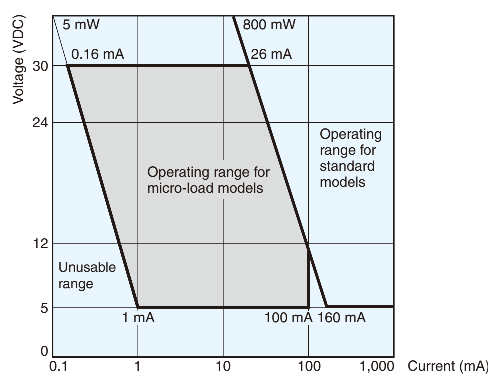
Do not use the following types of contact protection circuit.

 This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.	 This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

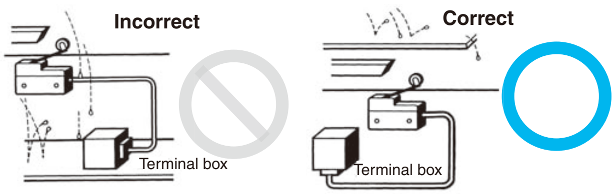
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, $\lambda_{60} = 0.5\times10^{-6}$/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

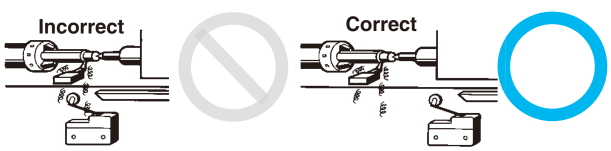


Operating Environment

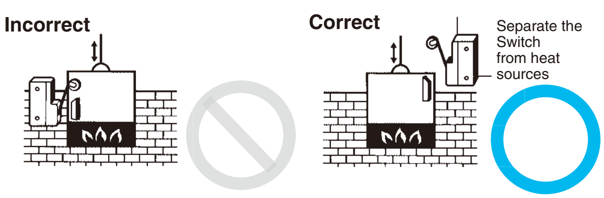
- The Switches are designed for use indoors.
  Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



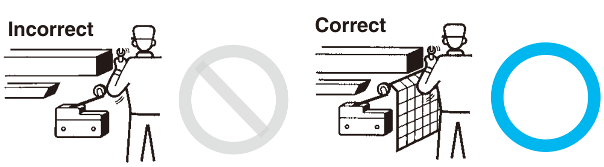
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges.
  The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog.
  If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.

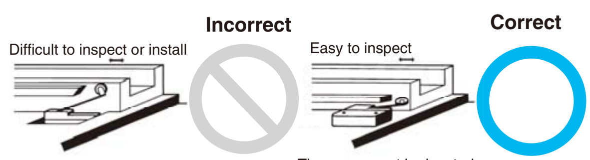


Prevent false operation

- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



The cover must be located in the direction ensuring ease of maintenance or inspection.

Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

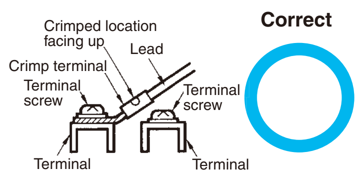
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

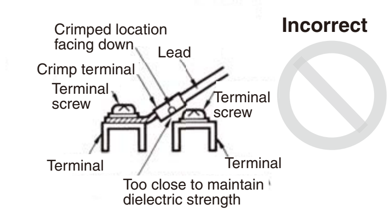
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

D4GL-mounting Slide Key

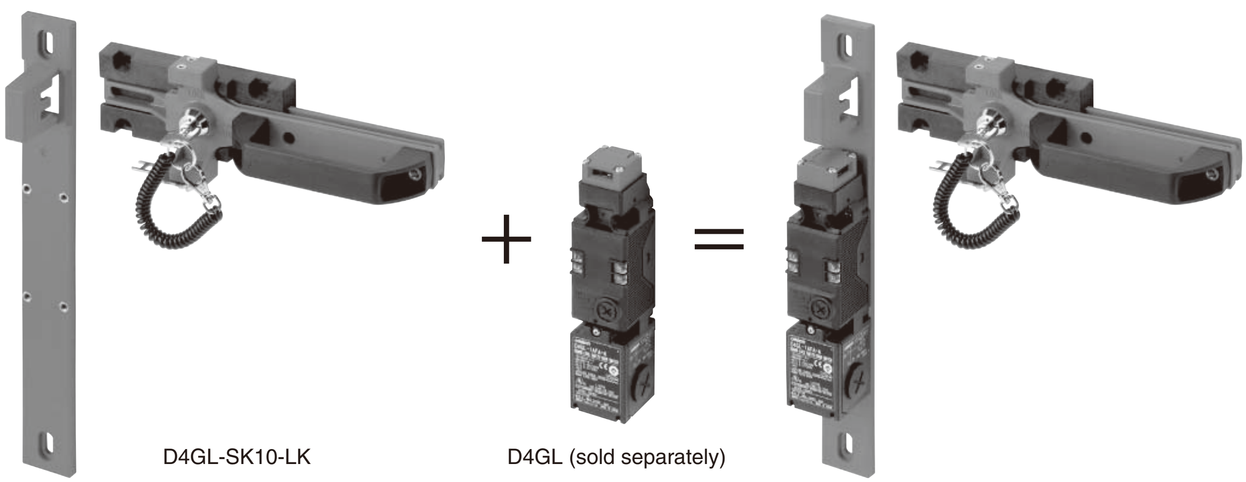
D4GL-SK10-LK

D4GL Door-mounting Accessory with Lockout Key to Prevent Workers from Becoming Trapped inside Hazardous Area

- The vertical D4GL Guard Lock Safety-door Switch can be easily mounted on 40 × 40 mm aluminum frames.
- The plastic material makes the Slide Key suitable for lightweight doors.

⚠ Be sure to read the *"Safety Precautions"* on page 5 and the *"Precautions for All Safety Door Switches"*.

Configuration



D4GL-SK10-LK + D4GL (sold separately) =

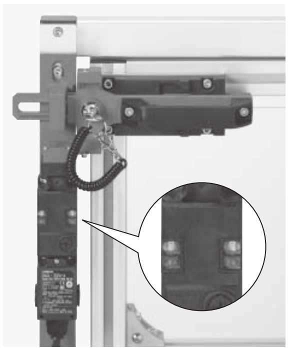
Features

The lockout key prevents workers from becoming trapped without using a padlock.

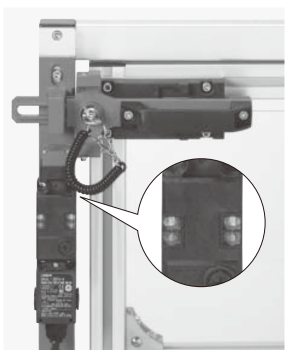
Note: Using two-color LEDs enables confirming whether the door is open or closed and locked or unlocked.

Example: D4GL-2DFA-A with mechanical lock and solenoid release

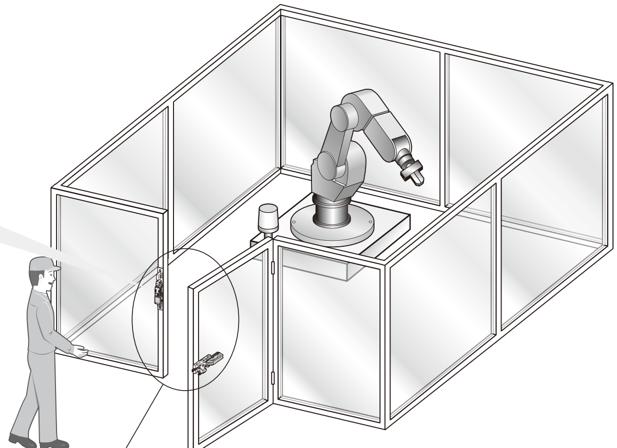
Close door. Locked (power not supplied to solenoid) The slide handle is closed.



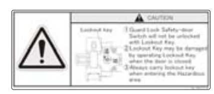
Close door. Unlocked (power supplied to solenoid) The slide handle is closed.



The slide handle can be pulled.



The handle-shaped fixture makes it easy to use the Door Switch.



Attach the supplied caution labels for display.

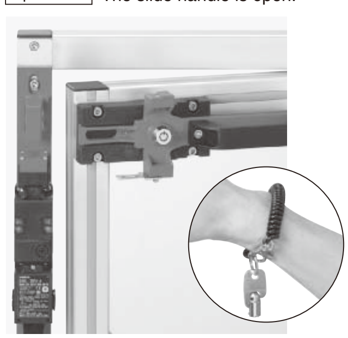
Lockout Key

- The door can be opened by supplying power to the solenoid of Guard Lock Safety-door Switch without operating the lockout switch.
- Do not turn the key as in the figure above if the slide handle is closed.

Open door. The slide handle is open.

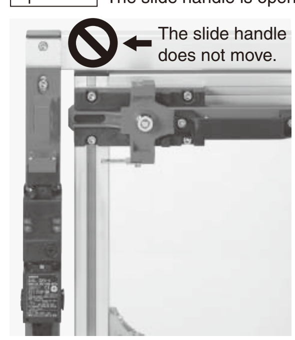
When the slide handle is open, the lockout key can be pulled regardless of whether power is being supplied to the solenoid or not.

Open door. The slide handle is open.



The slide handle is secured at the position shown in the figure.
A worker holding the lockout key will not be trapped locked inside the hazardous area by another person.

Open door. The slide handle is open.



If the lockout key is not mounted, the slide handle will not move and the door will not close.

Ordering Information

Appearance	Specifications	Contents	Model	Applicable Door Switch
	Weight: Approx. 0.6 kg Mechanical durability: 20,000 operations min.	Slide Key: 1 (not yet mounted) D4GL mounting plate: 1 Door Switch special mounting screws: 4 D4DS-K1 (operation key): 1 D4DS-K1 special mounting screws: 2 Lockout keys: 2 Lockout key strap: 1 Caution labels (stickers): 2 sheets (English and Japanese)	**D4GL-SK10-LK**	D4GL

Note: 1. The Door Switch is not included. Select the Door Switch depending on the necessary number of contacts and the conduit size.
The contents are provided as a total set, individual contents cannot be ordered separately.
2. Perform risk assessment for the equipment in question, configure relay units and other safety circuits, and use properly.

Applicable Door Switches

Guard Lock Safety-door Switch D4GL

- The two-color (orange/green) LED indicators enable checking whether the door is locked and the key is inserted.
- With gold-plated contacts used as standard, general loads and microloads are supported.

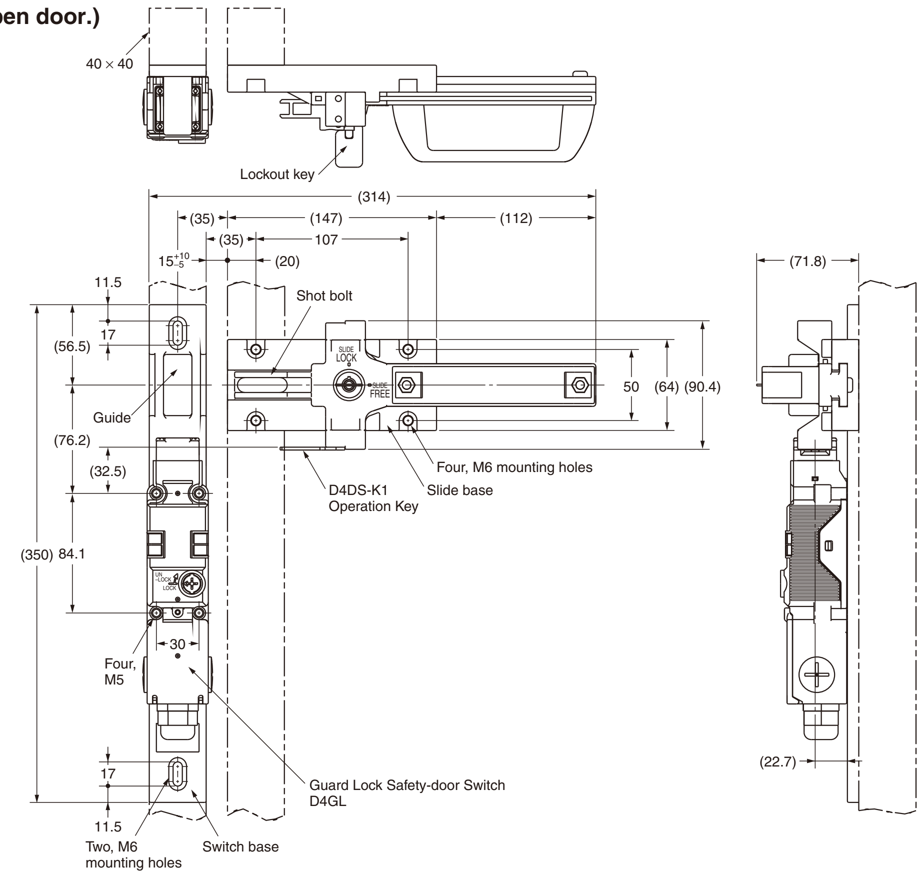
List of Models

Release key type	Solenoid voltage and indicator type	Lock and release types	Contact configuration (door open/closed detection switch and lock monitor switch contacts)	Conduit opening	Model
Standard	Solenoid: 24 VDC Orange/green LED: 24 VDC	Mechanical lock, Solenoid release	1NC/1NO+1NC/1NO	Pg13.5	**D4GL-1AFA-A**
				G1/2	**D4GL-2AFA-A**
				M20	**D4GL-4AFA-A**
			1NC/1NO+2NC	Pg13.5	**D4GL-1BFA-A**
				G1/2	**D4GL-2BFA-A**
				M20	**D4GL-4BFA-A**
			2NC+1NC/1NO	Pg13.5	**D4GL-1CFA-A**
				G1/2	**D4GL-2CFA-A**
				M20	**D4GL-4CFA-A**
			2NC+2NC	Pg13.5	**D4GL-1DFA-A**
				G1/2	**D4GL-2DFA-A**
				M20	**D4GL-4DFA-A**
			2NC/1NO+1NC/1NO	Pg13.5	**D4GL-1EFA-A**
				G1/2	**D4GL-2EFA-A**
				M20	**D4GL-4EFA-A**
			2NC/1NO+2NC	Pg13.5	**D4GL-1FFA-A**
				G1/2	**D4GL-2FFA-A**
				M20	**D4GL-4FFA-A**
			3NC+1NC/1NO	Pg13.5	**D4GL-1GFA-A**
				G1/2	**D4GL-2GFA-A**
				M20	**D4GL-4GFA-A**
			3NC+2NC	Pg13.5	**D4GL-1HFA-A**
				G1/2	**D4GL-2HFA-A**
				M20	**D4GL-4HFA-A**
		Solenoid lock, Mechanical release	1NC/1NO+1NC/1NO	Pg13.5	**D4GL-1AFG-A**
				G1/2	**D4GL-2AFG-A**
				M20	**D4GL-4AFG-A**
			1NC/1NO+2NC	Pg13.5	**D4GL-1BFG-A**
				G1/2	**D4GL-2BFG-A**
				M20	**D4GL-4BFG-A**
			2NC+1NC/1NO	Pg13.5	**D4GL-1CFG-A**
				G1/2	**D4GL-2CFG-A**
				M20	**D4GL-4CFG-A**
			2NC+2NC	Pg13.5	**D4GL-1DFG-A**
				G1/2	**D4GL-2DFG-A**
				M20	**D4GL-4DFG-A**
			2NC/1NO+1NC/1NO	Pg13.5	**D4GL-1EFG-A**
				G1/2	**D4GL-2EFG-A**
				M20	**D4GL-4EFG-A**
			2NC/1NO+2NC	Pg13.5	**D4GL-1FFG-A**
				G1/2	**D4GL-2FFG-A**
				M20	**D4GL-4FFG-A**
			3NC+1NC/1NO	Pg13.5	**D4GL-1GFG-A**
				G1/2	**D4GL-2GFG-A**
				M20	**D4GL-4GFG-A**
			3NC+2NC	Pg13.5	**D4GL-1HFG-A**
				G1/2	**D4GL-2HFG-A**
				M20	**D4GL-4HFG-A**

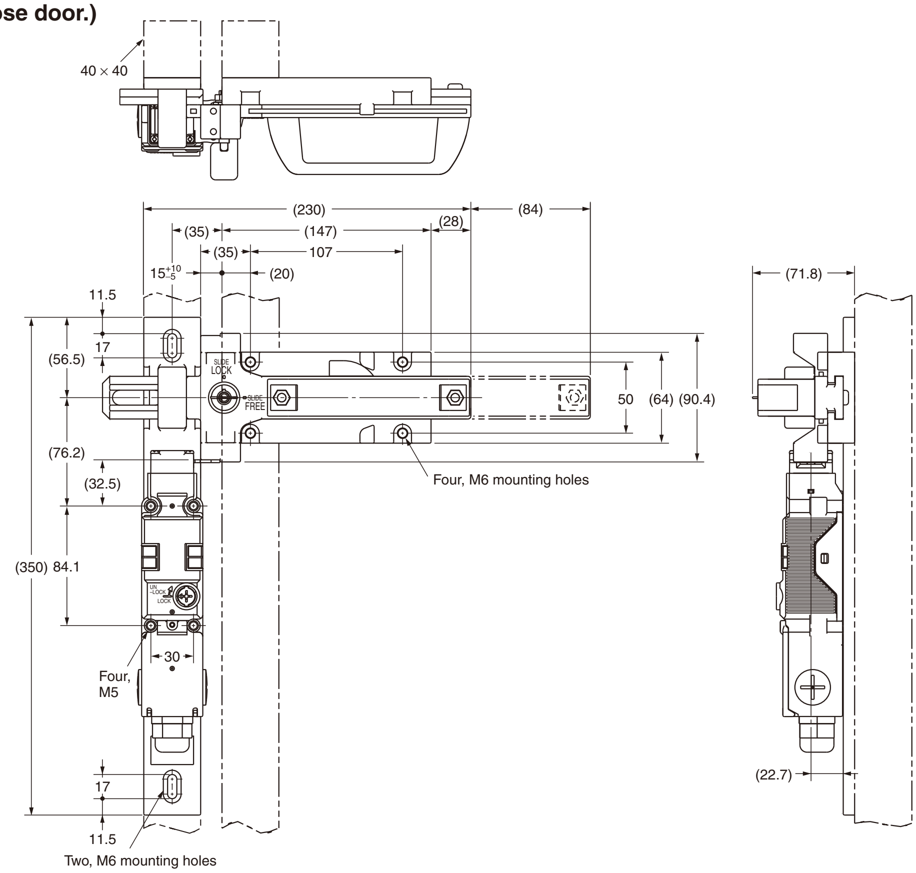
Dimensions

(Unit: mm)

D4GL-SK10-LK (Open door.)



D4GL-SK10-LK (Close door.)



Safety Precautions

Refer to the *"Precautions for All Switches"* and *"Precautions for All Safety Door Switches"*.

⚠ CAUTION

Do not use this product mounted so that it slides vertically. This may cause malfunction, resulting in personal injury.

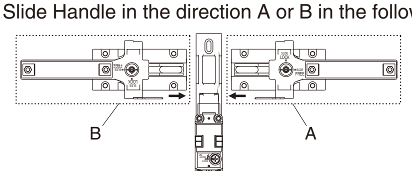
Do not insert the operation key with the door open. Devices may start to operate, resulting in injury.

Precautions for Safe Use

- Do not drop the Product. Doing so may prevent the Product from functioning to full capacity.
- Mount the Product securely to prevent it from falling. Otherwise, injury may occur.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Make sure that the gap between the shot bolt and the guide is ±0.5 mm. Otherwise, excessive wear or damage may cause malfunction.
- To ensure safety, do not operate the Switch with anything other than the Slide Key Unit.
- Your hand may be injured by being pinched between the Operation Key and Switch when closing the door with your hand on the Product.
- Be careful to avoid pinching your hand when operating the Slide Handle.
- Do not impose a force of exceeding 1 N·m when operating the Lockout Key. Otherwise, the Product may be damaged and may not operate properly.
  To prevent damage, attach the supplied labels for display near the Product.
- Do not force the slide handle to move when the lockout key is not inserted. Doing so may damage the product and make operation impossible.
- Do not force the slide handle to move when the door is locked.
- Do not close the door with the shot bolt removed. Doing so may damage the product and make operation impossible.
- Turn the Lockout Key to the "SLIDE LOCK" position and remove it when opening the door to prevent a third party from operating the Slide Handle.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations given in the performance specifications.
- The user must not maintain or repair equipment incorporating the Switch. Contact the manufacturer of the equipment for any maintenance or repairs required.
- Refer to the *D4GL Guard Lock Safety-door Switch Datasheet* and *Instruction Sheet* about storage conditions, ambient conditions, Switch details, and handling methods.

Precautions for Correct Use

- This product is for D4GL Guard Lock Safety-door Switch only. This product cannot be used with any other manufacturer's door switches.
- Use the Slide Handle in the direction A or B in the following figure.



- Loose screws may result in malfunction. Use washers and tighten the screws to the specified torques. Mount the Slide Base at four points with screws. Adding adhesive is recommended for preventing the screws from loosening.
  Also, when mounting the Product to a door for disable-prevention purposes, purchase and use tamper-resistant screws.

Appropriate Tightening Torque

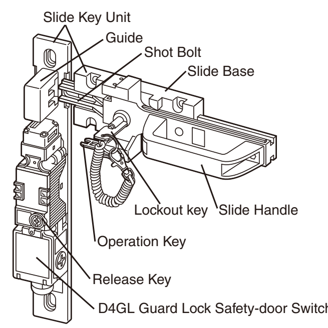
Slide Key mounting screw (M6)	6.0 to 7.0 N·m
Operation key special mounting screw (screws supplied)	2.4 to 2.8 N·m
Switch special mounting screw (screws supplied)	1.3 to 1.5 N·m

Technical Specifications

Ambient operating temperature	−10 to 55°C (with no icing)
Ambient operating humidity	95% max.
Mechanical durability	20,000 operations min.
Weight	Approx. 0.6 kg (not including D4JL Guard Lock Safety-door Switch)

- Do not store the Switch where corrosive gases (e.g., H_2S, SO_2, NH_3, HNO_3 or Cl_2) or dust is present, or in locations subject to high temperature or humidity.
- Perform maintenance inspections periodically.
- When the lockout key is attached to your wrist, be careful that the strap does not get stuck in equipment.

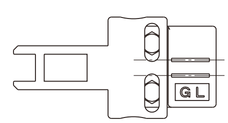
Nomenclature



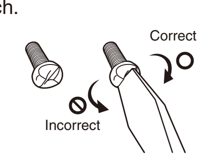
Differences between Lockout Key and Trapped Key (Reference)

	Lockout key	Trapped key (Refer to information on the D4JL-□□□A-□7-□□)
Closing the door	The door cannot be closed unless the lockout key is inserted in the slide and turned.	The door cannot be closed unless the trapped key is inserted in the Switch and turned.
Opening the door	The door can be opened by supplying power to the Switch solenoid without operating the lockout switch.	The door can never be opened without both supplying power to the Switch solenoid and operating the trapped key.

- When mounting the operation key, line up the inside edges of the long operation key holes with the outer edges of the slide handle as in the following figure to ensure easy position adjustment.



- Use the supplied special screws to mount the operation key and D4GL Guard Lock Safety-door Switch.
  To tighten the screws, use the tip of a flat-head screwdriver on the screw heads as shown in the following figure.
- The special screws cannot be removed once they are tightened.



Note: The special screws are designed so that they cannot be turned counter-clockwise using a flat-head screwdriver.

Precautions for All Safety Door Switches

Note: Refer to the *Safety Precautions* section for each Switch for specific precautions applicable to each Switch.

⚠ CAUTION

Do not insert the Operation Key when the door is open.
The machine may operate, possibly causing injury.

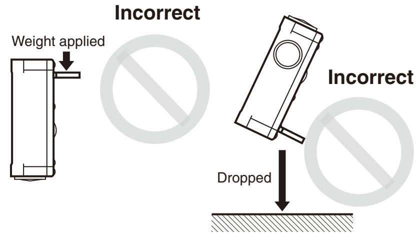
Precautions for Safe Use

- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch body is protected from the ingress of dust or water, avoid the ingress of foreign substance through the key hole on the head. Otherwise, accelerated wear, breaking, or malfunction may result.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch in a starting circuit. (Use the Switch for safety confirmation signal purposes.)
- Connect a fuse in series with the Switch to protect it from short-circuit damage. The value of the breaking current of the fuse must be calculated by multiplying the rated current by 150% to 200%.
  When using the Switch for an EN rating, use a 10 A fuse of type gI or gG that complies with IEC 60269.
- Mount the Operation Key so that it will not come into contact with persons in the area when the door is opened and closed. Injury may result.
- Do not drop the Switch. Doing so may prevent the Switch from functioning to its full capability.
- Do not under any circumstances disassemble or modify the Switch. Doing so may cause malfunction.

Precautions for Correct Use

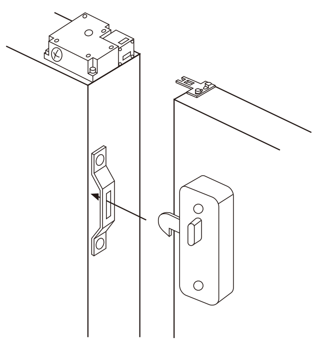
Operation Key

- Use only the designated Operation Key. The Head has been designed so that operation is not possible with a screwdriver or other tools. Using anything other than the designated Operation Key may damage the Switch or affect machine safety.
- Do not operate the Switch with anything other than the special OMRON Operation Key, otherwise the Switch may break or the safety of the system may not be maintained.
- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.



Securing the Door

If the closed door (with the Operation Key inserted) pulls the Operation Key past the operating/lock position (i.e., the set zone) because of, for example, the door's own weight, machine vibration, or the door cushion rubber, the Switch may be damaged.
Also, with a magnetic lock, it may not be possible to unlock the Switch if there is weight placed on the Operation Key. Secure the door with a stopper so that the Operation Key remains within the set zone.



Operating Environment

- Safety Door Switches are designed for use indoors. Using a Switch outdoors may damage it.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperature or high humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switch in the following locations:
  - ･Locations subject to severe temperature changes
  - ･Locations subject to high temperatures or condensation
  - ･Locations subject to severe vibration
  - ･Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - ･Locations where the Switch may come into contact with thinner or detergents
  - ･Locations where explosive or flammable gases are present

Storing Switches

Do not store Switches in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

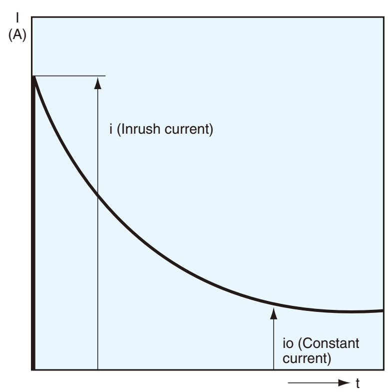
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly. If the terminal is wired incorrectly, the Switch will not function. Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

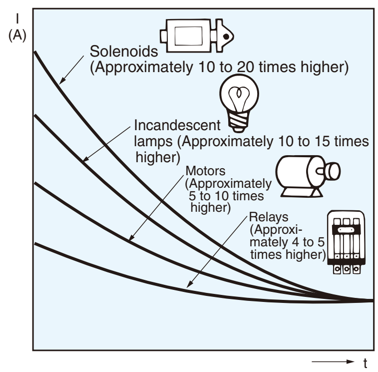
Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

Inductive load:	A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)
Lamp load:	An inrush current 10 times higher than the normal current
Motor load:	An inrush current 6 times higher than the normal current

1. Ambient temperature: 5°C to 35°C
2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

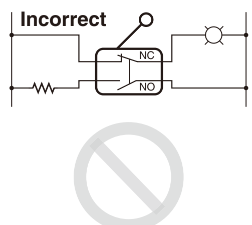
Electrical Conditions

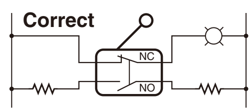
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

Connections

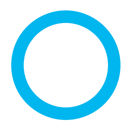
- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

Power Connection Examples
(Connection of Different Polarities)

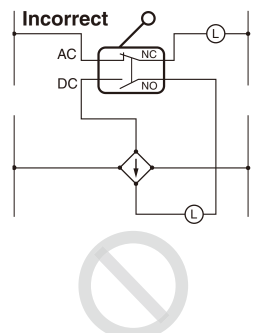




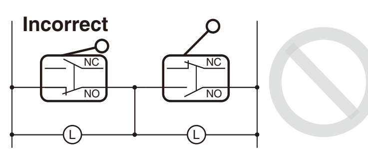
Connect the load to the same polarities.



Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

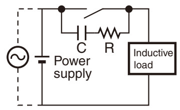
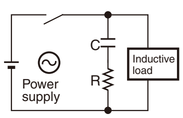
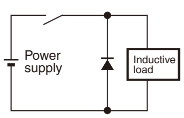
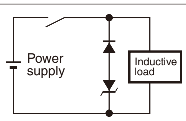
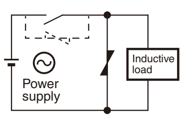


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

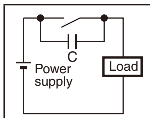
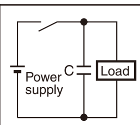
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

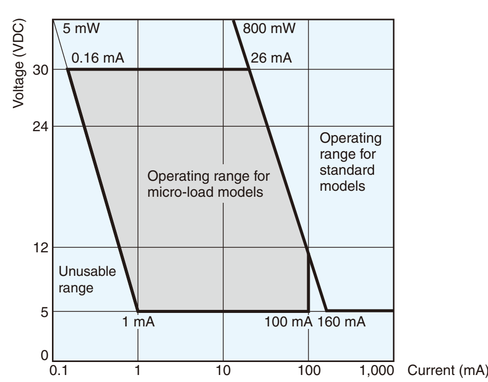
Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

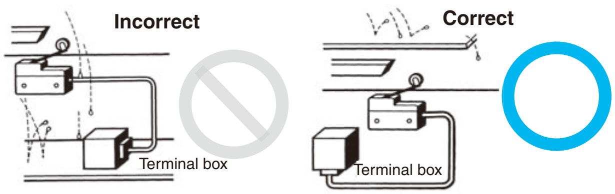
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, $\lambda_{60} = 0.5 \times 10^{-6}$/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

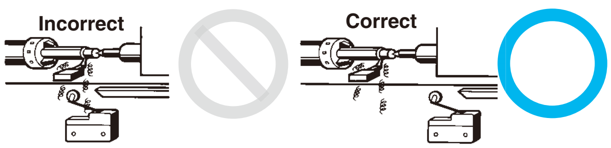


Operating Environment

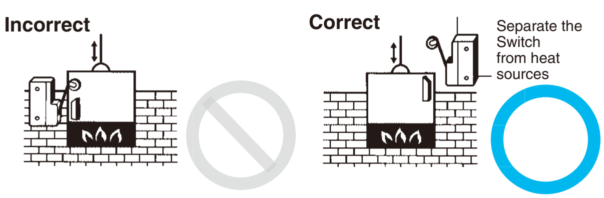
- The Switches are designed for use indoors.
  Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



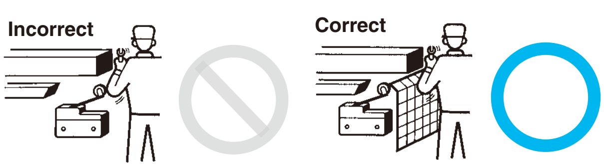
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges.
  The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog.
  If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.

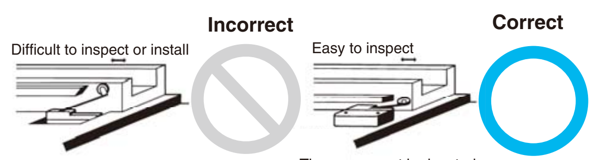


Prevent false operation

- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



The cover must be located in the direction ensuring ease of maintenance or inspection.

Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

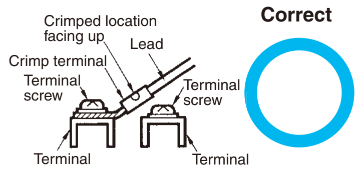
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

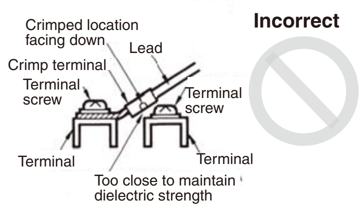
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

Guard Lock Safety-door Switch
D4JL

World's Top* Holding Force of 3,000 N

***For plastic models, as of May 2007**

■ Two safety circuits and two monitor contacts provide an array of monitoring patterns.

■ Standard gold-clad contacts enable use with ordinary loads and microloads.

■ Models with trapped keys prevent workers from being locked in hazardous work areas.

■ Models with rear release buttons allow people to unlock the Switch and escape if they are locked into hazardous areas.

■ IP67 degree of protection

⚠ Be sure to read the *"Safety Precautions"* on page 20 and the *"Precautions for All Safety Door Switches"*.

Features

Plastic Guard Lock Safety-door Switches Rank Among the Strongest in the World

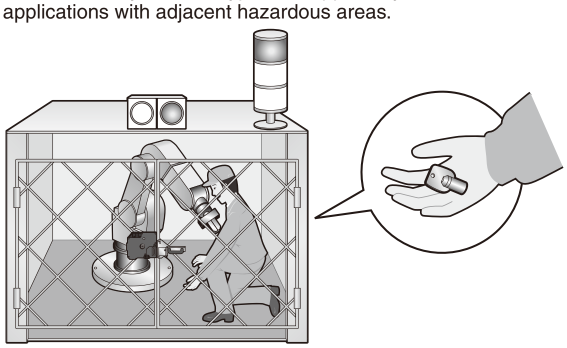
A holding force of 3,000 N makes these Switches suitable for large, heavy doors.

Models with Trapped Keys

(See page 5 for a list of models.)

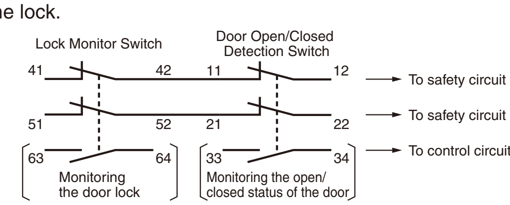
OMRON also offers Trapped Key Switches (on mechanical lock models only).
As long as a person has the trapped key when he enters a hazardous area, he does not have to worry about somebody locking the door and trapping him inside.
The door can be opened only by supplying power to the solenoid and then turning the trapped key to unlock the D4JL.

There are thirty different types of trapped keys available for use in applications with adjacent hazardous areas.



Two Safety Circuits and Two Monitor Contacts

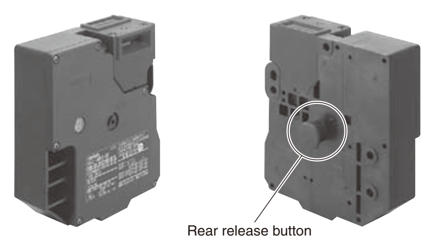
The D4JL has two safety circuits. It also has two contacts to separately monitor the open/closed status of the door and the status of the lock.

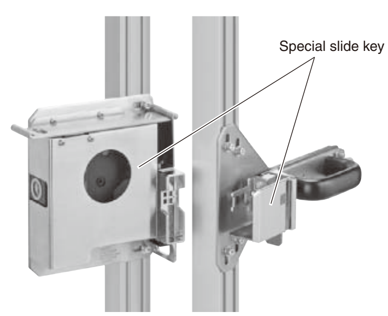


Models with Rear Release Buttons

(See page 4 for a list of models.)

A Switch with a rear release button allows the door to be unlocked from inside a hazardous area in an emergency. OMRON also offers Switches with Special Slide Keys. Refer to the *"D4NS-SK/D4JL-SK"* for details.





Model Number Structure

Model Number Legend

Switches

D4JL-□□□□-□□-□□
1 2 3 4 5 6 7

1. **Conduit Size**
   1: Pg13.5
   2: G1/2
   3: 1/2-14NPT *1
   4: M20
2. **Built-in Switch**
   N: 2NC/1NO + 2NC/1NO (slow-action contacts)
   P: 2NC/1NO + 3NC (slow-action contacts)
   Q: 3NC + 2NC/1NO (slow-action contacts)
   R: 3NC + 3NC (slow-action contacts)
3. **Head Material**
   F: Plastic
4. **Door Lock and Release**
   A: Mechanical lock/24 VDC solenoid release
   G: 24 VDC Solenoid lock/Mechanical release
5. **Indicator**
   C: 24 VDC (green LED indicator)
   D: 24 VDC (orange LED indicator)
6. **Release Key Type**
   5: Special release key. *2
   6: Special release key + rear release button. *2
   7: Trapped key
7. **Trapped Key Type**
   01 to 30: 30 types *3

Operation Keys

D4JL-K□
1

1. **Operation Key Type**
   1: Horizontal mounting
   2: Vertical mounting

Note: A 24 VDC solenoid lock cannot be combined with a trapped key.
A 24 VDC solenoid lock cannot be combined with a special release key and rear release button.

*1. Models with M20 conduits come with an M20 to 1/2-14NPT Adaptor.
*2. Release keys are provided.
*3. Thirty types of trapped keys can be manufactured. Specify the trapped key type in numerical order starting from 01 when ordering.

Ordering Information

Switches (Operation Keys are sold separately.)

Standard Models

(shaded) : Models with certified direct opening contacts.

Release key type	Indicator	Lock and release types	Contact configuration (door open/closed detection switch and lock monitor switch contacts)	Conduit opening	Model
Special release key	Green	Mechanical lock Solenoid release	2NC/1NO+2NC/1NO	PG13.5	D4JL-1NFA-C5
				G1/2	D4JL-2NFA-C5
				1/2-14NPT	D4JL-3NFA-C5
				M20	D4JL-4NFA-C5
			2NC/1NO+3NC	PG13.5	D4JL-1PFA-C5
				G1/2	D4JL-2PFA-C5
				1/2-14NPT	D4JL-3PFA-C5
				M20	D4JL-4PFA-C5
			3NC+2NC/1NO	PG13.5	D4JL-1QFA-C5
				G1/2	D4JL-2QFA-C5
				1/2-14NPT	D4JL-3QFA-C5
				M20	D4JL-4QFA-C5
			3NC+3NC	PG13.5	D4JL-1RFA-C5
				G1/2	D4JL-2RFA-C5
				1/2-14NPT	D4JL-3RFA-C5
				M20	D4JL-4RFA-C5
		Solenoid lock Mechanical release	2NC/1NO+2NC/1NO	PG13.5	D4JL-1NFG-C5
				G1/2	D4JL-2NFG-C5
				1/2-14NPT	D4JL-3NFG-C5
				M20	D4JL-4NFG-C5
			2NC/1NO+3NC	PG13.5	D4JL-1PFG-C5
				G1/2	D4JL-2PFG-C5
				1/2-14NPT	D4JL-3PFG-C5
				M20	D4JL-4PFG-C5
			3NC+2NC/1NO	PG13.5	D4JL-1QFG-C5
				G1/2	D4JL-2QFG-C5
				1/2-14NPT	D4JL-3QFG-C5
				M20	D4JL-4QFG-C5
			3NC+3NC	PG13.5	D4JL-1RFG-C5
				G1/2	D4JL-2RFG-C5
				1/2-14NPT	D4JL-3RFG-C5
				M20	D4JL-4RFG-C5
	Orange	Mechanical lock Solenoid release	2NC/1NO+2NC/1NO	PG13.5	D4JL-1NFA-D5
				G1/2	D4JL-2NFA-D5
				1/2-14NPT	D4JL-3NFA-D5
				M20	D4JL-4NFA-D5
			2NC/1NO+3NC	PG13.5	D4JL-1PFA-D5
				G1/2	D4JL-2PFA-D5
				1/2-14NPT	D4JL-3PFA-D5
				M20	D4JL-4PFA-D5
			3NC+2NC/1NO	PG13.5	D4JL-1QFA-D5
				G1/2	D4JL-2QFA-D5
				1/2-14NPT	D4JL-3QFA-D5
				M20	D4JL-4QFA-D5
			3NC+3NC	PG13.5	D4JL-1RFA-D5
				G1/2	D4JL-2RFA-D5
				1/2-14NPT	D4JL-3RFA-D5
				M20	D4JL-4RFA-D5
		Solenoid lock Mechanical release	2NC/1NO+2NC/1NO	PG13.5	D4JL-1NFG-D5
				G1/2	D4JL-2NFG-D5
				1/2-14NPT	D4JL-3NFG-D5
				M20	D4JL-4NFG-D5
			2NC/1NO+3NC	PG13.5	D4JL-1PFG-D5
				G1/2	D4JL-2PFG-D5
				1/2-14NPT	D4JL-3PFG-D5
				M20	D4JL-4PFG-D5
			3NC+2NC/1NO	PG13.5	D4JL-1QFG-D5
				G1/2	D4JL-2QFG-D5
				1/2-14NPT	D4JL-3QFG-D5
				M20	D4JL-4QFG-D5
			3NC+3NC	PG13.5	D4JL-1RFG-D5
				G1/2	D4JL-2RFG-D5
				1/2-14NPT	D4JL-3RFG-D5
				M20	D4JL-4RFG-D5

Models with Rear Release Buttons

: Models with certified direct opening contacts.

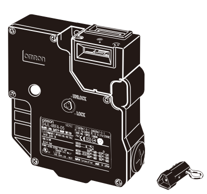
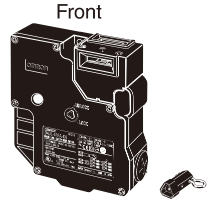
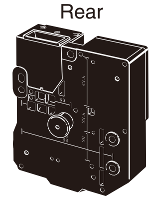
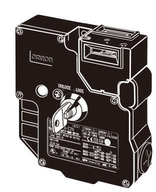
Release key type	Indicator	Lock and release types	Contact configuration (door open/closed detection switch and lock monitor switch contacts)	Conduit opening	Model
Special release key	Green	Mechanical lock Solenoid release	2NC/1NO+2NC/1NO	PG13.5	**D4JL-1NFA-C6**
				G1/2	**D4JL-2NFA-C6**
				1/2-14NPT	**D4JL-3NFA-C6**
				M20	**D4JL-4NFA-C6**
			2NC/1NO+3NC	PG13.5	**D4JL-1PFA-C6**
				G1/2	**D4JL-2PFA-C6**
				1/2-14NPT	**D4JL-3PFA-C6**
				M20	**D4JL-4PFA-C6**
			3NC+2NC/1NO	PG13.5	**D4JL-1QFA-C6**
				G1/2	**D4JL-2QFA-C6**
				1/2-14NPT	**D4JL-3QFA-C6**
				M20	**D4JL-4QFA-C6**
			3NC+3NC	PG13.5	**D4JL-1RFA-C6**
				G1/2	**D4JL-2RFA-C6**
				1/2-14NPT	**D4JL-3RFA-C6**
				M20	**D4JL-4RFA-C6**
	Orange		2NC/1NO+2NC/1NO	PG13.5	**D4JL-1NFA-D6**
				G1/2	**D4JL-2NFA-D6**
				1/2-14NPT	**D4JL-3NFA-D6**
				M20	**D4JL-4NFA-D6**
			2NC/1NO+3NC	PG13.5	**D4JL-1PFA-D6**
				G1/2	**D4JL-2PFA-D6**
				1/2-14NPT	**D4JL-3PFA-D6**
				M20	**D4JL-4PFA-D6**
			3NC+2NC/1NO	PG13.5	**D4JL-1QFA-D6**
				G1/2	**D4JL-2QFA-D6**
				1/2-14NPT	**D4JL-3QFA-D6**
				M20	**D4JL-4QFA-D6**
			3NC+3NC	PG13.5	**D4JL-1RFA-D6**
				G1/2	**D4JL-2RFA-D6**
				1/2-14NPT	**D4JL-3RFA-D6**
				M20	**D4JL-4RFA-D6**

Models with Trapped Keys

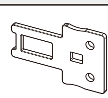
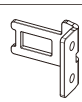
: Models with certified direct opening contacts.

Release key type	Indicator	Lock and release types	Contact configuration (door open/closed detection switch and lock monitor switch contacts)	Conduit opening	Model
Trapped key *1	Green	Mechanical lock Solenoid release	2NC/1NO+2NC/1NO	PG13.5	D4JL-1NFA-C7-01
				G1/2	D4JL-2NFA-C7-01
				1/2-14NPT	D4JL-3NFA-C7-01
				M20	D4JL-4NFA-C7-01
			2NC/1NO+3NC	PG13.5	D4JL-1PFA-C7-01
				G1/2	D4JL-2PFA-C7-01
				1/2-14NPT	D4JL-3PFA-C7-01
				M20	D4JL-4PFA-C7-01
			3NC+2NC/1NO	PG13.5	D4JL-1QFA-C7-01
				G1/2	D4JL-2QFA-C7-01
				1/2-14NPT	D4JL-3QFA-C7-01
				M20	D4JL-4QFA-C7-01
			3NC+3NC	PG13.5	D4JL-1RFA-C7-01
				G1/2	D4JL-2RFA-C7-01
				1/2-14NPT	D4JL-3RFA-C7-01
				M20	D4JL-4RFA-C7-01
	Orange		2NC/1NO+2NC/1NO	PG13.5	D4JL-1NFA-D7-01
				G1/2	D4JL-2NFA-D7-01 *2
				1/2-14NPT	D4JL-3NFA-D7-01
				M20	D4JL-4NFA-D7-01
			2NC/1NO+3NC	PG13.5	D4JL-1PFA-D7-01
				G1/2	D4JL-2PFA-D7-01 *2
				1/2-14NPT	D4JL-3PFA-D7-01
				M20	D4JL-4PFA-D7-01
			3NC+2NC/1NO	PG13.5	D4JL-1QFA-D7-01
				G1/2	D4JL-2QFA-D7-01 *2
				1/2-14NPT	D4JL-3QFA-D7-01
				M20	D4JL-4QFA-D7-01
			3NC+3NC	PG13.5	D4JL-1RFA-D7-01
				G1/2	D4JL-2RFA-D7-01 *2
				1/2-14NPT	D4JL-3RFA-D7-01
				M20	D4JL-4RFA-D7-01

*1. Thirty types of trapped keys can be manufactured. Specify the trapped key type in numerical order starting from 01 when ordering.
*2. Models with Korean S-mark certification.

Release key position	Front	Front and rear release button	Front
Release key type	**Special release key**	**Special release key**	**Trapped key**
Switch appearance		Front  Rear 	

Operation Keys

Type	Model
Horizontal mounting 	**D4JL-K1**
Vertical mounting 	**D4JL-K2**

Specifications

Standards and EC Directives

Conforms to the following EC Directives:

- Machinery Directive
- Low Voltage Directive
- EN 1088
- EN 60204-1
- GS-ET-19
- CCC

Certified Standards

Certification body	Standard	File No.
TÜV Product Service	EN 60947-5-1 (certified direct opening)	Consult your OMRON representative for details.
UL *1	UL 508, CSA C22.2 No.14	
CQC (CCC)	GB14048.5	2005010305167533
KOSHA *2	EN60947-5-1	2005-196

*1. CSA C22.2 No. 14 was certified by UL.
*2. Only certain models have been certified.

Certified Standard Ratings

TÜV (EN 60947-5-1)

Item Utilization category	AC-15	DC-13
Rated operating current (Ie)	3 A	0.27 A
Rated operating voltage (Ue)	240 V	250 V

Note: Use a 10 A fuse type gI or gG that conforms to IEC 60269 as a short-circuit protection device. This fuse is not built into the Switch.

UL/CSA (UL 508, CSA C22.2 No. 14)

A300

Rated voltage	Carry current	Current (A)		Volt-amperes (VA)	
		Make	Break	Make	Break
120 VAC	10 A	60	6	7,200	720
240 VAC		30	3		

Q300

Rated voltage	Carry current	Current (A)		Volt-amperes (VA)	
		Make	Break	Make	Break
125 VDC	2.5 A	0.55	0.55	69	69
250 VDC		0.27	0.27		

Solenoid Coil Characteristics

Item Type	24 VDC
Rated operating voltage (100% ED)	24 VDC $^{+10\%}_{-15\%}$
Current consumption	Approx. 200 mA
Insulation Class	Class F (130°C max.)

Indicator Characteristics

Item Type	LED	
Rated voltage	24 VDC	24 VDC
Current consumption	Approx. 1 mA	Approx. 8 mA
Color (LED)	Orange	Green

Characteristics

Degree of protection *1		IP67 (EN60947-5-1)
Durability *2	Mechanical	1,000,000 operations min. (trapped key: 10,000 operations min., rear release button: 3,000 operations min.)
	Electrical	500,000 operations min. (3 A resistive load at 250 VAC) *3
Operating speed		0.05 to 0.5 m/s
Operating frequency		30 operations/minute max.
Direct opening force *4		60 N min. (EN60947-5-1)
Direct opening travel *4		15 mm min. (EN60947-5-1)
Holding force *5		3,000 N min.
Contact resistance		25 mΩ max. (per contact)
Minimum applicable load *6		1 mA resistive load at 5 VDC (N-level reference value)
Rated insulation voltage (U_i)		300 V (EN60947-5-1)
Rated frequency		50/60 Hz
Protection against electric shock		Class II (double insulation)
Pollution degree (operating environment)		3 (EN60947-5-1)
Impulse withstand voltage (EN60947-5-1)	Between terminals of same polarity	2.5 kV
	Between terminals of different polarity	4 kV
	Between other terminals and non-current carrying metallic parts.	6 kV
Insulation resistance		100 MΩ min. (at 500 VDC)
Contact gap		2 × 2 mm min.
Vibration resistance	Malfunction	10 to 55 Hz, 0.75 mm single amplitude
Shock resistance	Destruction	1,000 m/s^2 min.
	Malfunction	80 m/s^2 min.
Conditional short-circuit current		100 A (EN60947-5-1) *7
Conventional free air thermal current (I_{th})		10 A (between terminals 12 and 41), 3 A (between all other terminals) (EN60947-5-1)
Ambient operating temperature		−10 to +55°C (with no icing)
Ambient operating humidity		95% max.
Weight		Approx. 650 g (D4JL-4NFA-C7-01)

Note: The above values are initial values.

*1. The degree of protection is tested using the method specified by the standard (EN60947-5-1). Confirm that sealing properties are sufficient for the operating conditions and environment beforehand. Although the switch box is protected from dust or water penetration, do not use the D4JL in places where foreign material may enter through the key hole on the head, otherwise Switch damage or malfunctioning may occur.

*2. The durability is for an ambient temperature of 5 to 35°C and an ambient humidity of 40% to 70%. For further conditions, consult your OMRON sales representative.

*3. Do not pass a 3 A, 250 VAC load through more than two circuits.

*4. These figures are minimum requirements for safe operation.

*5. This figure is based on the GS-ET-19 evaluation method.

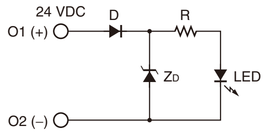
*6. This value will vary with the switching frequency, environment, and reliability level. Confirm that correct operation is possible with the actual load beforehand.

*7. Use a 10 A fuse type gI or gG that conforms to IEC 60269 as a short-circuit protection device.

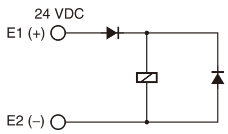
Connections

Internal Circuit Diagram

Indicator



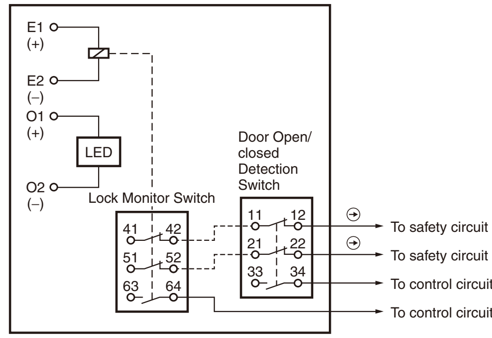
Solenoid



Circuit Connection Example

(Examples for the D4JL-□NF□-□)

- Terminals 11-42 and terminals 21-52 are connected internally and so connect terminals 12-41 and 22-51 for safety-circuit input (GS-ET-19).



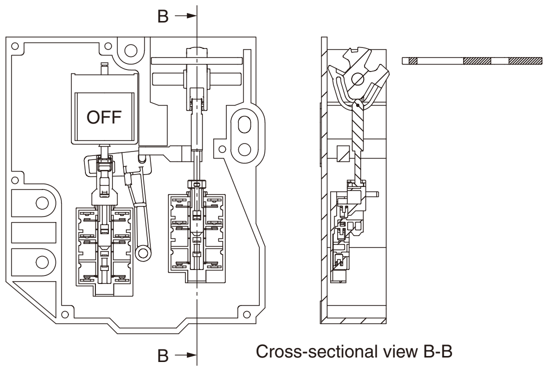
- Direct opening contacts used as safety-circuit input are indicated with the ⊖ mark.
  Terminals 11-12 and terminals 21-22 are direct opening contacts.
- Do not connect the indicator directly to direct opening contacts. If indicator is connected in parallel with direct opening contacts, a short-circuit current may flow in the event that the indicator is damaged, causing equipment to malfunction.
- Do not switch standard loads for more than 2 circuits at the same time. Otherwise, the level of insulation may decrease.
- The solenoid terminals have polarity (E1: + and E2: –). Confirm the polarity before wiring.

Operation Method

Operation Principles

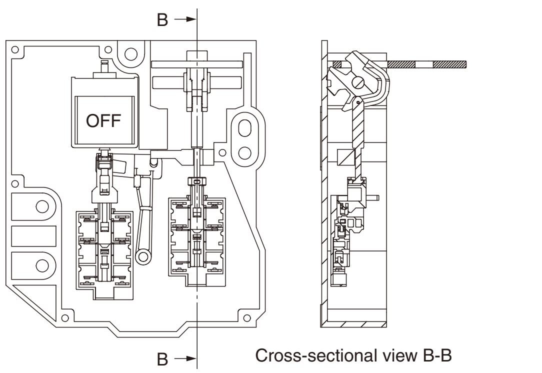
Mechanical Lock Models

Operation Key removed.



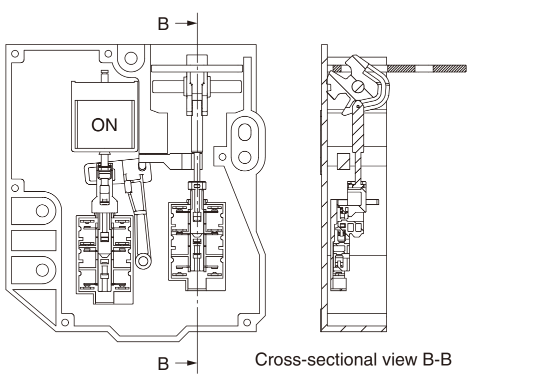
Cross-sectional view B-B

Operation Key inserted: Door locked.



Cross-sectional view B-B

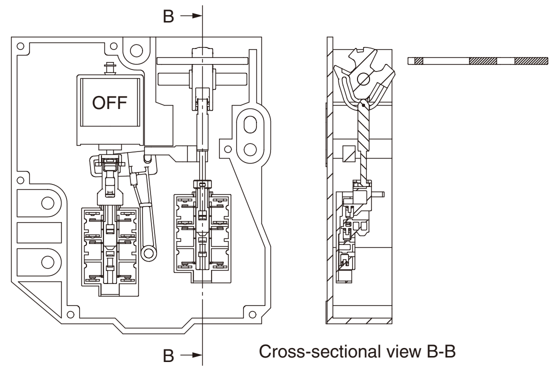
Solenoid ON: Door unlocked.



Cross-sectional view B-B

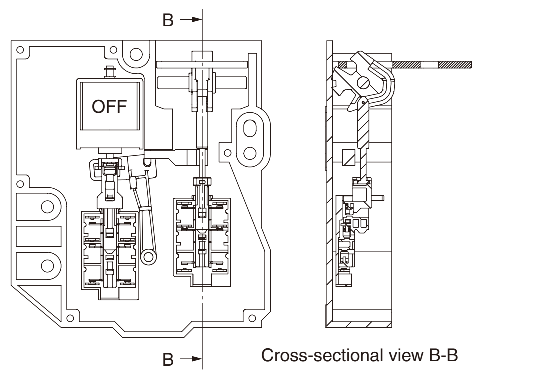
Solenoid Lock Models

Operation Key removed.



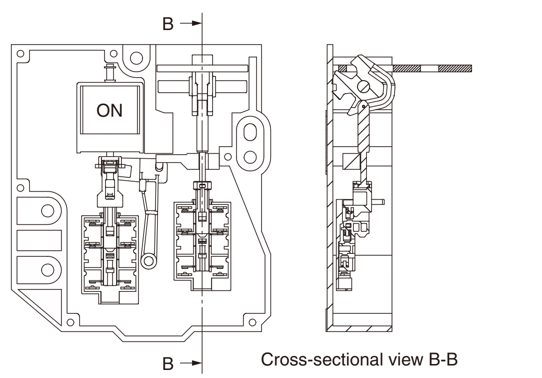
Cross-sectional view B-B

Operation Key inserted: Door unlocked.



Cross-sectional view B-B

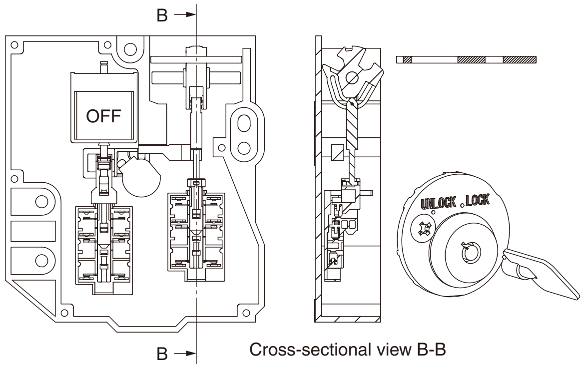
Solenoid ON: Door locked.



Cross-sectional view B-B

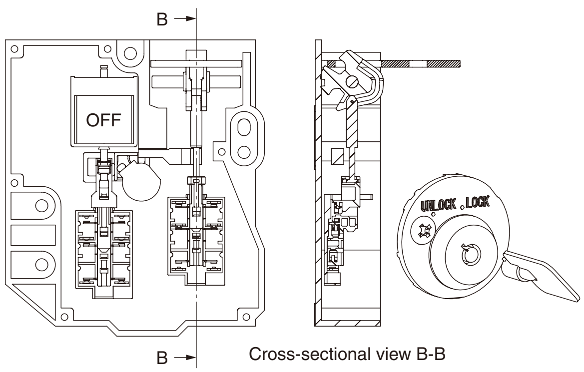
Trapped Key Models

(1) Operation Key removed, solenoid OFF, and trapped key removed.



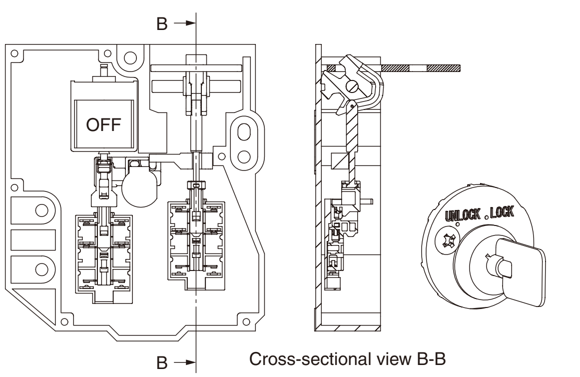
Cross-sectional view B-B

(2) Operation Key inserted, solenoid OFF, and trapped key removed. Status: Door unlocked.



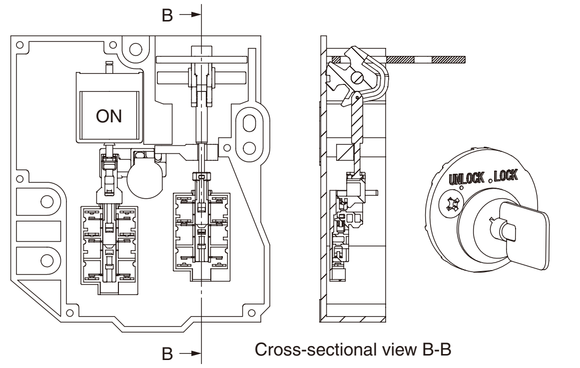
Cross-sectional view B-B

(3) Operation Key inserted, solenoid OFF, and trapped key inserted. Status: Door locked and trapped key cannot be removed.



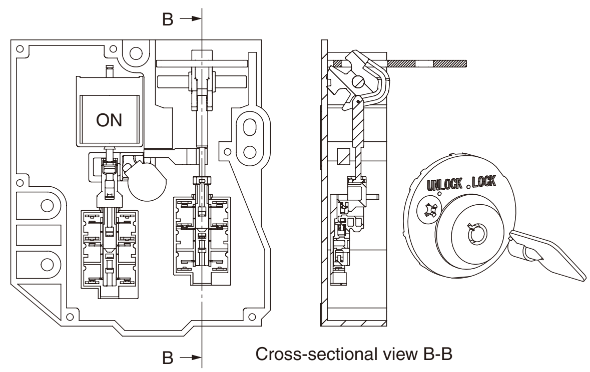
Cross-sectional view B-B

(4) Operation Key inserted, solenoid ON, and trapped key inserted. Status: Door locked and trapped key can be removed.



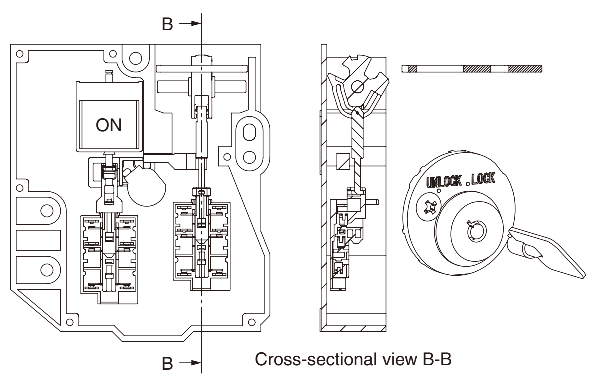
Cross-sectional view B-B

(5) Operation Key inserted, solenoid ON, and trapped key removed. Status: Door unlocked.



Cross-sectional view B-B

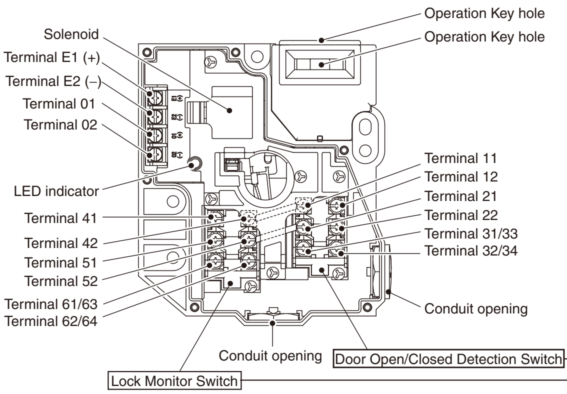
(6) Operation Key removed, solenoid ON, and trapped key removed.

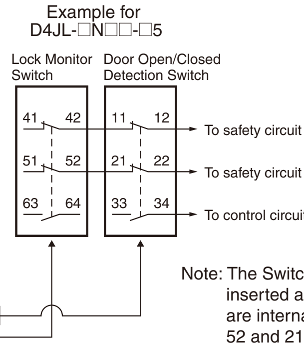


Cross-sectional view B-B

Structure and Nomenclature

Structure (D4JL-□□□A-5 and D4JL-□□□G-□5)

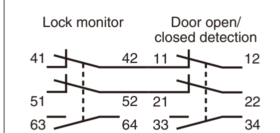
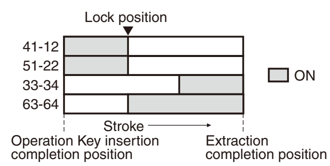
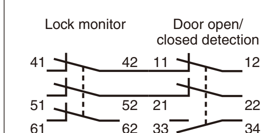
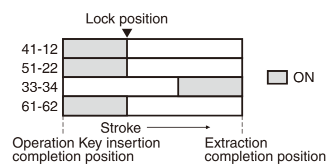
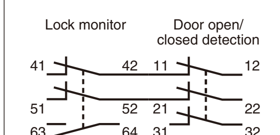
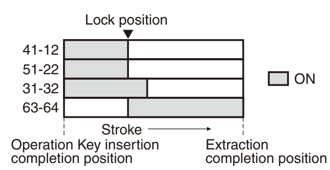
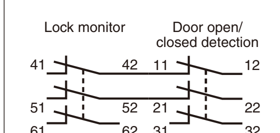
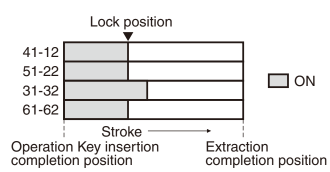




Note: The Switch is shown with the key inserted and locked. Terminals 42 and 11 are internally connected, as are terminals 52 and 21 (according to GS-ET-19).

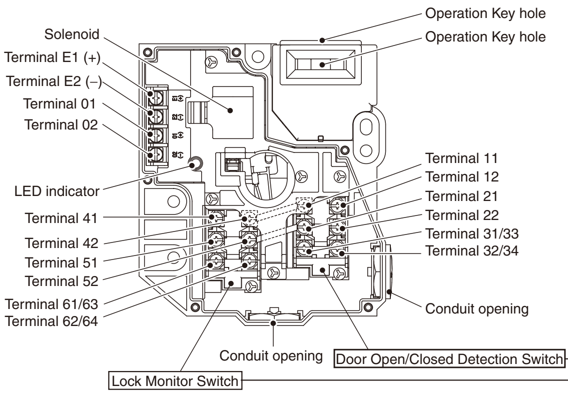
Contact Forms

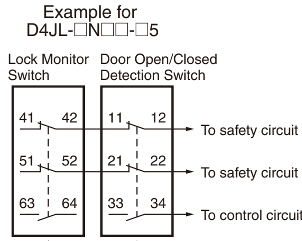
Indicates conditions where the Key is inserted and the lock is applied. Terminals 42-11 and terminals 52-21 are connected internally (as per BIA GS-ET-19).

Model	Contact (door open/closed detection and lock monitor)	Contact form		Operating pattern	Remarks
		Lock monitor	Door open/closed detection		
D4JL-□NF□-□	2NC/1NO+2NC/1NO				NC contacts 11-12 and 21-22 have a certified direct opening mechanism (⊖). The terminals 41-12, 51-22, 33-34, and 63-64 can be used as unlike poles.
D4JL-□PF□-□	2NC/1NO+3NC				NC contacts 11-12 and 21-22 have a certified direct opening mechanism (⊖). The terminals 41-12, 51-22, 33-34, and 61-62 can be used as unlike poles.
D4JL-□QF□-□	3NC+2NC/1NO				NC contacts 11-12, 21-22 and 31-32 have a certified direct opening mechanism (⊖). The terminals 41-12, 51-22, 31-32, and 63-64 can be used as unlike poles.
D4JL-□RF□-□	3NC+3NC				NC contacts 11-12, 21-22, and 31-32 have a certified direct opening mechanism (⊖). The terminals 41-12, 51-22, 31-32, and 61-62 can be used as unlike poles.

Operating Cycle

Structure (D4JL-□□□A-5 and D4JL-□□□G-□5)

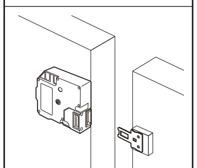
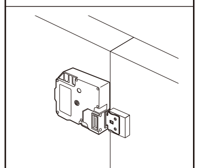
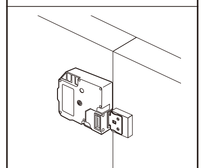
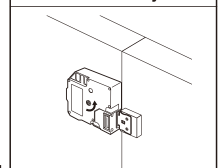




Note: The Switch is shown with the key inserted and locked. Terminals 42 and 11 are internally connected, as are terminals 52 and 21 (according to GS-ET-19).

Operating Cycle Examples (for Standard Models)

D4JL-□□□A-□5 (Mechanical Lock Models with Special Release Keys)

Door condition		Condition 1	Condition 2	Condition 3	Turning the special release key
					 Return to condition 1 
Terminal No. and function		Door open. The door will lock when the door closes.	Door closed. The door is locked.	Door closed. The door can be opened.	Door closed. No power is supplied to the solenoid. The door is unlocked manually.
E1-E2	Solenoid ON				
41-12 (NC) 51-22 (NC)	Door open/closed detection and lock monitor contacts				
31-32 (NC)	Door open/closed detection contact				
33-34 (NO)	Door open/closed detection contact				
61-62 (NC)	Lock monitor contact				
63-64 (NO)	Lock monitor contact				

D4JL-□□□G-□5 (Solenoid Lock Models with Special Release Keys)

Door condition Terminal No. and function		Even when the door is closed, it does not lock until power is supplied to the solenoid.	Door closed. The door is locked.	Door closed. The door can be opened.
E1-E2	Solenoid ON			
41-12 (NC) 51-22 (NC)	Door open/closed detection and lock monitor contacts			
31-32 (NC)	Door open/closed detection contact			
33-34 (NO)	Door open/closed detection contact			
61-62 (NC)	Lock monitor contact			
63-64 (NO)	Lock monitor contact			

The shaded areas indicate the contact is closed and power is supplied to the solenoid.

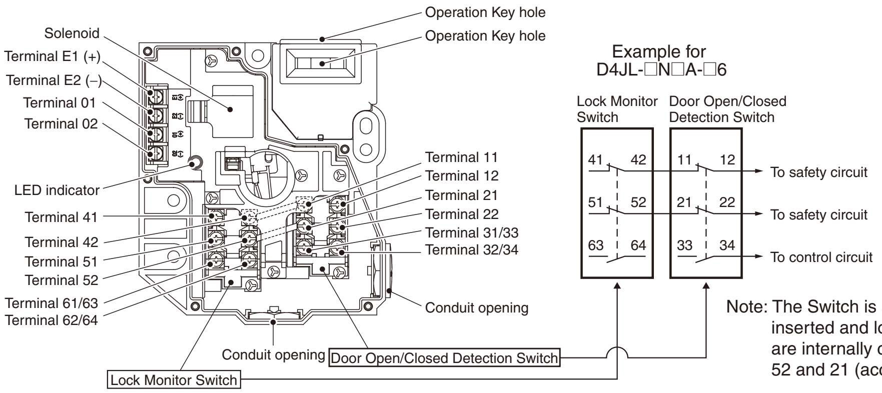
Door open/closed detection and lock monitor contacts: Can be used in safety circuits because of the direct opening mechanisms.

Door open/closed detection contact: Can be used to confirm whether the key is inserted and to monitor the open/closed status of a door.

Lock monitor contact: Can be used to confirm whether power is supplied to the solenoid and to monitor whether or not a door can be opened or closed.

Note: The door open/closed detection and lock monitor contact configuration depends on the model.

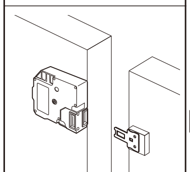
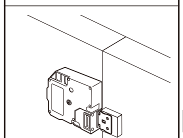
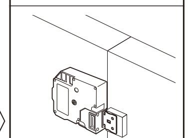
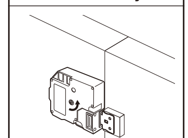
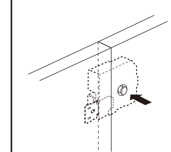
Structure (D4JL-□□□A-□6)



Note: The Switch is shown with the key inserted and locked. Terminals 42 and 11 are internally connected, as are terminals 52 and 21 (according to GS-ET-19).

Operating Cycle Examples (for Models with Rear Release Buttons)

D4JL-□□□A-□6 (Mechanical Lock Models with Special Release Keys and Rear Release Buttons)

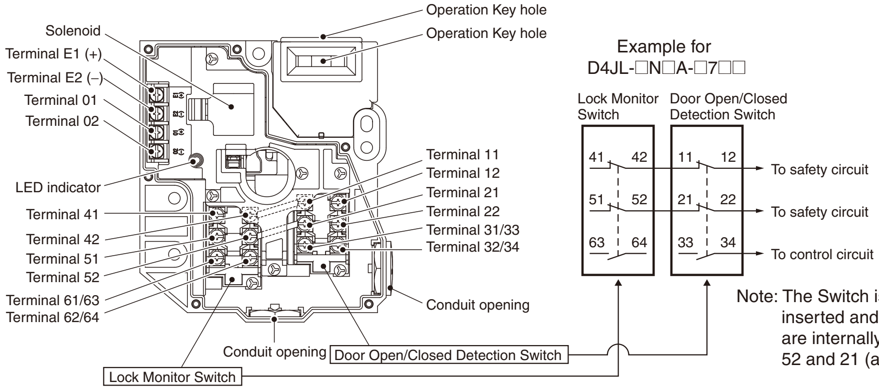
Door condition		Condition 1	Condition 2	Condition 3		Turning the special release key	Pressing the rear release button
Terminal No. and function		 Door open. The door will lock when the door closes.	 Door closed. The door is locked.	 Door open. The door can be opened.	Return to condition 1	 Door closed. No power is supplied to the solenoid. The door is unlocked manually.	 Door closed. No power is supplied to the solenoid. The door is unlocked manually.
E1-E2	Solenoid ON			■			
41-12 (NC) 51-22 (NC)	Door open/closed detection and lock monitor contacts		■				
31-32 (NC)	Door open/closed detection contact		■	■		■	■
33-34 (NO)	Door open/closed detection contact	■					
61-62 (NC)	Lock monitor contact		■				
63-64 (NO)	Lock monitor contact	■		■		■	■

■ The shaded areas indicate the contact is closed and power is supplied to the solenoid.

Door open/closed detection and lock monitor contacts:	Can be used in safety circuits because of the direct opening mechanisms.
Door open/closed detection contact:	Can be used to confirm whether the key is inserted and to monitor the open/closed status of a door.
Lock monitor contact:	Can be used to confirm whether power is supplied to the solenoid and to monitor whether or not a door can be opened.

Note: The door open/closed detection and lock monitor contact configuration depends on the model.

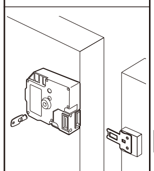
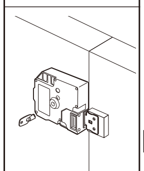
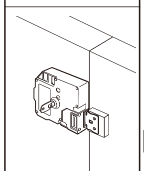
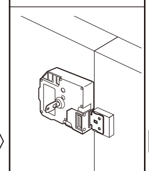
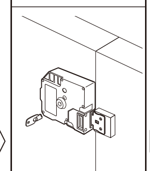
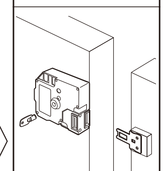
Structure (D4JL-□□□A-□7-□□)



Note: The Switch is shown with the key inserted and locked. Terminals 42 and 11 are internally connected, as are terminals 52 and 21 (according to GS-ET-19).

Operating Cycle Examples (for Models with Trapped Keys)

D4JL-□□□A-□7□□ (Models with Trapped Keys)

Door condition		Condition 1	Condition 2	Condition 3	Condition 4	Condition 5	Condition 6
							
Terminal No. and function		Door open. The Key is not inserted. The door will not lock when the door closes.	Door closed. The Key is not inserted. The door is not locked.	Door closed. The Key is inserted. The door is locked.	Door closed. The Key is inserted. The door remains locked.	Door closed. The Key is not inserted. The door can be opened.	Door closed. The Key is not inserted. The door will not lock when the door closes.
E1-E2	**Solenoid ON**						
41-12 (NC) 51-22 (NC)	**Door open/ closed detection and lock monitor contacts**						
31-32 (NC)	**Door open/ closed detection contact**						
33-34 (NO)	**Door open/ closed detection contact**						
61-62 (NC)	**Lock monitor contact**						
63-64 (NO)	**Lock monitor contact**						

Return to condition 1

The shaded areas indicate the contact is closed and power is supplied to the solenoid.

Door open/closed detection and lock monitor contacts: Can be used in safety circuits because of the direct opening mechanisms.
Door open/closed detection contact: Can be used to confirm whether the key is inserted and to monitor the open/closed status of a door.
Lock monitor contact: Can be used to confirm whether power is supplied to the solenoid and to monitor whether or not a key can be removed.

Note: 1. Door open/closed detection and lock monitor contact configuration depends on the model.
2. If power is supplied to the solenoid, the door cannot be unlocked until the Key is turned to the left and removed. The Key cannot be removed unless it is in the UNLOCK position.

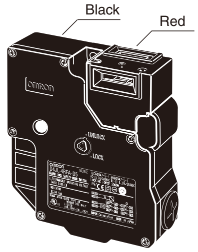
Dimensions

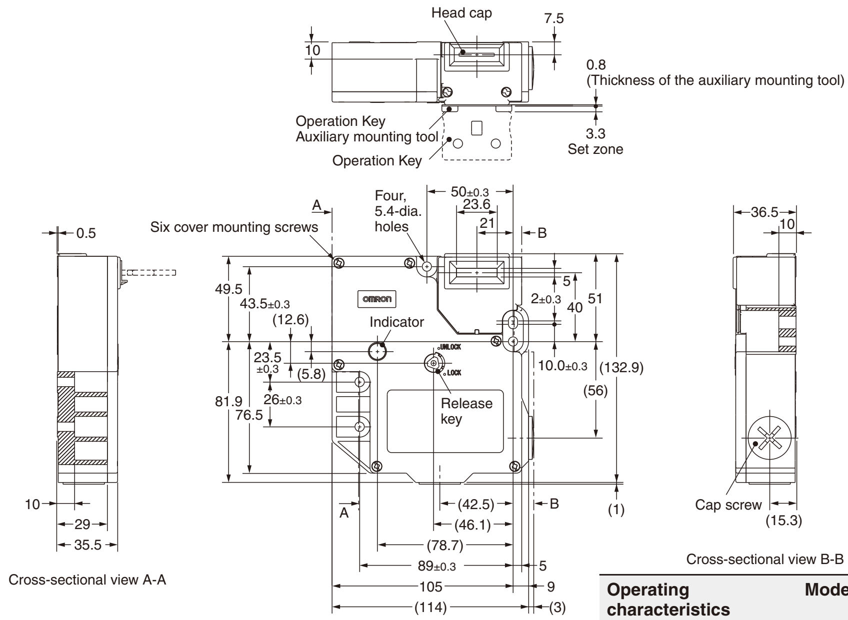
(Unit: mm)

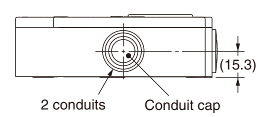
Dimensions and Operating Characteristics

Switches

D4JL-□□F□-C5
D4JL-□□F□-D5

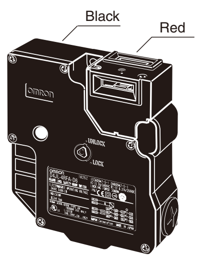


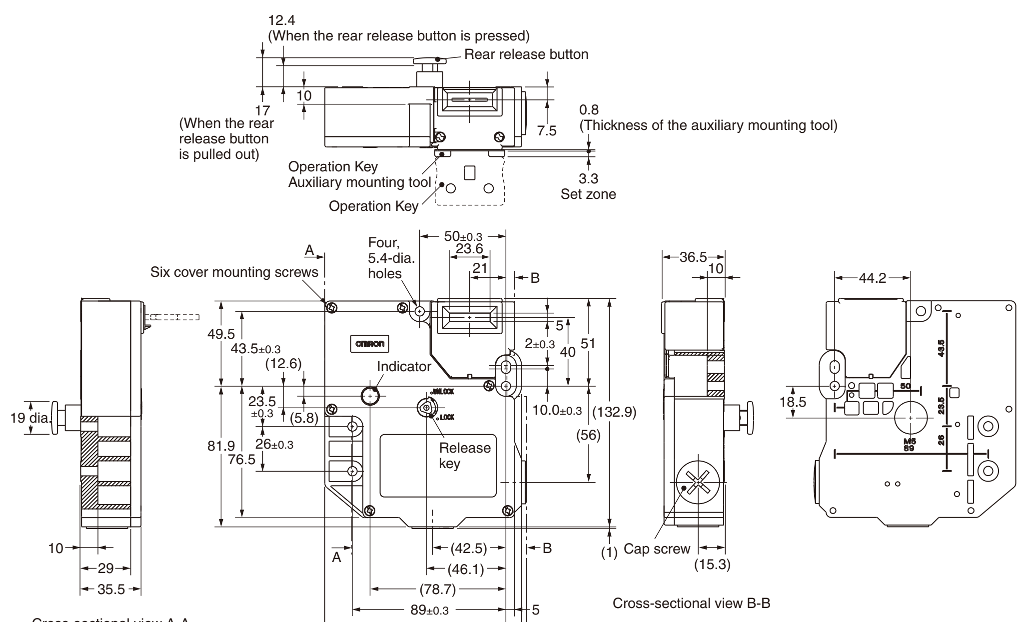


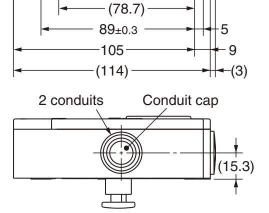


Operating characteristics / Model	D4JL-□□F□-C5 D4JL-□□F□-D5
Key insertion force Key extraction force	20 N max. Approx. 6 N
Pre-travel distance	14 mm max.
Movement before being locked	3.3 mm min.

D4JL-□□FA-C6
D4JL-□□FA-D6

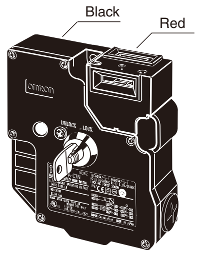


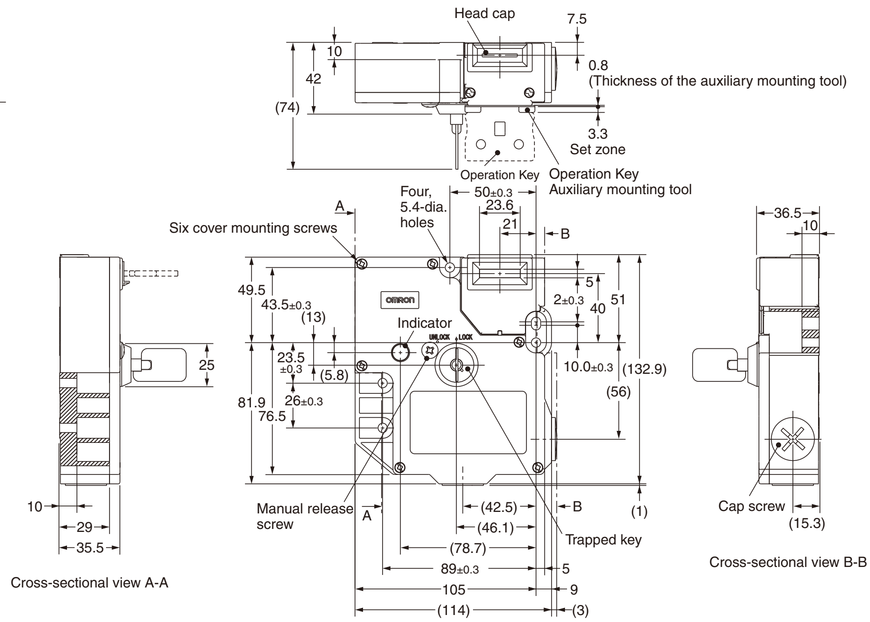


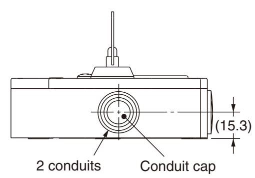


Operating characteristics / Model	D4JL-□□FA-C6 D4JL-□□FA-D6
Key insertion force Key extraction force	20 N max. Approx. 6 N
Pre-travel distance	14 mm max.
Movement before being locked	3.3 mm min.

D4JL-□□FA-C7
D4JL-□□FA-D7



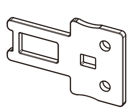


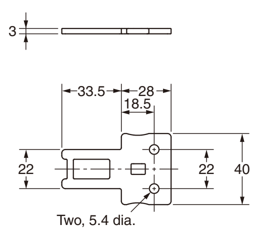


Operating characteristics / Model	D4JL-□□FA-C7 D4JL-□□FA-D7
Key insertion force **Key extraction force**	20 N max. Approx. 6 N
Pre-travel distance	14 mm max.
Movement before being locked	3.3 mm min.

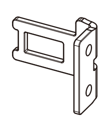
Operation Keys

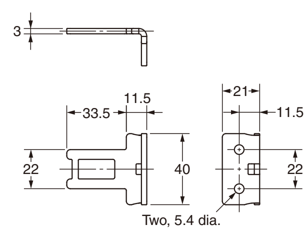
D4JL-K1





D4JL-K2

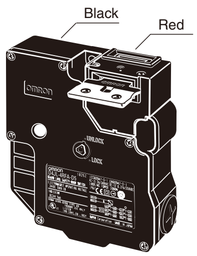


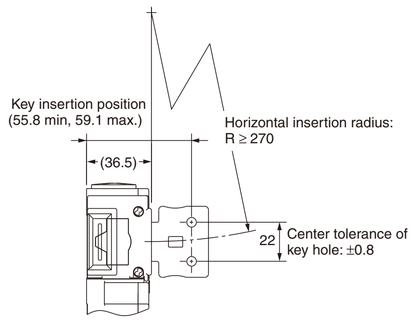


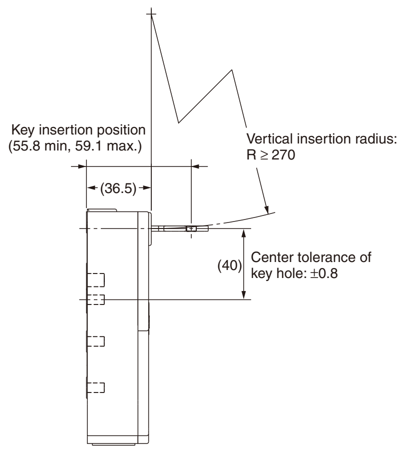
Note: Unless otherwise specified, a tolerance of ±0.8 mm applies to all Switch dimensions and a tolerance of ±0.4 mm applies to Operation Key dimensions.

With Operation Key Inserted

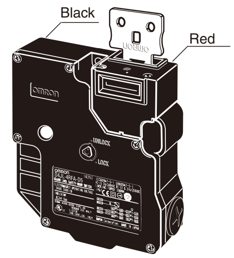
D4JL+D4JL-K1 (with Front-inserted Operation Key)

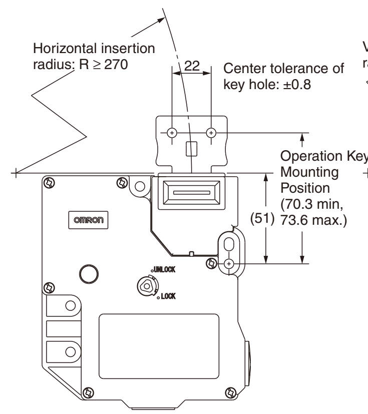


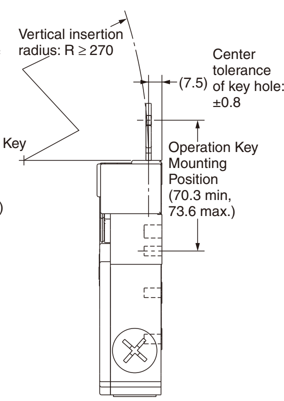




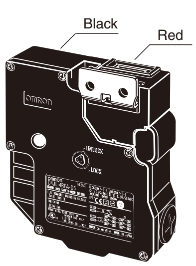
D4JL+D4JL-K1 (with Top-inserted Operation Key)

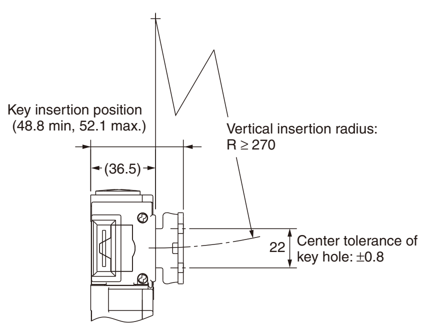


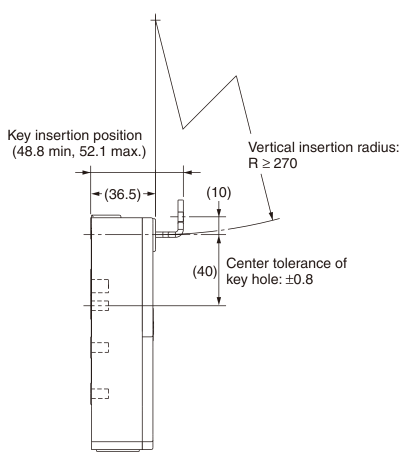




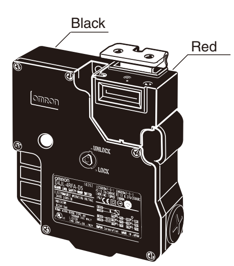
D4JL+D4JL-K2 (with Front-inserted Operation Key)

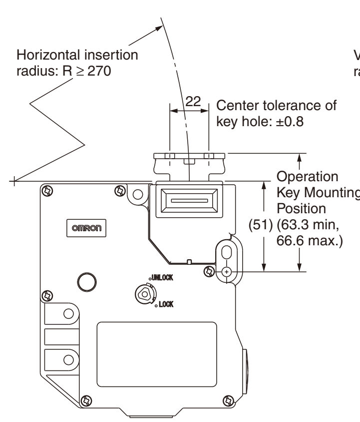


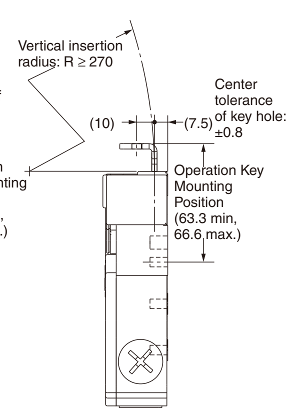




D4JL+D4JL-K2 (with Top-inserted Operation Key)

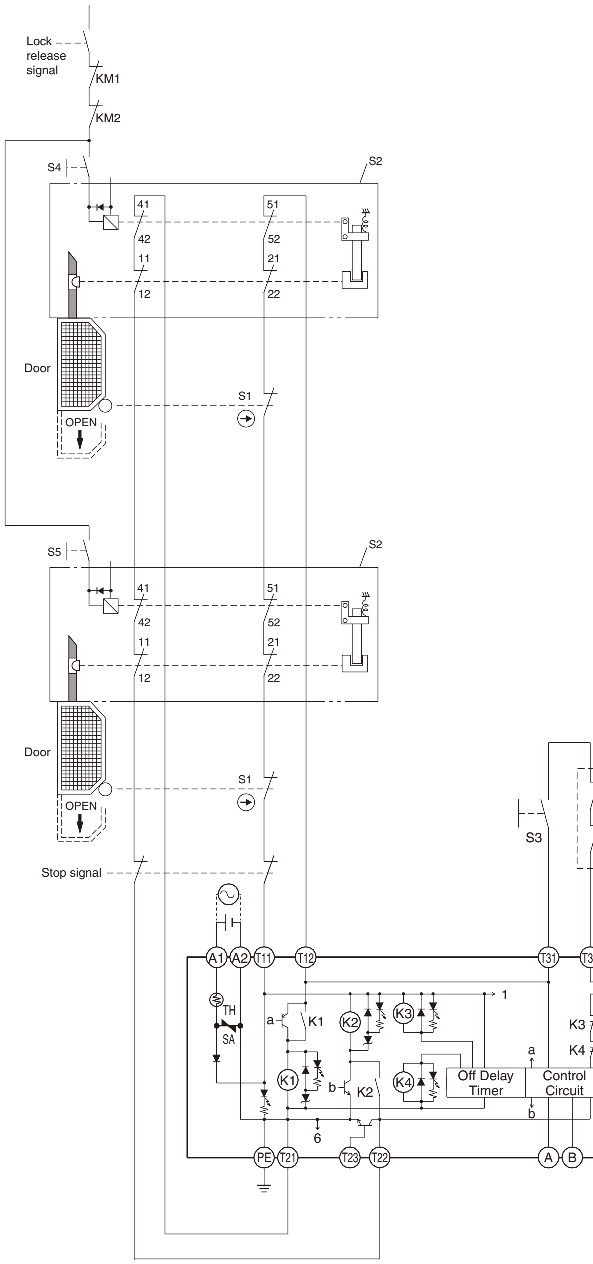
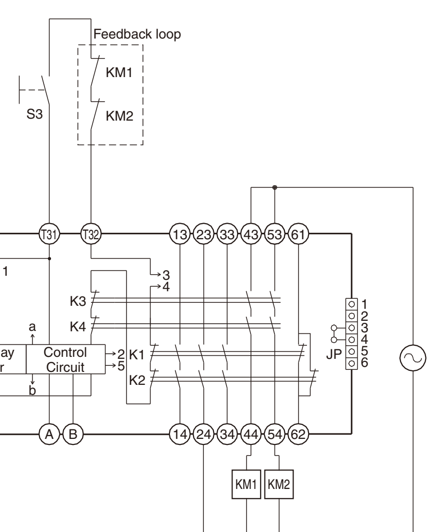




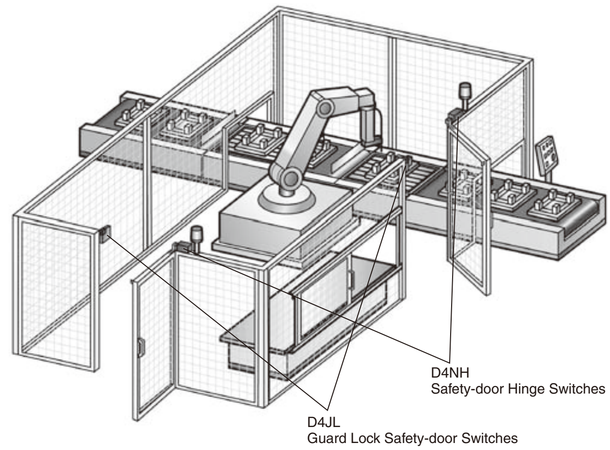


Application Examples

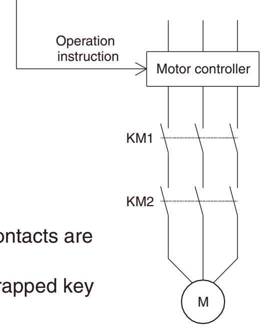
G9SA-321-T□ (24 VAC/VDC) + D4JL-□□□A-□□ (Mechanical Lock Models)/Manual Reset

Application Example
Stopping a Robot on a Conveyor Line

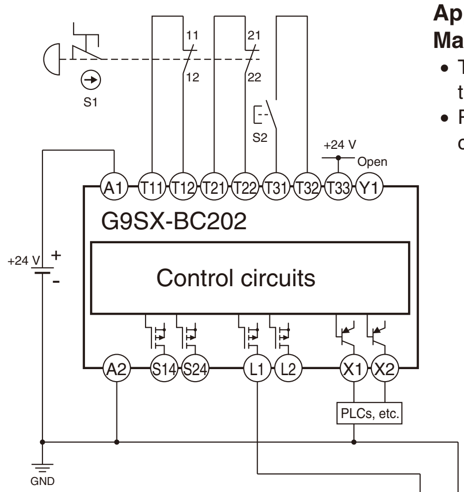


S1: Safety-door Switch with direct opening contact
S2: Guard Lock Safety-door Switch
S3: Reset switch
S4 and S5: Lock release switches
KM1 and KM2: Magnetic contactors
M: 3-phase motor



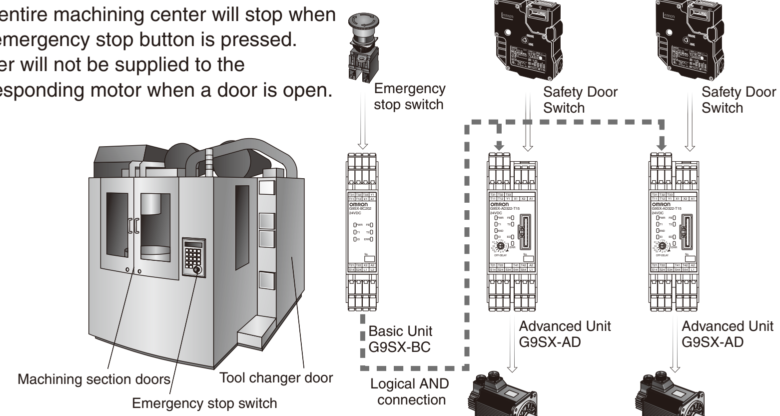
Note: 1. This circuit conforms to EN954-1 Safety Category 3.
2. When the release button is pressed on rear release models, the solenoid contacts are turned OFF.
3. With Trapped Key Models, the door will not lock when it is closed with the trapped key removed.

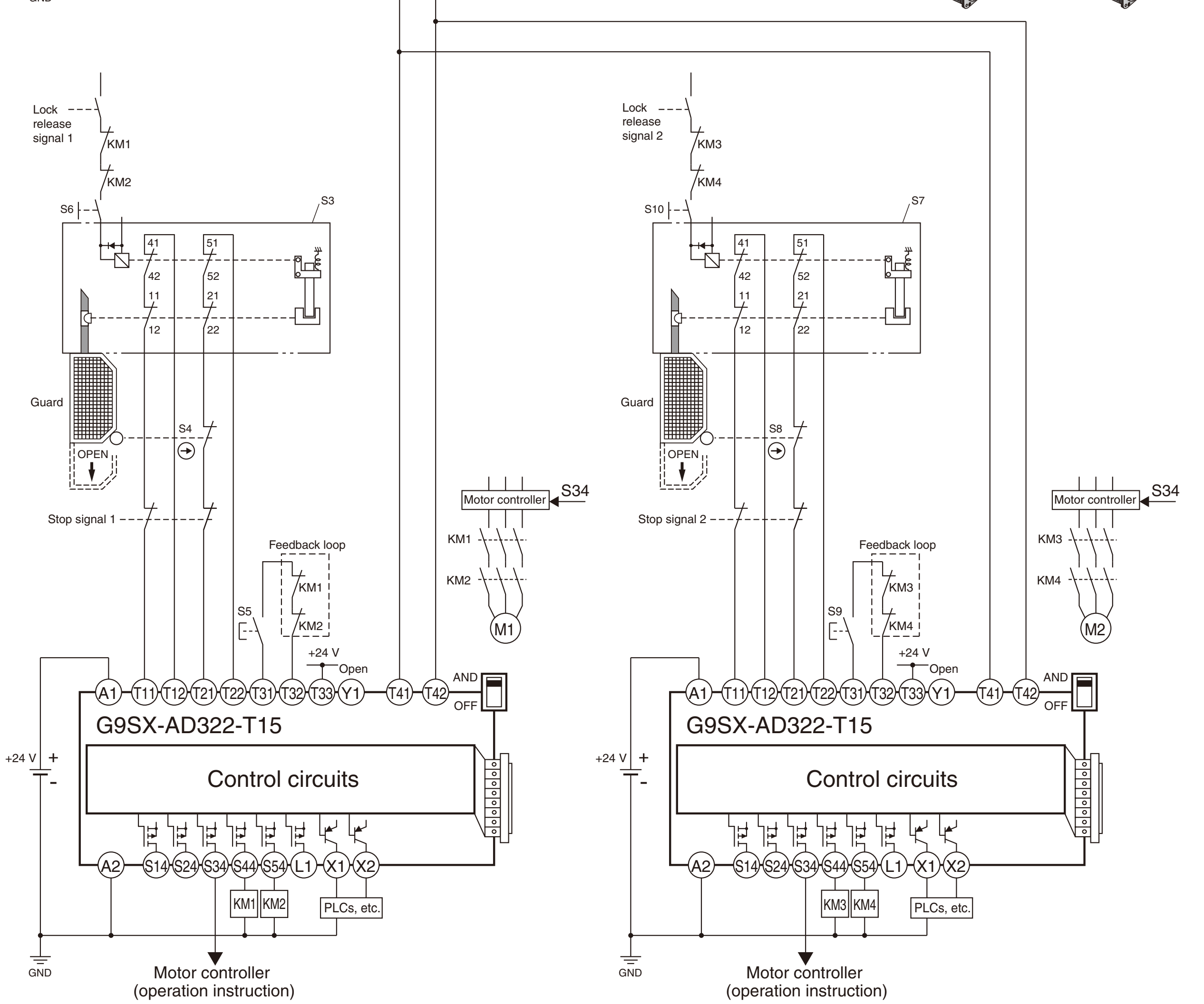
G9SX-AD322-T15 (24 VDC) + D4JL-□□□A-□□ (Mechanical Lock Models)/Manual Reset



Application Example
Machining Center

- The entire machining center will stop when the emergency stop button is pressed.
- Power will not be supplied to the corresponding motor when a door is open.





S1:	Emergency stop switch
S3 and S7:	Guard Lock Safety-door Switches
S2, S5, and S9:	Reset switches
S6 and S10:	Lock release switches
S4 and S8:	Safety Limit Switches with direct opening contacts
KM 1, KM 2, KM3, and KM4:	Magnetic contactors
M1 and M2:	3-phase motors

Safety Precautions

Refer to the *"Precautions for All Switches"* and *"Precautions for All Safety Door Switches"*.

DANGER

Injury may occasionally occur. Always check to make sure that the safety functions operate correctly before using the machine. The safety functions may not operate correctly because of wiring mistakes, setting mistakes, or Switch malfunction, causing some machines to continue operating in situations where they should be stopped.

Injury may occasionally occur. If the machine is used with the release key in the UNLOCK position, the electromagnetic lock may not operate, causing some machines to continue operating in situations where they should be stopped. Be sure to put the release key in the LOCK position before using the machine. Also, check the condition of the lock and safety circuits.

Injury may occasionally occur. When the electromagnetic lock function or Switch function is damaged, some machines may continue operating in situations where they should be stopped. Do not use the electromagnetic lock function of the Switch in place of a door lock. Always provide a lock separate from the Switch, attach a warning seal to prevent people from using excessive force to open the door when it is locked, or provide an indicator lamp to show the locked/ unlocked status of the door.

CAUTION

Electric shock may occasionally occur.
Do not use metal connectors or metal conduits.

Precautions for Safe Use

Installation Environment

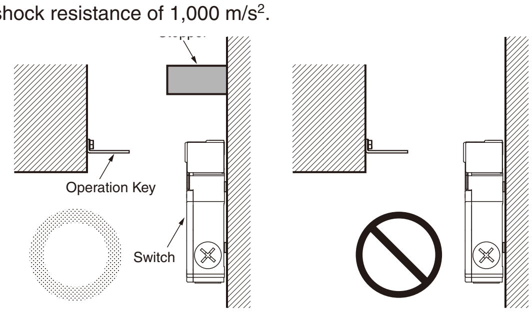
- Do not use the Switch submersed in oil or water or in locations continuously subject to splashes of oil or water. Doing so may result in oil or water entering the Switch. (The IP67 degree of protection of the Switch specifies the amount of water penetration after the Switch is submerged in water for a certain period of time.)

Wiring

- Do not switch circuits for two or more standard loads (250 VAC, 3 A) at the same time. Doing so may adversely affect insulation performance.
- Do not use screws longer than 9 mm when using metal connectors. Otherwise it may result in electric shock.
- Do not use metal conduits. Damage to the conduit opening may result in an improper seal or electric shock.
- Do not use metal connectors or metal conduits when using 1/2-14NPT connectors. Damage to the conversion adapter may result in an improper seal or electric shock.
- Always attach the cover after completing wiring and before using the Switch. Do not supply power when the cover is not attached. Electric shock may occur if the Switch is used without the cover attached.

Installation

- Make sure the Switch is mounted securely to prevent it from falling off. Otherwise injury may result.
- Do not use the Switch as a stopper. Be sure to install a stopper as shown in the following illustration when mounting the Switch and adjust the stopper so that the Operation Key is within the setting zone.
  Do not subject the Switch to a shock that exceeds the Switch's shock resistance of 1,000 m/s^2.

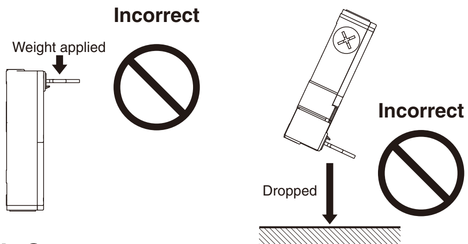


Correct **Incorrect**

Precautions for Correct Use

Operation Key

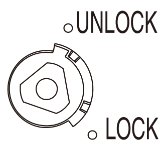
- Use only the designated Operation Key. The Head has been designed so that operation is not possible with a screwdriver or other tools. Using anything other than the designated Operation Key may damage the Switch or affect machine safety.
- Do not operate the Switch with anything other than the special OMRON Operation Key, otherwise the Switch may break or the safety of the system may not be maintained.
- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.



Switch Contacts

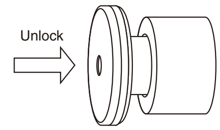
The Switch contacts can be used with either standard loads or microloads. Once the contacts have been used to switch a load, however, they cannot be used to switch smaller loads. The contact surfaces will become rough once they have been used and contact reliability for smaller loads may be reduced.

Release Key



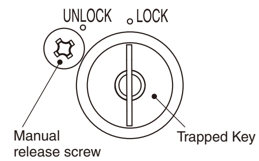
- The release key is used to unlock the Switch in case of emergency or if the power supply to the Switch stops.
- If the release key setting is changed from LOCK to UNLOCK using the enclosed release key, the lock will be released and the safety door can be opened (mechanical lock models only).
- After setting the release key to UNLOCK to, for example, change the head direction or perform maintenance, be sure to return it to the LOCK setting before resuming operation.
- The release key is set in the unlock position at the factory for the D4JL-□□□A-□5 and D4JL-□□□A-□6 and in the lock position for the D4JL-□□□G-□5 and D4JL-□□□A-□7-□□.
- If the release key is set to UNLOCK when the Switch is used for the door of a machine room to ensure the safety of people performing adjustment work inside, the door will not be locked when the door is closed and no power will be supplied to the equipment.
- Do not use the release key to start or stop machines.
- The auxiliary lock must be released using the release key only by authorized personnel.
- Do not impose a force exceeding 1 N·m on the release key screws. The release key may be damaged and may not operate properly.
- To prevent the release key from being used by unauthorized personnel, set it to LOCK and seal it with sealing wax.

Rear Release Button



- The rear release button is used for emergency escapes when someone locks a worker in the work area (hazardous area).
- The door can be unlocked by pressing the rear release button.
- After the rear release button is used to unlock the door, pull the button out to restore it to its original state. If the button is left pressed in, the door will not lock when the door is closed and power will not be supplied to the equipment.
- Mount the Switch so that the rear release button can be operated by a worker inside the work area (hazardous area).

Trapped Key



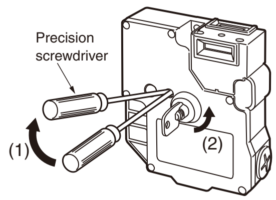
- The trapped key is released when power is supplied to the solenoid. Turn the trapped key to the UNLOCK position and remove the key to unlock the door.
  The door cannot be unlocked solely by supplying power to the solenoid.
  As long as a worker has the trapped key with him when he enters the work area (hazardous area), he cannot be locked inside by another worker.
- Do not impose a force exceeding 1 N·m when operating the key. Otherwise, the Switch may be damaged and may not operate properly.

Attaching a Cover

- Make sure the release key is set to the LOCK position before covering the D4JL.
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.
- Use one of the following methods when covering a Trapped Key Switch.
  When the Operation Key is removed (door open):
    Cover with the trapped key removed (UNLOCK).
  When the Operation Key is inserted (door closed):
    Cover with the trapped key inserted (LOCK).

Manual Release

- Manual release is used to unlock the Switch when power cannot be supplied to the solenoid, such as when power is interrupted or the equipment is being repaired.
  1. Use a Phillips screwdriver to remove the manual release screw. Use a precision screwdriver to press down the lever inside the Switch far enough to release the trapped key.
  2. The door is unlocked when the trapped key is turned to the UNLOCK position and removed.
- Do not use manual release to stop machines.
- After the Switch has been manually released, re-install the manual release screw in its proper position on the Switch using the specified torque.



Hinged Doors

If the Switch is mounted too close to the hinge, the force imposed on the lock will be much larger than for locations far from the hinge and the lock may be damaged. Mount the Switch close to the handle.

Solenoid Lock Models

The solenoid lock locks the door only when power is supplied to the solenoid. The door will be unlocked if the power supply to the solenoid stops. Therefore, do not use the solenoid lock models for machines that may be operating and dangerous even after the machine stops operating.

Mounting Methods

Appropriate Tightening Torque

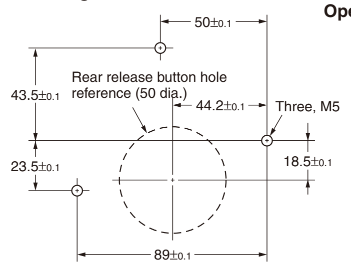
Be sure to tighten each screw of the Switch properly. Loose screws may result in malfunction.

Type	Appropriate tightening torque
Terminal screw	0.6 to 0.8 N·m
Cover mounting screw	0.7 to 0.9 N·m
Manual release screw	0.6 to 0.8 N·m
Operation Key mounting screw	2.4 to 2.8 N·m
Switch mounting screw	3.2 to 3.8 N·m
Connector	1.8 to 2.2 N·m (except 1/2-14NPT)
	1.4 to 1.8 N·m (for 1/2-14NPT)
Cap screw	1.3 to 1.7 N·m

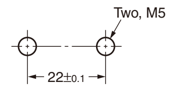
Switch and Operation Key Mounting

- Mount the Switch and Operation Key securely to the applicable tightening torque with M5 screws and washers.
  To ensure safety, use screws that cannot be easily removed or another means to prevent the Switch and Operation Key from easily being removed.

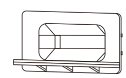
Mounting Holes for Switches



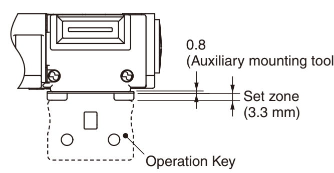
Mounting Holes for Operation Keys



- Do not operate the Switch with anything other than the special OMRON Operation Key. Otherwise, the Switch may be damaged and the safety of the system may not be maintained.
- Ensure that the alignment offset between the Operation Key and the key hole does not exceed ±0.8 mm. If the Operation Key is offset or at an angle, accelerated wear or damage to the Switch may result.
- When inserting the Operation Key, install the provided mounting auxiliary tool in the key hole and use the tool to position the key in the key hole center and set zone.


Auxiliary mounting tool

- Remove the mounting auxiliary tool from the Switch after the Operation Key is properly inserted.
- Observe the specified insertion radius for the Operation Key and insert it in a direction perpendicular to the key hole.



- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.
- Attach the enclosed cap head to any Operation Key hole that is not used.

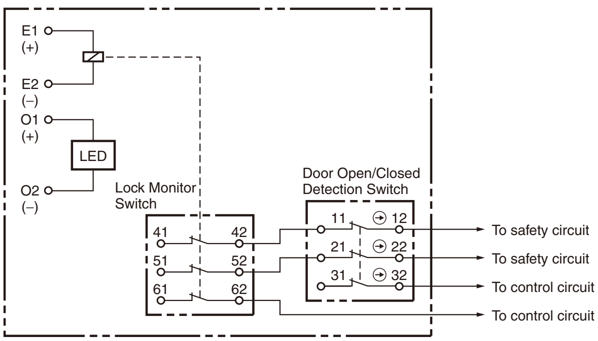
Securing Doors

When the door is closed (with the Operation Key inserted), the Operation Key may exceed the set zone because of, for example, the door's own weight, machine vibration, or the door cushion rubber. Then, when an attempt is made to open the door, it may result in damage or malfunction. Also, it may not be possible to unlock the Switch if there is weight placed on the Operation Key. Do not rely on the Switch to substitute for a door locking device. Secure the door with a stopper so that the Operation Key remains within the set zone.

Wiring

Circuit Connection Example

- Direct opening contacts used for safety circuit inputs are indicated with the ⊖ mark. Terminals 12-41 and terminals 22-51 have direct opening contacts.
- Connect the indicators in parallel to the auxiliary circuits or terminals E1 and E2. Do not connect the indicators in parallel with the direct opening contact. If the indicators are broken, a short-circuit current may flow, causing equipment to malfunction.
- Do not switch circuits for two or more standard loads at the same time. Doing so may adversely affect insulation performance.
- The 24 VDC solenoid terminals have polarity (E1: +, E2: –). Confirm the polarity before wiring.
- The contact ON/OFF timing for Switches is not synchronized. Confirm performance before application.

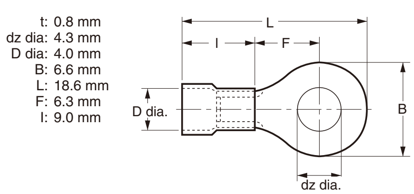


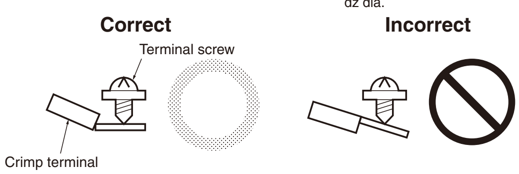
Wiring

- Do not wire the Switch while power is being supplied. Doing so may result in electric shock.
- Do not let particles, such as small pieces of lead wire, enter the switch body when wiring.
- Make sure that the wiring does not hide the LED indicator when wiring E1/E2 or O1/O2.
- When connecting to the terminals via insulating tube and M3.5 crimp terminals, arrange the crimp terminals so that they do not rise up onto the case or the cover.
- Applicable lead wire size: AWG22 to AWG18 (0.3 to 0.75 mm^2). Use lead wires of an appropriate length. Not doing so may result in excess length causing the cover to rise and not fit properly.
- Do not pull on the lead wires with excessive force. Doing so may disconnect them.
- Do not push crimp terminals into gaps in the case interior. Doing so may cause damage or deformation of the case.

[Reference] Crimp Terminals

Manufacturer	Model
J.S.T. Mfg Co.	FN1.25-M4 (F Type) N1.25-M4 (Straight Type)





Processing the Conduit Opening

- Connect a recommended connector to the opening of the conduit and tighten the connector to the proper torque. The case may be damaged if excessive tightening torque is applied.
- When using a 1/2-14NPT conduit, wind sealing tape around the conduit end of the connector so that the enclosure will conform to IP67.
- Make sure that the outer diameter of the cable connected to the connector is correct.
- Attach a conduit cap to the unused conduit opening when wiring and tighten it to a suitable torque. The conduit cap is provided with the Switch.

Recommended Connectors

Use a connector with a screw section not exceeding 9 mm. Otherwise, the screws will protrude into the case interior. The connectors given in the following table have connectors with screw sections not exceeding 9 mm. Use the following connectors to ensure conformance to IP67.

Size	Manufacturer	Model		Applicable cable diameter
G1/2	LAPP	ST-PF1/2	5380-1002	6.0 to 12.0 mm
PG13.5	LAPP	ST-13.5	5301-5030	6.0 to 12.0 mm
M20	LAPP	ST-M20 × 1.5	5311-1020	7.0 to 13.0 mm
1/2-14NPT	LAPP	ST-NPT1/2	5301-6030	6.0 to 12.0 mm

Use LAPP connectors together with Seal Packing (JPK-16, GP-13.5, or GPM20), and tighten to the applicable torque. Seal Packing is sold separately.

- LAPP is a German manufacturer.
- For a 1/2-14NPT conduit, use the above connector after attaching the provided Adaptor to the Switch and wrapping it with sealing tape.

Other Precautions

- A Guard Lock Safety-door Switch will heat when power is supplied to the solenoid. Do not touch these Switches.

Precautions for All Safety Door Switches

Note: Refer to the *Safety Precautions* section for each Switch for specific precautions applicable to each Switch.

⚠ CAUTION

Do not insert the Operation Key when the door is open. The machine may operate, possibly causing injury.

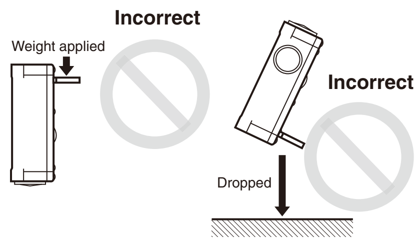
Precautions for Safe Use

- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch body is protected from the ingress of dust or water, avoid the ingress of foreign substance through the key hole on the head. Otherwise, accelerated wear, breaking, or malfunction may result.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch in a starting circuit. (Use the Switch for safety confirmation signal purposes.)
- Connect a fuse in series with the Switch to protect it from short-circuit damage. The value of the breaking current of the fuse must be calculated by multiplying the rated current by 150% to 200%.
  When using the Switch for an EN rating, use a 10 A fuse of type gI or gG that complies with IEC 60269.
- Mount the Operation Key so that it will not come into contact with persons in the area when the door is opened and closed. Injury may result.
- Do not drop the Switch. Doing so may prevent the Switch from functioning to its full capability.
- Do not under any circumstances disassemble or modify the Switch. Doing so may cause malfunction.

Precautions for Correct Use

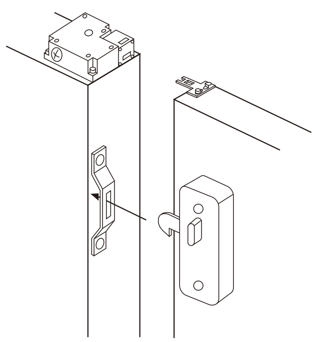
Operation Key

- Use only the designated Operation Key. The Head has been designed so that operation is not possible with a screwdriver or other tools. Using anything other than the designated Operation Key may damage the Switch or affect machine safety.
- Do not operate the Switch with anything other than the special OMRON Operation Key, otherwise the Switch may break or the safety of the system may not be maintained.
- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.



Securing the Door

If the closed door (with the Operation Key inserted) pulls the Operation Key past the operating/lock position (i.e., the set zone) because of, for example, the door's own weight, machine vibration, or the door cushion rubber, the Switch may be damaged.
Also, with a magnetic lock, it may not be possible to unlock the Switch if there is weight placed on the Operation Key. Secure the door with a stopper so that the Operation Key remains within the set zone.



Operating Environment

- Safety Door Switches are designed for use indoors. Using a Switch outdoors may damage it.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperature or high humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switch in the following locations:
  - ･Locations subject to severe temperature changes
  - ･Locations subject to high temperatures or condensation
  - ･Locations subject to severe vibration
  - ･Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - ･Locations where the Switch may come into contact with thinner or detergents
  - ･Locations where explosive or flammable gases are present

Storing Switches

Do not store Switches in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

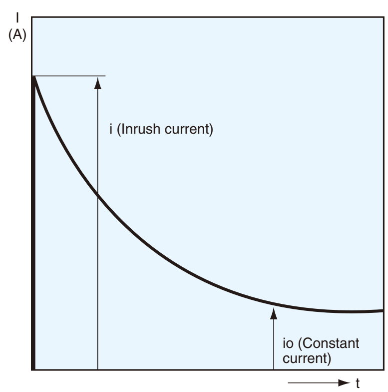
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly.
If the terminal is wired incorrectly, the Switch will not function.
Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

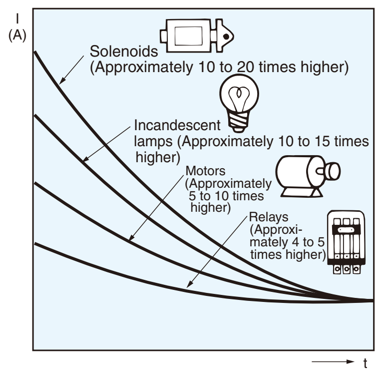
Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

Inductive load:	A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)
Lamp load:	An inrush current 10 times higher than the normal current
Motor load:	An inrush current 6 times higher than the normal current

1. Ambient temperature: 5°C to 35°C
2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

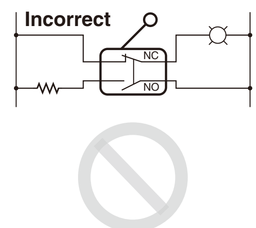
Electrical Conditions

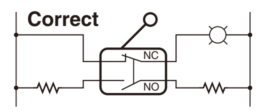
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

Connections

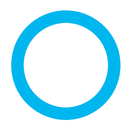
- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

Power Connection Examples
(Connection of Different Polarities)

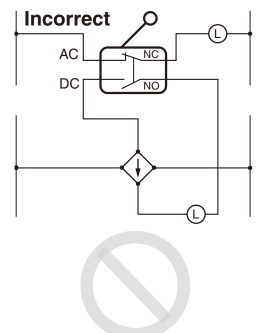




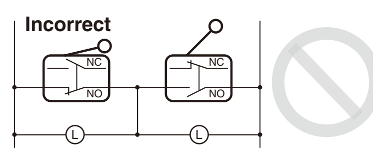
Connect the load to the same polarities.



Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

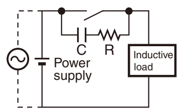
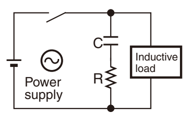
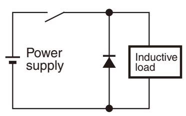
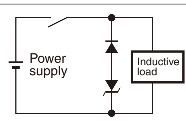
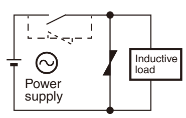


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

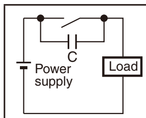
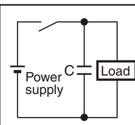
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

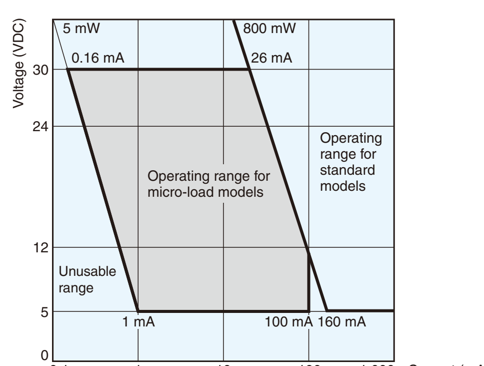
Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

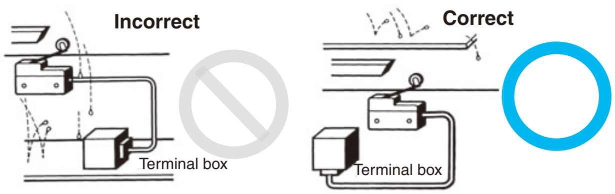
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, $\lambda_{60} = 0.5\times10^{-6}$/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

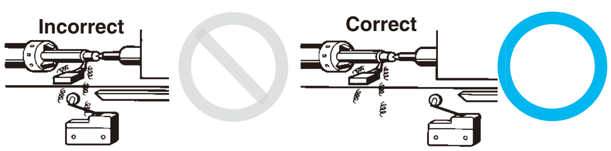


Operating Environment

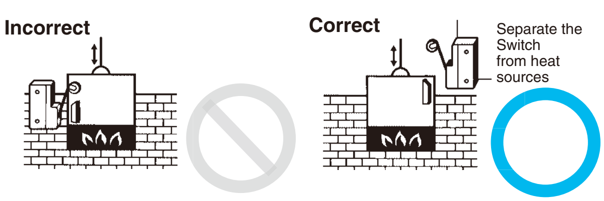
- The Switches are designed for use indoors.
  Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



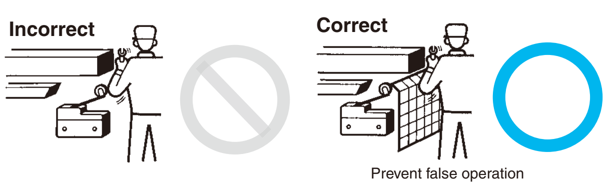
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges.
  The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog.
  If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



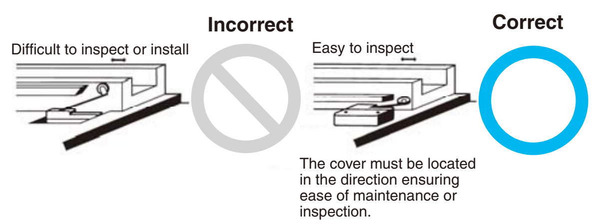
- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.



- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

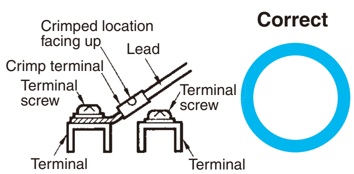
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

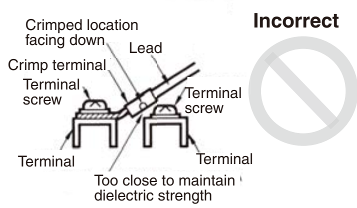
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Safty-door Switch

D4NS

Multi-contact, Labor-saving, Environment-friendly, Next-generation Safety-door Switch

- ■ Lineup includes three contact models with 2NC/1NO and 3NC contact forms and MBB models in addition to the previous contact forms 1NC/1NO, and 2NC.
- ■ M12-connector models are available, saving on labor and simplifying replacement.
- ■ Standardized gold-clad contacts provide high contact reliability.
  Applicable to both standard loads and microloads.

⚠ Be sure to read the *"Safety Precautions"* on page 10 and the *"Precautions for All Safety Door Switches"*.

Model Number Structure

Model Number Legend

Switch

D4NS-□□□
1 2 3

1. Conduit/Connector size
1:Pg13.5 (1-conduit)
2:G1/2 (1-conduit)
3:1/2-14NPT (1-conduit)
4:M20 (1-conduit)
5:Pg13.5 (2-conduit)
6:G1/2 (2-conduit)
7:1/2-14NPT compatible (2-conduit model with M20 conduit size includes an M20-to-1/2-14NPT conversion adapter)
8:M20 (2-conduit)
9:M12 connector (1-conduit)

2. Built-in Switch
A:1NC/1NO (slow-action)
B:2NC (slow-action)
C:2NC/1NO (slow-action)
D:3NC (slow-action)
E:1NC/1NO (MBB contact)
F:2NC/1NO (MBB contact)

3. Head Mounting Direction
F:Four mounting directions possible (Front-side mounting at shipping)

Note: An order for the head part or the switch part alone cannot be accepted. (The Operation Key is sold separately.)

Operation Key

D4DS-K□
1

1. Operation Key Type
1:Horizontal mounting
2:Vertical mounting
3:Adjustable mounting (Horizontal)
5:Adjustable mounting (Horizontal/Vertical)

Ordering Information

Switches (Operation Keys are sold separately.)

: Models with certified direct opening contacts.

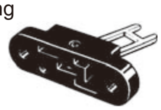
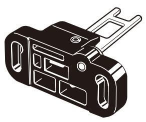
Type	Contact configuration		Conduit opening/Connector	Model
1-Conduit	Slow-action	1NC/1NO	Pg13.5	D4NS-1AF *
			G1/2	D4NS-2AF *
			1/2-14NPT	D4NS-3AF
			M20	D4NS-4AF
		2NC	Pg13.5	D4NS-1BF *
			G1/2	D4NS-2BF *
			1/2-14NPT	D4NS-3BF
			M20	D4NS-4BF
		2NC/1NO	Pg13.5	D4NS-1CF *
			G1/2	D4NS-2CF *
			1/2-14NPT	D4NS-3CF
			M20	D4NS-4CF
		3NC	Pg13.5	D4NS-1DF *
			G1/2	D4NS-2DF *
			1/2-14NPT	D4NS-3DF
			M20	D4NS-4DF
	Slow-action MBB contact	1NC/1NO	Pg13.5	D4NS-1EF
			G1/2	D4NS-2EF
			1/2-14NPT	D4NS-3EF
			M20	D4NS-4EF
		2NC/1NO	Pg13.5	D4NS-1FF
			G1/2	D4NS-2FF
			1/2-14NPT	D4NS-3FF
			M20	D4NS-4FF
2-Conduit	Slow-action	1NC/1NO	Pg13.5	D4NS-5AF
			G1/2	D4NS-6AF
			M20, includes M20-to-1/2-14NPT conversion adapter	D4NS-7AF
			M20	D4NS-8AF
		2NC	Pg13.5	D4NS-5BF
			G1/2	D4NS-6BF
			M20, includes M20-to-1/2-14NPT conversion adapter	D4NS-7BF
			M20	D4NS-8BF
		2NC/1NO	Pg13.5	D4NS-5CF
			G1/2	D4NS-6CF
			M20, includes M20-to-1/2-14NPT conversion adapter	D4NS-7CF
			M20	D4NS-8CF
		3NC	Pg13.5	D4NS-5DF
			G1/2	D4NS-6DF
			M20, includes M20-to-1/2-14NPT conversion adapter	D4NS-7DF
			M20	D4NS-8DF
	Slow-action MBB contact	1NC/1NO	Pg13.5	D4NS-5EF
			G1/2	D4NS-6EF
			M20, includes M20-to-1/2-14NPT conversion adapter	D4NS-7EF
			M20	D4NS-8EF
		2NC/1NO	Pg13.5	D4NS-5FF
			G1/2	D4NS-6FF
			M20, includes M20-to-1/2-14NPT conversion adapter	D4NS-7FF
			M20	D4NS-8FF
1-Conduit, with connector	Slow-action	1NC/1NO	M12 connector	D4NS-9AF
		2NC		D4NS-9BF
	Slow-action MBB contact	1NC/1NO		D4NS-9EF

Note: 1. The recommended models for equipment and machinery being exported to Europe are those with an M20 or Pg13.5 conduit sizes, and for North America, the recommended models are those with a 1/2-14NPT conduit sizes.

2. Resin is used as the material for the D4NS housing and head. Use the metal D4BS Safety-door Switch for applications requiring greater mechanical strength.

* Models with Korean S-mark certification.

Operation Keys

Type	Model
Horizontal mounting 	**D4DS-K1**
Vertical mounting 	**D4DS-K2**
Adjustable mounting (Horizontal) 	**D4DS-K3**
Adjustable mounting (Horizontal/Vertical) 	**D4DS-K5**

Specifications

Standards and EC Directives

Conforms to the following EC Directives:

- Machinery Directive
- Low Voltage Directive
- EN50047
- EN60204-1
- EN1088
- GS-ET-15

Certified Standards

Certification body	Standard	File No.
TÜV Product Service	EN60947-5-1 (certified direct opening)	Consult your OMRON representative for details.
UL *1	UL508, CSA C22.2 No.14	E76675
CQC (CCC)	GB14048.5	2003010305077330
KOSHA *2	EN60947-5-1	2005-197

*1. Certification for CSA C22.2 No. 14 is authorized by the UL mark.
*2. Only certain models have been certified.

Certified Standard Ratings

TÜV (EN60947-5-1), CCC (GB14048.5)

Item / Utilization category	AC-15	DC-13
Rated operating current (I_e)	3 A	0.27 A
Rated operating voltage (U_e)	240 V	250 V

Note: Use a 10 A fuse type gI or gG that conforms to IEC60269 as a short-circuit protection device. This fuse is not built into the Switch.

UL/CSA (UL508, CSA C22.2 No. 14)

A300

Rated voltage	Carry current	Current (A)		Volt-amperes (VA)	
		Make	Break	Make	Break
120 VAC	10 A	60	6	7,200	720
240 VAC		30	3		

Q300

Rated voltage	Carry current	Current (A)		Volt-amperes (VA)	
		Make	Break	Make	Break
125 VDC	2.5 A	0.55	0.55	69	69
250 VDC		0.27	0.27		

Characteristics

Degree of protection *1		IP67 (EN60947-5-1)
Durability *2	**Mechanical**	1,000,000 operations min.
	Electrical	500,000 operations min. (3 A resistive load at 250 VAC) *3 300,000 operations min. (10 A resistive load at 250 VAC)
Operating speed		0.05 to 0.5 m/s
Operating frequency		30 operations/minute max.
Direct opening force *4		60 N min.
Direct opening travel *4		10 mm min.
Contact resistance		25 mΩ max.
Minimum applicable load *5		1 mA resistive load at 5 VDC (N-level reference value)
Rated insulation voltage (U_i)		300 V
Rated frequency		50/60 Hz
Protection against electric shock		Class II (double insulation)
Pollution degree (operating environment)		3 (EN60947-5-1)
Impulse withstand voltage (EN60947-5-1)	**Between terminals of same polarity**	2.5 kV
	Between terminals of different polarity	4 kV
	Between each terminal and non-current carrying metallic parts	6 kV
Insulation resistance		100 MΩ min.
Contact gap		2 × 2 mm min.
Vibration resistance	**Malfunction**	10 to 55 Hz, 0.75 mm single amplitude
Shock resistance	**Destruction**	1,000 m/s^2 min.
	Malfunction	300 m/s^2 min.
Conditional short-circuit current		100 A (EN60947-5-1)
Conventional free air thermal current (I_{th})		10 A (EN60947-5-1)
Ambient operating temperature		−30 to 70°C (with no icing)
Ambient operating humidity		95% max.
Weight		Approx. 96 g (D4NS-1CF)

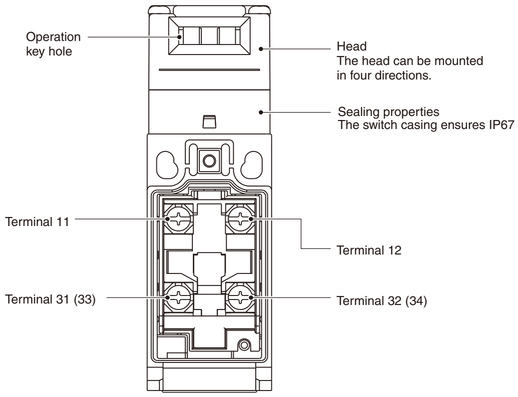
Note: 1. The above values are initial values.
2. The Switch contacts can be used with either standard loads or microloads. Once the contacts have been used to switch a load, however, they cannot be used to switch smaller loads. The contact surfaces will become rough once they have been used and contact reliability for smaller loads may be reduced.

*1. The degree of protection is tested using the method specified by the standard (EN60947-5-1). Confirm that sealing properties are sufficient for the operating conditions and environment beforehand. Although the switch box is protected from dust or water penetration, do not use the D4NS in places where foreign material may enter through the key hole on the head, otherwise Switch damage or malfunctioning may occur.
*2. The durability is for an ambient temperature of 5 to 35°C and an ambient humidity of 40% to 70%. For more details, consult your OMRON representative.
*3. Do not pass the 3 A, 250 VAC load through more than 2 circuits.
*4. These figures are minimum requirements for safe operation.
*5. This value will vary with the switching frequency, environment, and reliability level. Confirm that correct operation is possible with the actual load beforehand.

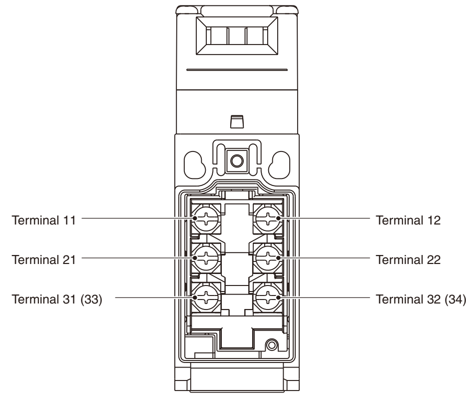
Structure and Nomenclature

Structure

D4NS-□A□, D4NS-□B□, D4NS-□E□



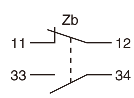
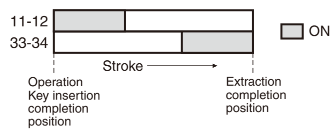
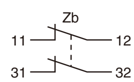
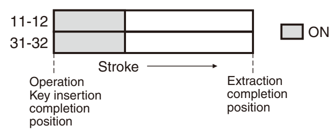
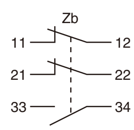
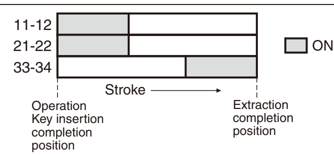
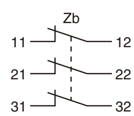
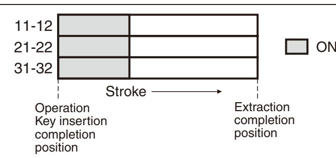
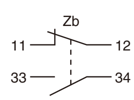
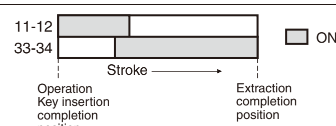
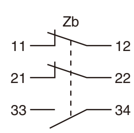
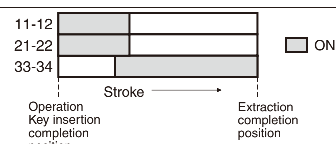
D4NS-□C□, D4NS-□D□, D4NS-□F□



Note: The 2-conduit models have the same terminal arrangement.

Contact Form

Diagrams Show State with Key Inserted.

Model	Contact	Contact form	Operating pattern	Remarks
D4NS-□A□	1NC/1NO			Only NC contacts 11-12 have a certified direct opening mechanism. The terminals 11-12 and 33-34 can be used as unlike poles.
D4NS-□B□	2NC			Only NC contacts 11-12 and 31-32 have a certified direct opening mechanism. The terminals 11-12 and 31-32 can be used as unlike poles.
D4NS-□C□	2NC/1NO			Only NC contacts 11-12 and 21-22 have a certified direct opening mechanism. The terminals 11-12, 21-22, and 33-34 can be used as unlike poles.
D4NS-□D□	3NC			Only NC contacts 11-12, 21-22, and 31-32 have a certified direct opening mechanism. The terminals 11-12, 21-22, and 31-32 can be used as unlike poles.
D4NS-□E□	1NC/1NO MBB *			Only NC contacts 11-12 have a certified direct opening mechanism. The terminals 11-12 and 33-34 can be used as unlike poles.
D4NS-□F□	2NC/1NO MBB *			Only NC contacts 11-12 and 21-22 have a certified direct opening mechanism. The terminals 11-12, 21-22 and 33-34 can be used as unlike poles.

* MBB (Make Before Break) contacts have an overlapping structure, so that before the normally closed contact (NC) opens, the normally open contact (NO) closes.

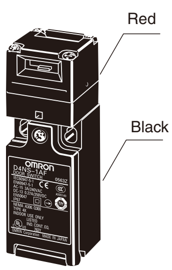
Dimensions

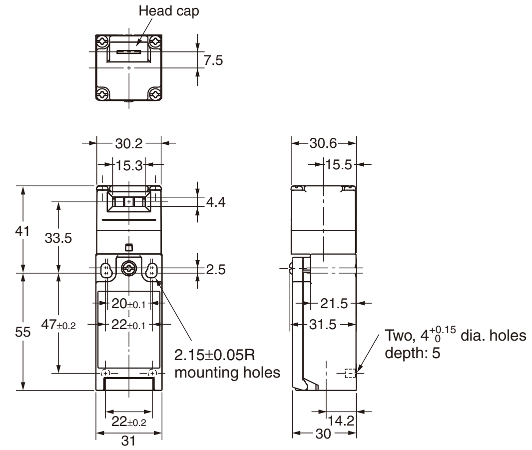
(Unit: mm)

Dimensions and Operating Characteristics

1-Conduit Models

D4NS-1□F
D4NS-2□F
D4NS-3□F
D4NS-4□F



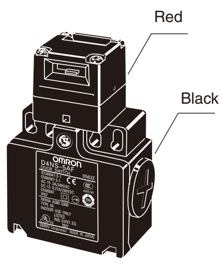


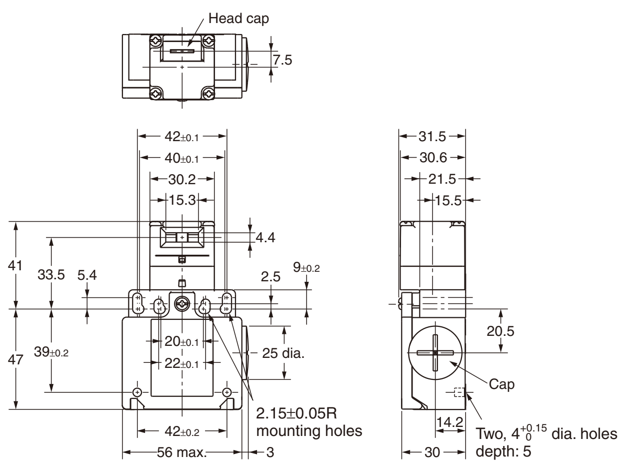
Operating characteristics \ Model	D4NS-1□F D4NS-2□F D4NS-3□F D4NS-4□F
Key insertion force Key extraction force	15 N max. 30 N max.
Pretravel (PT)	6±3 mm
Total travel (TT)	(28 mm)
Direct opening force* Direct opening stroke*	60 N min. 10 mm min.

* Always maintain the above operating characteristics for safe use.

2-Conduit Models

D4NS-5□F
D4NS-6□F
D4NS-7□F
D4NS-8□F



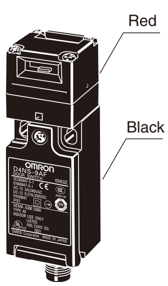


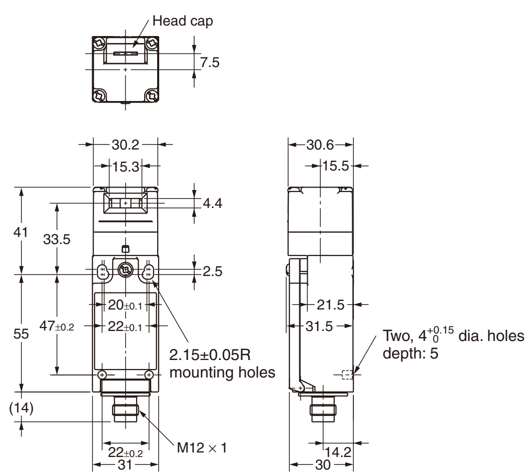
Operating characteristics \ Model	D4NS-5□F D4NS-6□F D4NS-7□F D4NS-8□F
Key insertion force Key extraction force	15 N max. 30 N max.
Pretravel (PT)	6±3 mm
Total travel (TT)	(28 mm)
Direct opening force* Direct opening stroke*	60 N min. 10 mm min.

* Always maintain the above operating characteristics for safe use.

1-Conduit Connector Models

D4NS-9□F





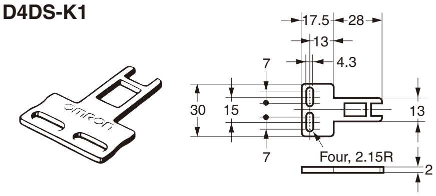
Operating characteristics \ Model	D4NS-9□F
Key insertion force Key extraction force	15 N max. 30 N max.
Pretravel (PT)	6±3 mm
Total travel (TT)	(28 mm)
Direct opening force* Direct opening stroke*	60 N min. 10 mm min.

* Always maintain the above operating characteristics for safe use.

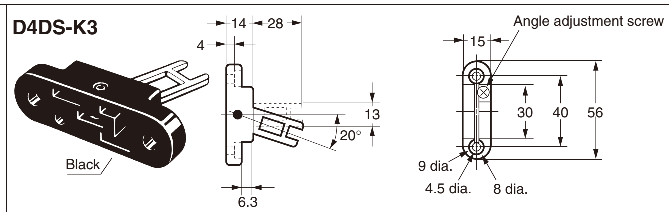
Note: 1. Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.
2. There are fluctuations in the contact ON/OFF timing for Switches with multiple poles (2NC, 2NC/1NO, or 3NC). Confirm performance before application.

Operation Keys

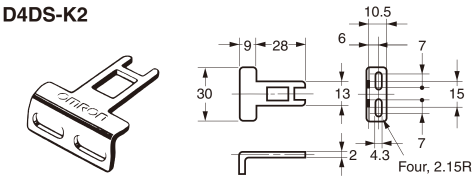
D4DS-K1



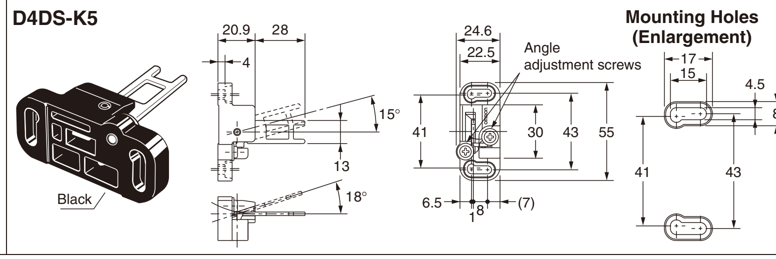
D4DS-K3



D4DS-K2



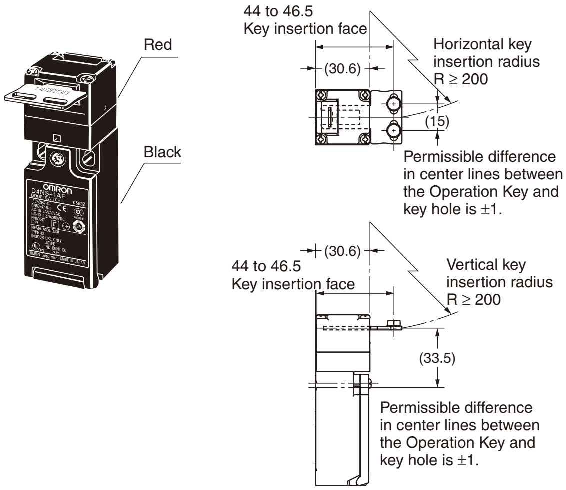
D4DS-K5



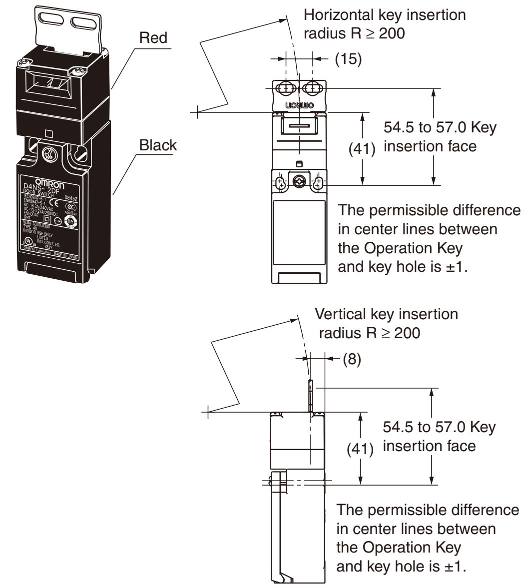
Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

With Operation Key Inserted (Relationship between Insertion Radius and Key Hole)

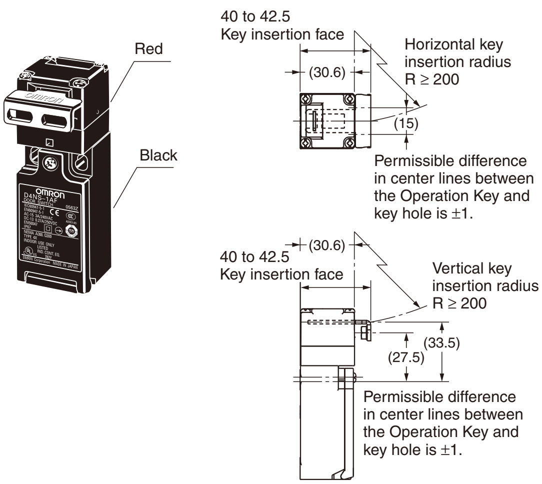
D4NS-1□F + D4DS-K1 (with Front-inserted Operation Key)



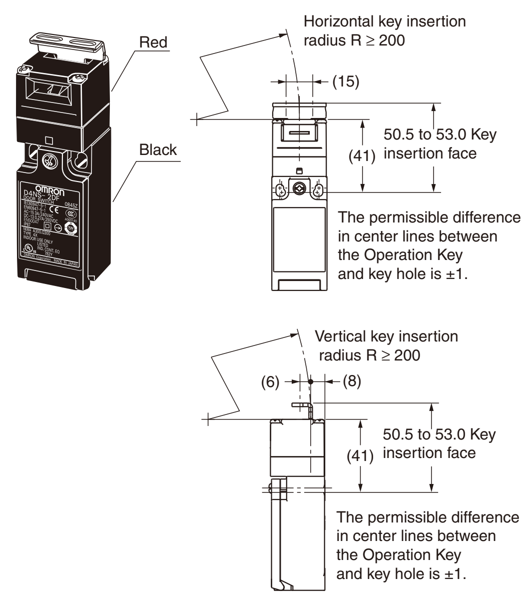
D4NS-1□F + D4DS-K1 (with Top-inserted Operation Key)



D4NS-1□F + D4DS-K2 (with Front-inserted Operation Key)

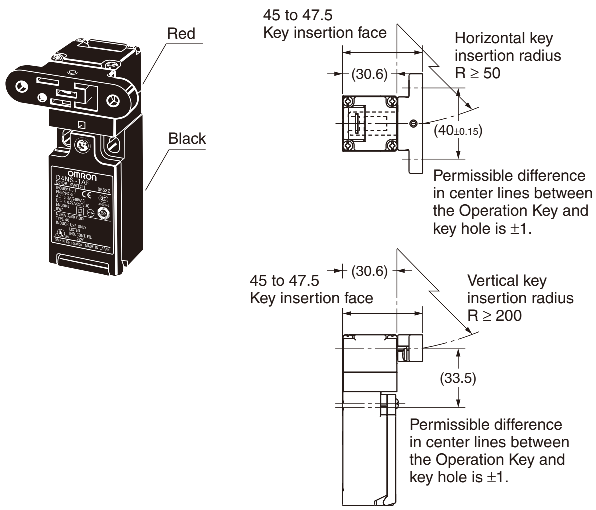


D4NS-1□F + D4DS-K2 (with Top-inserted Operation Key)

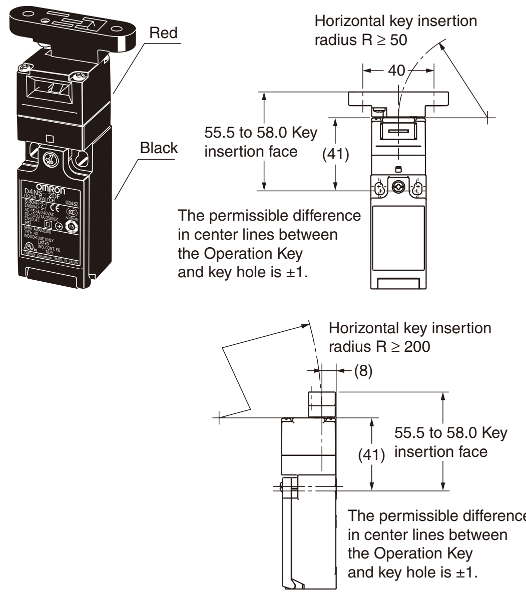


Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

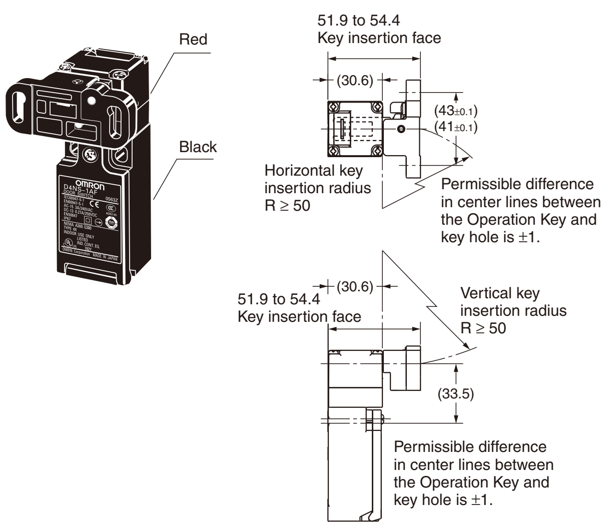
D4NS-1□F + D4DS-K3 (with Front-inserted Operation Key)



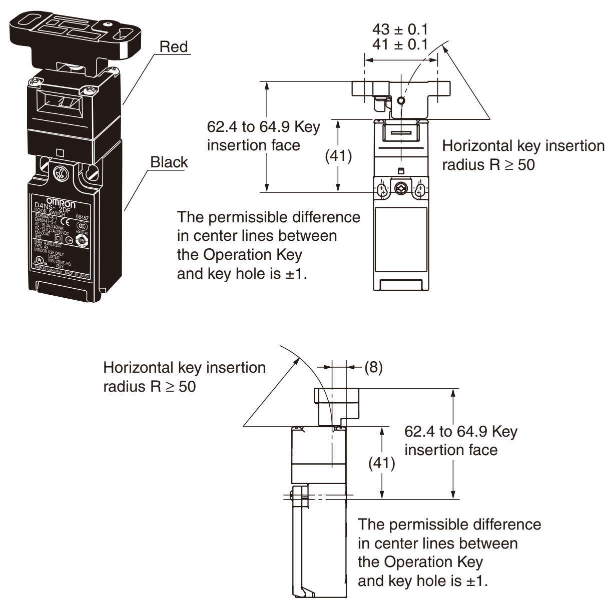
D4NS-1□F + D4DS-K3 (with Top-inserted Operation Key)



D4NS-1□F + D4DS-K5 (with Front-inserted Operation Key)



D4NS-1□F + D4DS-K5 (with Top-inserted Operation Key)



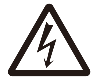
Note: Unless otherwise specified, a tolerance of ±0.4 mm applies to all dimensions.

Safety Precautions

Refer to the *"Precautions for All Switches"* and *"Precautions for All Safety Door Switches"*.

⚠ CAUTION

Electric shock may occasionally occur.
Do not use metal connectors or metal conduits.

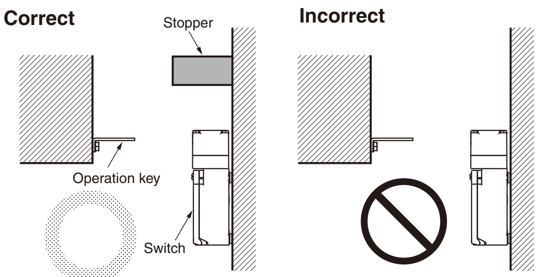


Precautions for Safe Use

- Do not use the Switch submersed in oil or water or in locations continuously subject to splashes of oil or water. Doing so may result in oil or water entering the Switch. (The IP67 degree of protection of the Switch specifies the amount of water penetration after the Switch is submerged in water for a certain period of time.)
- Always attach the cover after completing wiring and before using the Switch. Also, do not turn ON the Switch with the cover open. Doing so may result in electric shock.
- Do not switch circuits for two or more standard loads (250 VAC, 3 A) at the same time. Doing so may adversely affect insulation performance.

Stopper Installation

Do not use a Switch as a stopper. Be sure to install a stopper as shown in the following illustration to ensure that the base of the Operation Key does not strike the Head, and adjust the stopper to be within the setting zone (0.5 to 3 mm) of the base of the Operation Key. Do not subject the Switch to a shock that exceeds the Switch's shock resistance of 1,000 m/s^2.



Precautions for Correct Use

The Switch contacts can be used with either standard loads or microloads. Once the contacts have been used to switch a load, however, they cannot be used to switch smaller loads. The contact surfaces will become rough once they have been used and contact reliability for smaller loads may be reduced.

Mounting Method

Appropriate Tightening Torque

- Loose screws may result in malfunction. Tighten the screws to the specified torques.

Terminal screw	0.6 to 0.8 N·m
Cover mounting screw	0.5 to 0.7 N·m
Head mounting screw	0.5 to 0.6 N·m
Operation Key mounting screw	2.4 to 2.8 N·m
Body mounting screw	0.5 to 0.7 N·m
Connector and M12 adaptor	1.8 to 2.2 N·m (except 1/2-14NPT)
	1.4 to 1.8 N·m (1/2-14NPT)
Cap screw	1.3 to 1.7 N·m

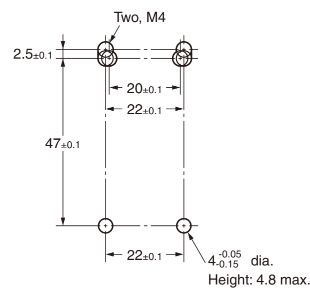
- When loosening a screw with an electrical screwdriver or similar tool while pressing down on the screw head, do not continue turning the screw past the point where the threads disengage. Doing so may strip the end of the threads.

Mounting Holes

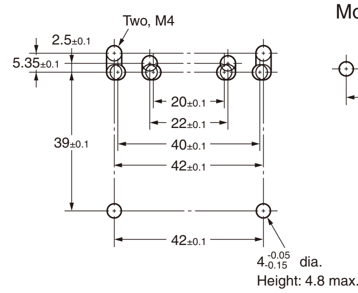
- Use M4 screws and washers to mount the Switch and Operation Key, and tighten the screws to a suitable torque. To ensure safety, use screws that cannot be easily removed or another means to prevent the Switch and Operation Key from easily being removed.
- As shown below, two studs with a maximum height of 4.8 mm and a diameter of $4^{-0.05}_{-0.15}$ mm can be provided, the studs inserted into the holes on the bottom of the Switch, and the Switch secured at four locations to increase the mounting strength.

Switch Mounting Holes and Studs

- 1-Conduit Modules

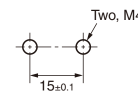


- 2-Conduit Modules

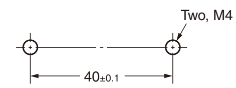


Operation Key Mounting Holes

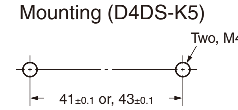
- Horizontal/Vertical Mounting (D4DS-K1/-K2)



- Horizontal Adjustable Mounting (D4DS-K3)



- Horizontal/Vertical Adjustable Mounting (D4DS-K5)



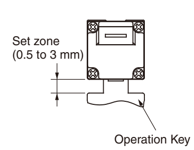
- Set the Operation Key so that it is within 1 mm of the center of the key hole. If the Operation Key is offset or at an angle, accelerated wear or breaking may result.
- Observe the specified insertion radius for the Operation Key and insert it in a direction perpendicular to the key hole.

Head Direction

- The rotation of the Switch head may be adjusted to any of the four directions by loosening the head mounting screws at the four corners of the head. Make sure that no foreign materials enter through the head.
- Do not insert or remove the Operation Key with the Switch head removed. Doing so may make it impossible to insert the Operation Key.

Securing the Door

When the door is closed (with the Operation Key inserted), the Operation Key may exceed the set zone because of, for example, the door's own weight, machine vibration, or the door cushion rubber. Secure the door with a stopper so that the Operation Key remains within the set zone.

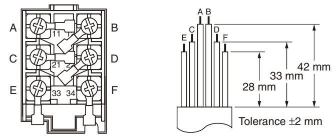


Wiring

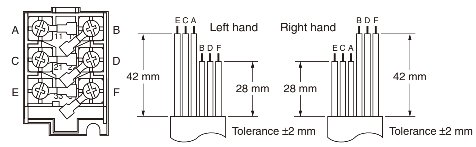
Wiring

- When connecting with insulation tubes and M3.5 crimp terminals, connect the terminals as shown in the following figure and wire without overriding to the case and the cover. Adequate conductor size is AWG 20 to AWG18 (0.5 to 0.75 mm^2).
  Prepare lead wires using the lengths given in the following diagrams. If lead wires are too long, they will press against the cover causing the cover to not close properly.

1-Conduit Models with 3 Poles



2-Conduit Models with 3 Poles



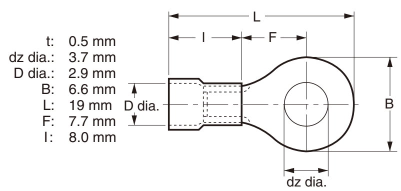
- Do not push the crimp terminal and the likes into the opening between the parts to prevent the case from being broken and deformed.
- Use terminals having the thickness of 0.5 mm or less to avoid the contact between the terminal and the Switch case inside.
  The terminals listed below have thickness of 0.5 mm or less.

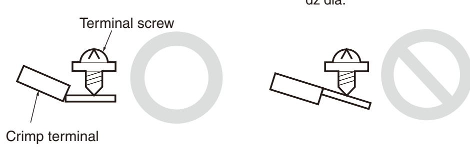
<Reference>

The crimp terminals listed below have a thickness of 0.5 mm or less.

Manufacture	Type
J.S.T. Mfg Co.	FN0.5-3.7 (F Type)
	N0.5-3.7 (Straight Type)

J.S.T is a Japanese manufacturer.





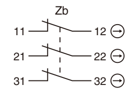
Correct **Incorrect**

Contact Arrangement

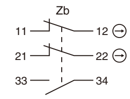
- The contact arrangements are shown below.

(Screw terminal type)

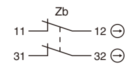
D4NS-□DF (3NC)



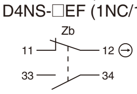
D4NS-□CF (2NC/1NO)
D4NS-□FF (2NC/1NO (MBB))



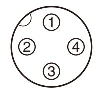
D4NS-□BF (2NC)



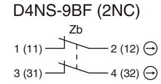
D4NS-□AF (1NC/1NO)
D4NS-□EF (1NC/1NO (MBB))



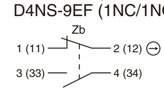
(Connector type)



D4NS-9BF (2NC)



D4NS-9AF (1NC/1NO)
D4NS-9EF (1NC/1NO (MBB))



Pin No. (Terminal No.)

- Suitable socket is XS2F-D421 series (OMRON).
- Refer to the Connector Catalog for corresponding Socket pin numbers and lead wire colors.

Socket Tightening (Models with Connectors)

- Turn the tightening screws on the Socket by hand and tighten them until the gap between the Socket and Plug essentially disappears.
- Make sure that the Socket's connector is tightened securely, otherwise the rated degree of protection (IP67) of the D4NS may not be maintained, or the Socket connector may be loosened by vibration.

Conduit Opening

- When using 1/2-14NPT conduits, apply sealing tape between the connector and conduit opening to maintain the degree of protection (IP67) of the Switch.
- Use cables with suitable diameters for the connector being used.
- When wiring, place the enclosed cap screw on unused conduit openings (for 2-Conduit Switches) and tighten them to the suitable tightening torque.

Recommended Connectors

Use the connector with thread section of 9 mm long or less. If a connector with a longer thread section is used, the protruding part may interfere with the other parts inside the body. Use the connectors listed below to ensure IP67 degree of protection.

Size	Manufacture	Model	Applicable cable diameter
G1/2	LAPP	ST-PF1/2 5380-1002	6.0 to 12.0 mm
Pg13.5	LAPP	S-13.5 5301-5030	6.0 to 12.0 mm
M20	LAPP	ST-M20 × 1.5 5311-1020	7.0 to 13.0 mm
1/2-14NPT	LAPP	ST-NPT1/2 5301-6030	6.0 to 12.0 mm

When use LAPP's products, use together with a Seal Packing which is sold separately (Type names, JPK-16, GP-13.5, or GPM20) and tighten with proper tightening torque.

- LAPP is a German manufacturer.
- Before using a 2-conduit type 1/2-14NPT connector, attach the enclosed adapter to the Switch, and used the above connector.

Production Discontinuation

Following the release of the D4NS, production of the D4DS was discontinued.

Date of Production Discontinuation

Production of the D4DS Series was discontinued as of the end of March 2006.

Recommended Substitute Product

Sale of the D4NS Series commenced in July 2003.

Product Substitution

1. Dimensions
   The D4DS and D4NS have basically the same structure, and use the same mounting method, Operation Keys, mounting hole and Operation Key insertion positions. The multi-contact structure and the extra 4 mm in length, however, are different.
2. Terminal Numbers
   For the 2-contact model, the terminals 21, 22, 23, and 24 on the D4DS are 31, 32, 33, and 34 on the D4NS.
3. Recommended Terminals
   If the recommended terminals are not used, the Switch may not be compatible. Make sure that the Switch is compatible with the terminals.

Comparison with Discontinued Products

Model	D4NS-□
Switch color	Very similar
Dimensions	Very similar
Wiring/connection	Significantly different
Mounting method	Completely compatible
Ratings/performance	Very similar
Operating characteristics	Very similar
Operating method	Completely compatible

Discontinued Products and Recommended Substitute Products

Switch

Discontinued Product	Recommended Substitute Product
D4DS-15FS	D4NS-1AF
D4DS-25FS	D4NS-2AF
D4DS-35FS	D4NS-3AF
D4DS-55FS	D4NS-5AF
D4DS-65FS	D4NS-6AF
D4DS-1AFS	D4NS-1BF
D4DS-2AFS	D4NS-2BF
D4DS-3AFS	D4NS-3BF
D4DS-5AFS	D4NS-5BF
D4DS-6AFS	D4NS-6BF

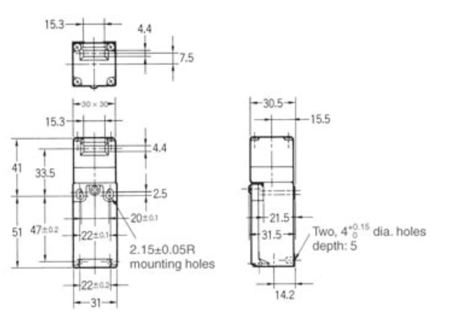
Operation Key

- D4DS-K1
- D4DS-K2
- D4DS-K3
- D4DS-K5

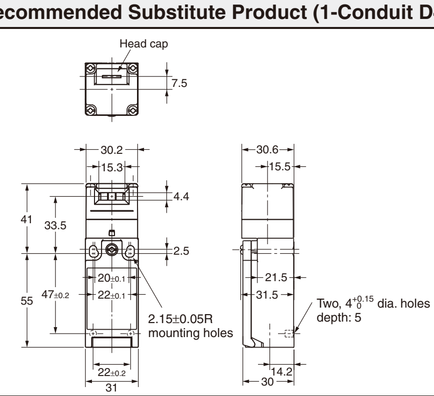
All of the above Operation Keys can be used with the D4NS.

Dimensions (Unit: mm)

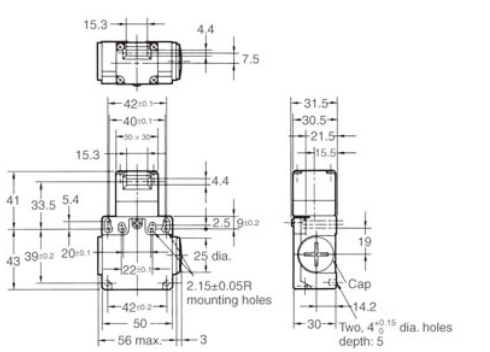
Discontinued Product (1-Conduit D4DS)



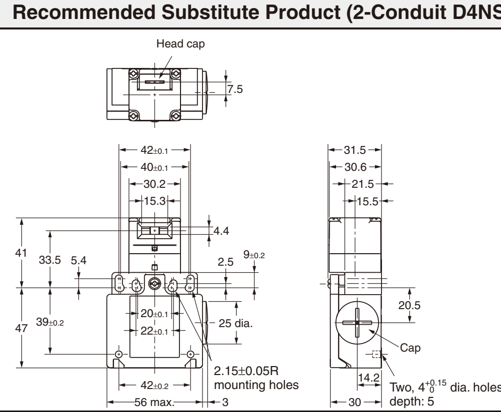
Recommended Substitute Product (1-Conduit D4NS)



Discontinued Product (2-Conduit D4DS)



Recommended Substitute Product (2-Conduit D4NS)



Precautions for All Safety Door Switches

Note: Refer to the *Safety Precautions* section for each Switch for specific precautions applicable to each Switch.

⚠ CAUTION

Do not insert the Operation Key when the door is open. The machine may operate, possibly causing injury.

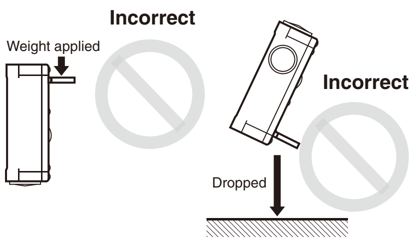
Precautions for Safe Use

- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch body is protected from the ingress of dust or water, avoid the ingress of foreign substance through the key hole on the head. Otherwise, accelerated wear, breaking, or malfunction may result.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch in a starting circuit. (Use the Switch for safety confirmation signal purposes.)
- Connect a fuse in series with the Switch to protect it from short-circuit damage. The value of the breaking current of the fuse must be calculated by multiplying the rated current by 150% to 200%.
  When using the Switch for an EN rating, use a 10 A fuse of type gI or gG that complies with IEC 60269.
- Mount the Operation Key so that it will not come into contact with persons in the area when the door is opened and closed. Injury may result.
- Do not drop the Switch. Doing so may prevent the Switch from functioning to its full capability.
- Do not under any circumstances disassemble or modify the Switch. Doing so may cause malfunction.

Precautions for Correct Use

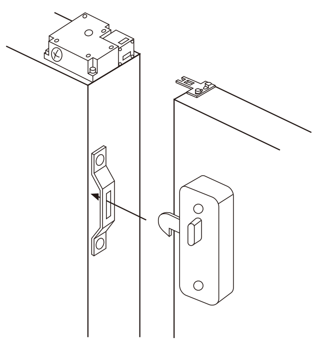
Operation Key

- Use only the designated Operation Key. The Head has been designed so that operation is not possible with a screwdriver or other tools. Using anything other than the designated Operation Key may damage the Switch or affect machine safety.
- Do not operate the Switch with anything other than the special OMRON Operation Key, otherwise the Switch may break or the safety of the system may not be maintained.
- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.



Securing the Door

If the closed door (with the Operation Key inserted) pulls the Operation Key past the operating/lock position (i.e., the set zone) because of, for example, the door's own weight, machine vibration, or the door cushion rubber, the Switch may be damaged.
Also, with a magnetic lock, it may not be possible to unlock the Switch if there is weight placed on the Operation Key. Secure the door with a stopper so that the Operation Key remains within the set zone.



Operating Environment

- Safety Door Switches are designed for use indoors. Using a Switch outdoors may damage it.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperature or high humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switch in the following locations:
  - Locations subject to severe temperature changes
  - Locations subject to high temperatures or condensation
  - Locations subject to severe vibration
  - Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - Locations where the Switch may come into contact with thinner or detergents
  - Locations where explosive or flammable gases are present

Storing Switches

Do not store Switches in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

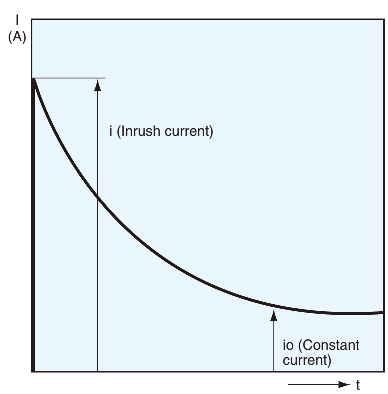
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly.
If the terminal is wired incorrectly, the Switch will not function.
Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

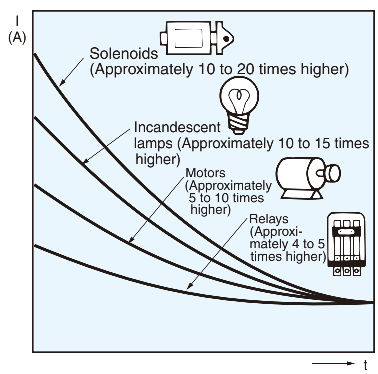
Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

Inductive load:	A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)
Lamp load:	An inrush current 10 times higher than the normal current
Motor load:	An inrush current 6 times higher than the normal current

1. Ambient temperature: 5°C to 35°C
2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

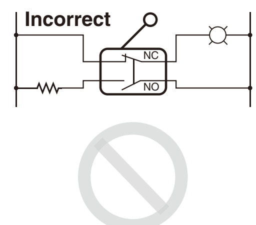
Electrical Conditions

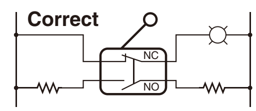
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

Connections

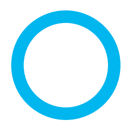
- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

Power Connection Examples
(Connection of Different Polarities)

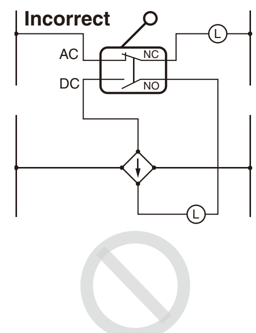




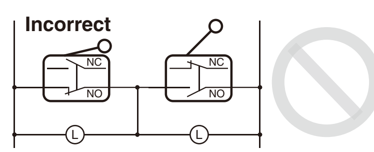
Connect the load to the same polarities.



Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

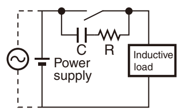
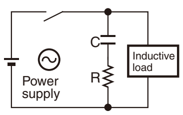
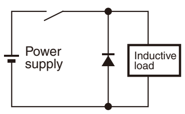
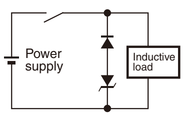
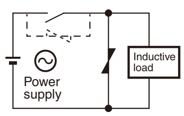


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

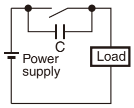
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

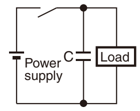
Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

Do not use the following types of contact protection circuit.



This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.

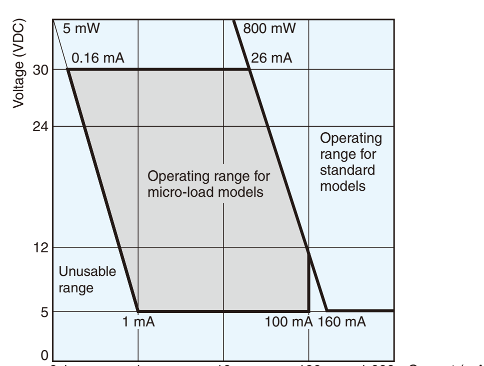


This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

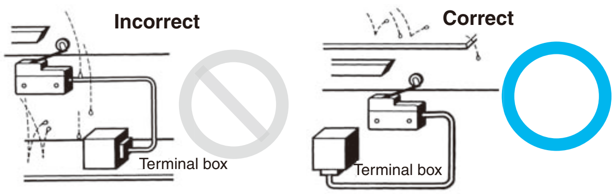
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, λ_{60} = 0.5×10^{-6}/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

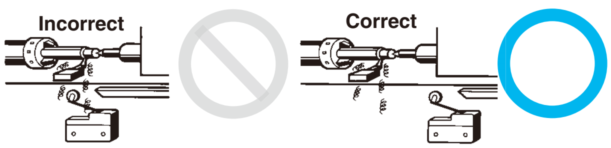


Operating Environment

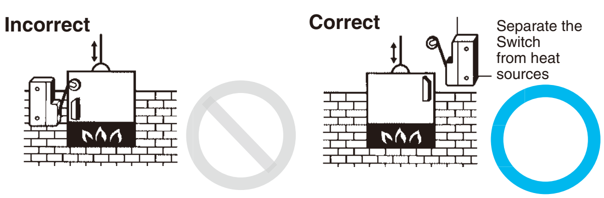
- The Switches are designed for use indoors.
  Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



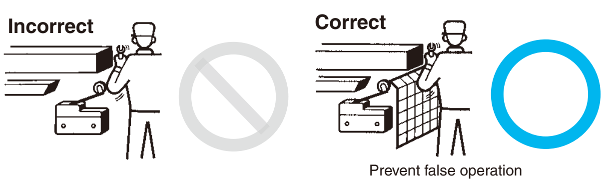
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges.
  The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog.
  If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



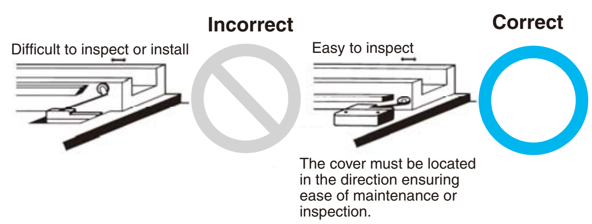
- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.



- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

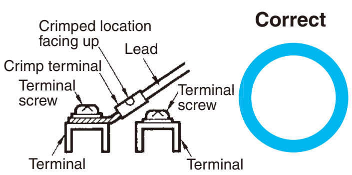
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

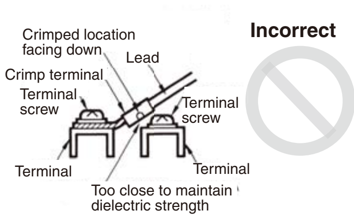
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.2

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

D4NS/D4JL-mounting Slide Keys
D4NS-SK/D4JL-SK

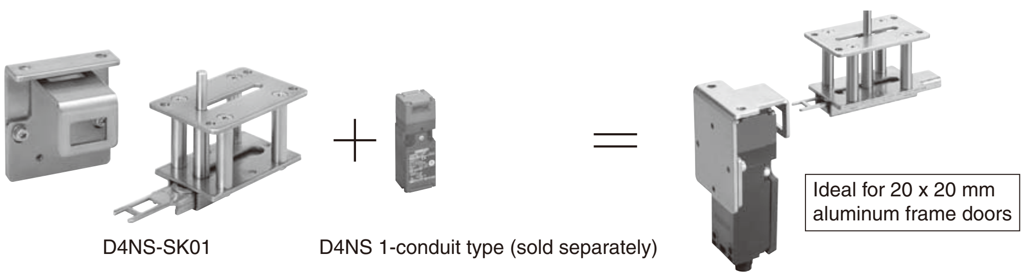
- ■ Safety-door Switch attachments fit doors on aluminum frames as small as 20 mm^2 and frames that are large enough to enclose robotics.
- ■ Shortens the lead time for Safety-door Switch mounting design.
- ■ Enables applications in compliance with ANSI/RIA U.S. robot standards. (Excluding the D4NS-SK01.)

Note: Safety-door Switches are sold separately.

⚠ Be sure to read the *"Safety Precautions"* on page 9 and the *"Precautions for All Safety Door Switches"*.

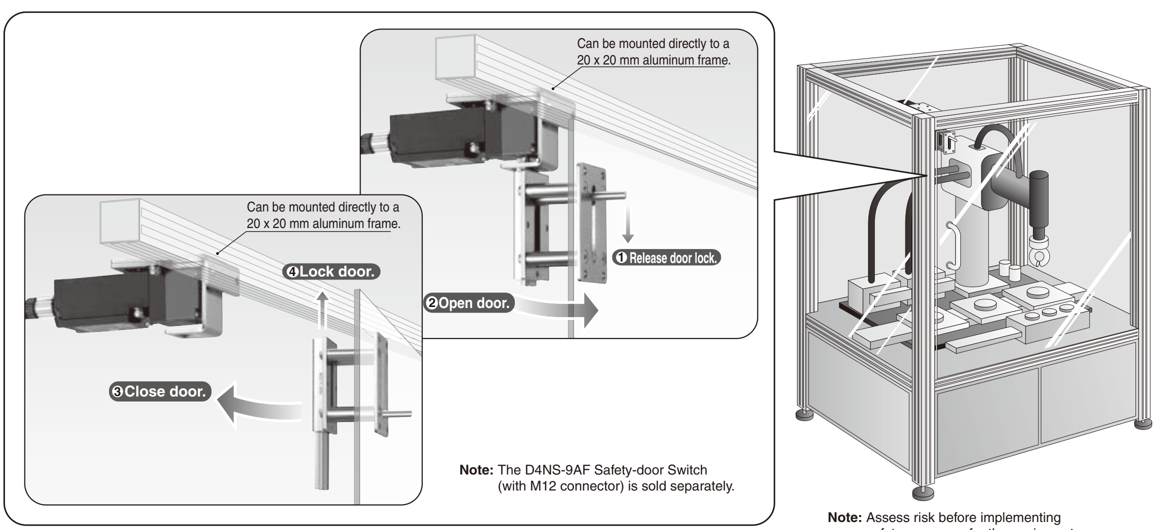
D4NS-SK01

Configuration



Features

Mounts directly to 20 x 20 mm aluminum frames.

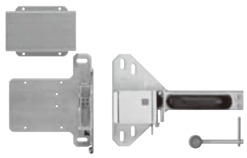


Note: The D4NS-9AF Safety-door Switch (with M12 connector) is sold separately.

Note: Assess risk before implementing safety measures for the equipment.

D4NS-SK30

Configuration



D4NS-SK30

+

D4NS 1-conduit type (sold separately)

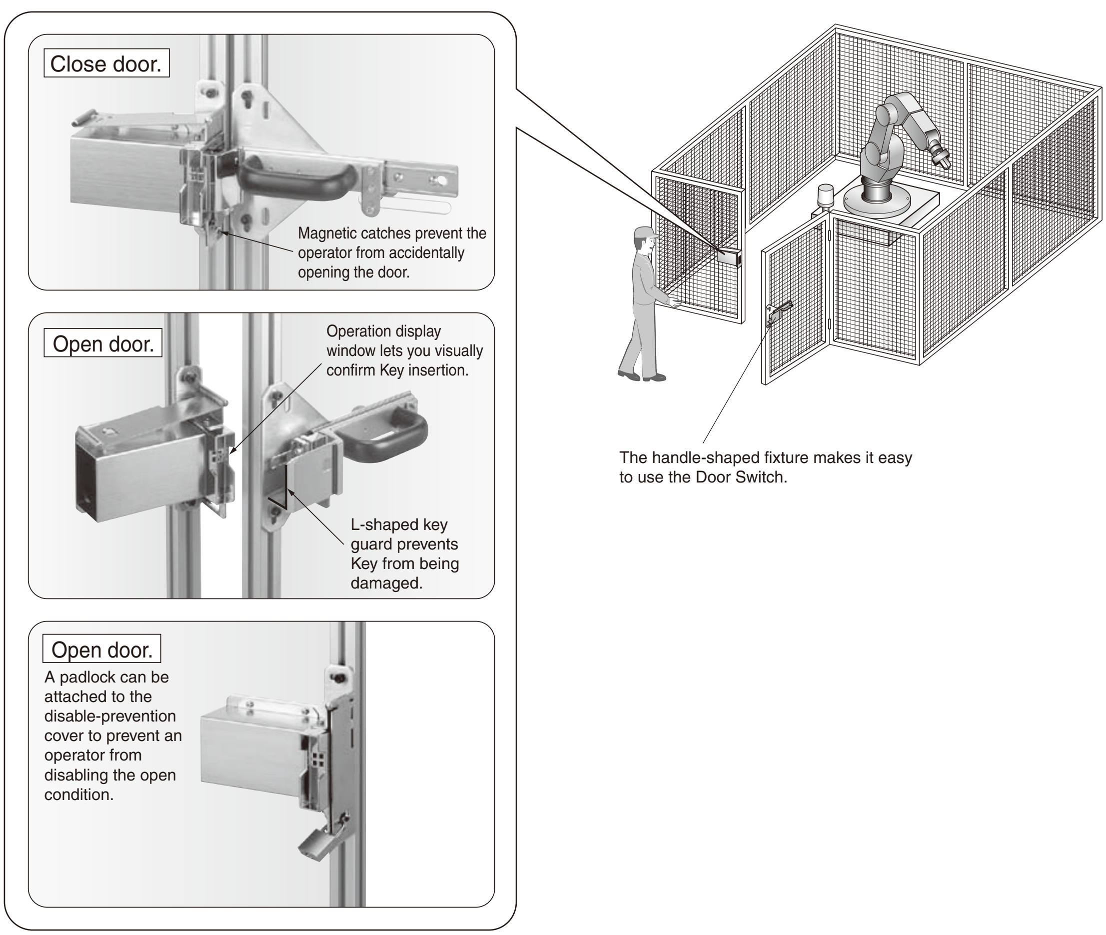
=

Features

- **The L-shaped key guard prevents the Key from being damaged, and helps to guide the Key in smoothly.**
- **When the door is opened, the key hole can be covered by the disable-prevention cover, and a padlock can be attached. The operator's safety is then assured because the door cannot be closed until the padlock is removed.**

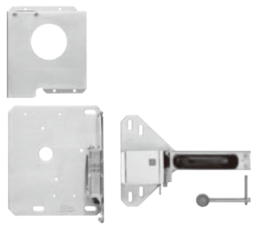
ANSI/RIA R15.06-1999 8.4 Protection of personnel within the safeguarded space
Personnel required to perform tasks within the safeguarded space shall be protected by:
a) Preventing the re-initiation of any motion or hazardous process while personnel are within the safeguarded space, for example locking a gate open;

- **The operation display window lets you visually confirm that the Key has been inserted.**
- **Magnetic catches prevent the door from opening if the operator accidentally bumps into it.**



D4JL-SK40

Configuration

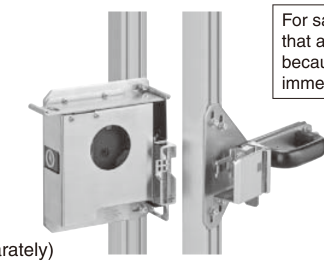


D4JL-SK40

+

D4JL model
with rear release button (sold separately)

=



For safety measures on large doors that are potentially dangerous because their movement cannot be immediately stopped.

Features

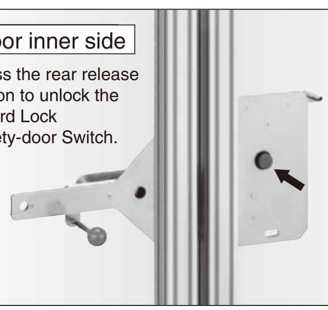
- **Can be combined with the D4JL Guard Lock Safety-door Switch to prevent locked doors from being too easily opened.**
- **Even if an operator were to be trapped inside a hazardous area, the D4JL model with rear release button would allow the operator to unlock the door from the inside with the lever.**

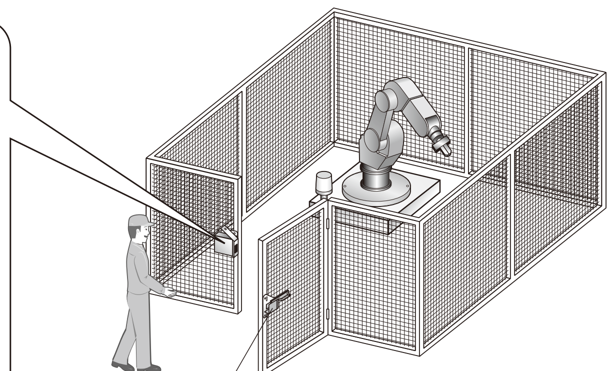
ANSI/RIA R15.06-1999 11.2.2 Interlocking portion
b) The interlocking portion of the interlocked barrier shall be installed, applied, and maintained so that:
8) be capable of being easily unlocked from the inside of the safeguarded space with or without power available, when the possibility of full body access exists;

Close door.

Door inner side

Press the rear release button to unlock the Guard Lock Safety-door Switch.

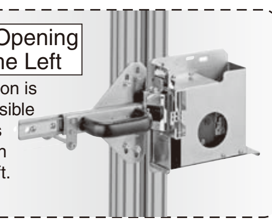




The handle-shaped fixture makes it easy to use the Door Switch.

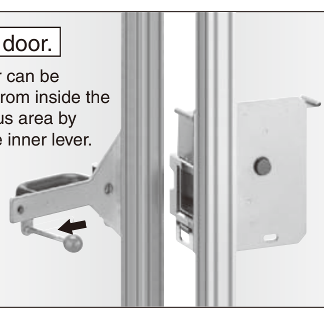
Door Opening to the Left

Application is also possible on doors that open to the left.



Open door.

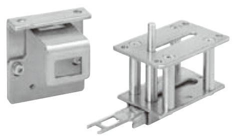
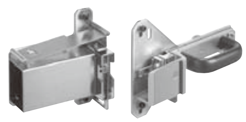
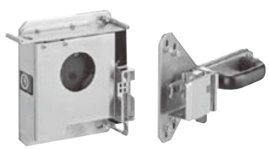
The door can be opened from inside the hazardous area by using the inner lever.



Open door.

A padlock can be attached to the disable-prevention cover to prevent an operator from disabling the open condition.

Ordering Information

Appearance	Specifications	Contents	Model	Applicable Door Switch
	Weight: 422 g Mechanical durability: 20,000 operations min.	Slide Key: 1 Auxiliary mounting bracket: 1 Receptacle bracket: 1	**D4NS-SK01**	D4NS 1-conduit type
	Weight: 2,800 g Mechanical durability: 20,000 operations min.	Slide Key: 1 D4NS mounting tool: 1 Inner lever: 1 Inner lever mounting screws: 2 Door Switch mounting one-way screws: 2 Switch protective cover: 1 Switch protective cover screws: 4 Disable-prevention cover (already mounted on Slide Key): 1	**D4NS-SK30**	D4NS 1-conduit type
	Weight: 3,400 g Mechanical durability: 20,000 operations min.	Slide Key: 1 D4JL mounting tool: 1 Inner lever: 1 Inner lever mounting screws: 2 Door Switch mounting one-way screws: 3 Switch protective cover: 1 Switch protective cover screws: 4 Disable-prevention cover (already mounted on Slide Key): 1	**D4JL-SK40**	D4JL-□□F□-□6 rear release button type

Note: 1. The Door Switch is not included. Select the Door Switch depending on the necessary number of contacts and the conduit size.
2. Perform risk assessment for the equipment in question, configure relay units and other safety circuits, and use properly.
3. Ask your OMRON representative for information on the D4JL-SK30.

Applicable Door Switches

Guard Lock Safety-door Switch
D4JL

- Two safety circuits and two monitor contacts provide an array of monitoring patterns.
- Standard gold-clad contacts enable use with ordinary loads and microloads.
- Models with rear release buttons allow people to unlock the Switch and escape if they are locked into hazardous areas.
- IP67 degree of protection

List of Models

Models with Rear Release Buttons

Release key type	Indicator	Lock and release types	Contact configuration (door open/closed detection switch and lock monitor switch contacts)	Conduit opening	Model
Special release key	Green	Mechanical lock Solenoid release	2NC/1NO+2NC/1NO	PG13.5	**D4JL-1NFA-C6**
				G1/2	**D4JL-2NFA-C6**
				1/2-14NPT	**D4JL-3NFA-C6**
				M20	**D4JL-4NFA-C6**
			2NC/1NO+3NC	PG13.5	**D4JL-1PFA-C6**
				G1/2	**D4JL-2PFA-C6**
				1/2-14NPT	**D4JL-3PFA-C6**
				M20	**D4JL-4PFA-C6**
			3NC+2NC/1NO	PG13.5	**D4JL-1QFA-C6**
				G1/2	**D4JL-2QFA-C6**
				1/2-14NPT	**D4JL-3QFA-C6**
				M20	**D4JL-4QFA-C6**
			3NC+3NC	PG13.5	**D4JL-1RFA-C6**
				G1/2	**D4JL-2RFA-C6**
				1/2-14NPT	**D4JL-3RFA-C6**
				M20	**D4JL-4RFA-C6**

Note: 1. To order models with an orange indicator, replace the "C6" at the end of the model number D4JL-□□FA-C6 with "D6".
2. For details on the D4JL, refer to the *"D4JL"*.
3. Ordinary D4JL types can also be mounted. However, because persons trapped inside the hazardous area cannot unlock the Switch from the inside, ordinary D4JL types do not satisfy ANSI requirements.

Safety-door Switch
D4NS

- Lineup includes three contact models with 2NC/1NO and 3NC contact forms in addition to the previous contact forms 1NC/1NO, and 2NC.
- M12-connector models are available, saving on labor and simplifying replacement.
- Standard gold-clad contacts provide high contact reliability.
  Applicable to both standard loads and microloads.
- Free of lead, cadmium, and hexavalent chrome, reducing the burden on the environment.

List of Models

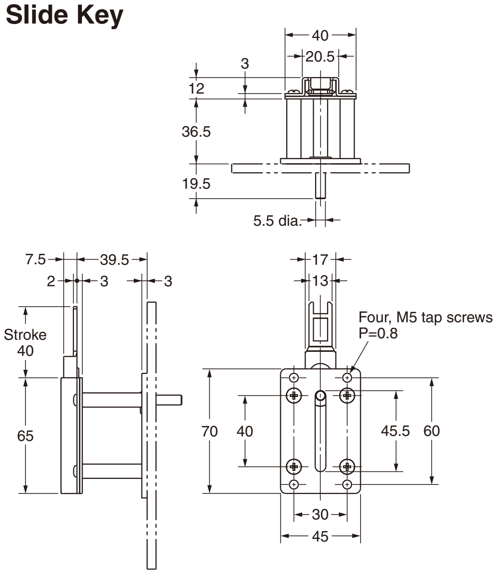
Type	Contact configuration		Conduit opening/ Connector	Model
1-conduit	Slow-action	1NC/1NO	Pg13.5	**D4NS-1AF**
			G1/2	**D4NS-2AF**
			1/2-14NPT	**D4NS-3AF**
			M20	**D4NS-4AF**
		2NC	Pg13.5	**D4NS-1BF**
			G1/2	**D4NS-2BF**
			1/2-14NPT	**D4NS-3BF**
			M20	**D4NS-4BF**
		2NC/1NO	Pg13.5	**D4NS-1CF**
			G1/2	**D4NS-2CF**
			1/2-14NPT	**D4NS-3CF**
			M20	**D4NS-4CF**
		3NC	Pg13.5	**D4NS-1DF**
			G1/2	**D4NS-2DF**
			1/2-14NPT	**D4NS-3DF**
			M20	**D4NS-4DF**
	Slow-action MBB contact	1NC/1NO	Pg13.5	**D4NS-1EF**
			G1/2	**D4NS-2EF**
			1/2-14NPT	**D4NS-3EF**
			M20	**D4NS-4EF**
		2NC/1NO	Pg13.5	**D4NS-1FF**
			G1/2	**D4NS-2FF**
			1/2-14NPT	**D4NS-3FF**
			M20	**D4NS-4FF**
1-conduit connector	Slow-action	1NC/1NO	M12 connector	**D4NS-9AF**
		2NC		**D4NS-9BF**
	Slow-action MBB contact	1NC/1NO		**D4NS-9EF**

Dimensions

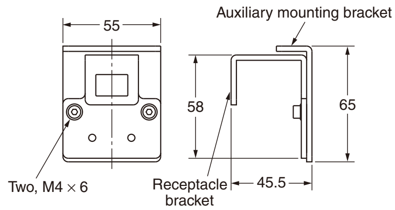
(Unit: mm)

D4NS-SK01

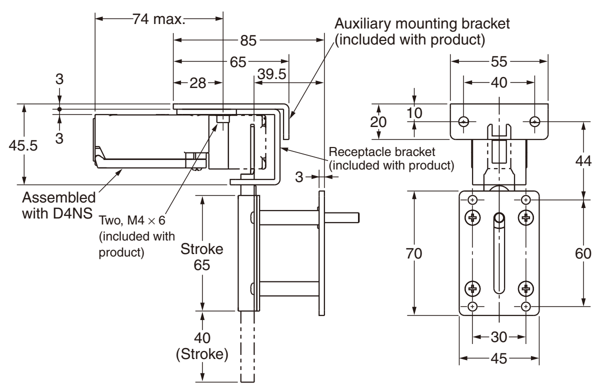
Slide Key



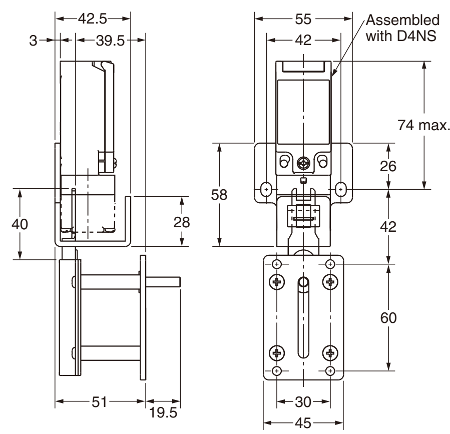
Auxiliary Mounting Bracket and Receptacle Bracket



Switch Mounting Pattern 1

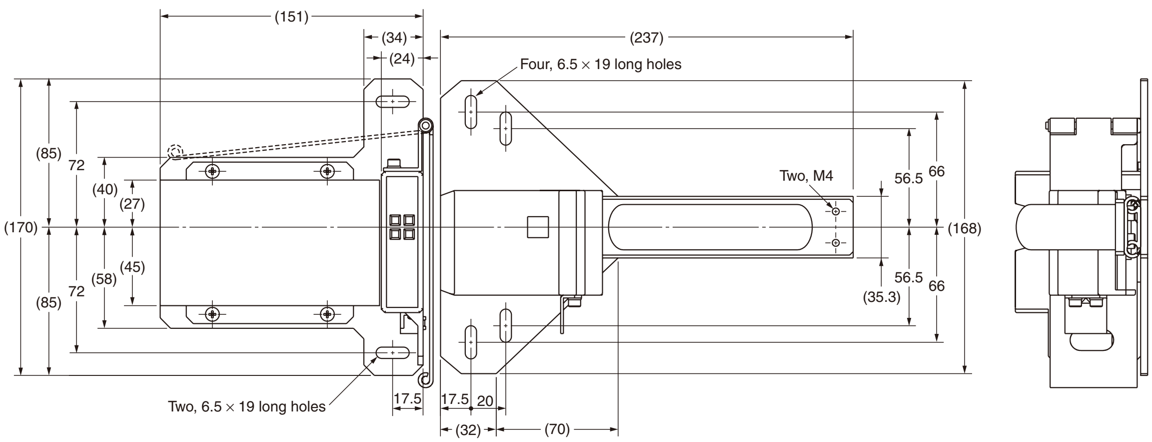


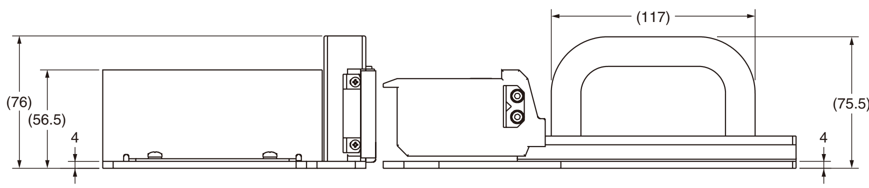
Switch Mounting Pattern 2



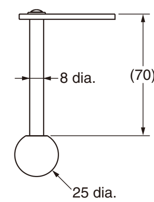
D4NS-SK30

Open Door

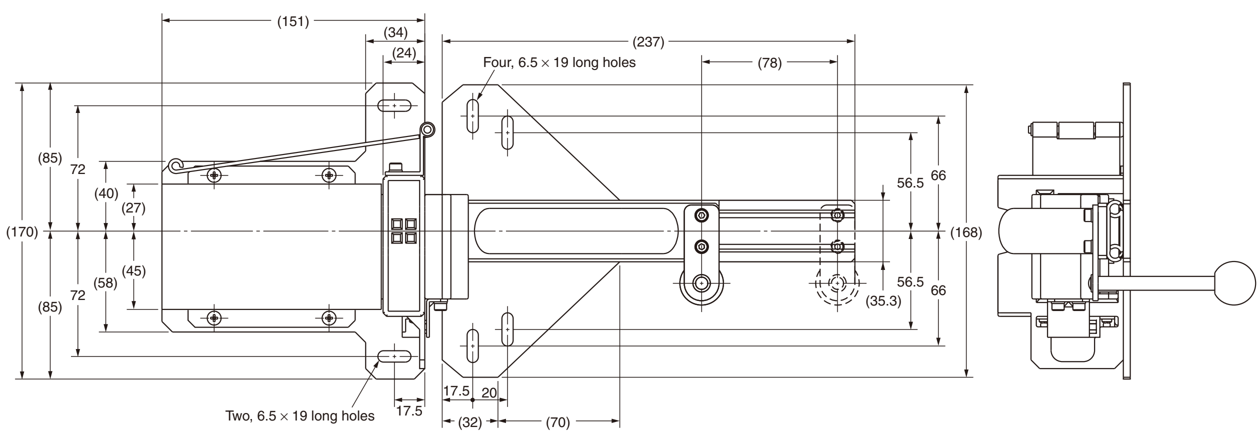


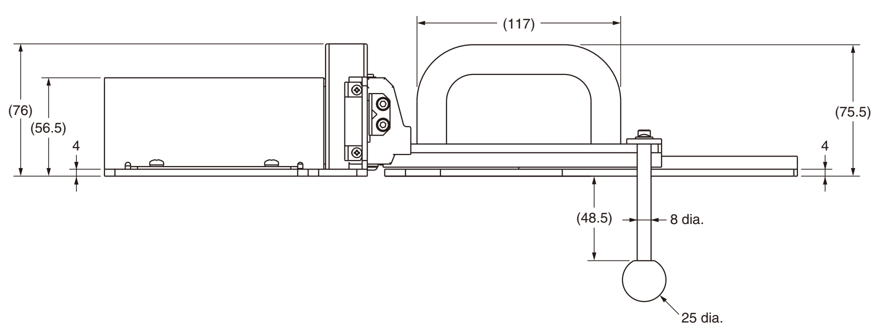


Lever unit



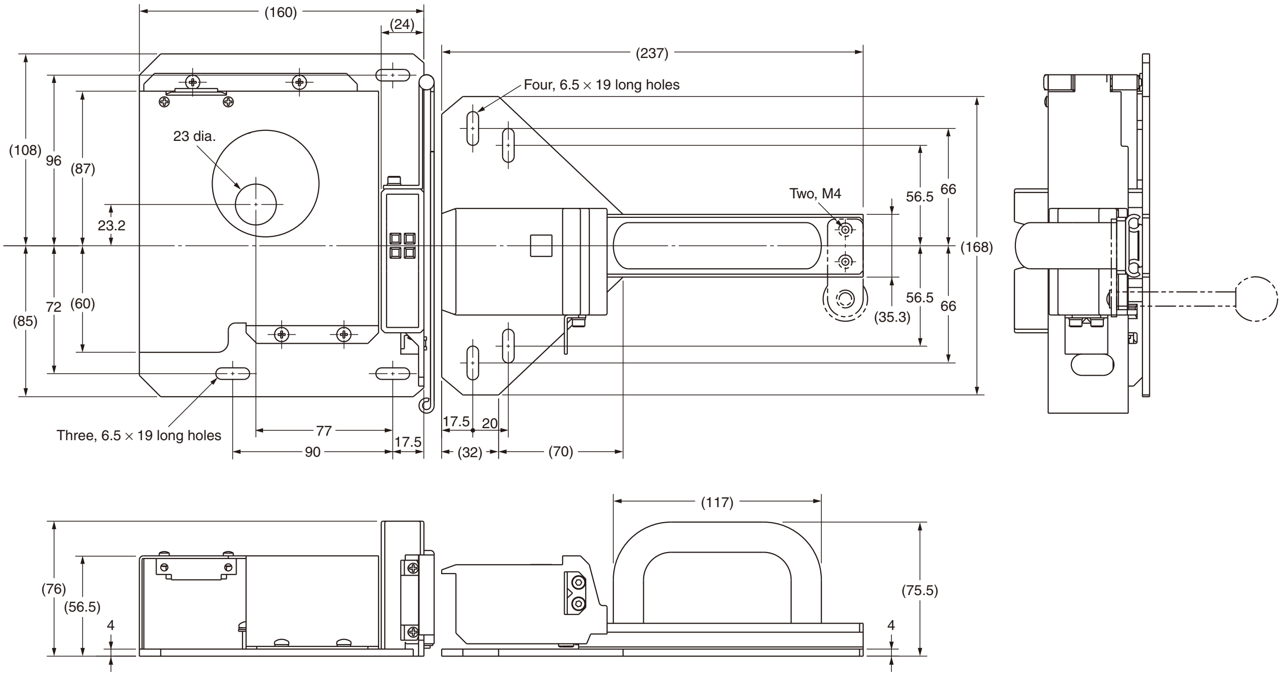
Closed Door



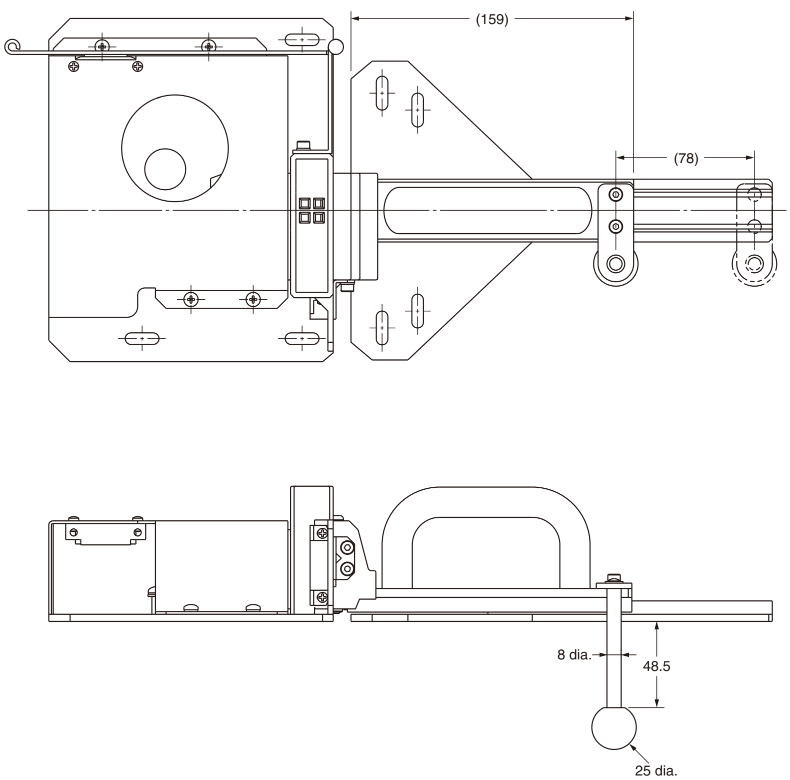


D4JL-SK40

Open Door



Closed Door



Safety Precautions

Refer to the *"Precautions for All Switches"* and *"Precautions for All Safety Door Switches"*.

⚠ CAUTION

Incorrect operation may cause injury. Also, the product is designed to be mounted so that it slides horizontally. Do not mount the product in a vertically sliding configuration.

Precautions for Safe Use

- Do not drop the Switch. Doing so may prevent the Switch from functioning to full capacity.
- Mount the Switch securely to prevent it from falling. Otherwise, injuries may occur.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Make sure that the gap between the shot bolt and guide is (±3 mm. Otherwise, excessive wear or damage may cause malfunction.
- To ensure safety, do not operate the Switch with anything other than a Slide Key.
- Be careful to avoid pinching your hand when operating the Switch.
- Be sure to mount the Switch protective cover. Otherwise, your hand may be injured by being pinched between the shot bolt and Switch when closing the door with your hand on the Switch.
- When opening the door, be sure to lower the disable-prevention cover into position, attach a padlock, or take other steps to prevent other people from operating the Switch.
- The durability of the Switch is greatly influenced by the switching conditions. Always test the Switch under actual working conditions before application and use it in a switching circuit for which there are no problems with performance.
- The user must not maintain or repair equipment incorporating the Switch. Contact the manufacturer of the equipment for any maintenance or repairs required.
- Refer to the D4JL Guard Lock Safety-door Switch, D4NS Safety-door Switch Datasheet, Instruction Sheet for details and handling information on the Switch.
- Do not shut the door while the shot bolt is extended. The Switch may be damaged, preventing proper operation.

Precautions for Correct Use

- Insert the slide handle until the red operation indicator is completely displayed in the operation display window.

Normal　　Insufficient insertion

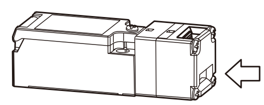
Operation display window

- Loose screws may result in malfunction. Use washers and tighten the screws to the specified torques. Also, when mounting the Switch to a door for disable-prevention purposes, purchase and use tamper-resistant screws.

Appropriate Tightening Torque

Slide Key mounting screw (M6)		6.0 to 7.0 N·m
Switch mounting screw (included with product)	**For D4JL**	3.2 to 3.8 N·m
	For D4NS	0.5 to 0.7 N·m
Switch protective cover mounting screw (included with product)		1.2 to 1.4 N·m
Lever mounting screw (included with product)		1.2 to 1.4 N·m

- Use the D4NS-SK30 only with the D4NS Safety-door Switch head in the direction shown below.



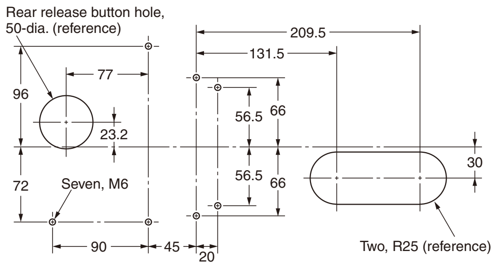
Technical Specifications

	D4JL-SK40	D4NS-SK30
Ambient operating temperature	−10 to 55°C (with no icing)	
Ambient operating humidity	95% max.	
Mechanical durability	20,000 operations min.	
Weight	Approx. 3.4 kg (not including D4JL Guard Lock Safety-door Switch)	Approx. 2.8 kg (not including D4NS Safety-door Switch)

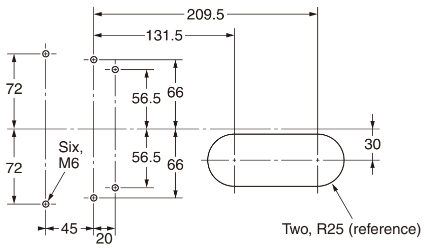
- Do not store the Switch where corrosive gases (e.g., H_2S, SO_2, NH_3, HNO_3, or CL_2) or dust are present, or in locations subject to high temperature or humidity.
- Perform maintenance inspections periodically.
- This product is for use only with OMRON Safety-door Switches. Do not use it with door switches made by other manufacturers.

Mounting Holes (Unit: mm)

D4JL-SK40



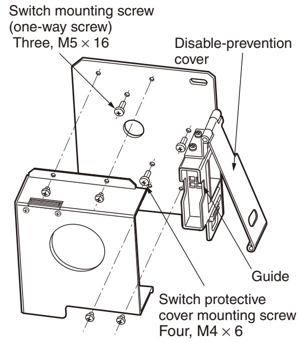
D4NS-SK30



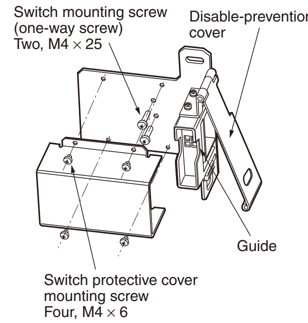
Assembly

Switch part

D4JL-SK40

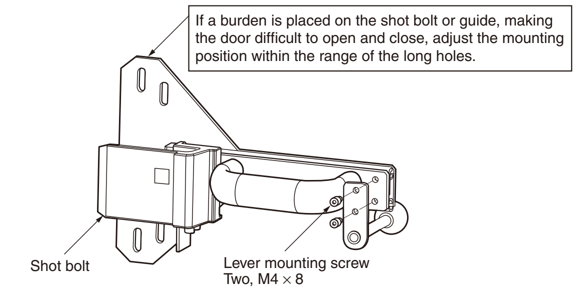


D4NS-SK30



Handle part

D4JL-SK40/D4NS-SK30



Precautions for All Safety Door Switches

Note: Refer to the *Safety Precautions* section for each Switch for specific precautions applicable to each Switch.

⚠ CAUTION

Do not insert the Operation Key when the door is open.
The machine may operate, possibly causing injury.

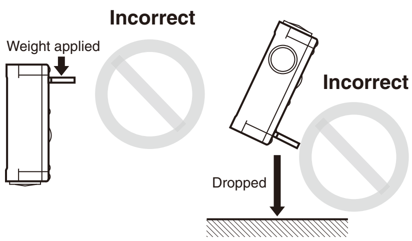
Precautions for Safe Use

- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch body is protected from the ingress of dust or water, avoid the ingress of foreign substance through the key hole on the head. Otherwise, accelerated wear, breaking, or malfunction may result.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch in a starting circuit. (Use the Switch for safety confirmation signal purposes.)
- Connect a fuse in series with the Switch to protect it from short-circuit damage. The value of the breaking current of the fuse must be calculated by multiplying the rated current by 150% to 200%.
  When using the Switch for an EN rating, use a 10 A fuse of type gI or gG that complies with IEC 60269.
- Mount the Operation Key so that it will not come into contact with persons in the area when the door is opened and closed. Injury may result.
- Do not drop the Switch. Doing so may prevent the Switch from functioning to its full capability.
- Do not under any circumstances disassemble or modify the Switch. Doing so may cause malfunction.

Precautions for Correct Use

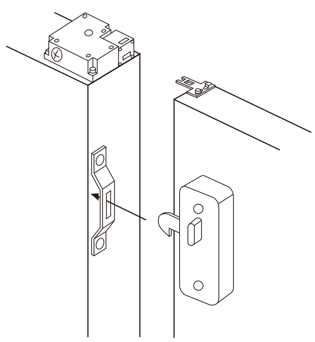
Operation Key

- Use only the designated Operation Key. The Head has been designed so that operation is not possible with a screwdriver or other tools. Using anything other than the designated Operation Key may damage the Switch or affect machine safety.
- Do not operate the Switch with anything other than the special OMRON Operation Key, otherwise the Switch may break or the safety of the system may not be maintained.
- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.



Securing the Door

If the closed door (with the Operation Key inserted) pulls the Operation Key past the operating/lock position (i.e., the set zone) because of, for example, the door's own weight, machine vibration, or the door cushion rubber, the Switch may be damaged.
Also, with a magnetic lock, it may not be possible to unlock the Switch if there is weight placed on the Operation Key. Secure the door with a stopper so that the Operation Key remains within the set zone.



Operating Environment

- Safety Door Switches are designed for use indoors. Using a Switch outdoors may damage it.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperature or high humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switch in the following locations:
  - · Locations subject to severe temperature changes
  - · Locations subject to high temperatures or condensation
  - · Locations subject to severe vibration
  - · Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - · Locations where the Switch may come into contact with thinner or detergents
  - · Locations where explosive or flammable gases are present

Storing Switches

Do not store Switches in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

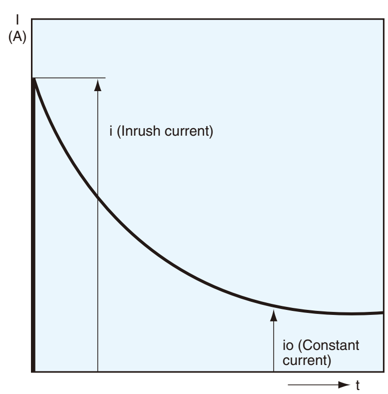
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly.
If the terminal is wired incorrectly, the Switch will not function.
Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

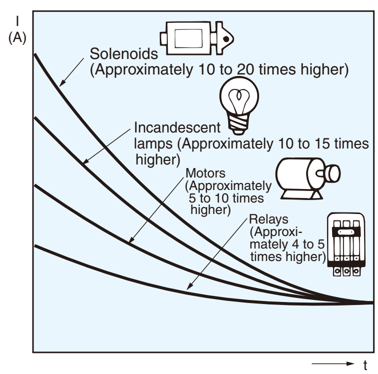
Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

Inductive load:	A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)
Lamp load:	An inrush current 10 times higher than the normal current
Motor load:	An inrush current 6 times higher than the normal current

1. Ambient temperature: 5°C to 35°C
2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

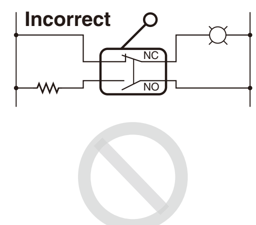
Electrical Conditions

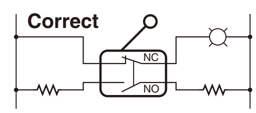
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

Connections

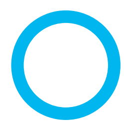
- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

Power Connection Examples
(Connection of Different Polarities)

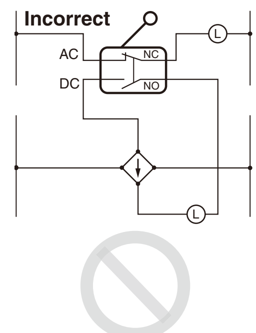




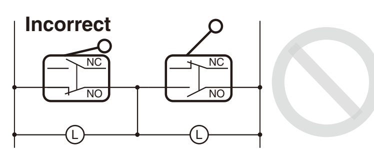
Connect the load to the same polarities.



Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

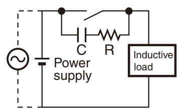
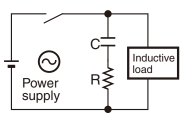
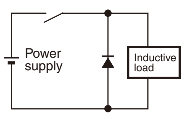
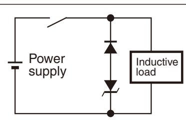
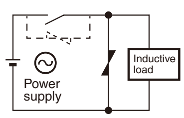


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

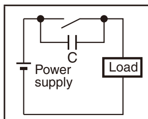
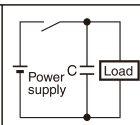
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current AC	Applicable current DC	Features and remarks	Element selection
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 µF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

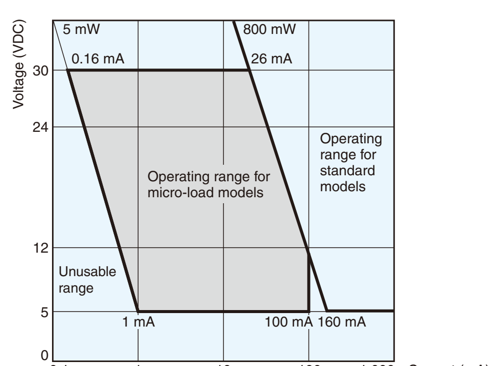
Do not use the following types of contact protection circuit.

	This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.		This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

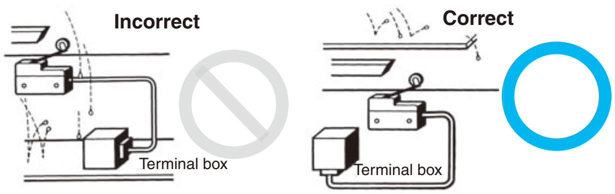
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, $\lambda_{60} = 0.5 \times 10^{-6}$/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

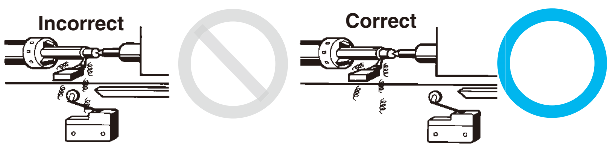


Operating Environment

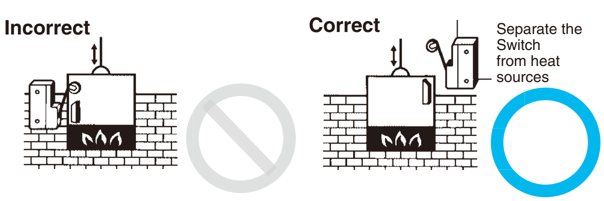
- The Switches are designed for use indoors.
  Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



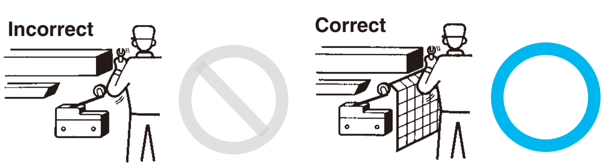
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges.
  The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog.
  If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.

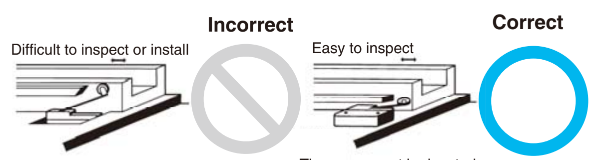


Prevent false operation

- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



The cover must be located in the direction ensuring ease of maintenance or inspection.

Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

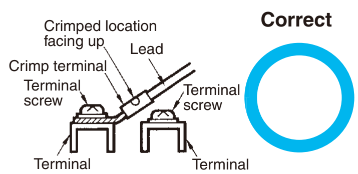
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

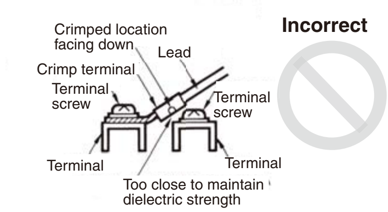
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

- Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

- Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

- Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

- Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

Compact Non-Contact Door Switch/Flexible Safety Unit
D40A/G9SX-NS

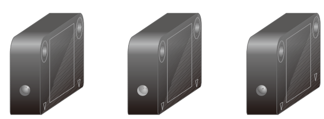
Electronic Detection Mechanism for Better Stability in Non-contact Door Switch Operation

Be sure to read the *"Safety Precautions"* on page 24 and the *"Precautions for All Safety Door Switches"*.

Features

Easy-to-see 2-Color Indicators

Switch status is easy to see at a glance with these red/yellow LED indicators.



Red: Open door detected.

Yellow: Closed door detected.

Not lit: Power OFF or failure

Mount from Either Side

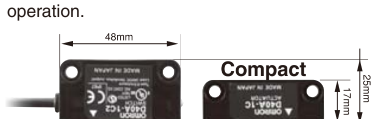
Mount from whichever side provides the easiest wiring path to enable mounting to all types of doors.

Swinging doors

Sliding doors

Small Actuator

An actuator that is smaller than the switch saves space, even inside the door.
Even when mounted with an L-bracket, the actuator's height will not hinder installation or operation.

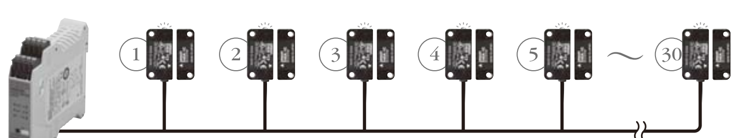


Switch

Actuator

Connect Up to 30 Switches to a Single Controller

Reduce costs by connecting up to 30 Switches to a single Controller.



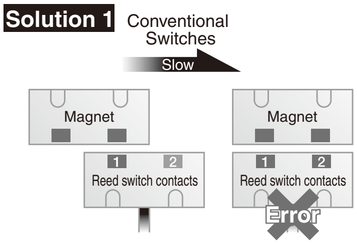
Up to 30 Switches

Solves Conventional Switch Issues to Provide Stable Detection

Issue 1 The Switch does not accurately detect the door when it is closed slowly, resulting in an error.

An error can occur if the door is closed slowly with conventional switches.

Solution 1

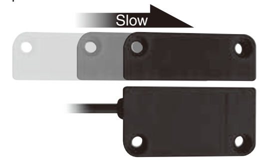


If the switching timing of reed switch contacts 1 and 2 varies too much, the Controller detects an error and turns OFF the output to maintain safety.

Note: The figure is intended only as an illustration.

Stable Detection with the D40A's New System

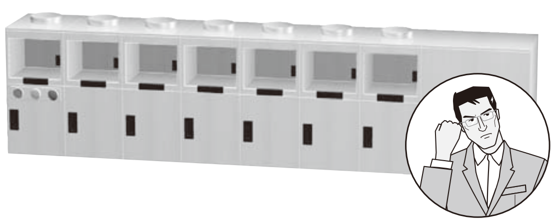
The D40A does not use reed switches and provides stable detection with electronic switches.



Detects slow lateral operation.

Detects slow rotating operation.

Issue 2 It is nearly impossible to tell which door is open in a multi-door application.



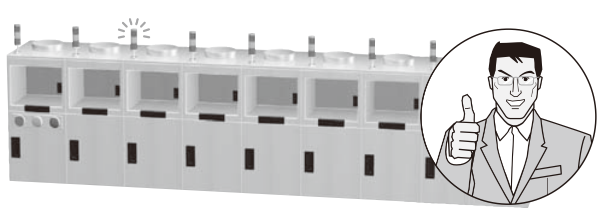
If an error occurs...

The system cannot be started because the Controller has turned OFF the output even though all doors appear to be closed.

It's impossible to tell if there is a door open or if an error has occurred.

All doors must be opened and closed before operation can be started.

Solution 2



With the D40A...

The auxiliary outputs can be used to easily indicate which door is open.
And with two-color indicators, mounting adjustments are also easy.
The D40A is the first Non-contact Door Switch to combine 2-color indicators, auxiliary outputs, and 30-switch connection capacity, allowing you to create a better safety environment.

Two Types of Controller to Solve Productivity, Expandability, and Maintenance Issues

The G9SX-NS and G9SX-NSA are designed specifically for use with the D40A, and with the G9SX-NSA you can also connect mechanical safety door switches. Among other features, these Controllers support logical AND connections that enable partial stops. These Controllers make the most of D40A Switches.

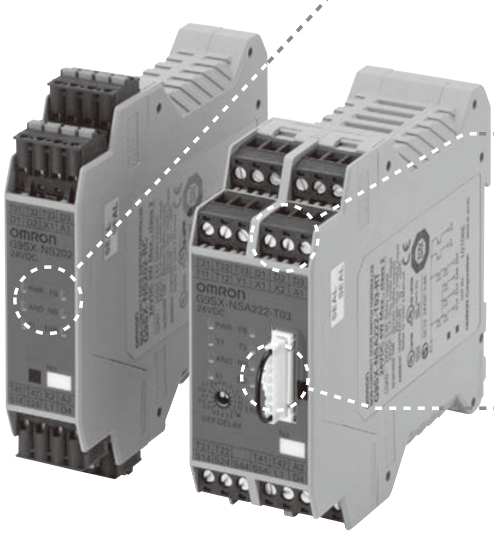
Two Different Controllers

G9SX-NS

- □Logical AND connection input
- □D40A input
- □Two instantaneous safety outputs
- □Logical AND connection output

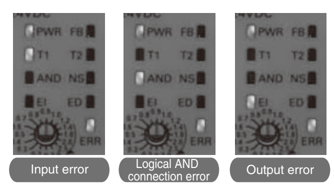
G9SX-NSA

- □Logical AND connection input
- □D40A plus mechanical safety door switch input, channel 1 or 2
- □Two instantaneous safety outputs
- □Two OFF-delay safety outputs
- □Logical AND connection output



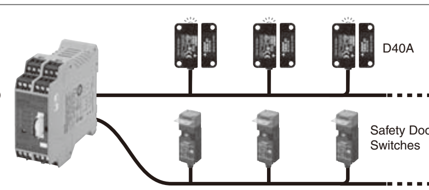
Indicators That Make Maintenance Easier

The indicators show the location and cause of wiring errors and any other errors that are detected. Auxiliary outputs for errors also contribute to reducing down time.



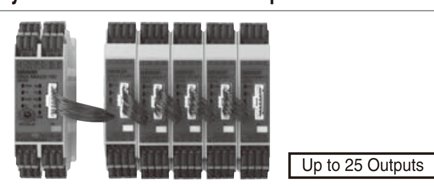
Mechanical Safety Door Switches Can Also Be Connected with the G9SX-NSA

Inputs can be accepted from both D40A Switches and mechanical switches to reduce the number of Controllers and costs.



Expansion Units to Easily Increase the Number of Outputs with the G9SX-NSA

The number of outputs can be easily increased using connectors.
Up to 25 outputs can be configured.



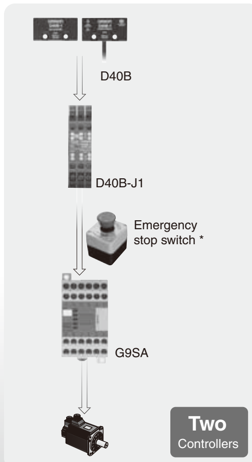
Reduce Costs with these New-Concept Controllers

Issue 1 Two Controllers are required for emergency stop switches and non-contact door switches.

Application

- **One hazard.**
- **The system must be stopped when either a door is opened or an emergency stop switch is pressed.**

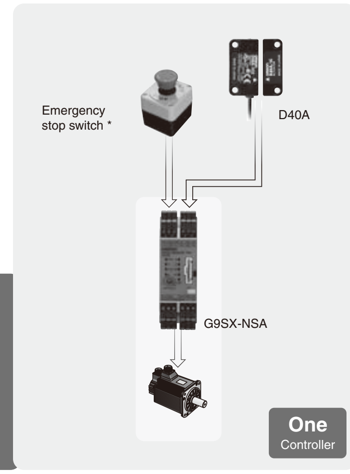
The G9SA must be added to connect the emergency stop switch.



Solution 1

The D40A Simplifies the Configuration

With only one G9SX-NSA222-T03□ Controller, both a Non-contact Door Switch and an emergency stop switch can be connected.

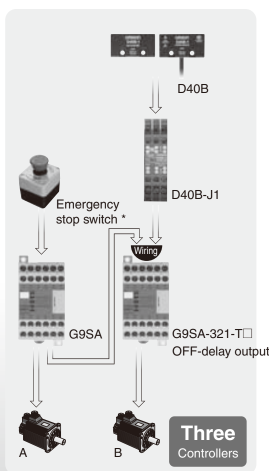


Issue 2 Another Controller has to be added to use an OFF-delay timer.

Application

- **Two hazards.**
- **The power supply must be turned OFF immediately when the emergency stop switch is pressed.**
- **When a door is opened, a stop signal is sent to only servomotor B and then the power supply is turned OFF.**

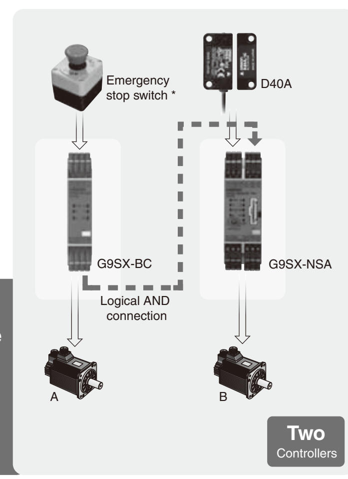
The G9SA must be added to use an OFF-delay timer.



Solution 2

The D40A Simplifies the Configuration

A Controller can be eliminated because the G9SX-NSA222-T03□ provides an OFF-delay output.



* Always use a manual reset when using an emergency stop.

Refer to G9SX for the features of the G9SX Series.

Model Number Structure

Model Number Legend

Non-Contact Door Switch (Switch/Actuator)

D40A - □□□
1 2 3

1. Type
1: Standard model

2. Auxiliary outputs
C: 1NO (PNP transistor output)

3. Cable length
2: 2 m
5: 5 m

Non-Contact Door Switch Controller

G9SX - □□□□□□ - □□□ - □□
1 2 3 4 5 6

1. Functions
NS/NSA: D40A Controller
EX: Expansion Unit

2. Output Configuration (Instantaneous Safety Outputs)
2: 2 outputs
4: 4 outputs

3. Output Configuration (OFF-delayed Safety Outputs)
0: None
2: 2 outputs

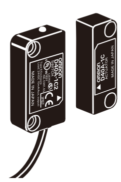
4. Output Configuration (Auxiliary Outputs)
1: 1 output
2: 2 outputs

5. Max. OFF-delay Time
D40A Controller
T03: 3 s (Variable)
Expansion Unit
Blank: No OFF delay
T: OFF delay

6. Terminal Block Type
RT: Screw terminals
RC: Spring-cage terminals

Ordering Information

Non-Contact Door Switches (Switch/Actuator)

Classification	Appearance	Auxiliary outputs	Cable length	Model
Standard models		Semiconductor outputs *	2 m	**D40A-1C2**
			5 m	**D40A-1C5**

Note: Must be used in combination with a G9SX-NS□ Non-contact Door Switch Controller.
* PNP open-collector semiconductor output.

Non-Contact Door Switch Controllers (Controllers for D40A)

Safety outputs *1		Auxiliary outputs *3	Logical AND connection input	Logical AND connection output	Max. OFF delay time *4	Rated voltage	Terminal block type	Model
Instantaneous	OFF-delayed *2							
2 (Semi-conductors)	0	2 (Semi-conductors)	1	1	---	24 VDC	Screw terminals	**G9SX-NS202-RT**
							Spring-cage terminals	**G9SX-NS202-RC**
	2 (Semiconductors)				3.0 s		Screw terminals	**G9SX-NSA222-T03-RT**
							Spring-cage terminals	**G9SX-NSA222-T03-RC**

*1. P channel MOS FET transistor output
*2. The OFF-delayed output becomes an instantaneous output by setting the OFF-delay time to 0 s.
*3. PNP transistor output
*4. The OFF-delay time can be set in 16 steps as follows:
0/0.2/0.3/0.4/0.5/0.6/0.7/0.8/0.9/1.0/1.2/1.4/1.8/2.0/2.5/3.0 s

Expansion Units

Safety outputs		Auxiliary outputs	OFF-delay time	Rated voltage	Terminal block type	Model
Instantaneous	OFF-delayed					
4PST-NO	---	1 (Semiconductor) *1	---	24 VDC	Screw terminals	**G9SX-EX401-RT**
					Spring-cage terminals	**G9SX-EX401-RC**
---	4PST-NO		*2		Screw terminals	**G9SX-EX041-T-RT**
					Spring-cage terminals	**G9SX-EX041-T-RC**

*1. PNP transistor output
*2. The OFF-delay time is synchronized to the OFF-delay time setting in the connected Controller (G9SX-NSA222-T03-□).

Specifications

Ratings and Characteristics (Non-contact Door Switches)

Item	Model	D40A-1C□
Operating characteristics *1	Operating distance OFF→ON	5 mm min.
	Operating distance ON→OFF	15 mm max.
	Differential travel	Refer to "*Detection Ranges*" on page 11
	Influence of temperature (max.)	±20% of operating distance at 23°C, within temperature range of −10 to 55°C
Ambient operating temperature		−10 to 55°C (no icing or condensation)
Ambient operating humidity		25% to 85%
Insulation resistance (between charged parts and case)		50 MΩ max. (at 500 VDC)
Dielectric strength (between charged parts and case)		1,000 VAC for 1 min
Vibration resistance		10 to 55 to 10 Hz (single amplitude: 0.75 mm, double amplitude: 1.5 mm)
Shock resistance		300 m/s^2 min.
Degree of protection		IP67
Material		PBT resin
Mounting method		M4 screws
Terminal screw tightening torque		1 N·m
Power consumption		0.6 W max.
Auxiliary outputs *2		24 VDC, 10 mA (PNP open-collector outputs)
LED indicators		Actuator not detected (red); actuator detected (yellow)
Connection cables		2 m, 5 m
Number of connectable switches *3		30 max. (wiring length: 100 m max.)
Weight		Switch: approx. 145 g, actuator: approx. 20 g (D40A-1C2)

*1. This is the distance where the switch operates from OFF to ON when approaching and the distance where the switch operates from ON to OFF when separating when the switch and actuator target marks are on the same axis, and the sensing surfaces coincide.
*2. Turns ON when the actuator is approaching.
*3. For details, refer to item 5 on page 25.

Ratings (Non-contact Door Switch Controllers)

Power input

Item / Model	G9SX-NS202-□	G9SX-NSA222-T03-□	G9SX-EX-□
Rated supply voltage	24 V DC		
Operating voltage range	–15% to 10% of rated supply voltage		
Rated power consumption *	3 W max.	4 W max.	2 W max.

* Power consumption of loads not included.

Inputs

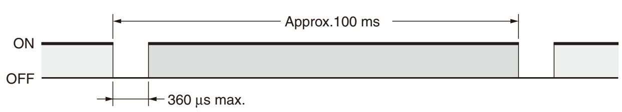
Item / Model	G9SX-NS202-□/G9SX-NSA222-T03-□
Safety input *	Operating voltage: 20.4 VDC to 26.4 VDC, internal impedance: approx. 2.8 kΩ
Feedback/reset input	

* Only applies to the G9SX-NSA222-T03-□. Refers to input other than that from the Non-contact Door Switch.

Outputs

Item / Model	G9SX-NS202-□/G9SX-NSA222-T03-□
Instantaneous safety output *1 OFF-delayed safety output *1	P channel MOS FET transistor output Load current: 0.8 A DC max. *2
Auxiliary output	PNP transistor output Load current: 100 mA max.

*1. While safety outputs are in the ON state, the following signal sequence is output continuously for diagnosis.
When using the safety outputs as input signals to control devices (i.e. Programmable Controllers), consider the OFF pulse shown below.



*2. The following derating is required when Units are mounted side-by-side.
G9SX-NS202-□/G9SX-NSA222-T03-□: 0.4 A max. load current

Expansion Unit

Item / Model	G9SX-EX-□
Rated load	250 VAC, 3 A/30 VDC, 3 A (resistive load)
Rated carry current	3 A
Maximum switching voltage	250 VAC, 125 VDC

Characteristics

Item	Model	G9SX-NS202-□	G9SX-NSA222-T03-□	G9SX-EX-□
Over-voltage category (IEC/EN 60664-1)		II		II (Relay outputs 13 to 43 and 14 to 44: III)
Operating time (OFF to ON state) *1		100 ms max. (Logical AND connection input ON and Non-contact Door Switch input ON)	50 ms max. (Safety input: ON) *2 100 ms max. (Logical AND connection input ON and Non-contact Door Switch input ON) *3	30 ms max. *4
Response time (ON to OFF state) *1		15 ms max. (Logical AND connection input: OFF) 20 ms max. (Non-contact Door Switch input OFF) *6	15 ms max. (Safety input OFF and logical AND connection input OFF) 20 ms max. (Non-contact Door Switch input: OFF) *6	10 ms max. *4
ON-state residual voltage		3.0 V max. (safety output, auxiliary output)		
OFF-state leakage current		0.1 mA max. (safety output, auxiliary output)		
Maximum wiring length of safety input, logical AND connection input, and Non-contact Door Switch input		100 m max. (External connection impedance: 100 Ω max. and 10 nF max.)		
Reset input time (Reset button pressing time)		100 ms min.		
Accuracy of OFF-delay time *5		---	Within ±5% of the set value	Within ±5% of the set value
Insulation resistance	Between logical AND connection terminals, and power supply input terminals and other input and output terminals connected together	20 MΩ min. (at 100 VDC)		---
	Between all terminals connected together and DIN rail			100 MΩ min. (at 500 VDC)
Dielectric strength	Between logical AND connection terminals, and power supply input terminals and other input and output terminals connected together	500 VAC for 1 min.		---
	Between all terminals connected together and DIN rail			1,200 VAC for 1 min
	Between different poles of outputs	---		
	Between relay outputs connected together and other terminals connected together			2,200 VAC for 1 min
Vibration resistance		10 to 55 to 10 Hz, 0.375 mm single amplitude (0.75 mm double amplitude)		
Shock resistance	Destruction	300 m/s²		
	Malfunction	100 m/s²		
Durability	Electrical	---		100,000 cycles min. rated load, switching frequency: 1,800 cycles/hour)
	Mechanical	---		5,000,000 cycles min. (switching frequency: 7,200 cycles/hour)
Ambient operating temperature		−10 to 55°C (no icing or condensation)		
Ambient operating humidity		25% to 85%		
Terminal tightening torque		0.5 N·m (For the G9SX-NS□-RT (with screw terminals) only)		
Weight		Approx. 125 g	Approx. 200 g	Approx. 165 g

*1. When two or more Units are connected by logical AND, the operating time and response time are the sum total of the operating times and response times, respectively, of all the Units connected by logical AND.
*2. Represents the operating time when the safety input turns ON with all other conditions set.
*3. Represents the operating time when the logical AND input and the Non-contact Door Switch input turn ON with all other conditions set.
*4. This does not include the operating time or response time of G9SX-NS□ that are connected.
*5. This does not include the operating time or response time of internal relays in the G9SX-EX-□.
*6. The failure detection time for 24 V short-circuit failure on the input to Non-contact Door Switches is 35 ms max.
If using the Switch for an application other than as a Door Switch, calculate the safe distance using a failure detection time of 35 ms.

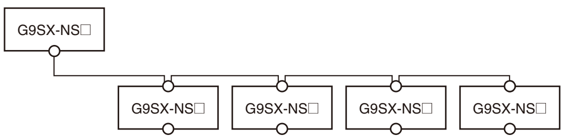
Logical AND Connection

Item / Model	G9SX-NS202-□	G9SX-NSA222-T03-□	G9SX-EX-□
Number of Units connected per logical AND output	4 Units max.		---
Total number of Units connected by logical AND *1	20 Units max.		---
Number of Units connected in series by logical AND	5 Units max.		---
Max. number of Expansion Units connected *2	---		5 Units max.
Maximum cable length for logical AND input	100 m max.		---

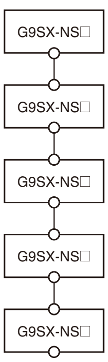
Note: See Logical AND Connection Combinations below for details.
*1. The number of G9SX-EX401-□ Expansion Units or G9SX-EX041-T-□ Expansion Units (OFF-delayed Model) not included.
*2. G9SX-EX401-□ Expansion Units and G9SX-EX041-T-□ Expansion Units (OFF-delayed Model) can be mixed.

Logical AND Connection Combinations

1. One logical AND connection output from a G9SX-NS□ Controller can be logical AND connected to up to four Controllers.

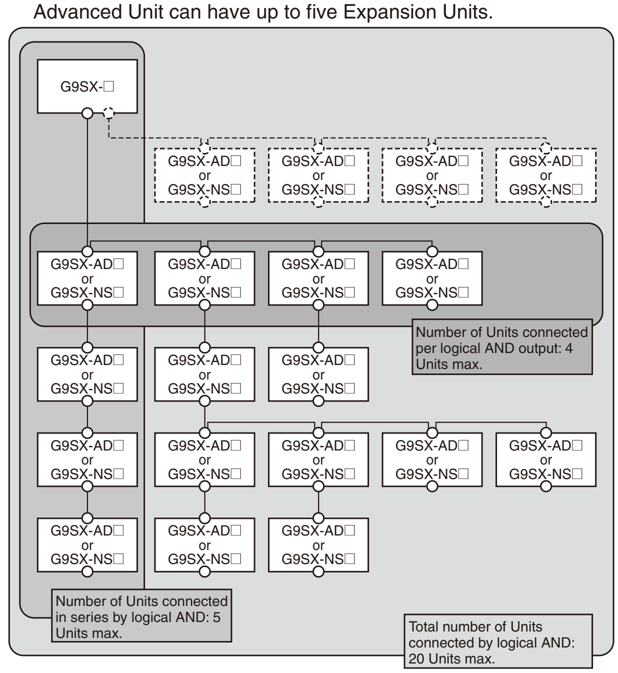


2. Any G9SX-NS□ Controller that receives a logical AND connection input can be logically connected to other Controllers on up to five layers.



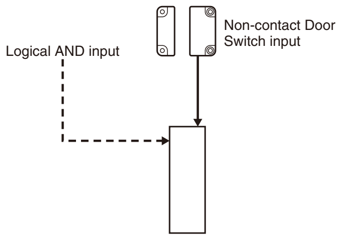
Note: The G9SX-NS□ in the above diagram can be replaced by the G9SX-AD□ Advanced Unit.
For details on G9SX-AD□ Advanced Units, refer to the G9SX-series Flexible Safety Unit catalog. (Cat. No. J150).

3. The largest possible system configuration contains a total of 20 G9SX-NS□ Controllers, G9SX-AD□ Advanced Units, and G9SX-BC Basic Units. In this configuration, each Controller or Advanced Unit can have up to five Expansion Units.



Response Time and Operating Time

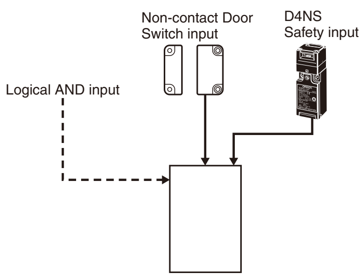
1. G9SX-NS□



	Max. response time (excluding Expansion Units) *1	Max. operating time (excluding Expansion Units) *2
Non-contact Door Switch input	20 ms	100 ms
Logical AND input	15 ms	100 ms

*1. The maximum response time is the time it takes the output to switch from ON to OFF after the input switches from ON to OFF.
*2. The maximum operating time is the time it takes the output to switch from OFF to ON after the input switches from OFF to ON.

2. G9SX-NSA□

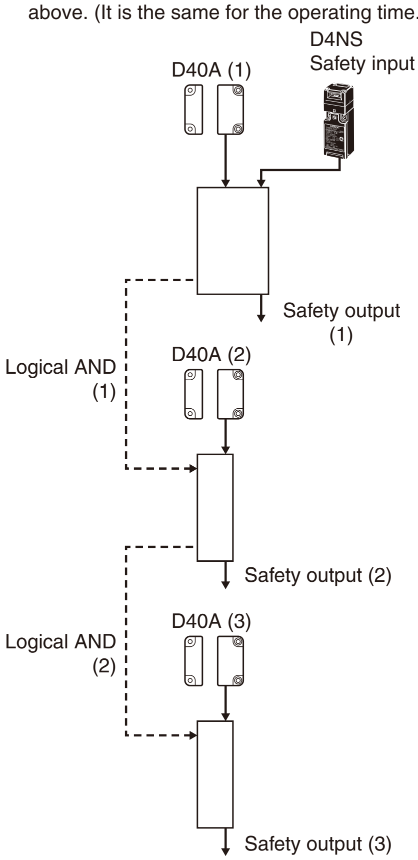


	Max. response time (excluding Expansion Units) *1	Max. operating time (excluding Expansion Units) *2
Non-contact Door Switch input	20 ms	100 ms
Safety input	15 ms	50 ms
Logical AND input	15 ms	100 ms

*1. The maximum response time is the time it takes the output to switch from ON to OFF after the input switches from ON to OFF.
*2. The maximum operating time is the time it takes the output to switch from OFF to ON after the input switches from OFF to ON.

3. Multiple G9SX-NS□/NSA□ Non-contact Door Switch Controllers

When multiple Controllers are logically connected with AND connections, the response time is the sum of the response times given in 1 and 2 above. (It is the same for the operating time.)



Case 1

Response Time from When D40A (1) Turns from ON to OFF until Safety Output (2) Turns from ON to OFF

20 ms	+	15 ms	=	35 ms
(D40A (1))		(Logical AND connection (1))		

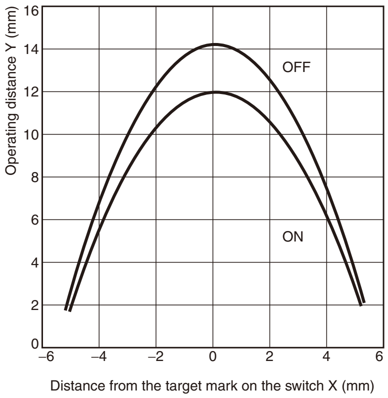
Case 2

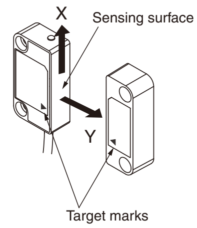
Response Time from When D4NS Turns from ON to OFF until Safety Output (3) Turns from ON to OFF

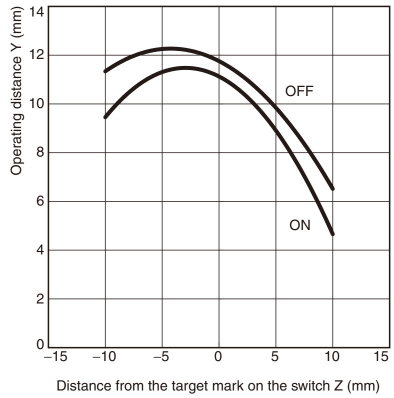
15 ms	+	15 ms	+	15 ms	=	45 ms
(D4NS)		(Logical AND connection (1))		(Logical AND connection (2))		

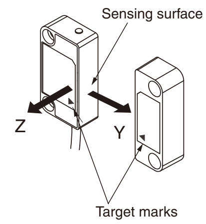
Engineering Data

Detection Ranges (Typical Characteristics Data)









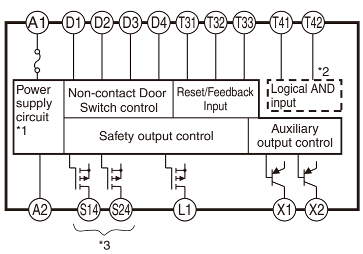
Note: 1. The operating distance is the distance between the switch and actuator sensing surfaces.

2. Data in the diagram is typical data at an ambient temperature of 23°C. Actual operating values may vary.
The operating distance may be affected by ambient metal, magnet catches, and temperature.

Connections

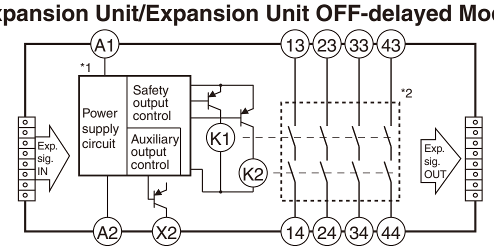
Internal Connection

G9SX-NS202-□ (Non-contact Door Switch Controller)



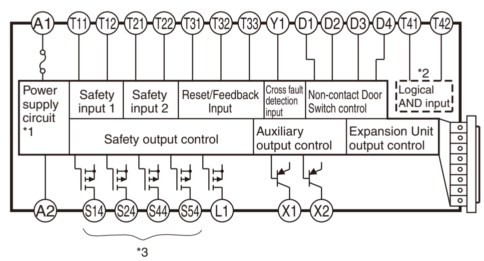
*1. Internal power supply circuit is not isolated.
*2. Logical AND input is isolated.
*3. Outputs S14 to S24 are internally redundant.

G9SX-EX401-□/G9SX-EX041-T-□ (Expansion Unit/Expansion Unit OFF-delayed Model)



*1. Internal power supply circuit is not isolated.
*2. Relay outputs are isolated.

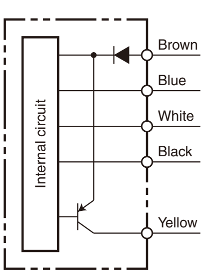
G9SX-NSA222-T03-□ (Non-contact Door Switch Controller)



*1. Internal power supply circuit is not isolated.
*2. Logical AND input is isolated.
*3. Outputs S14 to S54 are internally redundant.

Internal Circuit Diagram

D40A-1C□

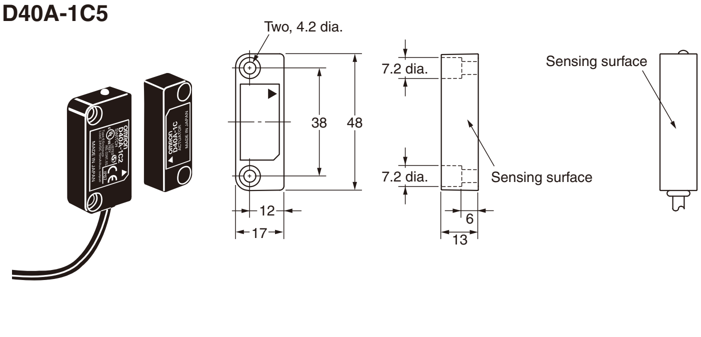


Dimensions and Terminal Arrangement

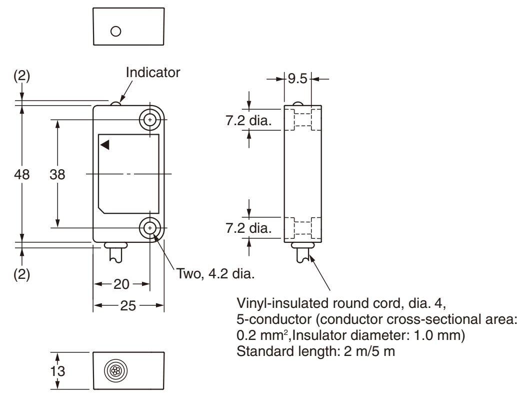
(Unit: mm)

Non-contact Door Switch (Switch/Actuator)

D40A-1C2
D40A-1C5



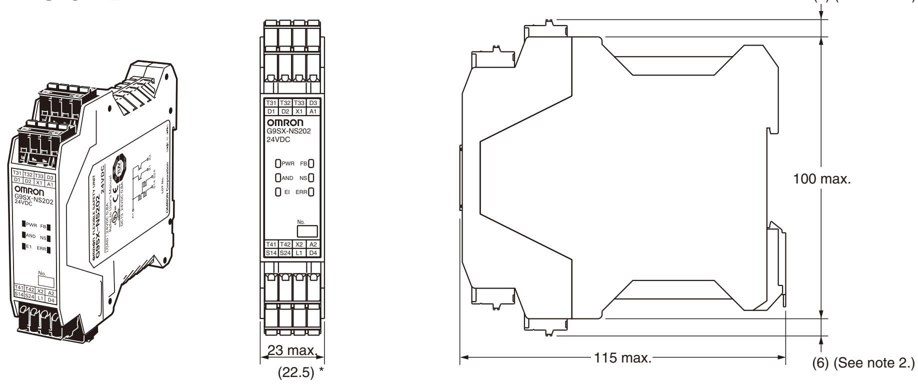
(Actuator)



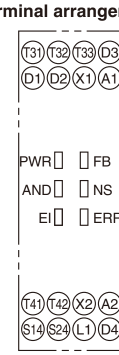
(Switch)

Non-contact Door Switch Controller

G9SX-NS202-□



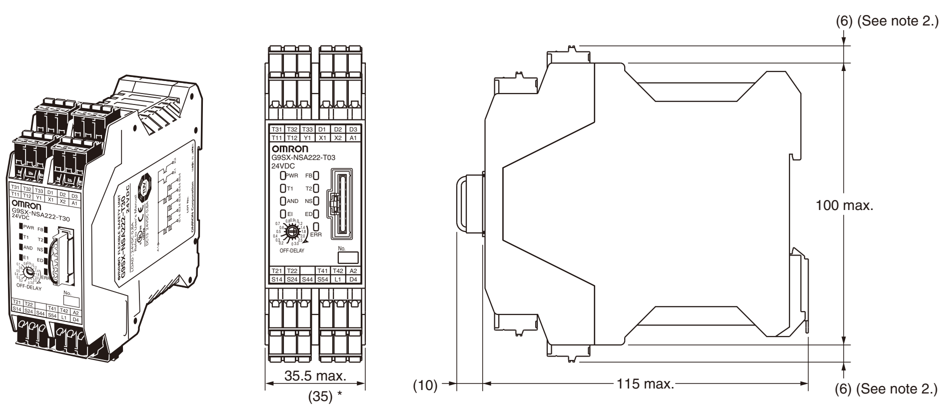
Terminal arrangement



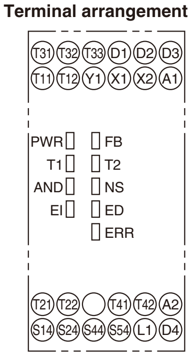
Note: 1. Above outline drawing is for models with spring-cage terminals (-RC).
2. For models with spring-cage terminals (-RC) only.
* Typical dimension

Non-contact Door Switch Controller

G9SX-NSA222-T03-□

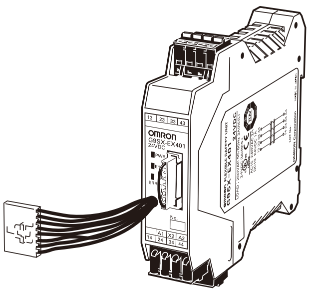


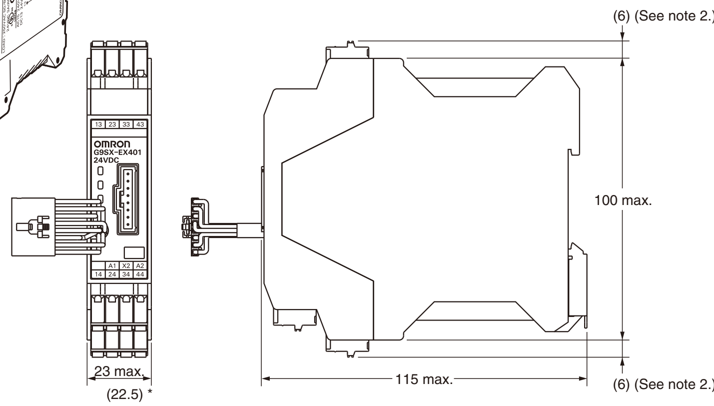
Terminal arrangement



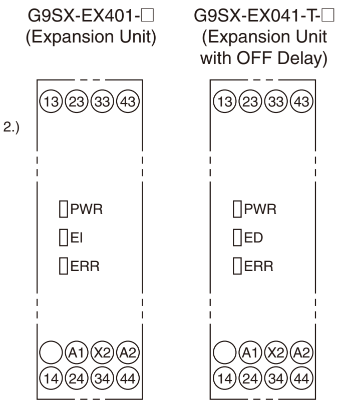
Note: 1. Above outline drawing is for models with spring-cage terminals (-RC).
2. For models with spring-cage terminals (-RC) only.
* Typical dimension

Expansion Unit
G9SX-EX401-□
Expansion Unit (OFF-delayed Model)
G9SX-EX041-T-□





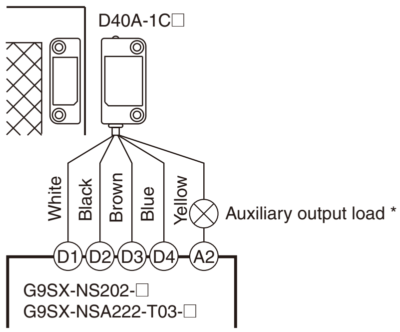
Terminal arrangement



Note: 1. Above outline drawing is for models with spring-cage terminals (-RC).
2. For models with spring-cage terminals (-RC) only.
* Typical dimension

Non-contact Door Switch and Non-contact Door Switch Controller Wiring

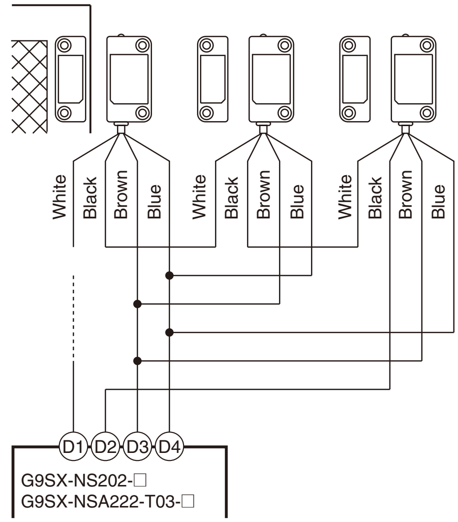
Example: Wiring a Single Switch



* The auxiliary output load current must be 10 mA max.

Example: Wiring Multiple Switches

Connect Up to 30 Non-contact Door Switches

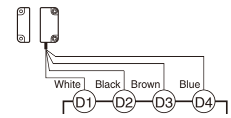
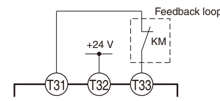
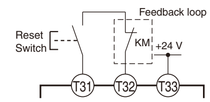
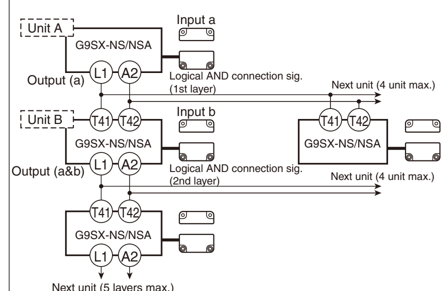


Wiring of Inputs and Outputs

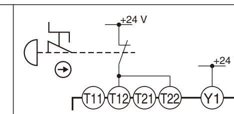
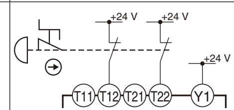
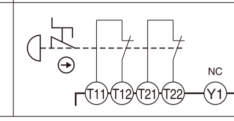
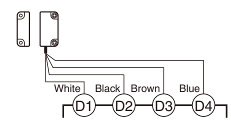
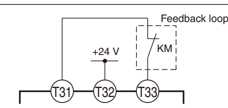
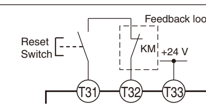
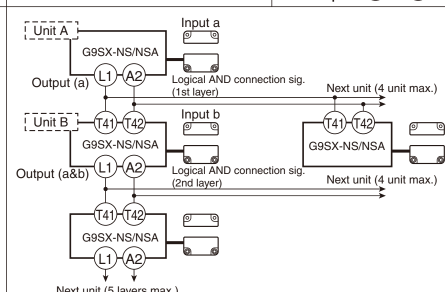
Signal name	Wire color	Description of operation
Non-contact Door Switch power supply input	Brown	Supplies power to the D40A. Connect to the D3 and D4 terminal of the G9SX-NS□.
	Blue	
Non-contact Door Switch input	White	Inputs signals from the G9SX-NS□. The Non-contact Door Switch input must be ON as a required condition for the Non-contact Door Switch output to be ON.
Non-contact Door Switch output	Black	Turns ON and OFF according to actuator detection and the status of the Non-contact Door Switch input.
Auxiliary output	Yellow	Turns ON when actuator is detected.

Wiring of Inputs and Outputs

G9SX-NS202-□

Signal name	Terminal name	Description of operation	Wiring	
Power supply input	A1, A2	Connect the power source to the A1 and A2 terminals.	Connect the power supply plus (24 VDC) to the A1 terminal. Connect the power supply minus (GND) to the A2 terminal.	
Non-contact Door Switch input	D1, D2, D3, D4	All Non-contact Door Switch inputs connected to the G9SX-NS□ must be ON as a required condition for the safety outputs to be ON. Otherwise the safety outputs cannot be in the ON state.		
Feedback/reset input	T31, T32, T33	To set the safety outputs in the ON state, the ON state signal must be input to T33. Otherwise the safety outputs cannot be in the ON state.	Auto reset	
		To set the safety outputs in the ON state, the signal input to T32 must change from the OFF state to the ON state, and then to the OFF state. Otherwise the safety outputs cannot be in the ON state.	Manual reset	
Logical AND connection input	T41, T42	A logical AND connection means that one unit (Unit A) outputs a safety signal "a" to a subsequent unit (Unit B) and Unit B calculates the logical AND (i.e., outputs the AND) of the signal "a" and safety signal "b", which is input to Unit B. Thereby the logic of the safety output of Unit B is (AND). (An AND of inputs "a" and "b" is output.) To set the safety outputs of the subsequent Unit in the ON state, its logical AND connection preset switch must be set to AND (enable) and the high signal must be input to T41 of the subsequent unit.		
Instantaneous safety output	S14, S24	Turns ON/OFF according to the state of the safety inputs, Non-contact Door Switch inputs, feedback/reset inputs, and logical AND connection inputs. During OFF-delay state, the Instantaneous safety outputs are not able to turn ON.	Keep these outputs open when not used.	
Logical AND connection output	L1	Outputs a signal of the same logic and at the same time as the instantaneous safety outputs.	Keep these outputs open when not used.	
Auxiliary monitor output	X1	Outputs a signal of the same logic and at the same time as the instantaneous safety outputs.	Keep these outputs open when not used.	
Auxiliary error output	X2	Outputs when the error indicator is lit or flashing.	Keep these outputs open when not used.	

G9SX-NSA222-T03-□

Signal name	Terminal name	Description of operation	Wiring
Power supply input	A1, A2	Connect the power source to the A1 and A2 terminals.	Connect the power supply plus (24 VDC) to the A1 terminal. Connect the power supply minus (GND) to the A2 terminal.
Safety input 1	T11, T12	To set the safety outputs in the ON state, the high state signals must be input to both safety input 1 and safety input 2. Otherwise the safety outputs cannot be in the ON state.	Corresponds to Safety Category 2  Corresponds to Safety Category 3 (without short-circuit monitoring between systems) 
Safety input 2	T21, T22		Corresponds to Safety Category 3 (Cross fault detecting mode (for safety inputs)) 
Non-contact Door Switch input	D1, D2, D3, D4	All Non-contact Door Switch inputs connected to the G9SX-NS must be ON as a required condition for the safety outputs to be ON. Otherwise the safety outputs cannot be in the ON state.	
Feedback/reset input	T31, T32, T33	To set the safety outputs in the ON state, the ON state signal must be input to T33. Otherwise the safety outputs cannot be in the ON state.	Auto reset 
		To set the safety outputs in the ON state, the signal input to T32 must change from the OFF state to the ON state, and then to the OFF state. Otherwise the safety outputs cannot be in the ON state.	Manual reset 
Logical AND connection input	T41, T42, T51, T52	A logical AND connection means that one unit (Unit A) outputs a safety signal “a” to a subsequent unit (Unit B) and Unit B calculates the logical AND (i.e., outputs the AND) of the signal “a” and safety signal “b”, which is input to Unit B. Thereby the logic of the safety output “b” is output.) To set the safety outputs of the subsequent Unit in the ON state, its logical AND connection preset switch must be set to AND (enable) and the high signal must be input to T41 of the subsequent unit.	
Cross fault detection input	Y1	Selects the mode for the failure detecting (cross fault detecting) function for the safety inputs of G9SX corresponding to the connection of the cross fault detection input.	Keep Y1 open when using T11, T21. (Cross fault detecting mode (for safety inputs)) Connect Y1 to 24 VDC when not using T11, T21. (Wiring corresponding to category 2 or 3, or when connecting safety sensors)
Instantaneous safety output	S14, S24	Turns ON/OFF according to the state of the safety inputs, feedback/reset inputs, and logical AND connection inputs. During OFF-delay state, the Instantaneous safety outputs are not able to turn ON.	Keep these outputs open when not used.
OFF-delayed safety output	S44, S54	OFF-delayed safety outputs. The OFF-delay time is set by the OFF-delay preset switch. When the delay time is set to zero, these outputs can be used as non-delay outputs.	Keep these outputs open when not used.
Logical AND connection output	L1	Outputs a signal of the same logic and at the same time as the instantaneous safety outputs.	Keep these outputs open when not used.
Auxiliary monitor output	X1	Outputs a signal of the same logic and at the same time as the instantaneous safety outputs.	Keep these outputs open when not used.
Auxiliary error output	X2	Outputs when the error indicator is lit or flashing.	Keep these outputs open when not used.

Connecting Safety Sensors

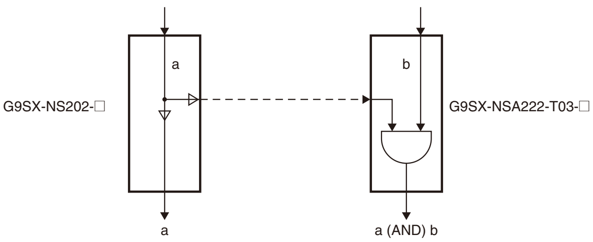
Safety sensors cannot be connected to safety inputs for the G9SX-NSA222-T03-□.

Operation

Functions

Logical AND Connection

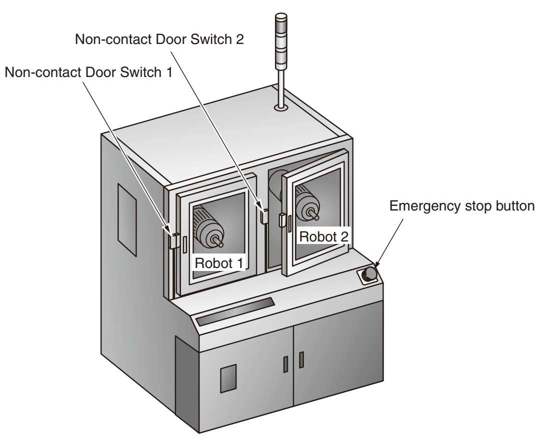
A logical AND connection means that the G9SX outputs a safety signal “a” to another G9SX, and that G9SX creates the logical AND of safety signal “a” and safety signal “b.” The safety output of the G9SX-NSA222-T03-□ with the logical AND connection shown in the following diagram is “a” AND “b.”

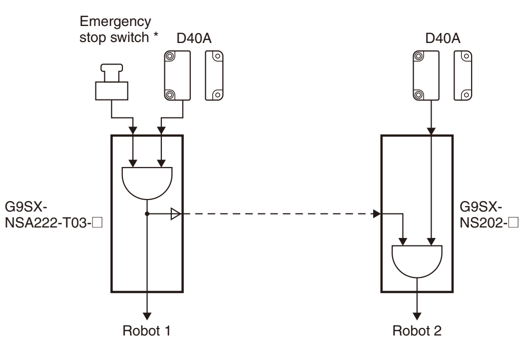


This is illustrated using the application in the following diagram as an example. The equipment here has two hazards identified as Robot 1 and Robot 2, and it is equipped with Non-contact Door Switches and an emergency stop button as safety measures. If the door to Robot 2 is opened, only Robot 2 is stopped (i.e., a partial stop). If the door to Robot 1 is opened or the emergency stop button is pressed, both Robot 1 and Robot 2 stop (i.e., a complete stop).

The actual situation using a G9SX for this application is shown in this example.

Note: The logical AND setting on the G9SX-NS202-□ must be set to AND (enabled).

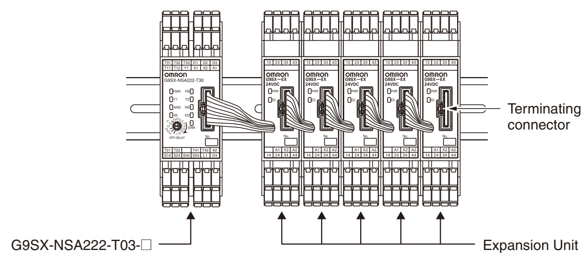




* A manual reset is required when an emergency stop is used.

Connecting Expansion Units

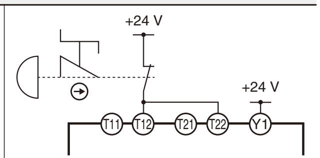
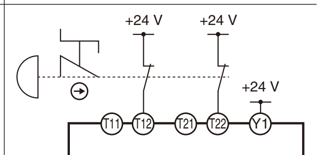
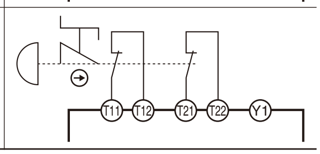
- The G9SX-EX and G9SX-EX-T Expansion Units can be connected to a G9SX-NSA222-T3-□ Non-contact Door Switch Controller to increase the number of safety outputs. (They cannot be connected to a G9SX-NS202-□.)
- A maximum of five Expansion Units can be connected to one G9SX-NSA222-T03-□. This may be a combination of G9SX-EX instantaneous models and G9SX-EX-T OFF-delayed models.
- Remove the terminating connector from the receptacle on G9SX-NSA222-T03-□ and insert the Expansion Unit cable connector into the receptacle. Insert the terminating connector into the receptacle on the Expansion Unit at the very end (rightmost).
- When Expansion Units are connected to a Controller, make sure that power is supplied to every Expansion Unit. (Refer to the following diagram for actual Expansion Unit connection.)



Setting Procedure

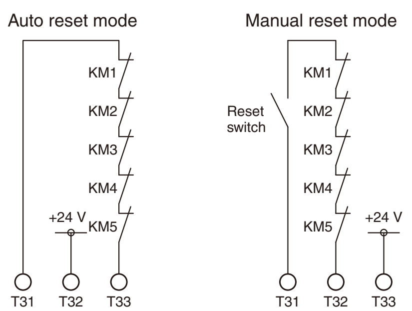
1. Cross Fault Detection (G9SX-NSA222-T03-□)

Set the cross fault detection mode for safety inputs by shorting Y1 to 24 V or leaving it open.
When cross fault detection is set to ON, short-circuit failures are detected between safety inputs T11-T12 and T21-22. When a cross fault is detected, the following will occur.
(1) The safety outputs and logical AND outputs lock out.
(2) The LED error indicator is lit.
(3) The error output (auxiliary output) turns ON.

Cross fault detection	Wiring	
OFF	Corresponds to Safety Category 2.	
	Corresponds to Safety Category 3.	
ON	Corresponds to Safety Category 3 (Cross fault detecting mode (for safety inputs)).	

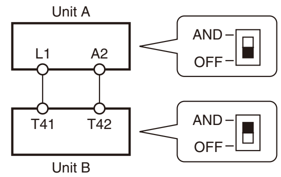
2. Reset Mode (G9SX-NS202-□/NSA222-T03-□)

Set the reset mode using feedback/reset input terminals T31, T32, and T33.
Auto reset mode is selected when terminal T32 is shorted to 24 V and manual reset mode is selected when terminal T33 is shorted to 24 V.



3. Setting Logical AND Connection (G9SX-NS202-□/ NSA222-T03-□)

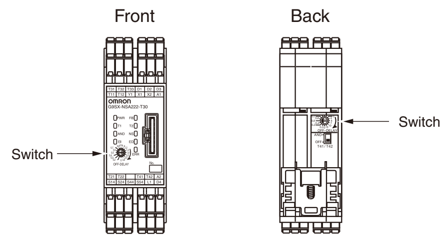
When connecting two or more Non-contact Door Switch Controllers by logical AND connection, set the logical AND connection preset switch on the Controller that is on the input side (Unit B in the following diagram) to AND.



Note: A setting error will occur and Unit B will lock out if the logical AND setting switch on the Unit B is set to OFF.

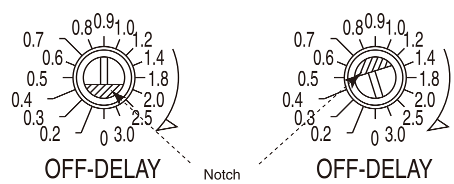
4. Setting the OFF-delay Time (G9SX-NSA222-T03-□)

The OFF-delay preset time on G9SX-NSA222-T03-□ is set from the OFF-delay time preset switch (1 each on the front and back of the Unit).
Normal operation will only occur if both switches are identically set. An error will occur if the switches are not identically set.



Refer to the following illustration for details on setting switch positions.

G9SX-NSA222-T03-□



Example 1: 0-second   Example 2: 0.8-second

LED Indicators

Marking	Color	Name	G9SX-NS202	G9SX-NSA222	G9SX-EX	G9SX-EX-T	Function	Reference
PWR	Green	Power supply indicator	❍	❍	❍	❍	Lights while power is supplied.	---
T1	Orange	Safety input #1 indicator	---	❍	---	---	Lights while a high signal is input to T12. Flashes when an error relating to safety input #1 occurs.	*
T2	Orange	Safety input #2 indicator	---	❍	---	---	Lights while a high signal is input to T22. Flashes when an error relating to safety input #2 occurs.	
NS	Orange	Non-contact Door Switch input indicator	❍	❍	---	---	Lights when the Non-contact Door Switch input turns ON. Flashes when an error relating to the Non-contact Door Switch input occurs.	
FB	Orange	Feedback/reset input indicator	❍	❍	---	---	Lights in the following cases: With automatic reset while a high signal is input to T33. With manual reset while a high signal is input to T32. Flashes when an error relating to feedback/reset input occurs.	
AND	Orange	Logical AND input indicator	❍	❍	---	---	Lights while a high signal is input to T41. Flashes when an error relating to logical AND connection input occurs.	
EI	Orange	Instantaneous safety output indicator	❍	❍	❍	---	Lights while the Instantaneous safety outputs (S14, S24, S34) are in the ON state. Flashes when an error relating to the instantaneous safety output occurs.	
ED	Orange	OFF-delayed safety output indicator	---	❍	---	❍	Lights while OFF-delayed safety outputs (S44, S54) are in the ON-state. Flashes when an error relating to OFF-delayed safety output occurs.	
ERR	Red	Error indicator	❍	❍	❍	❍	Lights or flashes when an error occurs.	

* Refer to *"Fault Detection"* on the next page for details.

Settings Indication (at Power ON)

Settings for the G9SX can be checked by the orange indicators for approx. 3 seconds after the power is turned ON. During this settings indication period, the ERR indicator will light, however the auxiliary error output will remain OFF.

Indicator	Item	Setting position	Indicator status	Setting mode	Setting status
T1	Cross fault detection mode	Y1 terminal	Lit	Detection mode	Y1 = open
			Not lit	Non-detection mode	Y1 = 24 VDC
FB	Reset mode	T32 or T33 terminal	Lit	Manual reset mode	T33 = 24 VDC
			Not lit	Auto reset mode	T32 = 24 VDC
AND	Logical AND connection input mode	Logical AND connection preset switch	Lit	Enable logical AND input	AND
			Not lit	Disable logical AND input	OFF

Fault Detection

When the Non-contact Door Switch Controller detects a fault, the ERR indicator and/or other indicators light up or flash to inform the user about the fault.
Check and take necessary measures referring to the following table, and then re-supply power to the Non-contact Door Switch Controller.

(G9SX-NS202-□/NSA222-T03-□)

ERR indicator	Other indicator	Fault	Expected causes of the fault	Check points and measures to take
Flashes	---	Fault due to electromagnetic disturbance or of internal circuits.	1. Excessive electromagnetic disturbance 2. Failure of the internal circuit	1. Check the disturbance level around the G9SX and the related system. 2. Replace with a new product.
● Lights	T1 flashes	Fault involved with safety input 1	1. Error in the wiring of safety input 1 2. Incorrect setting of cross fault detection input 3. Failure of the circuit of safety input 1	1. Check the wiring to T11 and T12. 2. Check the wiring to Y1. 3. Replace with a new product.
	T2 flashes	Fault involved with safety input 2	1. Error in the wiring of safety input 2 2. Incorrect setting of cross fault detection input 3. Failure of the circuit of safety input 2	1. Check the wiring to T21 and T22. 2. Check the wiring to Y1. 3. Replace with a new product.
	NS flashes	Fault involved with Non-contact Door Switch input	1. Error in the wiring of Non-contact Door Switch input 2. Error in the wiring of Non-contact Door Switch inputs in series connections. 3. Failure of the internal circuits of Non-contact Door Switch inputs 4. Failure of the Non-contact Door Switch	1. Check the wiring to D1 and D2. 2. Check the wiring to the D40A. 3. Replace with a new product. 4. Replace with a new D40A.
	FB flashes	Fault involved with feedback/reset inputs	1. Error in the wiring of feedback/reset input. 2. Failure of the circuit of feedback/ reset input	1. Check the wiring to T31, T32 and T33. 2. Replace with a new product.
		Fault in Expansion Unit	1. Improper feedback signals from Expansion Unit 2. Abnormal supply voltage to Expansion Unit 3. Failure of the circuit of safety relay contact outputs	1. Check the connecting cable of Expansion Unit and the connection of the termination socket. 2. Check the supply voltage to Expansion Unit. **Note:** Make sure that all Expansion Units' PWR indicators are lit. 3. Replace with a new product.
	EI flashes	Fault involved with instantaneous safety outputs, logical AND connection outputs, or auxiliary monitor output	1. Error in the wiring of instantaneous safety outputs 2. Failure of the circuit of instantaneous safety outputs 3. Error in the wiring of the logical AND connection output 4. Failure of the circuit of the logical AND connection output 5. Error in the wiring of the auxiliary monitor output 6. Impermissible high ambient temperature	1. Check the wiring to S14 and S24. 2. Replace with a new product. 3. Check the wiring to L1. 4. Replace with a new product. 5. Check the wiring to X1. 6. Check the ambient temperature and spacing around the G9SX.
	ED flashes	Fault involved with OFF-delayed safety outputs	1. Error in the wiring of OFF-delayed safety relay contact outputs 2. Incorrect set values for OFF-delay time 3. Failure of the circuit of OFF-delayed safety relay contact outputs 4. Impermissible high ambient temperature	1. Check the wiring to S44 and S54. 2. Check the settings of the OFF-delay time setting switch. 3. Replace with a new product. 4. Check the ambient temperature and spacing around the G9SX.

ERR indicator	Other indicator	Fault	Expected causes of the fault	Check points and measures to take
● Lights	AND flashes	Fault involved with logical AND connection input	1. Error in the wiring of the logical AND connection input	1. Check the wiring to T41 and T42. **Note: 1.** Make sure that the wiring length for the T41, T42 terminal is 100 meters or less. **2.** Make sure that the logical AND connection signal is branched for 4 units or fewer.
			2. Incorrect setting for the logical AND connection input 3. Failure of the circuit of the logical AND connection input	2. Confirm the set value of the logical AND connection preset switch. 3. Replace with a new product.
	All indicators except PWR flash	Supply voltage outside the rated value	1. Supply voltage outside the rated value	1. Check the supply voltage to the Units.

When indicators other than the ERR indicator flash, check and take necessary actions referring to the following table.

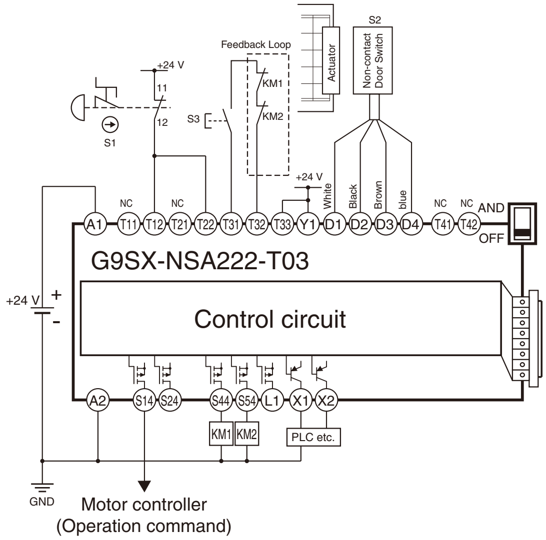
ERR indicator	Other indicators		Fault	Expected cause of the fault	Check points and measures to take
○ Off	T1	flash	Mismatch between input 1 and input 2.	The input status between input 1 and input 2 is different, due to contact failure or a short circuit of safety input device(s) or a wiring fault.	Check the wiring from safety input devices to the G9SX. Or check the input sequence of safety input devices. After removing the fault, turn both safety inputs 1 and 2 to the OFF state.
	T2				

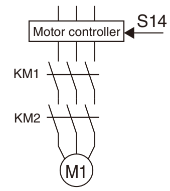
(Expansion Unit)

ERR indicator	Other indicators	Fault	Expected cause of the fault	Check points and measures to take
● Lights	---	Fault involved with safety relay outputs of Expansion Units	1. Welding of relay contacts 2. Failure of the internal circuit	Replace with a new product.

Application Examples

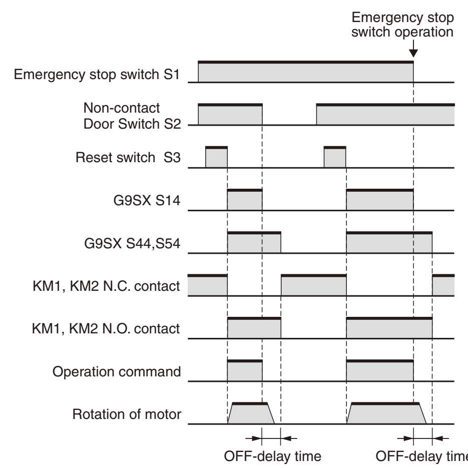
G9SX-NSA222-T03-□ (24 VDC) (1-channel Emergency Stop Switch Input + Non-contact Door Switch/Manual Reset)





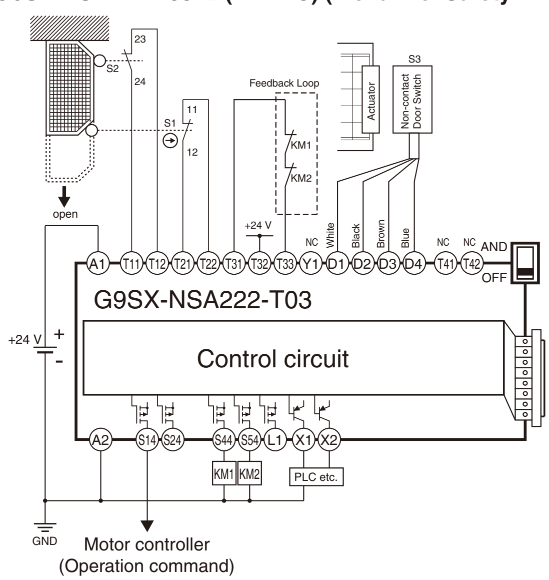
S1: Emergency Stop Switch
S2: Non-contact Door Switch
S3: Reset Switch
KM1, KM2: Contactor
M1: 3-phase motor

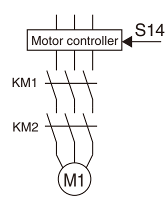
Timing chart



Note: 1. This example corresponds to category 2.
2. For details on Non-contact Door Switch wiring, refer to pages 15 and 16 or to the User's Manual.

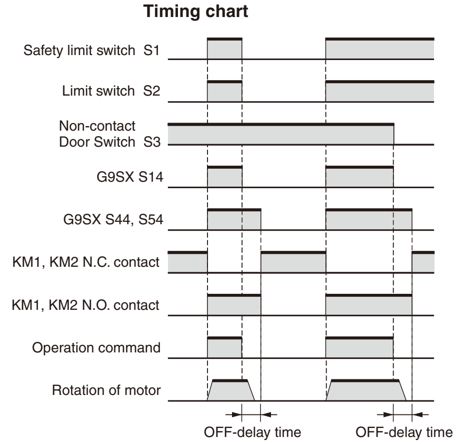
G9SX-NSA222-T03-□ (24 VDC) (2-channel Safety Limit Switch Input + Non-contact Door Switch/Auto Reset)





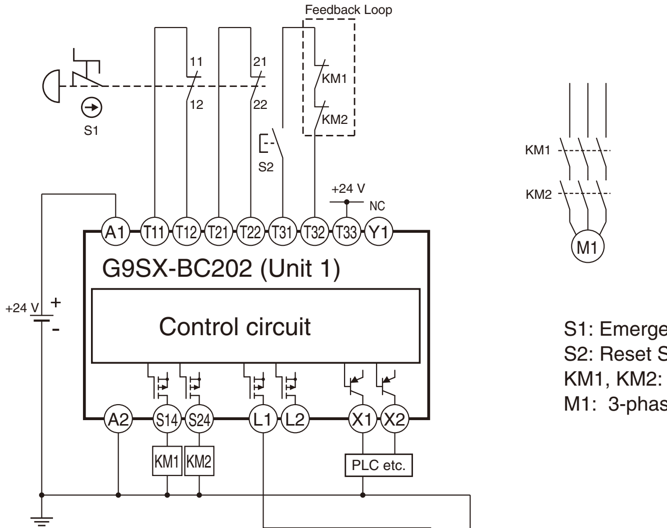
S1: Safety limit switch
S2: Limit switch
S3: Non-contact Door Switch
KM1, KM2: Contactor
M1: 3-phase motor

Timing chart

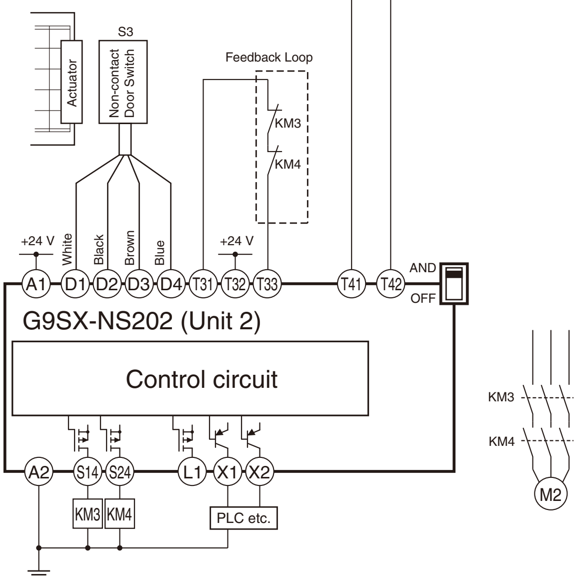


Note: 1. This example corresponds to category 3.
2. For details on Non-contact Door Switch wiring, refer to pages 15 and 16 or to the User's Manual.

G9SX-BC202 (24 VDC) (2-channel Emergency Stop Switch Input/Manual Reset) + G9SX-NS202-□ (24 VDC) (Non-contact Door Switch Input/Auto Reset)



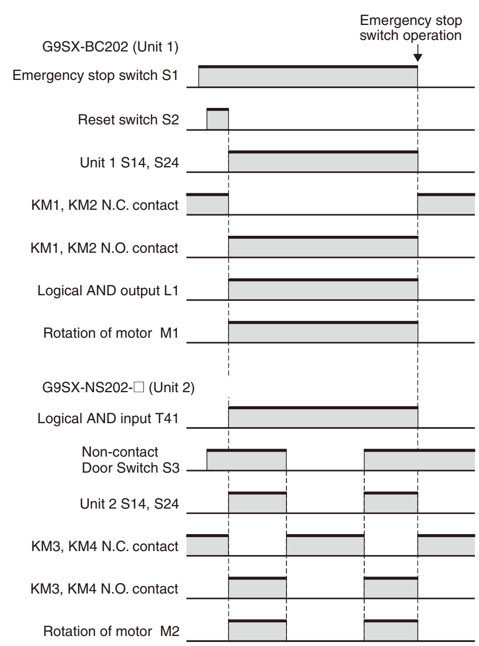
S1: Emergency Stop Switch
S2: Reset Switch
KM1, KM2: Contactor
M1: 3-phase motor



S3: Non-contact Door Switch
KM3, KM4: Contactor
M2: 3-phase motor

Note: 1. This example corresponds to category 3.
2. For details on Non-contact Door Switch wiring, refer to pages 15 and 16 or to the User's Manual.

Timing chart



Safety Precautions

Refer to the *"Precautions for All Switches"* and *"Precautions for All Safety Door Switches"*.

⚠ CAUTION

Serious injury may possibly occur due to breakdown of safety outputs.
Do not connect loads beyond the rated value to the safety outputs.

Serious injury may possibly occur due to loss of required safety functions.
Wire the D40A and G9SX-NS properly so that supply voltages or voltages for loads do NOT touch the safety outputs accidentally.

Serious injury may possibly occur due to damage to safety outputs.
Provide protective circuits against counter-electromotive force if inductive loads are connected to safety outputs.

Serious injury may possibly occur due to loss of safety functions.
Use appropriate devices referring to the information provided below.

The machine may start operating and may result in serious injury or death.
Do not put the actuator close to the switch when the door is open.

Control device	Requirements
Emergency stop switch	Use approved device with direct opening mechanism complying with IEC/EN 60947-5-1.
Safety door switch, Safety limit switch	Use approved device with direct opening mechanism complying with IEC/EN 60947-5-1 and capable of switching micro loads of 24 VDC, 5 mA.
Non-contact Door Switch	The G9SX-NS must be used with D40A Non-contact Door Switches.
Relay with forcibly guided contacts	Use approved devices with forcibly guided contacts complying with EN 50205. For feedback, use devices with contacts capable of switching micro loads of 24 VDC, 5 mA.
Contactor	Use contactors with forcibly guided mechanism to input the signal to the Feedback/Reset input of the G9SX-NS through the NC contact of the contactor. For feedback, use devices with contacts capable of switching micro loads of 24 VDC, 5 mA. Failure to open contacts of a contactor cannot be detected by connecting NC contact of the contactor without a forcibly guided mechanism to the Feedback/Reset input.
Other devices	Evaluate whether devices used are appropriate to satisfy the requirements of the safety category level.

Precautions for Safe Use

1. Disconnect the G9SX-NS from the power supply when wiring the D40A.
   1. Turn OFF the load power supply before wiring. Failure to do so may cause electric shock.
   2. Devices connected to the product may operate unexpectedly.

2. Do not operate the product in atmospheres containing flammable or explosive gas. Arcs or heating of relays during switching may cause fire or explosion.

3. Wire conductors correctly and verify the operation of the product before using the system in which the product is incorporated. Incorrect wiring may lead to loss of safety functions.

4. Auxiliary monitoring outputs are NOT safety outputs. Do not use auxiliary monitoring outputs as safety outputs. Such incorrect use will cause loss of safety function of D40A and peripheral devices.

5. After installing the D40A, qualified personnel must confirm the installation, and must conduct test operations and maintenance. The qualified personnel must be qualified and authorized to secure safety at each phases of design, installation, running, maintenance, and disposal of the system.

6. A qualified person in charge, who is familiar with the machine in which the D40A is to be installed, must conduct and verify the installation.

7. Be sure to inspect the D40A daily and every 6 months. Otherwise, serious injury may possibly occur due to system malfunctions.

8. Connect the D40A to only appropriate components or devices complying with relevant safety standards corresponding to the required level of safety category. Conformity to requirements of the safety category must be determined for the entire system. It is recommended to consult an authorized certification body regarding assessment of conformity to the required safety level.

9. Do not dismantle, repair, or modify the product. Doing so may lead to loss of safety functions.

10. Use the G9SX within an enclosure with a IP54 degree of protection or higher according to IEC/EN 60529.

11. Do not apply DC voltages exceeding the rated voltages, nor any AC voltages to G9SX-NS□.

12. Use a DC supply satisfying the requirements given below to prevent electric shock.
- A DC power supply with double or reinforced insulation, for example, according to IEC/EN 60950 or EN 50178, or a transformer according to IEC/EN 61558.
- A DC supply satisfying the requirements for class 2 circuits or limited voltage/current circuits stated in UL 508.

13. Properly apply the specified voltages to the inputs. Applying inappropriate voltages may cause the product to fail to perform its specified function, which could lead to the loss of safety functions or damages to the product.

14. Auxiliary error outputs and auxiliary monitoring outputs are NOT safety outputs. Do not use these outputs as safety outputs. Such incorrect use will cause loss of safety functions of the G9SX and its relevant system. Also logical AND connection outputs can only be used for logical AND connections with the G9SX-□.

15. After installing the G9SX-NS□, qualified personnel must confirm the installation, and must conduct test operations and maintenance. The qualified personnel must be qualified and authorized to secure safety at each phases of design, installation, running, maintenance, and disposal of system.

16. A qualified person in charge, who is familiar with the machine in which G9SX-NS□ is to be installed, must conduct and verify the installation.

17. Perform daily and 6-month inspections for the G9SX-NS□. Otherwise, the system may fail to work properly, resulting in serious injury.

18. Connect to the G9SX-NS□ only appropriate components or devices complying with relevant safety standards corresponding to the required level of safety category.
Conformity to requirements of safety category must be determined as an entire system. It is recommended to consult an authorized certification body regarding assessment of conformity to the required safety level.

19. OMRON is not responsible for conformity with any safety standards covering the customer's entire system.

20. Be careful not to have your fingers caught when mounting terminal blocks.

21. The service life will depend on the switching conditions. Be sure to check the actual operating conditions using the actual devices, and make sure that the number of switching operations will not cause performance problems.

Precautions for Correct Use

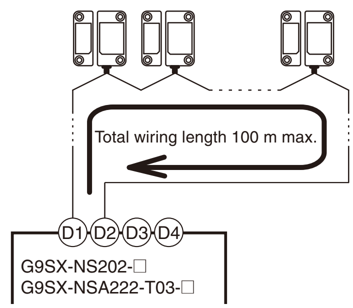
1. Connection with Non-contact Door Switch
Wire conductors between the G9SX-NS□ and the D40A Non-contact Door Switch correctly and verify operation, before using the system.

2. The D40A must be used with a designated actuator and G9SX-NS□ Controller.

3. Handle with Care.
Do not drop the product or expose it to excessive vibration or mechanical shock. The product may be damaged and may not function properly.

4. Storage and Operating Conditions
Do not store or use the products under the following conditions.
1. In direct sunlight
2. At ambient temperatures not between −10 and 55°C
3. At relative humidity not between 25% and 85% or under temperature changes that could causes condensation
4. In corrosive or combustible gases
5 Where subject to vibration or mechanical shock beyond the rated values
6. Where subject to contact with water, oil, or chemicals
7. In an atmosphere containing excessive dust, saline, or metal powder
8. Where iron filings or powder may fall on the product

5. Use cables with a length of less than 100 m total to connect D40A Switches.



6. Disconnect the G9SX-NS□ from the power supply when replacing the D40A. Devices connected to the G9SX-NS□ may operate unexpectedly.

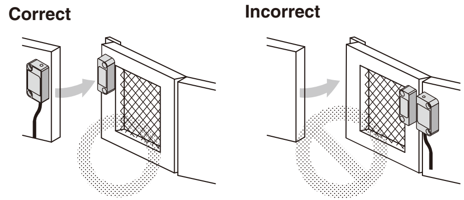
7. Do not use the D40A in a magnetic field of 1.5 mT or higher. The D40A may not function properly.

8. Do not use the D40A in the water or in an environment continuously exposed to water. Water may penetrate into the D40A. (The IP67 degree of protection for this switch means that it has been checked for penetration of water after having been left in water for a fixed period of time.)

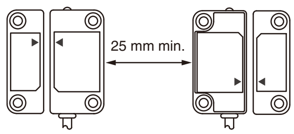
9. Be sure to mount a guard stopper and guide to prevent the D40A Non-contact Door Switch from being subjected to impact.

10. Do not use the switch or actuator as a stopper. Protect the switch and the actuator by installing a stopper. Separate the switch and the actuator to a distance of 1 mm or more.

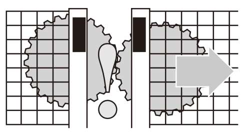
11. Install the actuator and switch at an appropriate distance so that they do not create a gap that provides access to the hazard.



12. Where two or more Switches are mounted side-by-side, they must be no closer than 25 mm.



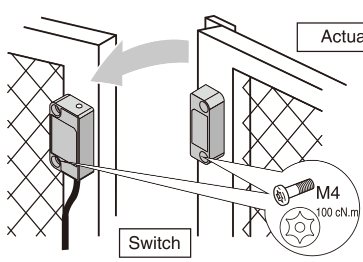
13. Check that the machine is stopped whenever the interlocked guard door is open.



14. Do not mount the switch and actuator on magnetic materials, otherwise it may affect the operating distance.

Distance from surface of magnetic body	Operating distance
0 to 5 mm	Reduce to approx. 90% of original value.
5 mm or longer	No influence.

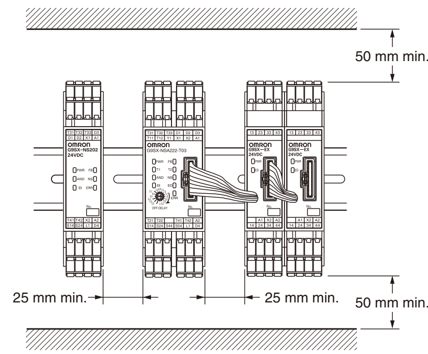
15. Tighten all screws to the specified torque by using non-magnetic M4 screws and washer for the installation of the switch and actuator. After installation and using, the actuator and switch fixing screws must be coated with tamper proof varnish or similar compound. Using anaerobic locking compounds can have a detrimental effect on the plastic switch case if the compounds come into contact with the switch case.



16. Wiring
1. Use the following to wire to the product.
   Stranded wire (flexible wire): 0.2 to 2.5 mm^2 (AWG24 to AWG12)
   Solid wire (steel wire): 0.2 to 2.5 mm^2 (AWG24 to AWG12)
2. When an auxiliary output is not used, cut off the wiring and cover it with tape so that it does not contact other terminals.

17. Mounting
Mount the G9SX-NS to a DIN rail using End Plates (PFP-M, not included with the product) so that the G9SX-NS does not fall off of the rails due to vibration or other causes, especially when the length of DIN railing is short compared to the width of the G9SX-NS□.

18. The following space must be provided around the G9SX-NS□ to enable applying the rated current to the outputs of the G9SX-NS□, to ensure sufficient ventilation, and to enable wiring:
1. At least 25 mm between side surfaces of the G9SX-NS□
2. At least 50 mm above the top surface of the G9SX-NS□ and below the bottom surface of the G9SX-NS□.



19. Wiring
1. G9SX-NS□-RT (with Screw Terminals)
   - Use the following to wire the G9SX-NS□-RT.

Solid wire (steel wire)	0.2 to 2.5 mm^2 (AWG24 to AWG12)
Stranded wire (flexible wire)	0.2 to 2.5 mm^2 (AWG24 to AWG12)

   - Tighten each screw to the specified torque of 0.5 to 0.6 N·m, or the G9SX-NS□ may malfunction or generate heat.
   - Strip the wire for no longer than 7 mm.
2. G9SX-NS□-RC (with Spring-cage Terminals)
   - Use the following to wire the G9SX-NS□-RC.

Solid wire (steel wire)	0.2 to 2.5 mm^2 (AWG24 to AWG12)
Stranded wire (flexible wire)	0.2 to 2.5 mm^2 (AWG24 to AWG12)

   - It is recommended that insulation-covered bar terminals (DIN 46228-4 compatible) be connected to stranded wires before connecting the wires.
3. Logical AND Connections
   - Use VCTF cables or shielded cables for logical AND connect ions between Units.

20. Connecting G9SX-EX□-□ Expansion Units
1. Remove the terminating connector from the connector on the G9SX-NSA222-T03□. Insert the connector on the connecting cable of Expansion Unit into the connector on the G9SX-NSA222-T03-□.
2. Connect the terminating connector to the connector on the Expansion Unit at the end position.
   When the G9SX-NSA222-T03-□ is used without Expansion Units, leave the terminating connector on the G9SX-NSA222-T03-□.
3. Do not remove the terminating connector or connecting cables of Expansion Units while the system is operating.
4. Before applying the supply voltage, confirm that the connectors are locked firmly.
5. All of the Expansion Units must be supplied with its specified voltages within 10 s after the connected G9SX-NSA222-T03-□ is supplied with voltage.
   Otherwise, the G9SX-NSA222-T03-□ will detect a power supply error for the Expansion Units.

21. Use cables with a length of less than 100 m total to connect the safety inputs, feedback/reset inputs, and logical AND connection inputs and outputs.

22. Set the time duration of OFF-delay to an appropriate value that does not cause the loss of safety functions of system.

23. Logical AND connections between Units (Refer to *"Functions"* on page 17.)
1. To use logical AND connection inputs, enable the logical AND connection input for the G9SX-NS□ that will receive the inputs.
2. Connect the logical AND connection inputs appropriately to the logical AND connection outputs of the G9SX-□.
3. When configuring the safety system, be sure to consider that the delay of response time caused by logical AND connection does not degrade the safety functions of the system. (Refer to *"Response Time and Operating Time"* on page 10.)
4. Use 2-conductor cabtire cable or shielded cable for logical AND connect ions between Units.

24. To determine safety distance to hazards, take into account the delay of safety outputs caused by the following time:
1. Response time of safety inputs
2. Response time of D40A Non-contact Door Switch inputs
3. Response time of logical AND connection input (Refer to *"Response Time and Operating Time"* on page 10.)
4. Preset OFF-delay time
5. Accuracy of OFF-delay time

25. Start the rest of the system after 5 s or longer has passed since applying supply voltage to all G9SX-□ in the system.

26. Be sure to ground the A2 terminal of the power supply to help prevent malfunctions caused by noise. Also, connect a surge absorber to each end of the coil on inductive loads to reduce noise generation. When sharing a power supply with a Light Curtain, use a DC power supply that will not fail for a momentary power interruption of 20 ms or less.

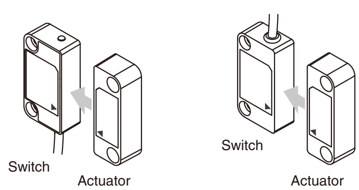
27. Devices connected to the G9SX-NS may operate unexpectedly. When replacing the G9SX-NS, disconnect it from power supply.

28. Adhesion of solvent
Do not allow organic solvents, such as alcohol, thinner, trichloroethane, or gasoline, to come into contact with the product. Such solvents make the markings on G9SX-NS illegible and cause deterioration of parts.

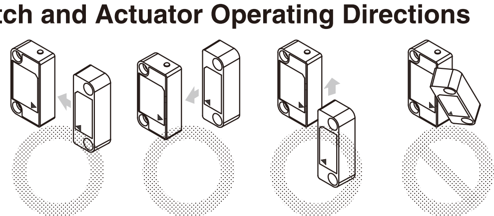
29. Do not mix AC and DC circuits for contact outputs in a single G9SX-EX□-□. When using AC and DC circuits, connect at least two G9SX-EX□-□ Units and use them respectively as dedicated DC-circuit and AC-circuit contact outputs.

Switch and Actuator Operation

Switch and Actuator Mounting Directions



Switch and Actuator Operating Directions



Correct **Correct** **Correct** **Incorrect**

Safety Category (EN 954-1)

When used in combination with the G9SX-NS□, the D40A can be used for the environments corresponding to safety category 3 as required by EN 954-1. The settings are determined by circuit examples provided by OMRON, however, and may not be applicable depending on the operating conditions.
Safety categories are determined for the safety control system as a whole. You must confirm conformity for the entire system.

To conform with Safety Category 3 (EN954-1):

1. Input two channels for the external inputs (T11-T12, T21-T22).
2. Use switches with direct opening mechanisms for external inputs (T11-T12, T21-T22).
   When using limit switches, use at least one switch with direct opening mechanisms for an input.
3. Connect D40A Switches for Non-contact Door Switch input terminals (D1, D2, D3, D4).
4. Input the contactor's NC signal between T31 and T32 (manual reset) or between T31 and T33 (auto reset). Refer to *"Application Examples"* on page 22.
5. The A2 terminal must be grounded.

Approved Standards

D40A-□/G9SX-NS□/G9SX-NSA□
- Approved by TÜV Product Service
  EN 50178
  EN 1088
  IEC/EN 60204-1
  EN 954-1 Cat. 3
  IEC/EN 61508 SIL3
  IEC/EN 60947-5-2
  IEC/EN 60947-5-3 PDF-M
- Approved by UL
  UL 508
- CAN/CSA C22.2 No.14
- KOSHA certification

Precautions for All Safety Door Switches

Note: Refer to the *Safety Precautions* section for each Switch for specific precautions applicable to each Switch.

⚠ CAUTION

Do not insert the Operation Key when the door is open. The machine may operate, possibly causing injury.

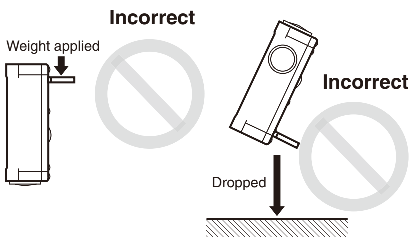
Precautions for Safe Use

- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch body is protected from the ingress of dust or water, avoid the ingress of foreign substance through the key hole on the head. Otherwise, accelerated wear, breaking, or malfunction may result.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch in a starting circuit. (Use the Switch for safety confirmation signal purposes.)
- Connect a fuse in series with the Switch to protect it from short-circuit damage. The value of the breaking current of the fuse must be calculated by multiplying the rated current by 150% to 200%.
  When using the Switch for an EN rating, use a 10 A fuse of type gI or gG that complies with IEC 60269.
- Mount the Operation Key so that it will not come into contact with persons in the area when the door is opened and closed. Injury may result.
- Do not drop the Switch. Doing so may prevent the Switch from functioning to its full capability.
- Do not under any circumstances disassemble or modify the Switch. Doing so may cause malfunction.

Precautions for Correct Use

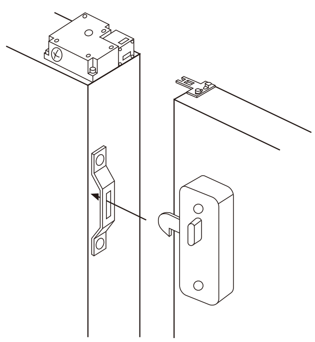
Operation Key

- Use only the designated Operation Key. The Head has been designed so that operation is not possible with a screwdriver or other tools. Using anything other than the designated Operation Key may damage the Switch or affect machine safety.
- Do not operate the Switch with anything other than the special OMRON Operation Key, otherwise the Switch may break or the safety of the system may not be maintained.
- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.



Securing the Door

If the closed door (with the Operation Key inserted) pulls the Operation Key past the operating/lock position (i.e., the set zone) because of, for example, the door's own weight, machine vibration, or the door cushion rubber, the Switch may be damaged.
Also, with a magnetic lock, it may not be possible to unlock the Switch if there is weight placed on the Operation Key. Secure the door with a stopper so that the Operation Key remains within the set zone.



Operating Environment

- Safety Door Switches are designed for use indoors. Using a Switch outdoors may damage it.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperature or high humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switch in the following locations:
  - Locations subject to severe temperature changes
  - Locations subject to high temperatures or condensation
  - Locations subject to severe vibration
  - Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - Locations where the Switch may come into contact with thinner or detergents
  - Locations where explosive or flammable gases are present

Storing Switches

Do not store Switches in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

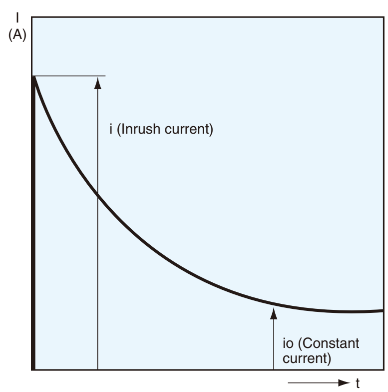
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly.
If the terminal is wired incorrectly, the Switch will not function.
Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

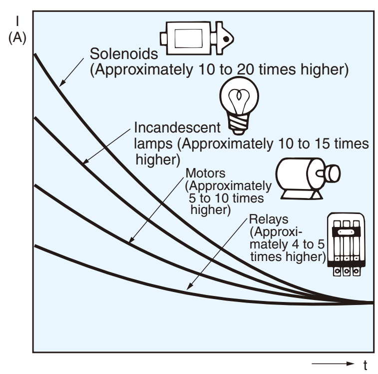
  Inductive load: A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)

  Lamp load: An inrush current 10 times higher than the normal current

  Motor load: An inrush current 6 times higher than the normal current

  1. Ambient temperature: 5°C to 35°C
  2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

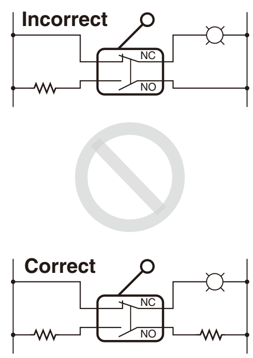
Electrical Conditions

- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

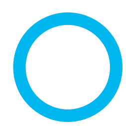
Connections

- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

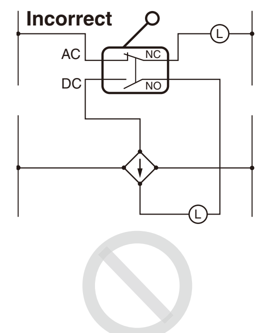
Power Connection Examples
(Connection of Different Polarities)



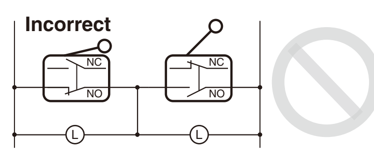
Connect the load to the same polarities.



Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

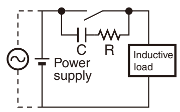
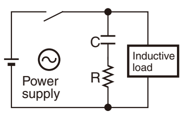
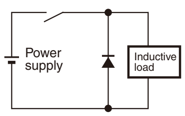
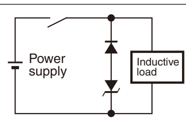
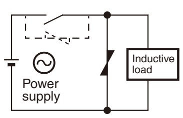


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

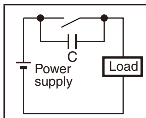
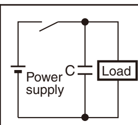
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

Typical Examples of Contact Protection Circuits

Circuit example		Applicable current		Features and remarks	Element selection
		AC	DC		
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

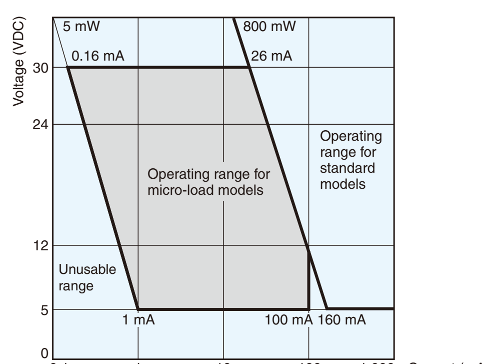
Do not use the following types of contact protection circuit.

 This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.	 This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

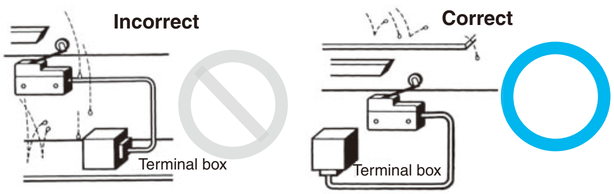
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, $\lambda_{60} = 0.5\times10^{-6}$/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

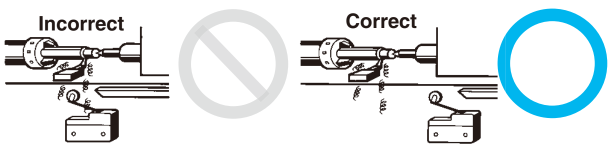


Operating Environment

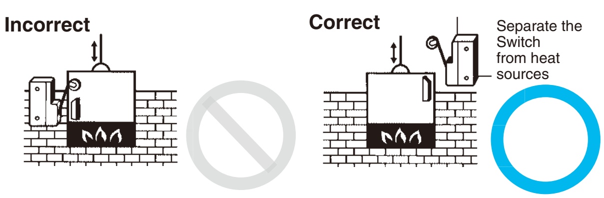
- The Switches are designed for use indoors.
  Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



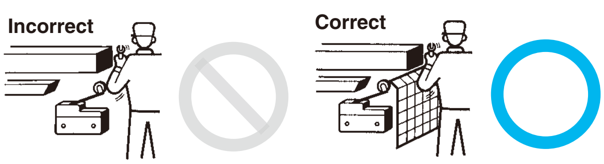
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges.
  The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog.
  If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.

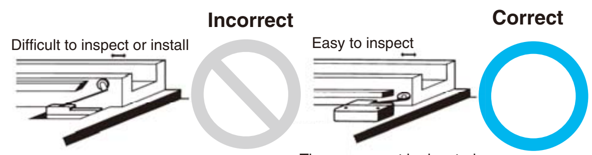


Prevent false operation

- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



The cover must be located in the direction ensuring ease of maintenance or inspection.

Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

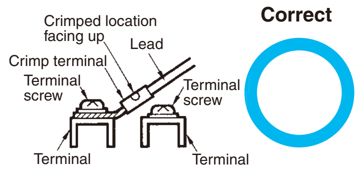
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

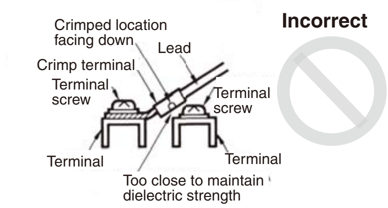
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

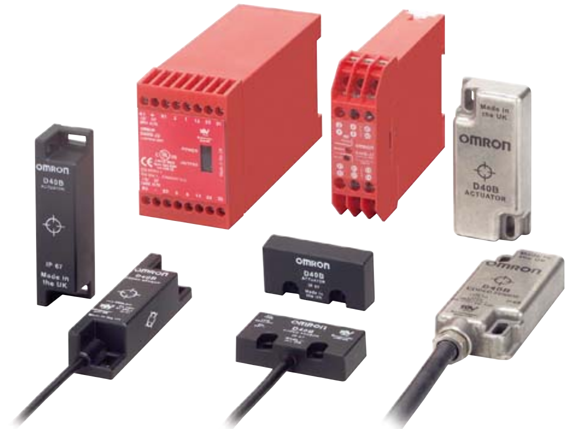
OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Compact Non-contact Door Switch
D40B Series

Detects the open/closed state of doors without making contact and has high resistance to the environment.



- Detects the open/closed state of doors without making contact by combining a special magnetic Actuator and Switch. The switching mechanism is not easily disabled.
- The non-contact operation prevents the creation of particles due to abrasion.
- The Actuator and Switch can be washed with water (not immersible in water). There are no key-holes where dirt can accumulate, making it easy to keep machinery clean.
- Small distortions in the door and mechanical discrepancies can be absorbed in the allowable operating range of the magnetic Actuator and Switch.
- Safety Category 3 (EN954-1).

> ⚠ Be sure to read the *"Safety Precautions"* on page 9 and the *"Precautions for All Safety Door Switches"*.

Features

Special Actuators and Control Unit to Prevent False Operation

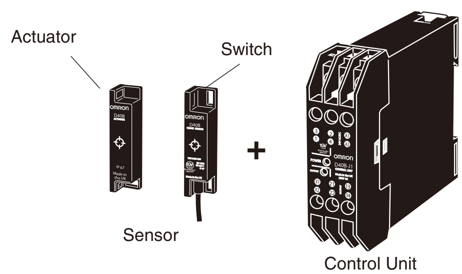
- A safety output on the Control Unit turns ON when the Special Actuator approaches.
- The safety output will not turn ON even if a magnet or magnetic body approaches.

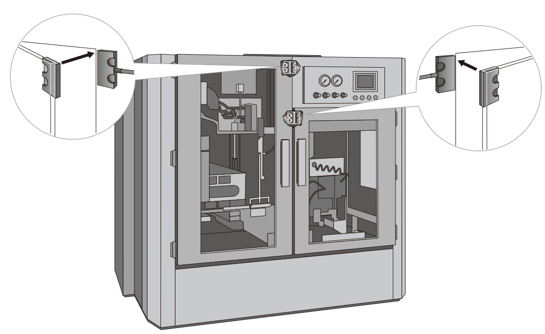
Safety Category 3 (EN954-1)

- The Control Unit detects failures in the Sensor or connected contactor.

Detect Closed Status for Multiple Covers

- Up to six Sensors can be connected to each Control Unit.
- Cover open/closed status can be monitored by using a Sensor with an auxiliary output.





Model Number Structure

Model Number Legend

Sensor

D40B-□□□□
1 2 3 4

1. **Type**
   1: Standard Sensor
   2: Elongated Sensor
   3: High-temperature Type Sensor
2. **Auxiliary Output**
   B: None
   D: 1 NC
   E: 1 NO
3. **Cable Length**
   3: 3 m
   5: 5 m
   10: 10 m
4. **Wiring Method**
   None: Pre-wired
   C: Connector (Switch side only)

Controller

D40B-J□
1

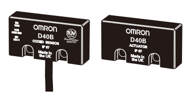
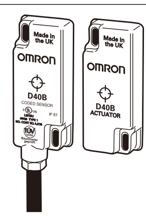
1. **Type**
   1: One main contact + one auxiliary contact *
   2: Two main contacts + one auxiliary contact *

* The auxiliary contacts use non-safety output.

Ordering Information

List of Models

Sensors (Switches/Actuators)

Classification	Shape	Auxiliary output	Cable length	Model
Standard Sensor		None	3 m	**D40B-1B3**
			10 m	**D40B-1B10**
		1 NC *	3 m	**D40B-1D3**
			10 m	**D40B-1D10**
Elongated Sensor		None	3 m	**D40B-2B3**
			10 m	**D40B-2B10**
		1 NC *	3 m	**D40B-2D3**
			10 m	**D40B-2D10**
High-temperature Type Sensor		1 NC *	5 m	**D40B-3D5C**
		1 NO *		**D40B-3E5C**

Note: A Sensor used in combination with a Controller is classified in Safety Category 3.
* The NC contact turns ON when the Actuator approaches the Switch and the NO contact turns ON when the Actuator separates from the Switch.

Controllers

Safety contacts	Auxiliary contacts/output *2	Rated voltage	Model
1 NO	1 NC *1	24 VAC/VDC	**D40B-J1**
2 NO	1 NC	24 VAC/VDC 110/230 VAC	**D40B-J2**

*1. MOS-FET output.
*2. Non-safety output.

Accessories

Classification	Model
Fuse	**D9M-P1**

Specifications

Certified Standards

- EN standards certified by TÜV Nord
  EN954-1
  EN/IEC60204-1
  EN/IEC60947-5-3
- UL508, CSA C22.2 No. 14
- EN1088 conformance

Ratings and Characteristics

Sensor (Switch/Actuator)

Item / Type	Standard Sensor	Elongated Sensor	High-temperature Type Sensor
Safety contact switching distance *1	OFF→ON: 5 mm min. ON→OFF: 15 mm max.	OFF→ON: 5 mm min. ON→OFF: 18 mm max.	OFF→ON: 8 mm min. ON→OFF: 21 mm max.
Auxiliary contact switching distance *1			OFF→ON: 5 mm min. ON→OFF: 21 mm max.
Actuator approach speed *2	17 mm/s min.		
Ambient operating temperature	–10 to +55°C		–25 to +125°C
Ambient operating humidity	90% at +50°C		
Degree of protection	IP67		
Material	ABS		Stainless steel
Mounting method	M4 screws		
Mounting screw tightening torque	1 N·m		
Switch auxiliary output rating *3	24 VDC, 10 mA, cosϕ = 1		

*1. These values represent the distances at which OFF changes to ON (approaching) or ON changes to OFF (separating) when the Switch and Actuator's target marks are aligned and the sensing surfaces have the same orientation.
*2. If the approach speed is less than the specified value, the Controller's safety contact output may not turn ON, even if the distance is less than the switching distance.
*3. Applies only to the D40B-1D□, D40B-2D□,and D40B-3□5C. Switches with contacts have no polarity.

Controller

Ratings

Power Supply

Item / Model	D40B-J1	D40B-J2
Power supply voltage	24 VAC 50/60 Hz/24 VDC	24 VAC 50/60 Hz/24 VDC, 110 VAC 50/60 Hz, or 230 VAC 50/60 Hz
Allowable voltage range	Power supply voltage ±15%	
Power consumption	2.0 VA max.	4.0 VA max.

Switch

Item / Model		D40B-J1	D40B-J2
Rated load	**Safety contacts**	250 VAC, 4 A, cosϕ = 1 30 VDC, 2 A, cosϕ = 1	
	Auxiliary contacts/output *	230 VAC, 100 mA, cosϕ = 1 24 VDC, 100 mA, cosϕ = 1	250 VAC, 4 A, cosϕ = 1 30 VDC, 2 A, cosϕ = 1

* D40B-J1: MOS-FET output; D40B-J2: Contact output.

Characteristics

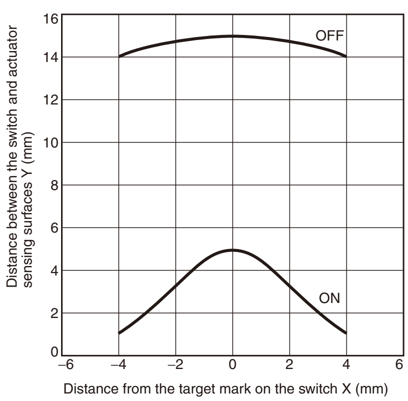
Item / Model		D40B-J1	D40B-J2
Contact resistance		100 mΩ max. (not including auxiliary output)	100 mΩ max. (including auxiliary output)
Auxiliary output ON resistance		36 Ω (nominal value)	---
Response time		25 ms max.	
Insulation resistance *		100 MΩ min. (at 500 VDC)	
Dielectric strength	Between output poles	1,500 VAC 1 min.	
	Between inputs and outputs		
	Between power supply and outputs		
Vibration resistance		10 to 55 to 10 Hz, 1 mm single amplitude (double amplitude: 2 mm), IEC68-2-6	
Shock resistance		300 m/s^2	
Durability	Mechanical	1,000,000 operations min.	
	Electrical	100,000 operation min. (at the rated load)	
Minimum rated current for safety contacts		10 VAC/VDC, 10 mA (reference values)	
Ambient operating temperature		−10 to +55°C	
Ambient operating humidity		90% at +50°C	
Mounting method		35 mm DIN Track (Screw mounting is not possible.)	
Terminal screw tightening torque		1 N·m	
Weight		147 g	590 g

* The measurement locations are the same as for the dielectric strength.

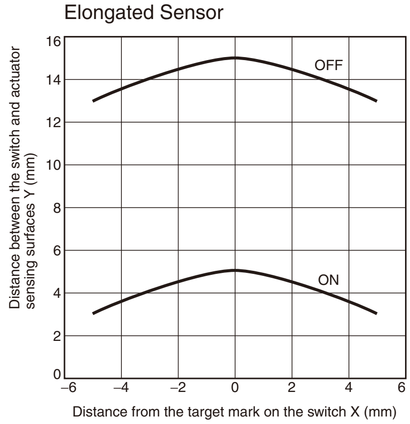
Engineering Data

Detection Ranges

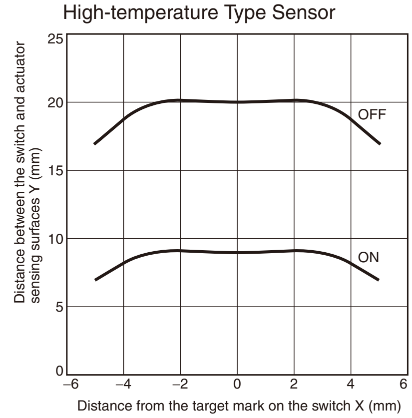
Standard Sensor



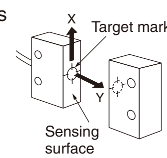
Elongated Sensor



High-temperature Type Sensor

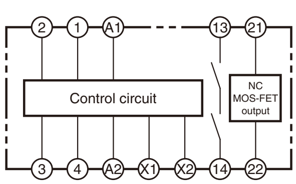


Note: The graph contains typical data collected in a standard testing environment. These figures are not guaranteed operating values. The actual operation distance may vary due to the effects of nearby metals, magnetic materials, and ambient temperature.

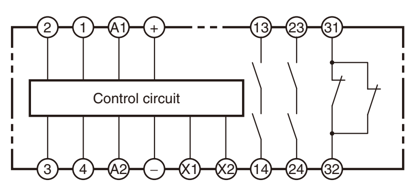


Internal Connection Diagram

D40B-J1



D40B-J2



Note: 1. If a 100/230 VAC power supply is used, connect it to the A1 and A2 terminals. Do not connect the power supply to the + and − terminals.

2. If a 24 VDC power supply is used, connect it to the + and − terminals. Do not connect the power supply to the A1 and A2 terminals.

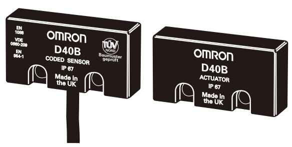
Dimensions and Terminal Arrangement

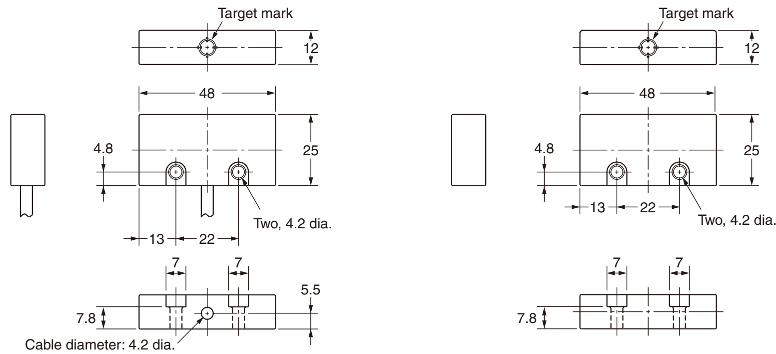
(Unit: mm)

Sensor (Switch/Actuator)

Standard Sensor

D40B-1B3
D40B-1B10
D40B-1D3
D40B-1D10

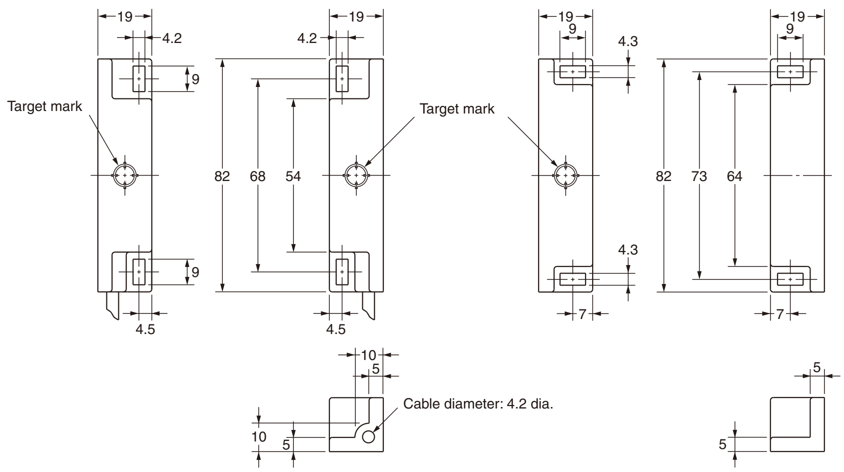




(Switch) (Actuator)

Elongated Sensor

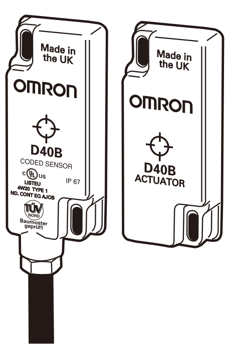
D40B-2B3
D40B-2B10
D40B-2D3
D40B-2D10

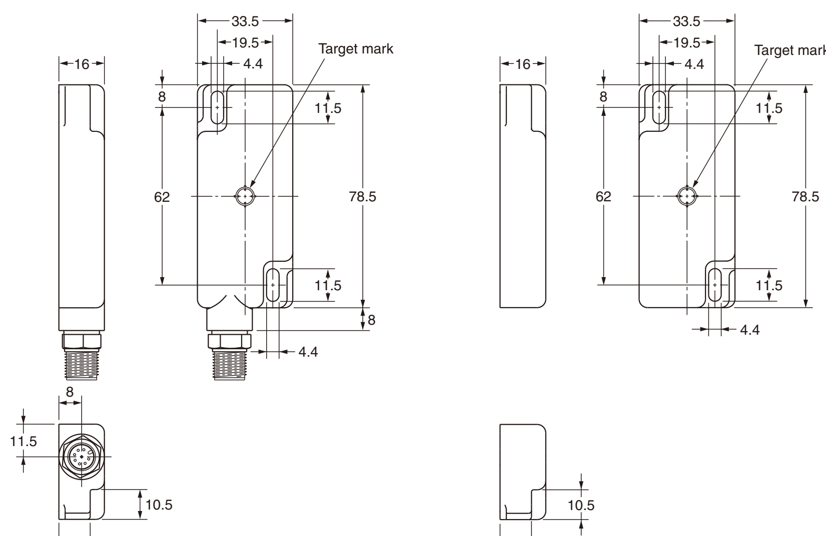


(Switch) (Actuator)

High-temperature Type Sensor

D40B-3D5C
D40B-3E5C



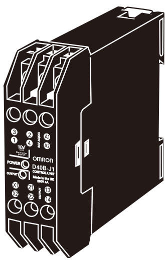


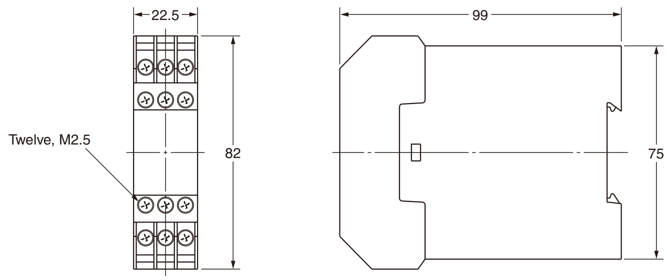
(Switch) (Actuator)

Controller

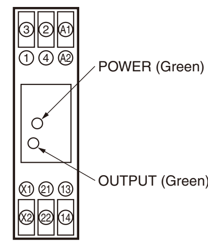
1-Pole Controller

D40B-J1



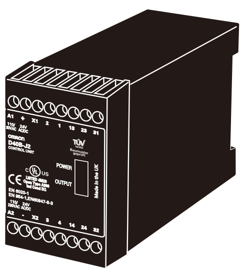


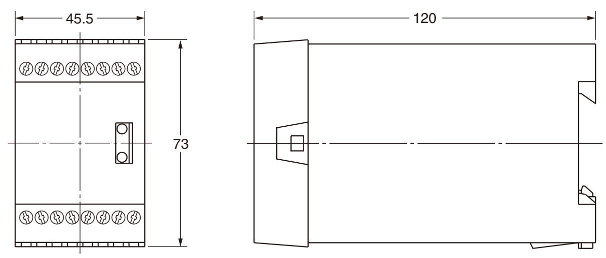
Terminal Arrangement



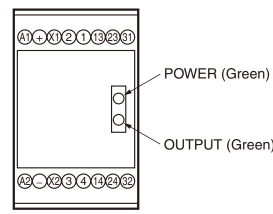
2-Pole Controller

D40B-J2





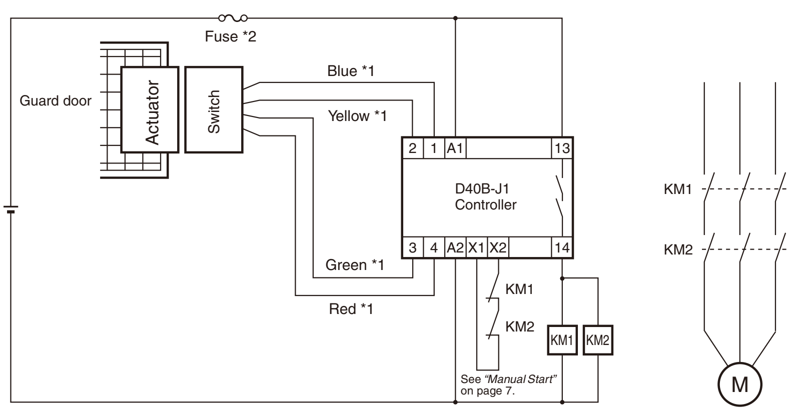
Terminal Arrangement



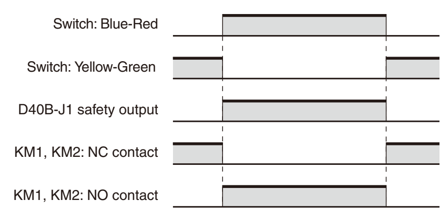
Application Examples

Wiring Example for 1 Sensor and 2 Contactors (with D40B-J1): Auto-reset

The configuration in this example is for auto-reset and contactor monitoring.



Timing Chart



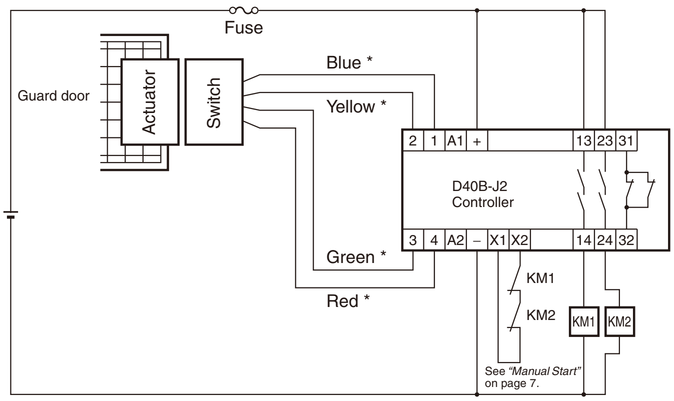
Note: The circuit in this example is equivalent to a Safety Category 3 circuit.

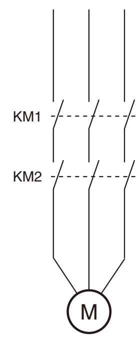
*1. This example applies to Standard or Elongated Sensors. The wire colors for the High-temperature Type Sensors are different. Refer to *"Sensor and Controller Connection Examples"* on page 8.

*2. Always use a fuse to protect the power supply from ground faults.

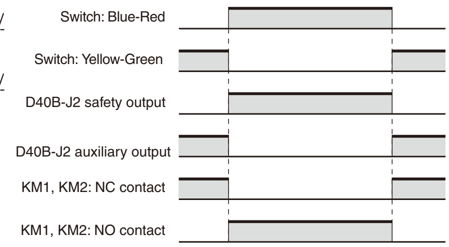
Wiring Example for 1 Sensor and 2 Contactors (with D40B-J2): Auto-reset

The configuration in this example is for auto-reset and contactor monitoring.





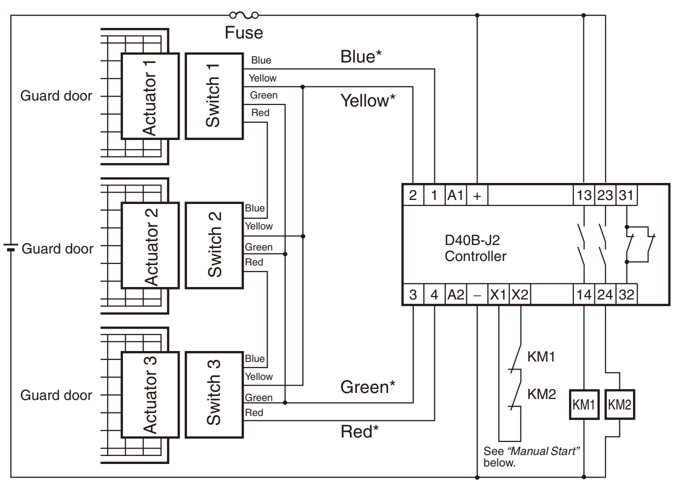
Timing Chart

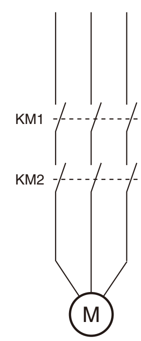


Note: The circuit in this example is equivalent to a Safety Category 3 circuit.
* This example applies to Standard or Elongated Sensors. The wire colors for the High-temperature Type Sensors are different. Refer to *"Sensor and Controller Connection Examples"* on page 8.

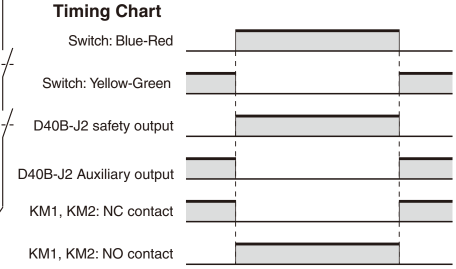
Wiring Example for 3 Sensors and 2 Contactors (with D40B-J2): Auto-reset

The configuration in this example is for auto-reset and contactor monitoring.





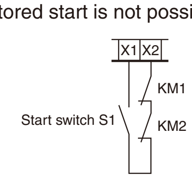
Timing Chart



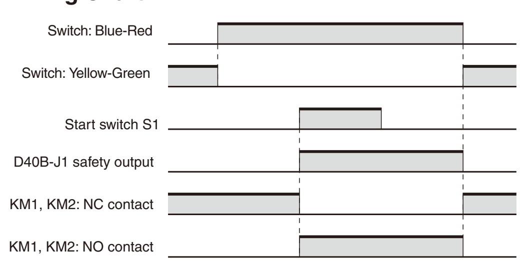
Note: 1. The circuit in this example is equivalent to a Safety Category 3 circuit.
2. If two or more Sensors are connected to one Controller, all of the guard doors must open and close independently. If two or more doors open and close at the same time, it is possible that a fault may not be detected.
3. Up to six Sensors can be connected to a single Controller.
* This example applies to Standard or Elongated Sensors. The wire colors for the High-temperature Type Sensors are different. Refer to *"Sensor and Controller Connection Examples"* on page 8.

Manual Start

If manual start is required, insert start switch S1 between X1 and X2 as shown below. Monitored start is not possible.

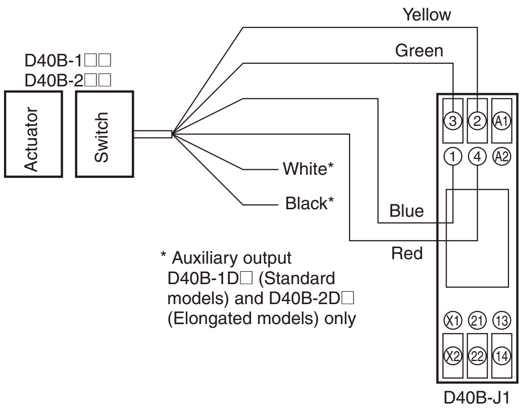


Timing Chart

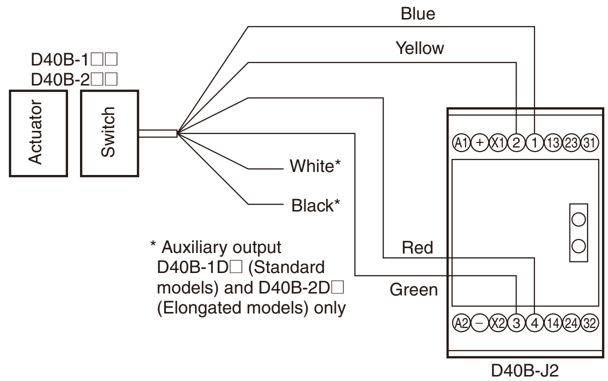


Sensor and Controller Connection Examples

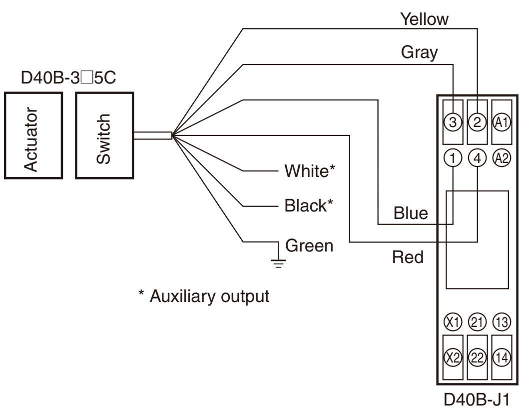
Connection between Standard or Elongated Sensor and 1-pole Controller



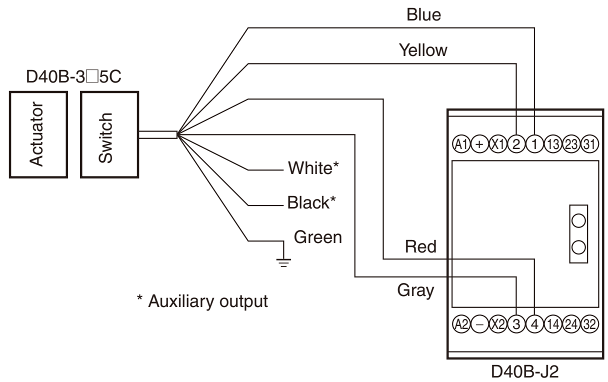
Connection between Standard or Elongated Sensor and 2-pole Controller



Connection between High-temperature Type Sensor and 1-pole Controller



Connection between High-temperature Type Sensor and 2-pole Controller



Safety Precautions

Refer to the *"Precautions for All Switches"* and *"Precautions for All Safety Door Switches"*.

⚠ WARNING

Serious injury may possibly occur due to breakdown of safety outputs.
Do not connect loads beyond the rated value to the safety outputs.

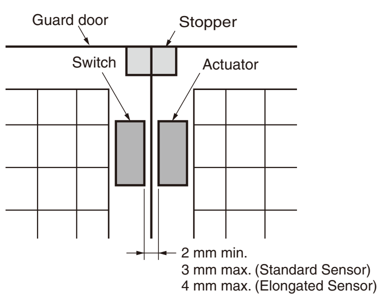
Serious injury may possibly occur due to loss of required safety functions.
Wire D40B properly so that supply voltages or voltages for loads do NOT touch the safety inputs accidentally or unintentionally.

⚠ CAUTION

Be sure to turn OFF the power before performing wiring. Do not touch charged parts (e.g., terminals) while power is ON. Doing so may result in electric shock.

Do not allow the Actuator to come close to the Switch with the door open. Doing so may cause machinery to start operating and may result in injury.

Use stoppers in the way shown below to ensure that the Switch and Actuator do not make contact when the guard door is closed.



Precautions for Safe Use

- Do not use the product in locations subject to explosive or flammable gases.
- Do not use load currents exceeding the rated value.
- Be sure to wire each conductor correctly.
- Be sure to confirm correct operation after completing mounting and adjustment.
- Do not drop or attempt to disassemble the product.
- Be sure to use the correct combination of Switch and Actuator.
- Do not mount the Switch and Actuator on magnetic materials, otherwise it may affect the operating distance.
- Use a power supply of the specified voltage. Do not use power supplies with large ripples or power supplies that intermittently generate incorrect voltages.
- Capacitors are consumable and require regular maintenance and inspection.
- Do not touch any of the terminals while the power is being supplied. Doing so may result in electric shock.
- Do not attempt to take any Unit apart while the power is being supplied.
  Doing so may result in electric shock.
- Do not allow metal fragments or lead wire scraps to fall inside this product. These may cause electric shock, fire, or malfunction.
- Be sure to turn OFF the power before performing wiring. Not doing so may result in electric shock.
- Apply the specified voltage to input terminals. Applying a different voltage may prevent proper operation and may result in product damage or burning.
- Do not under any circumstances, use the product for loads that exceed the product's contact ratings, such as the switching capacity (switching voltage and switching current). Doing so may not only result in faulty insulation, contact deposition, contact failure, or other problems affecting product performance, it may also result in damage or burning.
- Do not drop the product or use components that have been disassembled. Doing so may not only adversely affect performance characteristics, it may also result in damage.
- Ensure that solvents, such as alcohol, thinner, trichloroethane, or gasoline do not come into contact with the product. Solvents may cause markings to fade and components to deteriorate.

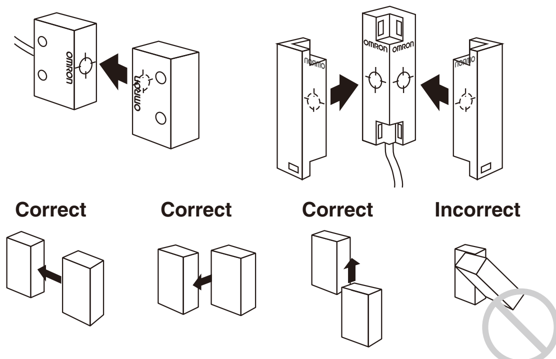
Precautions for Correct Use

Description

1. The D40B-series Sensor (switch and actuator) must only be used with the D40B-series Controller.
2. The D40B-series guard interlock switch system is self monitoring and comprises a magnetic actuator and switch connected via two wiring channels to a Controller.

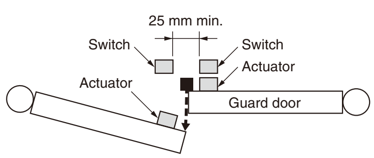
Mounting Direction of Switch and Actuator

The Sensor will not operate properly if the Switch and Actuator approach each other diagonally. The Sensor will operate correctly when the Switch and Actuator approach each other directly (face to face), horizontally, or vertically.
Also, as shown in the following figures, use the D40B-1□ with the OMRON logos appearing on the same sides of the Switch and Actuator, and use the D40B-2□ and D40B-3□ with the OMRON logos on the Switch and Actuator facing each other.



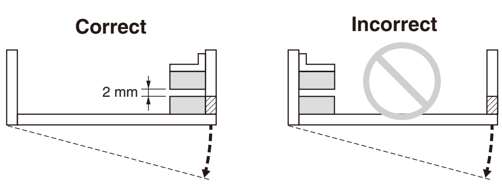
Mutual Interference

If the Switch and Actuator are mounted in parallel, be sure to separate them by at least 25 mm, as shown below.



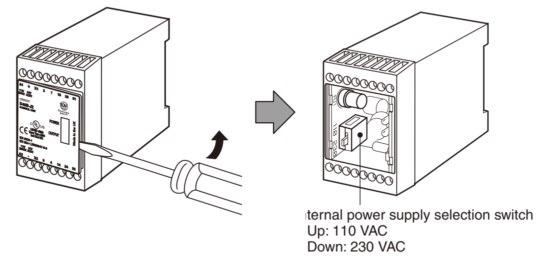
Using for Hinged Doors

On hinged doors, install the Sensor at an opening edge as shown below.



Switching Power Supply Voltage (D40B-J2 Only)

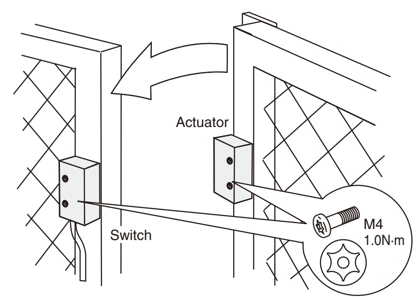
- Turn OFF the power to the Controller.
- Open the Controller's front cover with a flat-bladed screwdriver.
- Change the power supply voltage as required with the internal power supply selection switch. The switch is factory-set to 230 VAC.



Mounting the Switch and Actuator

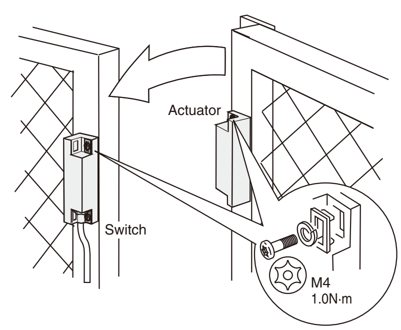
Whenever possible, mount the Switch and Actuator to nonferrous materials.
The operating distance will be affected if they are mounted to ferrous materials.
When mounting the Switch and Actuator, separate them by at least 2 mm.

Standard Sensors
D40B-1□□



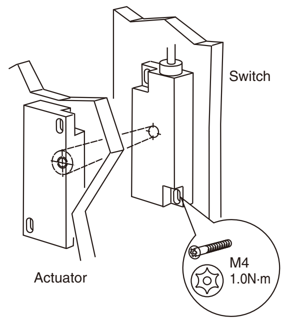
Always use a Standard Actuator with a Standard Switch.

Elongated Sensors
D40B-1□□



Always use an Elongated Actuator with an Elongated Switch.

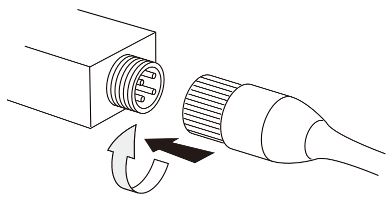
High-temperature Sensors
D40B-3□5C



Always use a High-temperature Actuator with a High-temperature Switch.

Note: Using anaerobic locking compounds can have a detrimental effect on the plastic switch case if the compounds come into contact with the switch case.

High-temperature Sensor Connectors

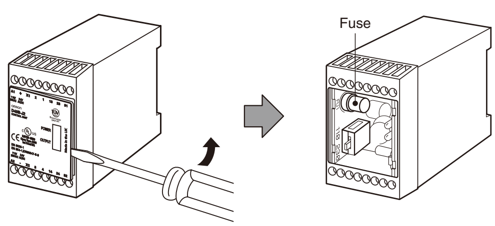


Installation Instructions

1. Installation must be in accordance with the following steps and must be carried out by suitably competent personnel.
2. This device is intended to be part of the safety related control system of a machine. Before installation, a risk assessment should be performed to determine whether the specifications of this device are suitable for all foreseeable operational and environmental characteristics of the machineto which it is to be fitted.
3. At regular intervals during the life of the machine check whether the characteristics foreseen remain valid and inspect this device for evidence of accelerated wear, material degradation or tampering. If necessary the device should be replaced.
4. OMRON cannot accept responsibility for a failure of this device if the procedures given in this sheet are not implemented or if it is used outside the recommended specifications in this sheet.
5. Guard stops and guides must be fitted to protect the D40B-series Sensor from shock.

Fuse Replacement Method (D40B-J2 Only)

- Turn OFF the power to the Controller.
- Open the Controller's front cover with a flat-bladed screwdriver.
- Replace the fuse (D9M-P1).



Note: Fuse replacement is not required for the D40B-J1 because it contains a self-resetting fuse.

Applicable Safety Category (EN954-1)

This product can be used in environments classified as Safety Category 3 according to the requirements of European standard EN954-1. This evaluation, however, is based on circuit configuration examples proposed by OMRON. The standard may not apply in some operating conditions.
The applicable safety category is determined from the whole safety control system. Make sure that the whole safety control system meets EN954-1 requirements.

Installation Location

- Do not install the product in the following locations. Doing so may result in product failure or malfunction.
  - Locations subject to direct sunlight
  - Locations subject to temperatures outside the range −25 to 55°C
  - Locations subject to humidity levels outside the range 35% to 85% or subject to condensation due to extreme temperature changes
  - Locations subject to corrosive or flammable gases
  - Locations subject to shock or vibration in excess of the product ratings
  - Locations subject to exposure to water, oil, or chemicals
  - Locations subject to dust (including iron dust) or salts
- Take appropriate and sufficient countermeasures when using the product in the following locations.
  - Locations subject to static electricity or other forms of noise
  - Locations subject to possible exposure to radioactivity
  - Locations close to power supply lines

Wiring

- Perform wiring using wires with the following dimensions.
  Stranded wires: 0.2 to 2.5 mm^2
  Solid wire: 0.2 to 4.0 mm^2
- Tighten the terminal screws with the specified torque. Not doing so may result in malfunction or abnormal heat generation.
  Terminal screw tightening torque: 1 N·m max.

Safety Functions

Adherence to the recommended inspection and maintenance instructions forms part of the warranty. When a single Sensor is connected to the Controller a single safety related fault at the Sensor, connecting wiring or inside the Controller will be detected either immediately or at the next opening of the guard (depending on the type of fault). When the fault is detected the Controller goes to a lock out condition. The output contacts will not close until the fault has been rectified. If multiple Sensors are connected to the Controller each guard door should be opened and then shut individually. Otherwise some single faults may not be detected and unintentional lockout reset may occur if two or more guard doors are open at the same time.

Precautions for All Safety Door Switches

Note: Refer to the *Safety Precautions* section for each Switch for specific precautions applicable to each Switch.

⚠ CAUTION

Do not insert the Operation Key when the door is open. The machine may operate, possibly causing injury.

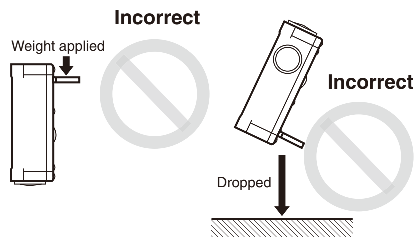
Precautions for Safe Use

- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch body is protected from the ingress of dust or water, avoid the ingress of foreign substance through the key hole on the head. Otherwise, accelerated wear, breaking, or malfunction may result.
- The durability of the Switch varies considerably depending on the switching conditions. Always confirm the usage conditions by using the Switch in an actual application, and use the Switch only for the number of switching operations that its performance allows.
- Do not use the Switch in a starting circuit. (Use the Switch for safety confirmation signal purposes.)
- Connect a fuse in series with the Switch to protect it from short-circuit damage. The value of the breaking current of the fuse must be calculated by multiplying the rated current by 150% to 200%.
  When using the Switch for an EN rating, use a 10 A fuse of type gI or gG that complies with IEC 60269.
- Mount the Operation Key so that it will not come into contact with persons in the area when the door is opened and closed. Injury may result.
- Do not drop the Switch. Doing so may prevent the Switch from functioning to its full capability.
- Do not under any circumstances disassemble or modify the Switch. Doing so may cause malfunction.

Precautions for Correct Use

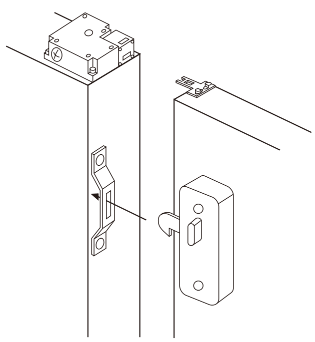
Operation Key

- Use only the designated Operation Key. The Head has been designed so that operation is not possible with a screwdriver or other tools. Using anything other than the designated Operation Key may damage the Switch or affect machine safety.
- Do not operate the Switch with anything other than the special OMRON Operation Key, otherwise the Switch may break or the safety of the system may not be maintained.
- Do not impose excessive force on the Operation Key while the Key is inserted into the Switch or drop the Switch with the Operation Key inserted. Doing either of these may deform the Key or break the Switch.



Securing the Door

If the closed door (with the Operation Key inserted) pulls the Operation Key past the operating/lock position (i.e., the set zone) because of, for example, the door's own weight, machine vibration, or the door cushion rubber, the Switch may be damaged.
Also, with a magnetic lock, it may not be possible to unlock the Switch if there is weight placed on the Operation Key. Secure the door with a stopper so that the Operation Key remains within the set zone.



Operating Environment

- Safety Door Switches are designed for use indoors. Using a Switch outdoors may damage it.
- Do not use the Switch in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to high temperature or high humidity. Doing so may damage the Switch due to contact failure or corrosion.
- Do not use the Switch in the following locations:
  - ･Locations subject to severe temperature changes
  - ･Locations subject to high temperatures or condensation
  - ･Locations subject to severe vibration
  - ･Locations where the interior of the Protective Door may come into direct contact with cutting chips, metal filings, oil, or chemicals
  - ･Locations where the Switch may come into contact with thinner or detergents
  - ･Locations where explosive or flammable gases are present

Storing Switches

Do not store Switches in locations where toxic gases, such as H_2S, SO_2, NH_3, HNO_3, and Cl_2, may be present, or in locations that are subject to excessive dirt, excessive dust, high temperature, or high humidity.

Other Precautions

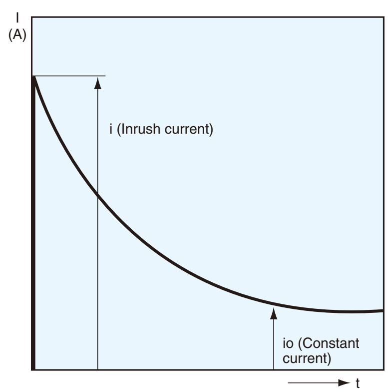
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- Use the Switch with a load current that does not exceed the rated current.
- Do not use any screws to connect the cover other than the specified ones. The seal characteristics may be reduced.

Precautions for All Switches

Refer to the Safety *Precautions* section for each Switch for specific precautions applicable to each Switch.

Precautions for Safe Use

- If the Switch is to be used as a switch in an emergency stop circuit or in a safety circuit for preventing accidents resulting in injuries or deaths, use a Switch with a direct opening mechanism, use the NC contacts with a forced release mechanism, and set the Switch so that it will operate in direct opening mode.
  For safety, install the Switch using one-way rotational screws or other similar means to prevent it from easily being removed.
  Protect the Switch with an appropriate cover and post a warning sign near the Switch to ensure safety.
- Do not perform wiring while power is being supplied. Wiring while the power is being supplied may result in electric shock.
- Keep the electrical load below the rated value.
- Be sure to evaluate the Switch under actual working conditions after installation.
- Do not touch the charged Switch terminals while the Switch has carry current, otherwise an electric shock may be received.
- If the Switch has a ground terminal, be sure to connect the ground terminal to a ground wire.
- The durability of the Switch greatly varies with switching conditions. Before using the Switch, be sure to test the Switch under actual conditions. Make sure that the number of switching operations is within the permissible range.
  If a deteriorated Switch is used continuously, insulation failures, contact welding, contact failures, Switch damage, or Switch burnout may result.
- Maintain an appropriate insulation distance between wires connected to the Switch.
- Some types of load have a great difference between normal current and inrush current. Make sure that the inrush current is within the permissible value. The greater the inrush current in the closed circuit is, the greater the contact abrasion or shift will be. Consequently, contact welding, contact separation failures, or insulation failures may result. Furthermore, the Switch may become broken or damaged.



- The user must not attempt to repair or maintain the Switch and must contact the machine manufacturer for any repairs or maintenance.
- Do not attempt to disassemble or modify the Switch. Doing so may cause the Switch to malfunction.
- Do not drop the Switch. Doing so may result in the Switch not performing to its full capability.

Wiring

Pay the utmost attention so that each terminal is wired correctly.
If the terminal is wired incorrectly, the Switch will not function.
Furthermore, not only will the Switch have a negative influence on the external circuit, the Switch itself may become damaged or burnt.

Mounting

- Do not modify the Actuator, otherwise the operating characteristics and performance of the Actuator will change.
- Do not enlarge the mounting holes of the Switch or modify the Switch, otherwise insulation failures, housing damage, or human accidents may result.
- Do not apply oil, grease, or other lubricants to the moving parts of the Actuator, otherwise the Actuator may not operate correctly. Furthermore, ingress of oil, grease, or other lubricants inside the Switch may reduce sliding characteristic or cause failures in the Switch.
- Mount the Switch and secure it with the specified screws tightened to the specified torque along with flat and spring washers.
- Be sure to wire the Switch so that the conduit opening is free of metal powder or any other impurities.
- If glue or bonding agent is applied, make sure that it does not adhere to the movable parts or enter the Switch, otherwise the Switch may not work correctly or cause contact failure. Some types of glue or bonding agent may generate a gas that may have a negative influence on the Switch. Pay the utmost attention when selecting the glue or locking agent.
- Some models allow changes in the head direction. When changing the head of such a model, make sure that the head is free of any foreign substance. Tighten each screw of the head to the rated torque.
- Be sure to take measures so that no foreign material, oil, or water will enter the Switch through the conduit opening. Be sure to attach a connector suitable for the cable thickness and tighten the connector securely to the rated torque.
- Do not impose shock or vibration on the Actuator while it is fully pressed. Otherwise, the Actuator will partially abrade and an actuation failure may result.

Precautions for Correct Use

Switch Operation

- The Switch in actual operation may cause accidents that cannot be foreseen from the design stage. Therefore, the Switch must be practically tested before actual use.
- When testing the Switch, be sure to apply the actual load conditions together with the actual operating environment.
- All the performance ratings in this catalog are provided under the following conditions unless otherwise specified.

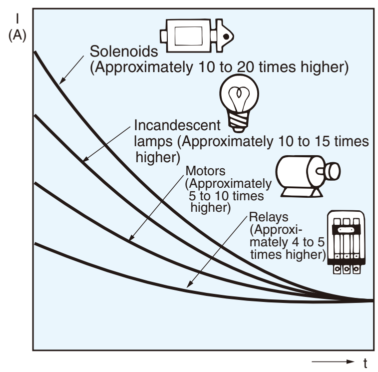
  Inductive load: A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)

  Lamp load: An inrush current 10 times higher than the normal current

  Motor load: An inrush current 6 times higher than the normal current

  1. Ambient temperature: 5°C to 35°C
  2. Ambient humidity: 40% to 70%.

Note: An inductive load causes a problem especially in DC circuitry. Therefore, it is essential to know the time constants (L/R) of the load.



Mechanical Conditions for Switch Selection

- An Actuator suitable for the operating method must be selected. Ask your OMRON representative for details.
- Check the operating speed and switching frequency.
  1. If the operating speed is extremely low, switching of the movable contact will become unstable, thus resulting in incorrect contact or contact welding.
  2. If the operating speed is extremely high, the Switch may break due to shock. If the switching frequency is high, the switching of the contacts cannot keep up with the switching frequency. Make sure that the switching frequency is within the rated switching frequency.
- Do not impose excessive force on the Actuator, otherwise the Actuator may become damaged or not operate correctly.
- Make sure that the stroke is set within the suitable range specified for the model, or otherwise the Switch may break.

Electrical Characteristics for Switch Selection

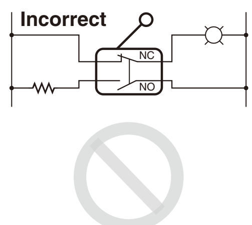
Electrical Conditions

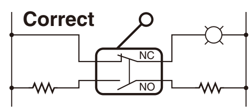
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may continue comparatively for a long time. Furthermore, the current direction is always the same, which results in contact relocation, whereby the contacts easily stick to each other and do not separate when the surfaces of the contacts are uneven.
- If the load is inductive, counter-electromotive voltage will be generated. The higher the voltage is, the higher the generated energy will be, which will increase the abrasion of the contacts and contact relocation load conditions. Be sure to use the Switch within the rated conditions.
- If the load is a minute voltage or current load, use a Switch designed for minute loads. The reliability of silver-plated contacts, which are used by standard Switches, will be insufficient if the load is a minute voltage or current load.

Connections

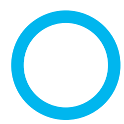
- With a Za contact form, do not contact a single Switch to two power supplies that are different in polarity or type.

Power Connection Examples
(Connection of Different Polarities)

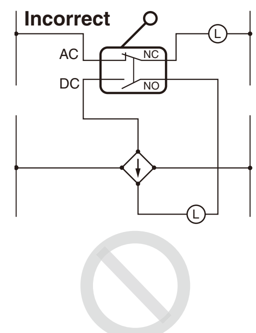




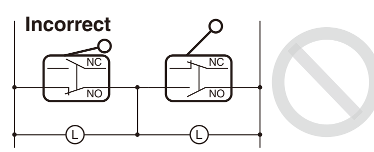
Connect the load to the same polarities.



Incorrect Power Connection Example
(Connection of Different Power Supplies)
There is a risk of AC and DC mixing.



- Do not use a circuit that will short-circuit if a fault occurs, otherwise the charged part may melt and break off.

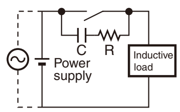
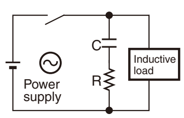
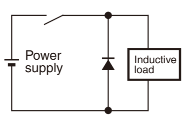
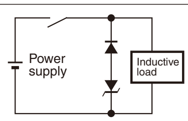
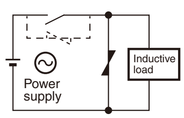


- Application of Switch to a Low-voltage, Low-current Electronic Circuit.
  1. If bouncing or chattering of the contacts results and causes problems, take the following countermeasures.
     (a) Insert an integral circuit.
     (b) Suppress the generation of pulses from the contact bouncing or chattering of the contacts so that it is less than the noise margin of the load.
  2. Conventional silver-plated contacts are not suitable for this application, in which particularly high reliability is required. Use gold-plated contacts, which are ideal for handling minute voltage or current loads.
  3. The contacts of the Switch used for an emergency stop must be normally closed with a positive opening mechanism.
- To protect the Switch from damage due to short-circuits, be sure to connect in series a quick-response fuse with a breaking current 1.5 to 2 times larger than the rated current to the Switch. When complying with EN certified ratings, use a 10-A IEC 60269-compliant gI or gG fuse.

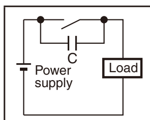
Contact Protection Circuits

Using a contact protection circuit to increase the contact durability, prevent noise, and suppress the generation of carbide or nitric acid. Be sure to apply the contact protection circuit correctly, otherwise adverse results may occur.
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for switching a load that easily generates arcs, such as an inductive load, the arcs may generate NOx, which will change into HNO_3 when it reacts with moisture. Consequently, the internal metal parts may corrode and the Switch may fail. Be sure to select the best contact protection circuit from the following table.

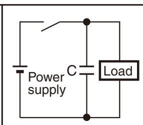
Typical Examples of Contact Protection Circuits

Circuit example		Applicable current		Features and remarks	Element selection
		AC	DC		
CR		* (Yes)	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.	Use the following as guides for C and R values: C: 1 to 0.5 μF per 1 A of contact current (A) R: 0.5 to 1 Ω per 1 V of contact voltage (V) These values depend on various factors, including the load characteristics. Confirm optimum values experimentally. Capacitor C suppresses the discharge when the contacts are opened, while the resistor R limits the current applied when the contacts are closed the next time. Generally, use a capacitor with a low dielectric strength of 200 to 300 V. For applications in an AC circuit, use an AC capacitor (with no polarity).
		Yes	Yes	The operating time of the contacts will be increased if the load is a Relay or solenoid. Connecting the CR circuit in parallel to the load is effective when the power supply voltage is 24 or 48 V and in parallel to the contacts when the power supply voltage is 100 to 200 V.	
Diode		No	Yes	The energy stored in the coil reaches the coil as current via the diode connected in parallel, and is dissipated as Joule heat by the resistance of the inductive load. This type of circuit increases the release time more than the CR type.	Use a diode having a reverse breakdown voltage of more than 10 times the circuit voltage, and a forward current rating greater than the load current.
Diode + Zener diode		No	Yes	This circuit effectively shortens the reset time in applications where the release time of a diode circuit is too slow.	Use a Zener diode with a low breakdown voltage.
Varistor		Yes	Yes	This circuit prevents a high voltage from being applied across the contacts by using the constant-voltage characteristic of a varistor. This circuit also somewhat increases the reset time. Connecting the varistor across the load is effective when the supply voltage is 24 to 48 V, and across the contacts when the supply voltage is 100 to 200 V.	---

Do not use the following types of contact protection circuit.



This circuit arrangement is very effective for diminishing arcing at the contacts when breaking the circuit. However, since electrical energy is stored in C (capacitor) when the contacts are open, the current from C flows into the contacts when they close. This may lead to contact welding.

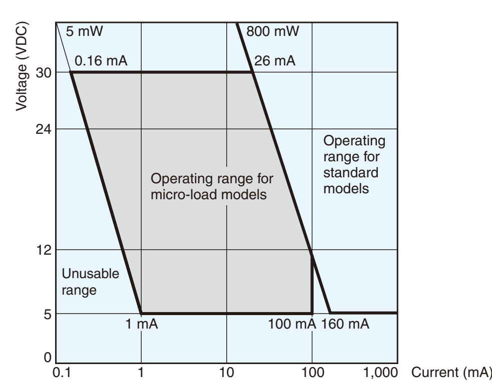


This circuit arrangement is very useful for diminishing arcing at the contacts when breaking the circuit. However, since the charging current to C flows into the contacts when they are closed, contact welding may occur.

Although it is thought that switching a DC inductive load is more difficult than a resistive load, an appropriate contact protection circuit can achieve almost the same characteristics.

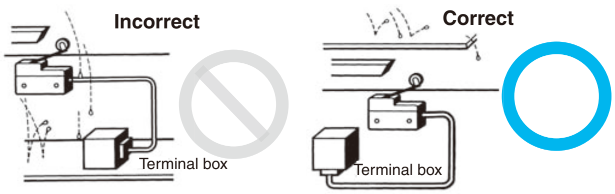
Using Switches for Microloads

Contact failure may occur if a Switch for a general load is used to switch a microload circuit. Use Switches in the ranges shown in the diagram right. However, even when using microload models within the operating range shown here, if inrush current occurs when the contact is opened or closed, it may increase contact wear and so decrease durability. Therefore, insert a contact protection circuit where necessary. The minimum applicable load is the N-level reference value. This value indicates the malfunction reference level for the reliability level of 60% (λ_{60}) (JIS C5003). The equation, $\lambda_{60} = 0.5\times10^{-6}$/operations indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

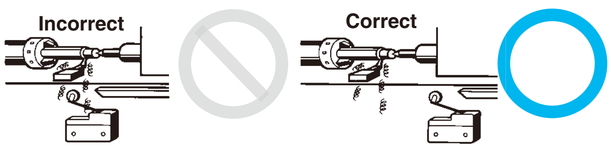


Operating Environment

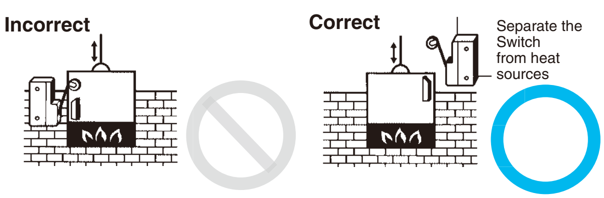
- The Switches are designed for use indoors.
  Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) in advance before using the Switch where it would be subject to oil, water, chemicals, or detergents. Contact with any of these may result in contact failure, insulation failure, earth leakage faults, or burning.
- Do not use the Switch in the following locations:
  - Locations subject to corrosive gases
  - Locations subject to severe temperature changes
  - Locations subject to high humidity, resulting in condensation
  - Locations subject to severe vibration
  - Locations subject to cutting chips, dust, or dirt
  - Locations subject to high humidity or high temperature
- Use protective covers to protect Switches that are not specified as waterproof or airtight whenever they are used in locations subject to splattering or spraying oil or water, or to accumulation of dust or dirt.



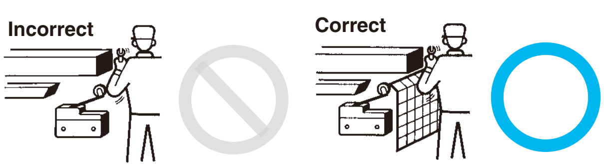
- Be sure to install the Switch so that the Switch is free from dust or metal powder. The Actuator and the Switch casing must be protected from the accumulation of dust or metal powder.



- Do not use the Switch in locations where the Switch is exposed to steam or hot water at a temperature greater than 60°C.
- Do not use the Switch under temperatures or other environmental conditions not within the specified ranges.
  The rated permissible ambient temperature range varies with the model. Refer to the *Specifications* in this catalog.
  If the Switch is exposed to radical temperature changes, the thermal shock may deform the Switch and the Switch may malfunction.



- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.

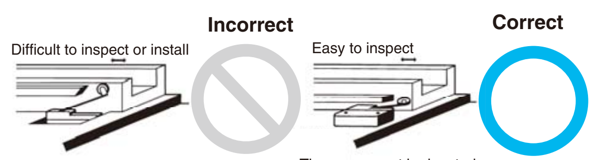


Prevent false operation

- Make sure to install the Switch in locations free of vibration or shock. If vibration or shock is continuously imposed on the Switch, contact failure, malfunction, or decrease in service life may be caused by abrasive powder generated from the internal parts. If excessive vibration or shock is imposed on the Switch, the contacts may malfunction or become damaged.
- Do not use the Switch with silver-plated contacts for long periods if the switching frequency of the Switch is comparatively low or the load is minute. Otherwise, sulfuric film will be generated on the contacts and contact failures may result. Use the Switch with gold-plated contacts or use a Switch designed for minute loads instead.
- Do not use the Switch in locations with corrosive gas, such as sulfuric gas (H_2S or SO_2), ammonium gas (NH_3), nitric gas (HNO_3), or chlorine gas (Cl_2), or high temperature and humidity. Otherwise, contact failure or corrosion damage may result.
- If the Switch is used in locations with silicone gas, arc energy may create silicon dioxide (SiO_2) on the contacts and a contact failure may result. If there is silicone oil, silicone sealant, or wire covered with silicone close to the Switch, attach a contact protection circuit to suppress the arcing of the Switch or eliminate the source of silicone gas generation.

Regular Inspection and Replacement

- If the Switch is normally closed with low switching frequency (e.g., once or less per day), a reset failure may result due to the deterioration of the parts of the Switch. Regularly inspect the Switch and make sure that the Switch is in good working order.
- In addition to the mechanical durability or electrical durability of the Switch described previously, the durability of the Switch may decrease due to the deterioration of each part, especially rubber, resin, and metal. Regularly inspect the Switch and replace any part that has deteriorated to prevent accidents from occurring.
- If the Switch is not turned ON and OFF for a long period of time, contact reliability may be reduced due to contact oxidation. Continuity failure may result in accidents (i.e., the switch may not turn ON due to increased contact resistance.)
- Be sure to mount the Switch securely in a clean location to ensure ease of inspection and replacement. The Switch with operation indicator is available, which is ideal if the location is dark or does not allow easy inspection or replacement.



The cover must be located in the direction ensuring ease of maintenance or inspection.

Storage of Switch

- When storing the Switch, make sure that the location is free of corrosive gas, such as H_2S, SO_2, NH_3, HNO_3, or Cl_2, or dust and does not have a high temperature or humidity.
- Be sure to inspect the Switch before use if it has been stored for three months or more.

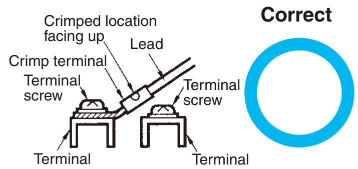
Typical Problems, Probable Causes, and Remedies

Problem		Probable cause	Remedy
Mechanical failure	1. The Actuator does not operate. 2. The Actuator does not return. 3. The Actuator has been deformed. 4. The Actuator is worn. 5. The Actuator has been damaged.	The shape of the dog or cam is incorrect.	• Change the design of the dog or cam and smooth the contacting surface of the cam. • Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	
		The operating direction of the Actuator is not correct.	
		The operation speed is excessively high.	• Attach a decelerating device or change the mounting position of the Switch.
		Excessive stroke.	• Change the stroke.
		The rubber or grease hardened due to low temperature.	• Use a cold-resistive Switch.
		The accumulation of sludge, dust, or cuttings.	• Use a drip-proof model or one with high degree of protection. • Use a protection cover and change the solvent and materials.
		Dissolution, expansion, or swelling damage to the rubber parts of the driving mechanism.	
	There is a large deviation in operating position (with malfunctioning involved).	Damage to and wear and tear of the internal movable spring.	• Regularly inspect the Switch. • Use a better quality Switch. • Tighten the mounting screws securely. Use a mounting board.
		Wear and tear of the internal mechanism.	
		The loosening of the mounting screws causing the position to be unstable.	
	The terminal part wobbles (The mold part has been deformed).	Overheating due to a long soldering time.	• Solder the Switch quickly. • Change the lead wire according to the carry current and ratings.
		The Switch has been connected to and pulled by thick lead wires with excessive force.	
		High temperature or thermal shock resulted.	• Use a temperature-resistive Switch or change mounting positions.
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	• Attach an anti-vibration mechanism. • Attach a rubber circuit to the solenoid. • Increase the operating speed (with an accelerating mechanism).
		Shock has been generated from a device other than the Switch.	
		Too-slow operating speed.	
	Oil or water penetration.	The sealing part has not been tightened sufficiently.	• Use a drip-proof or waterproof Switch. • Use the correct connector and cable.
		The wrong connector has been selected and does not conform to the cable.	
		The wrong Switch has been selected.	
		The terminal part is not molded.	
		The Switch has been burnt or carbonated due to the penetration of dust or oil.	
	Deterioration of the rubber part.	The expansion and dissolution of the rubber caused by solvent or lubricating oil.	• Use an oil-resistant rubber or Teflon bellows. • Use a weather-resistant rubber or protective cover. • Use a Switch with a metal bellows protective cover.
		Cracks due to direct sunlight or ozone.	
		Damage to the rubber caused by scattered or heated cuttings.	
	Corrosion (rusting or cracks).	The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	• Change the lubricating oil or change mounting positions. • Use a crack-resistant material.
		The Switch has been operated in a corrosive environment, near the sea, or on board a ship.	
		The electrical deterioration of metal parts of the Switch resulted due to the ionization of cooling water or lubricating oil.	
		The cracking of alloyed copper due to rapid changes in temperature.	
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	Inductive interference in the DC circuit.	• Add an erasing circuit.
		Carbon generated on the surface of the contacts due to switching operations.	• Use a Switch with a special alloy contact or use a sealed Switch.
		A short-circuit or contact welding due to contact migration.	• Reduce the switching frequency or use a Switch with a large switching capacity.
		Contact welding due to an incorrectly connected power source.	• Change the circuit design.
		Foreign materials or oil penetrated into the contact area.	• Use a protective box.

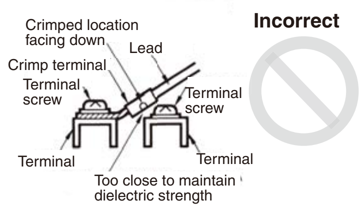
Other

- The standard material for the Switch seal is nitrile rubber (NBR), which has superior resistance to oil. Depending on the type of oil or chemicals in the application environment, however, NBR may deteriorate, e.g., swell or shrink. Confirm performance in advance.
- The correct Switch must be selected for the load to ensure contact reliability. Refer to *Precautions* for microloads in individual product information for details.
- Wire the leads as shown in the following diagram.

Correct Wiring



Incorrect Wiring



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

In the interest of product improvement, specifications are subject to change without notice.

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

Single-beam Safety Sensor

E3ZS/E3FS

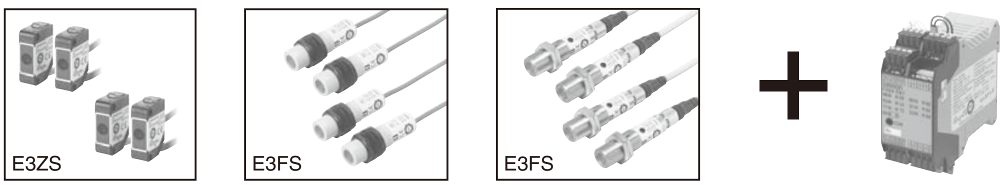
Detects Intrusions into Hazardous Areas with a Single Beam and Complies with International Safety Standards.

⚠ Be sure to read the *"Safety Precautions"* on page 15 and the *"Precautions for All Safety Sensors"* .

Features

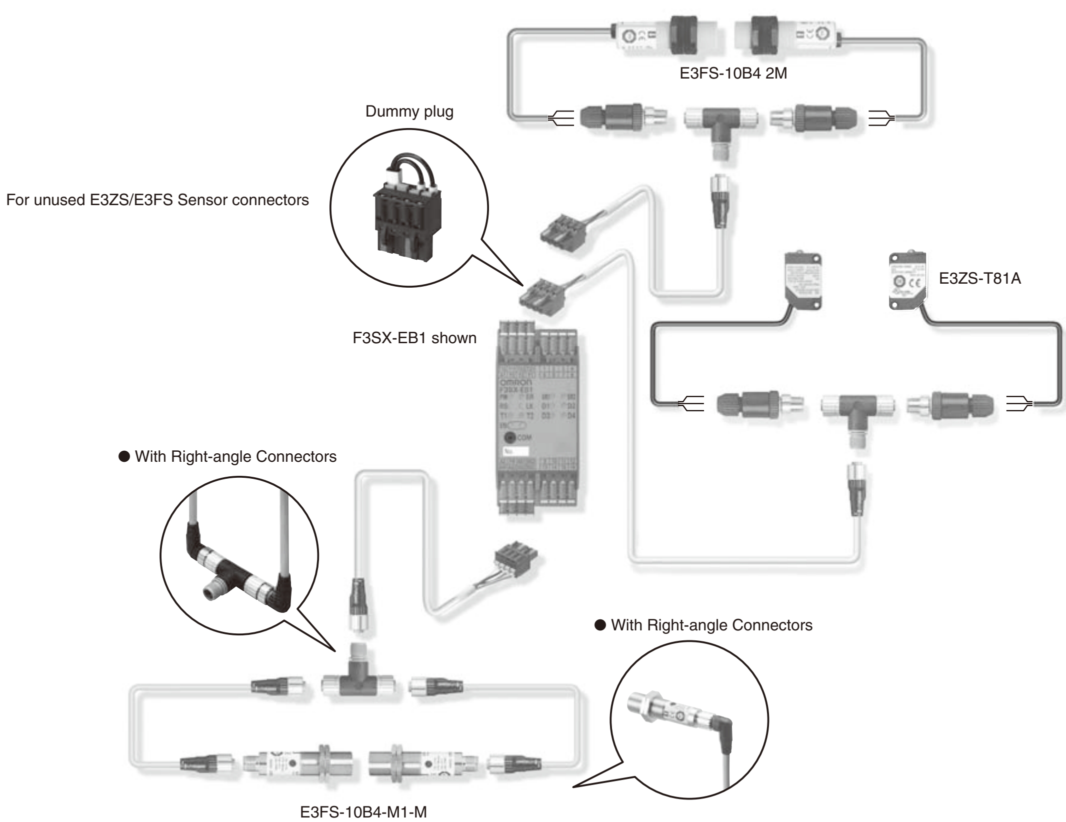
Connect up to 4 sets of E3ZS/E3FS per B1 Module for F3SX Safety Controller
Connect to a B1 Module for F3SX to Create a Type 2 Safety Sensor

Note: The B1 Module is designed specifically for E3ZS/E3FS input of the F3SX. The safety output turns OFF when light is interrupted or when an error occurs with one or more of the E3ZS/E3FS Sensors connected to the B1 Module.



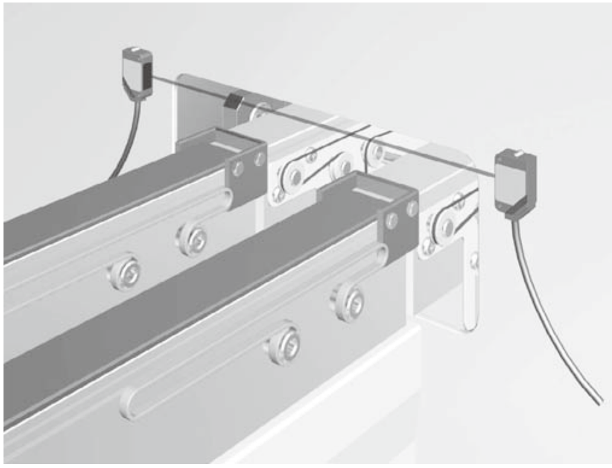
B1 Module for the F3SX
(F3SX-EB1 shown here)

Connects simply and easily using a wide range of accessories.



Application Examples

For gaps in small-sized equipment



Protect personnel from the hazards of gaps in small-sized equipment or of semi-automated machinery.

The E3ZS is a Human Body Detection Sensor (Type 2) for production equipment. Make sure to use it in combination with an F3SX Safety Controller.
When used by itself, the E3ZS conforms to EN954-1 (Category 1). No particular safety restrictions apply to the E3ZS when used by itself, except the inability to use in human detection safety applications. We recommend using it in Light ON mode and using it with error detection via test input.

Note: Test Input
Use this function to enable the emitter of E3ZS to be turned ON/OFF from outside. It is possible to detect a number of E3ZS errors by monitoring the status of the test input and the E3ZS output signal.

For gaps in small to medium-sized equipment

Use as a safety measure for protection from hazardous gaps or as guards for medium-sized equipment.

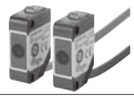
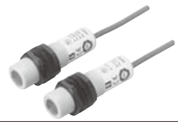
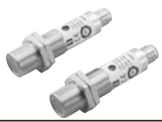
The E3FS is a Human Body Detection Sensor (Type 2) for production equipment. Make sure to use it in combination with a F3SX Safety Controller. A combination of E3FS and E3ZS Sensors can be connected to the B1 Module of the F3SX.

Note: Since the E3FS has not received any safety certification for use by itself, make sure to connect it with an F3SX for use in safety applications.

Ordering Information

Sensors

Red light / Infrared light

Sensor method	Appearance	Case material	Connection method	Sensing distance	Output	Model
Through-beam		Polybutylene terephthalate	Pre-wired cable (2 m)	0.2 to 3 m	PNP	**E3ZS-T81A**
		ABS		10 m		**E3FS-10B4 2M**
		Brass	M12 connector	10 m		**E3FS-10B4-M1-M**

Controller

Instant Breaking Models

F3SX-N-□□□R (with Relay Safety Output)

Input types				Model	Width (W)	Weight
E3ZS/E3FS Safety Sensors	F3SJ/F3SN/F3SH Safety Light Curtains	Emergency Stop Switches	Door Switches			
4 sets	---	1 set	---	**F3SX-N-B1R**	90.0 mm	Approx. 0.5 kg
4 sets	---	1 set	2 sets	**F3SX-N-B1D1R**	112.5 mm	Approx. 0.6 kg
4 sets	---	1 set	4 sets	**F3SX-N-B1D1D1R**	135.0 mm	Approx. 0.7 kg
4 sets	2 sets	1 set	---	**F3SX-N-L2B1R**	112.5 mm	Approx. 0.6 kg

Instant Breaking Models

F3SX-E-□□□ (with DC Solid-state Safety Output)

Input types				Model	Width (W)	Weight
E3ZS/E3FS Safety Sensors	F3SJ/F3SN/F3SH Safety Light Curtains	Emergency Stop Switches	Door Switches			
4 sets	---	1 set	---	**F3SX-EB1**	45.0 mm	Approx. 0.3 kg
8 sets	---	1 set	---	**F3SX-E-B1B1**	67.5 mm	Approx. 0.4 kg
4 sets	---	1 set	2 sets	**F3SX-E-B1D1**	67.5 mm	Approx. 0.4 kg
4 sets	2 sets	1 set	---	**F3SX-E-L2B1**	67.5 mm	Approx. 0.4 kg

Instant Breaking Models

F3SX-E-□□□R (with Relay Safety Output and DC Solid-state Safety Output)

Input types				Model	Width (W)	Weight
E3ZS/E3FS Safety Sensors	F3SJ/F3SN/F3SH Safety Light Curtains	Emergency Stop Switches	Door Switches			
4 sets	---	1 set	---	**F3SX-E-B1R**	90.0 mm	Approx. 0.5 kg

OFF-delay Time Setting Models (Using Function Setup Software for the F3SX)

F3SX-N-□□□RR2 (with Relay Safety Output and DC Solid-state Safety Output)

Input types				Model	Width (W)	Weight
E3ZS/E3FS Safety Sensors	F3SJ/F3SN/F3SH Safety Light Curtains	Emergency Stop Switches	Door Switches			
4 sets	---	1 set	2 sets	**F3SX-N-B1D1RR2**	157.5 mm	Approx. 0.7 kg
4 sets	2 sets	1 set	---	**F3SX-N-L2B1RR2**	157.5 mm	Approx. 0.7 kg

OFF-delay Time Setting Models (Using Function Setup Software for the F3SX)

F3SX-E-□□□R2 (with Relay Safety Output and DC Solid-state Safety Output)

Input types				Model	Width (W)	Weight
E3ZS/E3FS Safety Sensors	F3SJ/F3SN/F3SH Safety Light Curtains	Emergency Stop Switches	Door Switches			
4 sets	---	1 set	---	**F3SX-E-B1R2**	90.0 mm	Approx. 0.5 kg
4 sets	---	1 set	2 sets	**F3SX-E-B1D1R2**	112.5 mm	Approx. 0.6 kg
4 sets	2 sets	1 set	---	**F3SX-E-L2B1R2**	112.5 mm	Approx. 0.6 kg

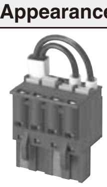
The F3SX-series Safety Controller is a multiple input, single output Controller. This is useful for individual control over the safety output when using multiple safety input devices. Custom models are also available. Refer to the F3SX , and consult with your OMRON representative.

Accessories

Branch Connector

Appearance	Model
	**F39-CN3**

Dummy Plug

Appearance	Model
	**F39-CN4**

Cables with Connectors on Both Ends for Branch Connector

Appearance	Model	Cable length
	**F39-JF1S**	1 m
	F39-JF2S	2 m
	F39-JF5S	5 m
	F39-JF10S	10 m

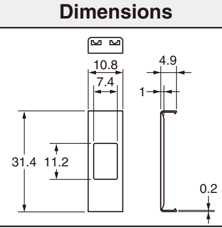
Sensor Mounting Bracket (for E3FS)

Appearance	Model
	**Y92E-B18**

Sensor Mounting Bracket (for E3ZS)

Appearance	Model
	**E39-L104**

Mutual Interference Prevention Filter (for E3ZS)

Dimensions	Model	Quantity	Remarks
	**E39-E11**	2 per Emitter and Receiver (4 total)	For use with E3ZS-T81A. This filter prevents mutual interference by changing the direction of polarized light of the 2 adjacent Emitter/ Receivers. However, when the filter is attached, the maximum sensing distance of the E3ZS is reduced to 1.5 m.

Cables with Connectors (Socket and Plug) on Both Ends

Type	Cable connection direction	Cable length L (m)	DC Model	UL standard
Standard cable	Straight/straight	1	**XS2W-D421-C81-A**	●
		2	**XS2W-D421-D81-A**	
		5	**XS2W-D421-G81-A**	
		10	**XS2W-D421-J81-A**	
	Right angle/right angle	2	**XS2W-D422-D81-A**	
		5	**XS2W-D422-G81-A**	
	Straight/right angle	2	**XS2W-D423-D81-A**	
		5	**XS2W-D423-G81-A**	
	Right angle/straight	2	**XS2W-D424-D81-A**	
		5	**XS2W-D424-G81-A**	
Robot cable (vibration resistant)	Straight/straight	1	**XS2W-D421-C81-R**	---
		2	**XS2W-D421-D81-R**	
		5	**XS2W-D421-G81-R**	
		10	**XS2W-D421-J81-R**	

Note: Overall cable length for both an E3FS Receiver connected to an F3SX and the Emitter connected to the F3SX must be within 50 m.

Cables with Connector (Socket) on One End

Type	Cable connection direction	Cable length L (m)	DC Model	UL standard
Standard cable	Straight	1	**XS2F-D421-C80-A**	●
		2	**XS2F-D421-D80-A**	
		5	**XS2F-D421-G80-A**	
		10	**XS2F-D421-J80-A**	
	Right angle	1	**XS2F-D422-C80-A**	
		2	**XS2F-D422-D80-A**	
		5	**XS2F-D422-G80-A**	
		10	**XS2F-D422-J80-A**	
Robot cable (vibration resistant)	Straight	1	**XS2F-D421-C80-R**	---
		2	**XS2F-D421-D80-R**	
		5	**XS2F-D421-G80-R**	
		10	**XS2F-D421-J80-R**	
	Right angle	1	**XS2F-D422-C80-R**	
		2	**XS2F-D422-D80-R**	
		5	**XS2F-D422-G80-R**	
		10	**XS2F-D422-J80-R**	

Note: Overall cable length for both an E3FS Receiver connected to an F3SX and the Emitter connected to the F3SX must be within 50 m.

Connector Plug Assemblies, Solder Type*

Applicable cable diameter (mm)	Cable connection direction	Connection method	Model
3 dia. (3 to 4 dia.)	Straight	Solder	**XS2G-D425**
	Right angle		**XS2G-D426**

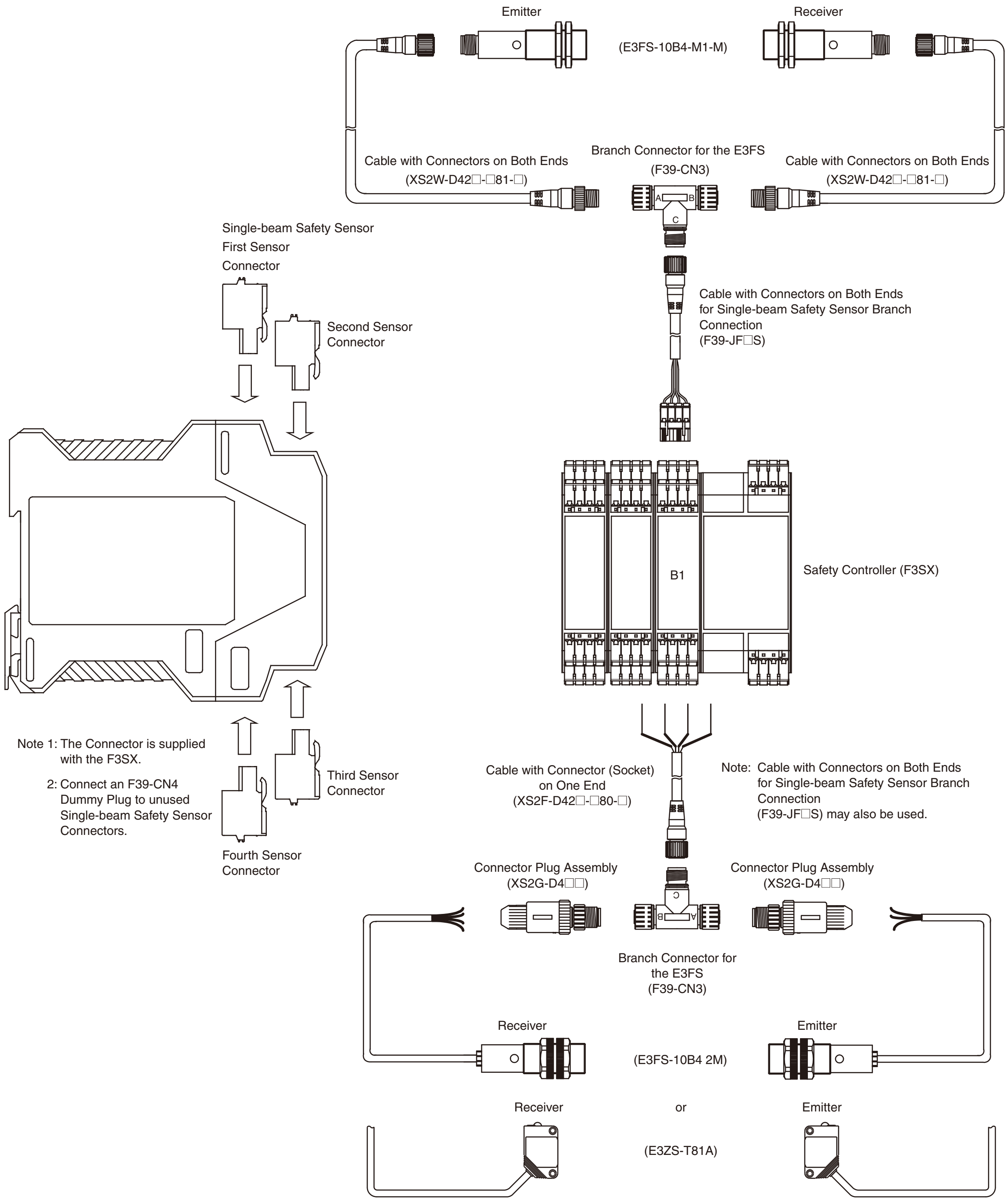
* Use when connecting an E3ZS-T81A or E3FS-10B4 2M to an F39-CN3 Branch Connector.

Connector Plug Assemblies, Screw-on Type*

Applicable cable diameter (mm)	Cable connection direction	Connection method	Model
3 dia. (3 to 4 dia.)	Straight	Screw-on	**XS2G-D4S5**
	Right angle		**XS2G-D4S6**

* Use when connecting an E3ZS-T81A or E3FS-10B4 2M to an F39-CN3 Branch Connector.

Accessory Connection Example



Specifications

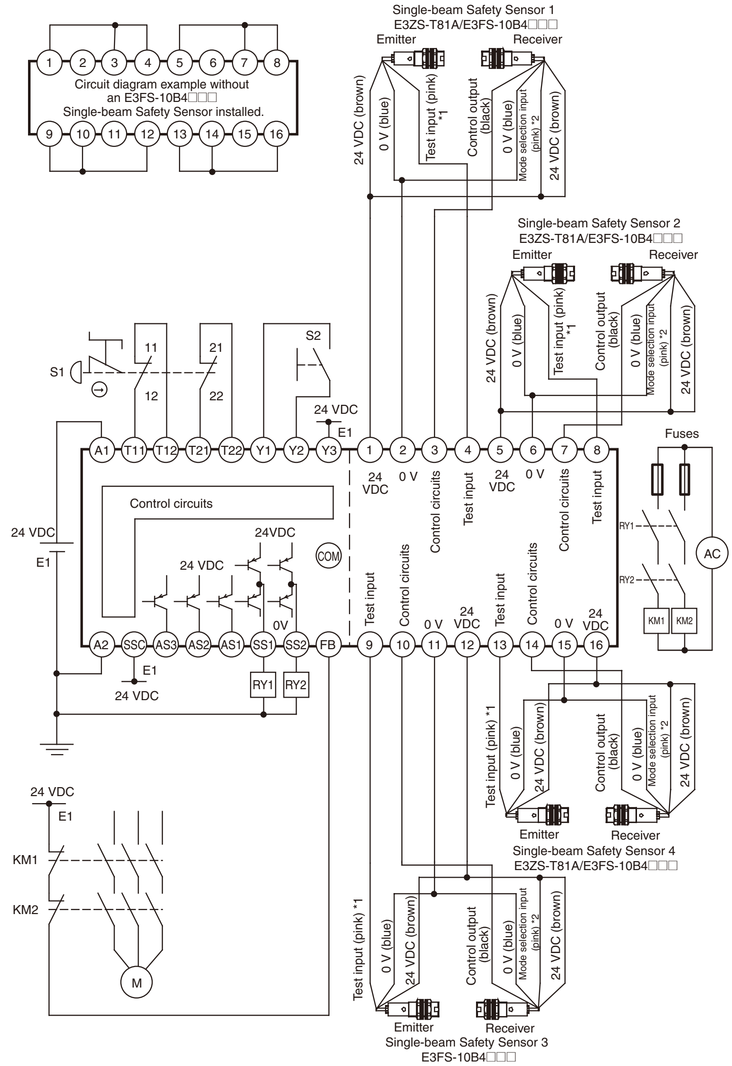
Item / Model		E3ZS-T81A	E3FS-10B4 2M	E3FS-10B4-M1-M
Sensing method		Through-beam		
Case material		Polybutylene terephthalate	ABS	Brass
Connection method		Pre-wired cable (2 m)		M12 connector
Controller		F3SX Series		
Power supply voltage		12 to 24 VDC±10% (ripple p-p 10% max.) *1	24 VDC±10% (ripple p-p 10% max.) *1	
Effective aperture angle (EAA)		±5° (at 3 m)		
Current consumption		Emitter:15 mA max. Receiver:20 mA max.	Emitter:50 mA max. Receiver:25 mA max.	
Sensing distance		0.2 to 3 m	0 to 10 m	
Standard sensing object		Opaque object: 18 mm in diameter or greater	Opaque object: 11 mm in diameter or greater	
Response time		1.0 ms (E3ZS only) *2	2.0 ms (E3FS only) *2	
Control output		PNP transistor output, load current: 100 mA max., Residual voltage: 1 V max., (when load current is less than 10 mA), Residual voltage: 2 V max. (when load current is between 10 mA and 100 mA) (except for voltage drop due to cable extension) *1	PNP transistor output, load current: 100 mA max., Residual voltage: 2 V max. (except for voltage drop due to cable extension) *1	
Switching element category (from IEC60947-5-3)		DC13 (control of electromagnetic load)	---	
Test input (Emitter)		22.5 to 24 VDC: Emitter OFF (source current: 3 mA max.) Open or 0 to 2.5 V: Emitter ON (leakage current: 0.1 mA max.) *1	21.5 to 24 VDC: Emitter OFF (source current: 3 mA max.) Open or 0 to 2.5 V: Emitter ON (leakage current: 0.1 mA max.) *1	
Startup waiting time		100 ms		
Ambient operating light intensity		Incandescent lamp: 3000 lx max. (light intensity on the receiver surface) Sunlight: 10,000 lx max. (light intensity on the receiver surface)		
Ambient temperature		Operating: −10 to 55°C Storage: −10 to 70°C (with no icing or condensation)	Operating: −20 to 55°C Storage: −30 to 70°C (with no icing or condensation)	
Ambient humidity		Operating: 35% to 85%, storage: 35% to 95% (with no icing or condensation)		
Insulation resistance		20 MΩ min. (at 500 VDC)		
Dielectric strength		1000 VAC 50/60 Hz 1 min		
Vibration resistance	Malfunction	10 to 55 Hz, double amplitude: 1.5 mm, 2 h each in the X, Y, and Z directions		
	Operating limit	10 to 55 Hz, double amplitude: 0.7 mm, 50 min each in the X, Y, and Z directions		
Shock resistance	Malfunction	500 m/s^2, 3 times each in the X, Y, and Z directions		
	Operating limit	100 m/s^2, 1000 times in the X, Y, and Z directions		
Degree of protection		IP67 (IEC standard)		
Light source (emitted wavelength)		Red LED (660 nm)	Infrared LED (870 nm)	
Operation indicators		Emitter: Emitting (orange); Receiver: Operation (orange), Stable (green)	Emitter: Emitting (orange); Receiver: Output OFF (red), Output OFF (red)	
Protective circuits		Power supply/output reverse connection protection, load short-circuit protection	Output reverse connection protection, load short-circuited protection	
Weight (packed state)		Approx. 120 g (for one set including 2-m cable)	Approx. 150 g (for one set including 2-m cable)	Approx. 125 g (for one set including only Sensor)
Applicable standards	Sensor only	IEC 60947-5-3 (PDF-D) EN954-1 (Category 1)	---	
	Sensor connected to F3SX	IEC (EN) 61496-1 Type 2 ESPE *3, IEC (prEN) 61496-2 Type 2 AOPD *4, EN 954-1 (Category 2)	IEC(EN)61496-1 Type2 ESPE *3 IEC(prEN)61496-2 Type2 AOPD *4	
Accessories		Operation manual *5	Operation manual *5, nuts for mounting Emitter/Receiver (2 each)	

*1. Connect the Sensor to an F3SX to use it as a safety device or as part of a safety system.
*2. This may vary according to the F3SX model connected to the Sensor. For details, refer to the F3SX operation manual.
*3. Electro-Sensitive Protective Equipment
*4. Active Opto-electronic Protective Device
*5. F3SX operation manual is not included.

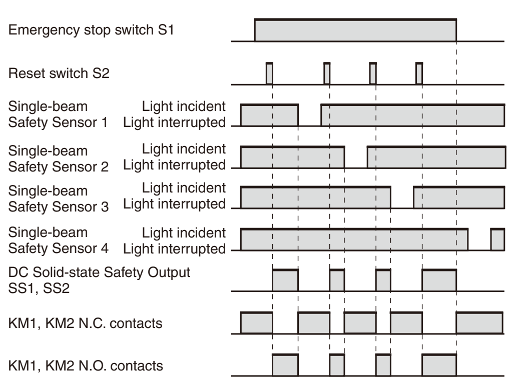
Connections

Circuit Diagram Example

F3SX-EB1 (Manual Reset)



Timing Chart



S1:	Emergency stop switch with positive opening mechanism (A165E or A22E)
S2:	Reset switch
KM1, KM2:	Magnetic contactor
RY1, RY2:	Relay
M:	Three-phase motor
E1:	24-VDC power supply (S82K)

Note: 1. The above circuit diagram example conforms to Category 2.

2. The EN60204-1 stop function category is 0 (zero) for the example in the above circuit diagram.

3. When the FB (feedback input) function of the F3SX is not used, make setting changes with the F3SX function setup software (F3SX-CD100-E1).

*1. The black wire is used when the Cable with Connector (Socket) on One End (XS2F-D42□-□80-□) is connected to an E3FS-10B4-M1-M Connector.

*2. The white wire is used when the Cable with Connector (Socket) on One End (XS2F-D42□-□80-□) is connected to an E3FS-10B4-M1-M Connector.

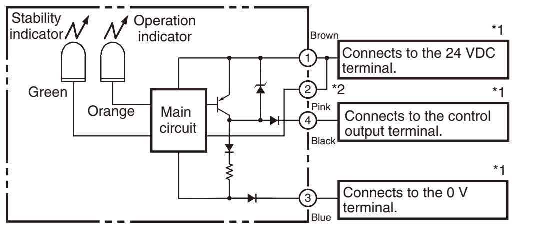
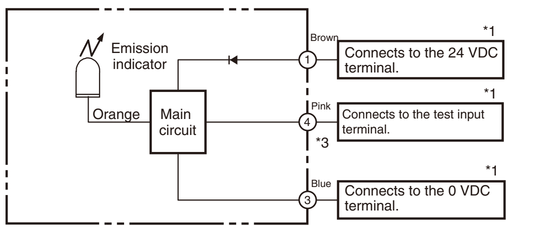
For connections, refer to the F3SX operation manual.

I/O Circuit Diagrams

E3ZS

Circuit Diagrams (E3ZS-T81A with PNP Output)

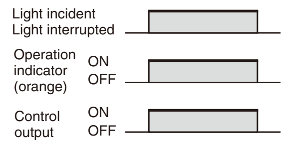
Output mode: ON when light is incident (Light ON)

	I/O circuit
Receiver	
Emitter	

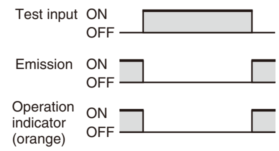
*1. When using in Safety Category 2 configurations, make sure all terminals on the B1 Module of the F3SX are properly connected. Do not connect the terminals to another module. See the F3SX operation manual for details.
*2. Make sure to connect the pink wire (mode selection input 2) to 24 VDC.
*3. Make sure to connect to the 0V terminal when the E3ZS is not connected to an F3SX and the test input is not used.

Timing Charts

Output Modes and Timing Char



Emitter Timing Chart

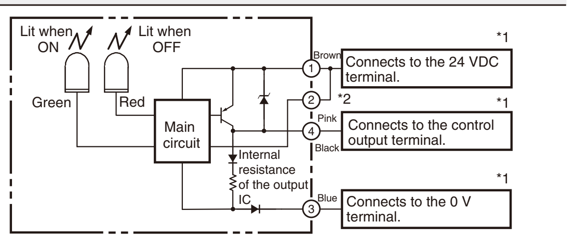
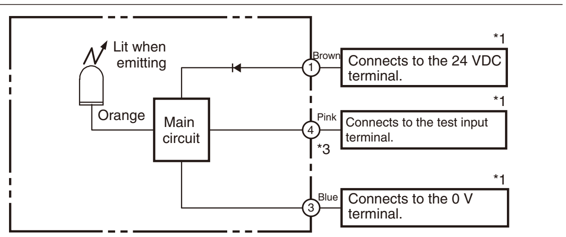


Note: The F3SX performs self-diagnosis every 20 ms.

E3FS

Circuit Diagrams (E3FS-10B4□□□ with PNP Output)

Output mode: ON when light is incident (Light ON).

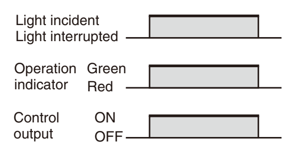
	I/O circuit
Receiver	
Emitter	

*1. Make sure all terminals on the B1 Module of the F3SX are properly connected. Do not connect the terminals to another Module. See the F3SX operation manual for details.
*2. Make sure to connect the pink wire (mode selection input 2) to 24 VDC.
*3. Make sure to connect to the 0V terminal when the E3FS is not connected to an F3SX and the test input is not used.

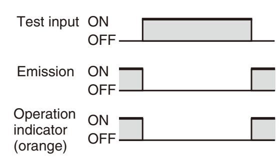
Note: The E3FS-10B4□□□ functions as a standalone Sensor when it is connected as shown in the wiring diagram above. However, it is certified a Type 2 Safety Sensor when it is properly connected to the B1 Module of the F3SX. This also means it must be properly connected to an F3SX to use it as part of a safety system.

Timing Charts

Output Modes and Timing Chart



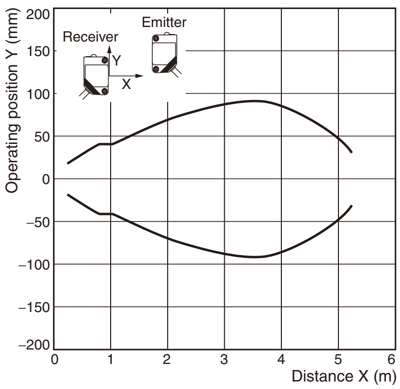
Emitter Timing Chart



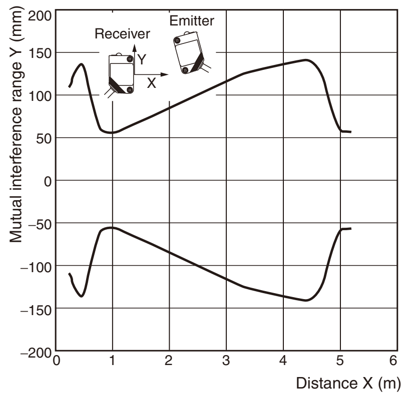
Engineering Data

E3ZS

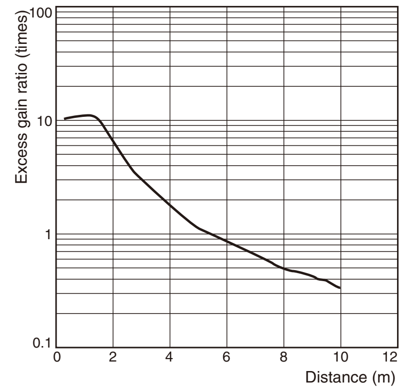
Parallel Operating Range



Mutual Interference Range

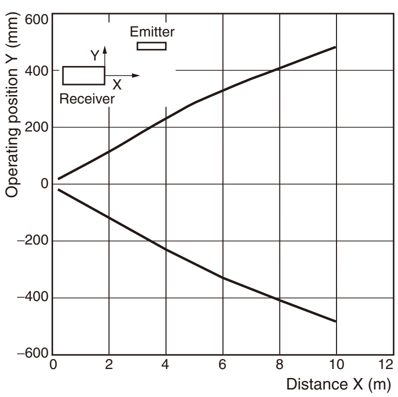


Excess Gain Ratio

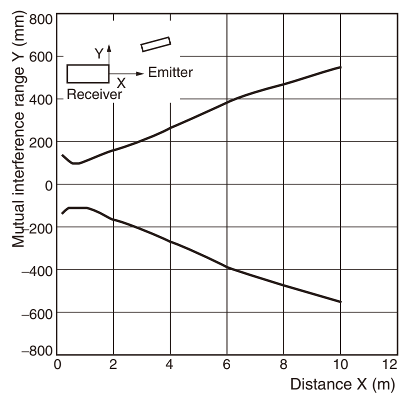


E3FS

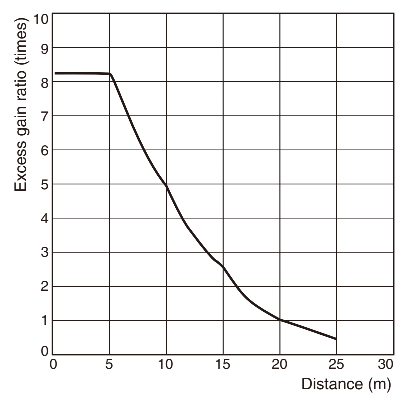
Parallel Operating Range



Mutual Interference Range



Excess Gain Ratio

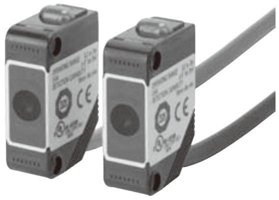


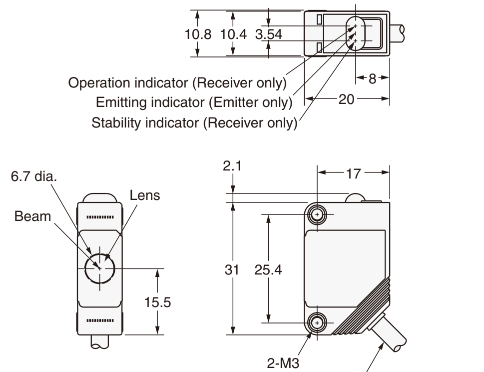
Dimensions

(Unit: mm)

Sensors

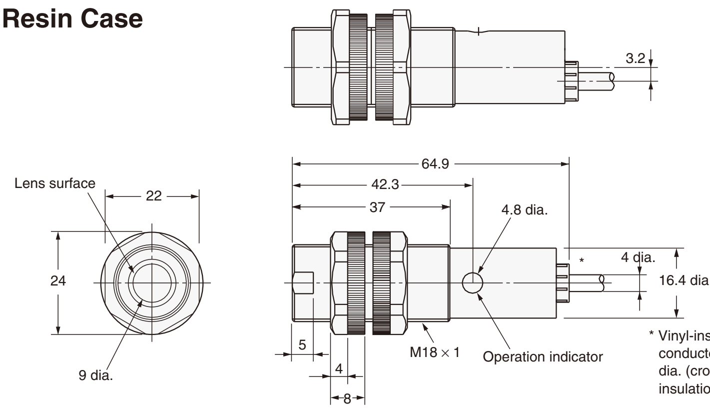
Pre-wired Cable with ABS Resin Case
E3ZS-T81A





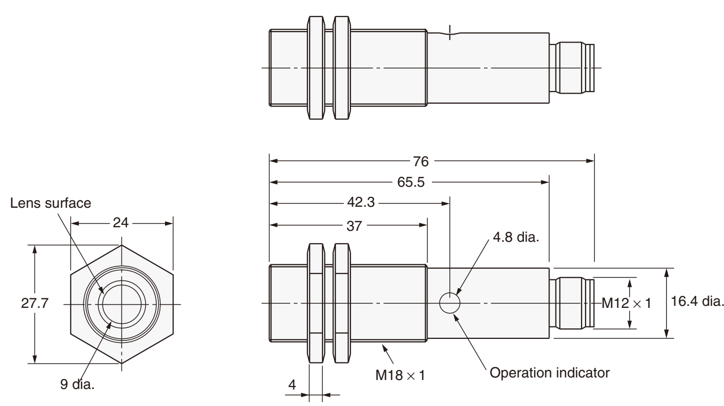
4-mm diameter vinyl-insulated round cable with 4 conductors (cross-sectional of conductors: 0.2 mm^2, insulation system: 1.1-mm diameter), Standard length: 2 m

Pre-wired Cable with ABS Resin Case
E3FS-10B4 2M



* Vinyl-insulated round cord with four Receiver conductors and three Emitter conductors, 4 dia. (cross sections of conductors: 0.2 mm^2, insulation system: 1.1 mm dia.)

Connector with Metal Case
E3FS-10B4-M1-M



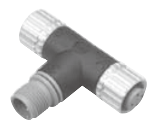
Safety Controller
F3SX

For details, refer to F3SX.

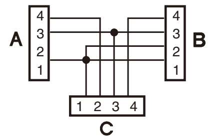
Accessories (Order Separately)

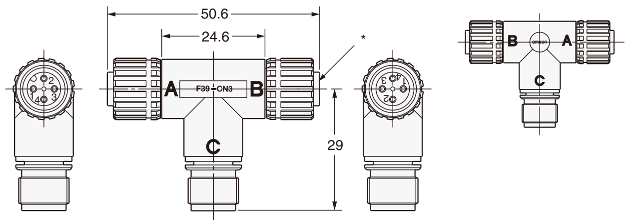
Branch Connector

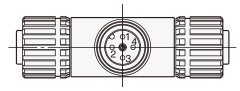
F39-CN3



Wiring Diagram



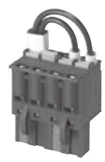


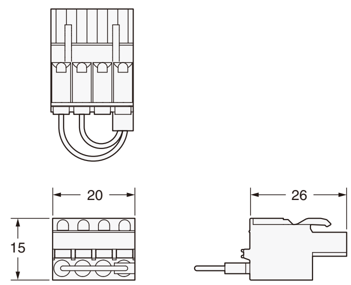


* The molded part B of the Connector is black.

Dummy Plug

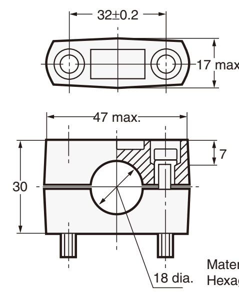
F39-CN4





Sensor Mounting Bracket (for E3FS)

Y92E-B18

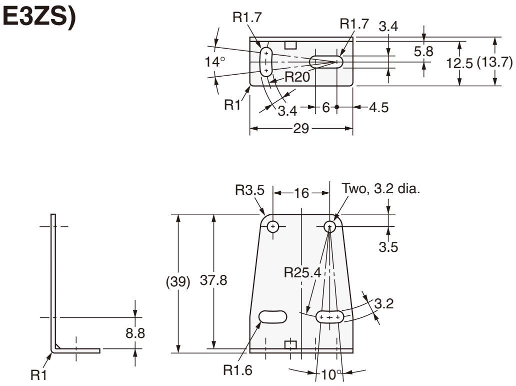


Material: Plastic
Hexagonal bolt: M5 x 32

Sensor Mounting Bracket (for E3ZS)

E39-L104

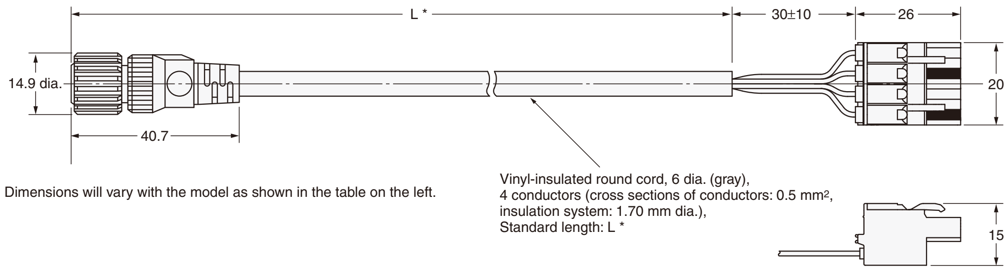
Material: Stainless steel (SUS304)



Cables with Connectors on Both Ends for Branch Connection

F39-JF1S
F39-JF2S
F39-JF5S
F39-JF10S

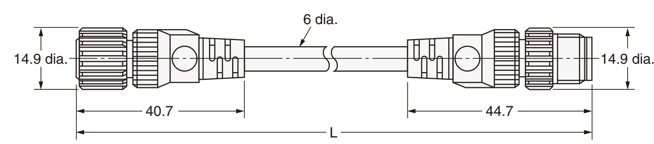
Model	L (mm)
F39-JF1S	$1,000^{+150}_{0}$
F39-JF2S	$2,000^{+150}_{0}$
F39-JF5S	$5,000^{+300}_{0}$
F39-JF10S	$10,000^{+300}_{0}$



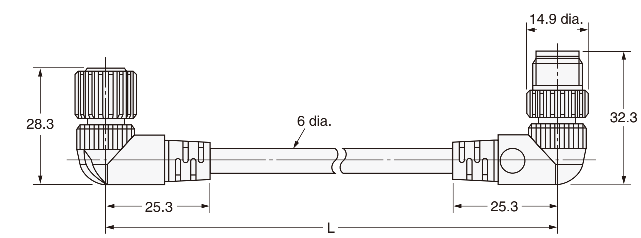
* Dimensions will vary with the model as shown in the table on the left.

Cables with Connectors (Socket and Plug) on Both Ends

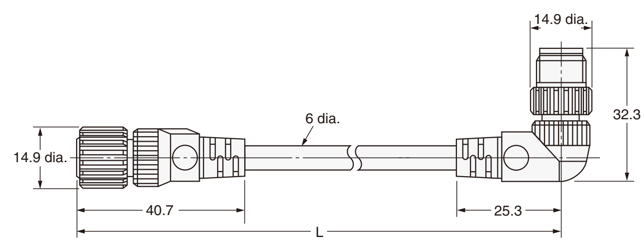
XS2W-D421-C81-A (L=1m)
XS2W-D421-D81-A (L=2m)
XS2W-D421-G81-A (L=5m)
XS2W-D421-J81-A (L=10m)
XS2W-D421-C81-R (L=1m)
XS2W-D421-D81-R (L=2m)
XS2W-D421-G81-R (L=5m)
XS2W-D421-J81-R (L=10m)



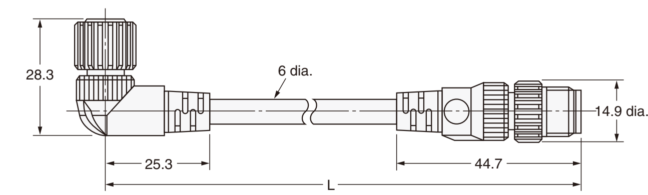
XS2W-D422-D81-A (L=2m)
XS2W-D422-G81-A (L=5m)



XS2W-D423-D81-A (L=2m)
XS2W-D423-G81-A (L=5m)

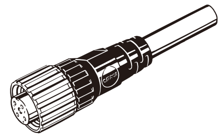


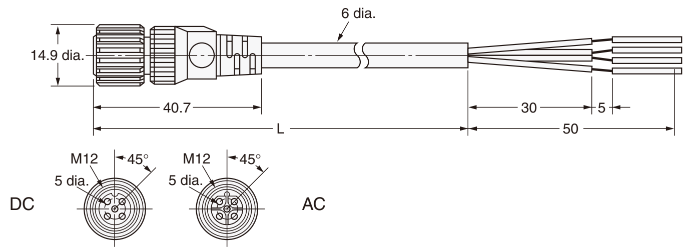
XS2W-D424-D81-A (L=2m)
XS2W-D424-G81-A (L=5m)



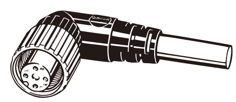
Cables with Connector (Socket) on One End

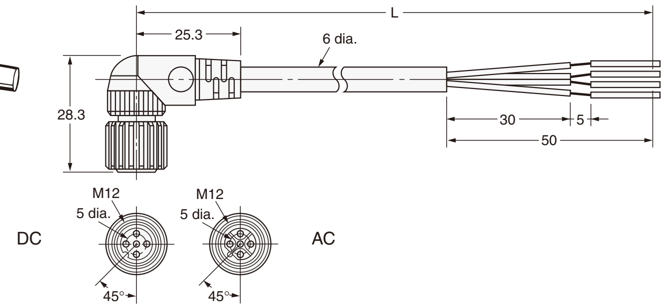
XS2F-D421-C80-A (L=1m)
XS2F-D421-D80-A (L=2m)
XS2F-D421-G80-A (L=5m)
XS2F-D421-J80-A (L=10m)
XS2F-D421-C80-R (L=1m)
XS2F-D421-D80-R (L=2m)
XS2F-D421-G80-R (L=5m)
XS2F-D421-J80-R (L=10m)





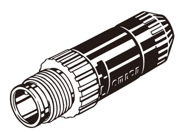
XS2F-D422-C80-A (L=1m)
XS2F-D422-D80-A (L=2m)
XS2F-D422-G80-A (L=5m)
XS2F-D422-J80-A (L=10m)
XS2F-D422-C80-R (L=1m)
XS2F-D422-D80-R (L=2m)
XS2F-D422-G80-R (L=5m)
XS2F-D422-J80-R (L=10m)

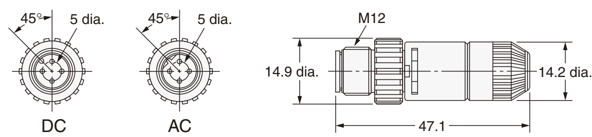




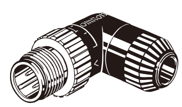
Connector Plug Assemblies, Solder Type

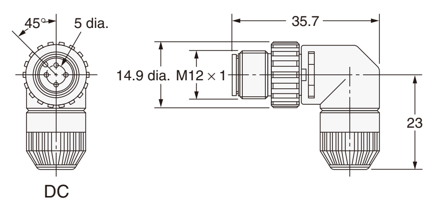
XS2G-D425





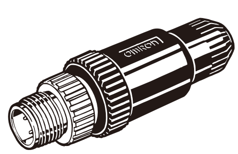
XS2G-D426

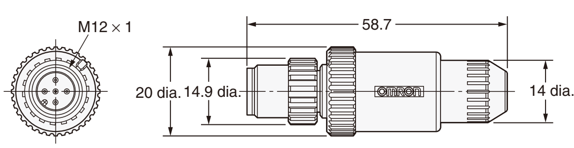




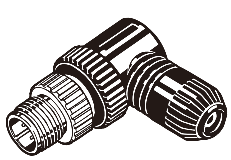
Connector Plug Assemblies, Screw-on Type

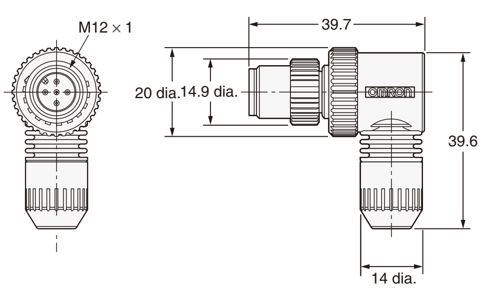
XS2G-D4S5





XS2G-D4S6





Safety Precautions

⚠ WARNING

OMRON's Single-beam Safety Sensor Input Module (B1 Module) from the F3SX Series is the only Controller that can be used for the E3ZS-T81A/E3FS-10B4□□□ (type 2). Normal operation may not be possible if another Single-beam Sensor Controller is used.

The Sensor cannot be used as part of a safety system when the mode selection input of the Single-beam Safety Sensor Receiver is connected to 0 V because the Sensor will turn ON when light is interrupted (Dark ON). Be sure to connect the mode selection input to 24 VDC if you want the Sensor to turn ON when light is incident (Light ON).

Safety Distance

The safety distance is the minimum distance that must be maintained between the Sensor and a hazardous part of the machine in order to stop the machine before someone or something reaches it. The safety distance is calculated based on the following equation when a person moves perpendicular to the detection zone of the Sensor.

Safety distance (S) = Intrusion speed into the detection zone (K)
× Total response time for the machine and Sensor
+ Additional distance calculated based on the detection capability of the Sensor (C)

The safety distance varies with national standards and individual machine standards. The equation is also different if the direction of intrusion is not perpendicular to the detection zone of the Sensor. Be sure to refer to related standards.

Here T = T1 + T2 + T3

Where

T1 = Maximum machine stop time (s)
T2 = Sensor response time (s)
(From ON to OFF: 2.0 ms for the E3FS)
T3 = F3SX response time (s)
(From ON to OFF: Refer to Response Time.)

The maximum stop time for a machine is the time it takes to actually stop dangerous parts after the machine receives a stop signal from the F3SX.

⚠ WARNING

Measure the actual maximum stop time for the machine and then periodically check it to see if the time changes.

Reference: Method for Calculating Safety Distance as Defined in the European Standard EN999 (with Intrusion Perpendicular to the Detection Zone)

- K and C are as follows for Single-beam Safety Sensors.

1. When a Single-beam Safety Sensor is used alone (when the risk assessment indicates that a single beam is sufficient)
   K = 1,600 mm/s
   C = 1,200 mm
   Height of the beam from the ground or from a reference surface: 750 mm (EN999 recommendation)
2. When multiple Single-beam Safety Sensors are installed at different heights.
   K = 1,600 mm/s
   C = 850 mm
   The beam heights in the following table are the EN999 recommendations.

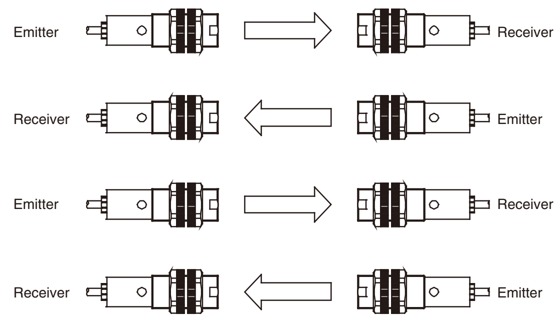
No. of beams	Height from the reference surface (example: the floor)
2	400 mm, 900 mm
3	300 mm, 700 mm, 1100 mm
4	300 mm, 600 mm, 900 mm, 1200 mm

Note: Refer to the F3SN/F3SH instruction manuals for details on Safety Light Curtains and Multi-beam Safety Sensors.

Preventing Mutual Interference

Observe the following items during installation to prevent Single-beam Safety Sensors from interfering with each other or with Safety Light Curtains.

- Leave adequate space between the Sensors during installation. (Refer to the instruction manuals for the E3ZS/E3FS and the F3SN/F3SH.)
- Use baffle plates to separate Sensors.
- Alternate Emitters and Receivers during installation. (See the figure below.)



Check for mutual interference between Single-beam Safety Sensors or Safety Light Curtains connected to the same or different Control Units before finalizing placement and starting normal operation.

⚠ WARNING

When installing multiple Safety Light Curtains, Multi-beam Safety Sensors, and Single-beam Safety Sensors, take necessary steps to prevent mutual interference. Otherwise detection may fail and serious injury may result.

Precautions for All Safety Sensors

Note: Refer to the "*Safety Precautions*" section for each Sensor for specific precautions applicable to each Sensor.

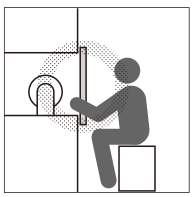
WARNING

Installation Conditions

Detection Zone and Intrusion Path

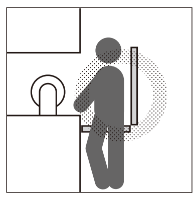
Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas.
If a person is able to step into the hazardous area of a machine and remain behind the Safety Light Curtain's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

Correct Installation



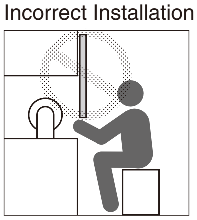
A person can only reach the hazardous part of the machinery by passing through the sensor's detection zone.

Correct Installation



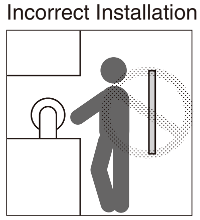
A person enters the detection zone during operation.

Incorrect Installation



A person can reach the hazardous part of the machinery without passing through the sensor's detection zone.

Incorrect Installation



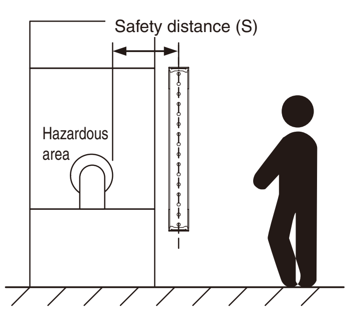
A person is between the sensor's detection zone and the hazardous part of the machinery.

Install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

The Safety Light Curtain cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

Safety Distance

The safety distance is the distance that must be set between the Safety Light Curtain and a machine's hazardous part to stop the hazardous part before a person or object reaches it. The safety distance varies according to the standards of each country and the individual specifications of each machine. In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the Safety Light Curtain. Always refer to relevant standards.



Make sure to secure the safety distance (S) between the Safety Light Curtain and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Note: The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops.
Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

How to calculate the safety distance specified by International standard ISO13855-2002 (European standard EN999-1999) (Reference)

If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.

S = K x T + C . . . Eq. (1)

- S: Safety distance
- K: Approach speed to the detection zone
- T: Total response time of the machine and Safety Light Curtain
- C: Additional distance calculated by the detection capability of the Safety Light Curtain

<System that has detection capability of 40 mm max.>
Use K = 2,000 mm/s and C = 8 x (d - 14 mm) in equation (1) for the calculation.
S = 2,000 mm/s x (Tm + Ts) + 8 x (d - 14 mm)

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s) *
- d = Size of Safety Light Curtain's detection capability (mm) *

* These values differ depending on the Switch. Refer to the "*Precautions for Correct Use*" for the Switch you are using.

[Calculation example]
When Tm = 0.05 s, Ts = 0.01 s, and d = 14 mm:
S = 2,000 mm/s x (0.05 s + 0.01 s) + 8 x (14 mm - 14 mm)
= 120 mm . . . Eq. (2)
If the result is less than 100 mm, use S = 100 mm.
If the result exceeds 500 mm, use the following equation where K = 1,600 mm/s.
S = 1,600 mm/s x (Tm + Ts) + 8 x (d - 14 mm) . . . Eq. (3)
If the result of this Eq. (3) is less than 500 mm, use S = 500 mm.

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 40 mm or Systems Using Multi-beam Safety Sensors>

Assuming K = 1,600 mm/s and C = 850 mm, the following calculation is made using Eq. (1).
S = 1,600 mm/s x (Tm + Ts) + 850 … Eq. 4,

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s)

Calculation example:
When Tm = 0.05 s and Ts = 0.01 s,
S = 1,600 mm/s x (0.05 s + 0.01 s) + 850 mm = 946 mm

How to calculate the safety distance specified by American standard ANSI B11.19
(Reference)
<Systems with a Smallest Detectable Object Size (Diameter) Less than 64 mm>
If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.
S = K x (Ts + Tc + Tr + Tbm) + Dpf

- S: Safety distance
- K: Approach speed to the detection zone (the value recommended by OSHA standard is 1,600 mm/s)

Approach speed K is not specified in the ANSI B.11.19 standard. To determine the value of K to apply, consider all factors, including the operator's physical ability.

- Ts = Machine's stop time (s)
- Tr = Response time of the Safety Light Curtain from ON to OFF (s)
- Tc = Machine control circuit's maximum response time required to activate its brake (s)
- Tbm = Additional time (s)

If a machine has a brake monitor, "Tbm = Brake monitor setting time - (Ts + Tc)". If it has no brake monitor, we recommend using 20% or more of (Ts + Tc) as additional time.

- Dpf = Additional distance

According to ANSI's formula, Dpf is calculated as shown below:
Dpf = 3.4 x (d - 7.0): Where d is the detection capability of the Safety Light Curtain (unit: mm)

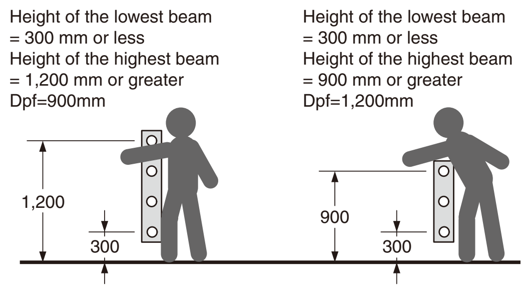
[Calculation example]
When K = 1,600 mm/s, Ts + Tc = 0.06 s, brake monitor setting time = 0.1 s, Tr = 0.01 s, d = 14 mm:
Tbm = 0.1 - 0.06 = 0.04 s
Dpf = 3.4 x (14 - 7.0) = 23.8 mm
S = 1,600 x (0.06 + 0.01 + 0.04) + 23.8 = 199.8 mm

Method for Calculating the Safety Distance as Provided by ANSI/RIA R15.06 (USA)
(Reference)
<Systems with a Smallest Detectable Object Size (Diameter) Greater than 64 mm and Less than 600mm>
The safety distance is calculated based on the following concepts when the human body intrudes perpendicular to the detection zone of the Safety Light Curtain.
S = K x (Ts + Tc + Tr) + Dpf

- S: Safety distance
- K = Intrusion speed into detection zone (1,600 mm/s min. recommended by OSHA)
- Ts = Stop time of machine/equipment (s)
- Tr = Light curtain ON-to-OFF response time (s)
- Tc = Maximum response time of the machine/equipment braking circuit required to operate the brake (s)
- Dpf = Additional distance (mm)

If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 1,200 mm or higher, the Dpf will be 900 mm.
If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 900 mm or higher, the Dpf will be 1,200 mm.

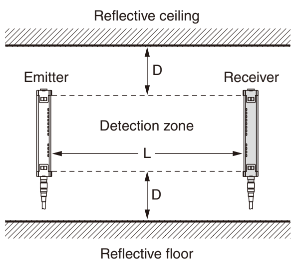
[Calculation example]
K = 1,600 mm/s, Ts + Tc = 0.06s,
If Tr = 0.01 s and Dpf = 900 mm:
S = 1,600 x (0.06 + 0.01) + 900 = 1,012 mm



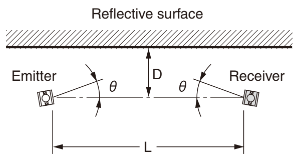
Distance from Glossy Surface

Install the sensor system so that it is not affected by reflection from a glossy surface. Failure to do so may hinder detection, resulting in serious injury.	⚠
Install the sensor system at distance D or further from highly reflective surfaces such as metallic walls, floors, ceilings, or workpieces, as shown below.	⚠

<Side View>



<Top View>



θ =5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ =10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.13 m	0.26 m
For 3 m or more	L/2 x tan5° = L x 0.044 (m)	L/2 x tan10° = L x 0.088 (m)

Others

To use the Safety Light Curtain in PSDI mode (restart of cycle operation by the sensor), you must configure an appropriate circuit between the Safety Light Curtain and the machine. For details about PSDI, refer to OSHA1910.217, IEC61496-1, and other relevant standards and regulations.	⚠
Do not try to disassemble, repair, or modify this product. Doing so may cause the safety functions to stop working properly.	⚠
Do not use the Safety Light Curtain in environments where flammable or explosive gases are present. Doing so may result in explosion.	⚠
Perform daily and 6-month inspections for the Safety Light Curtain. Otherwise, the system may fail to work properly, resulting in serious injury.	⚠

Installation

Prevention of Mutual Interference

The emitter and the receiver to be set facing each other should be a pair of the same set. Erroneous combination may create a zone where objects cannot be detected.	⚠
Do not use a sensor system in a reflective configuration. Doing so may hinder detection. Mirrors can be used change the optical route.	⚠
When using more than 1 set of Safety Light Curtain, install them so that mutual interference does not occur, such as by configuring series connections or using physical barriers between adjacent sets.	⚠

Precautions for Safe Use

Do not used the product in atmospheres or environments that exceed product ratings

Installation

Prevention of Mutual Interference

For series connection

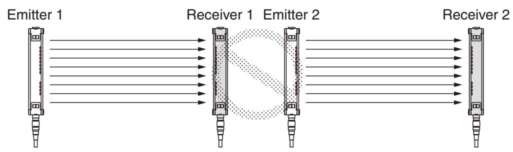
Refer to the "*Precautions for Correct Use*" for individual models for information on preventing mutual interference of linkable Safety Light Curtains.

For no series connection

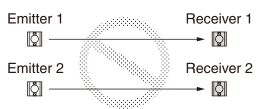
When installing two or more pairs of light curtains independently from each other due to inconvenience of wiring or other reason, take proper measures to prevent mutual interference. If mutual interference occurs, a lockout condition will result for the Safety Light Curtain.

- Installation which may cause mutual interference

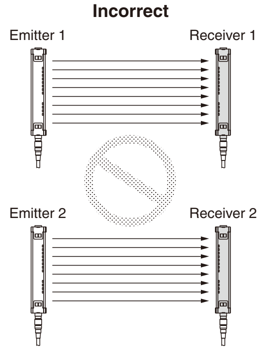
Incorrect



Incorrect



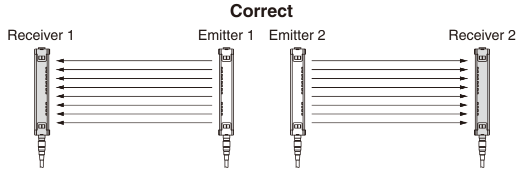
Incorrect



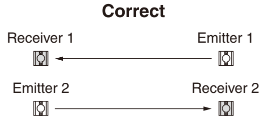
- Installation to prevent mutual interference

(1)Install so that the two light curtains emit in the opposite directions (staggered).

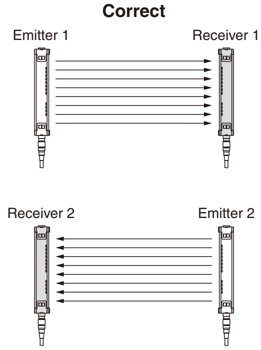
Correct



Correct

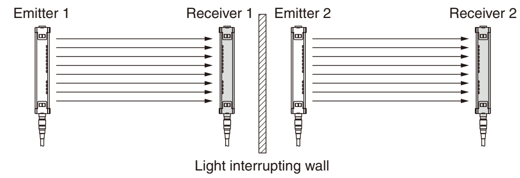


Correct



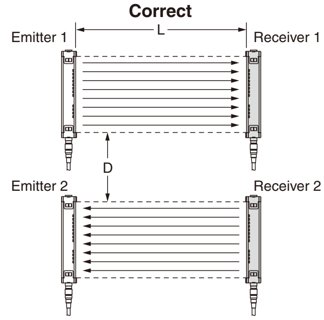
(2)Install a light interrupting wall in between sensors.

Correct

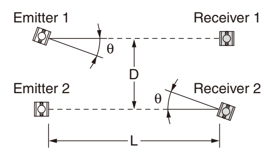


(3)Install the light curtains facing away from the one another to eliminate mutual interference.

Correct



Correct



θ= 5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ= 10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.26 m	0.52 m
For 3 m or more	L x tan5° = L x 0.088 (m)	L x tan10° = L x 0.18 (m)

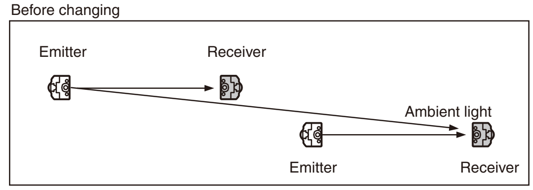
Operating range

Chattering may occur in the output when the distance between the emitter and the receiver is less than 0.2 m. Use only in the rated operating range.

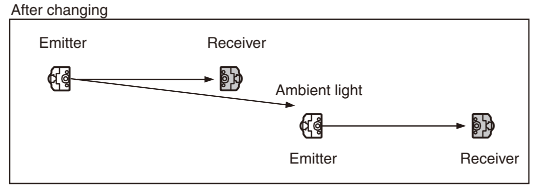
(4)Use a spatter protection slit cover. (F3SN and F3SH)

(5)Shorten the detection distance by setting with a setting tool. (F3SJ)

Before changing



After changing



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
 ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
 ISO 12100 Basic Concepts, General Principles for Design
 IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
 ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
 ISO 12100 Basic Concepts, General Principles for Design
 IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
 IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
 ISO 12100 Basic Concepts, General Principles for Design
 IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Safety Light Curtain (Type 4)
F3SJ Ver.2

The updated F3SJ is even easier to use.

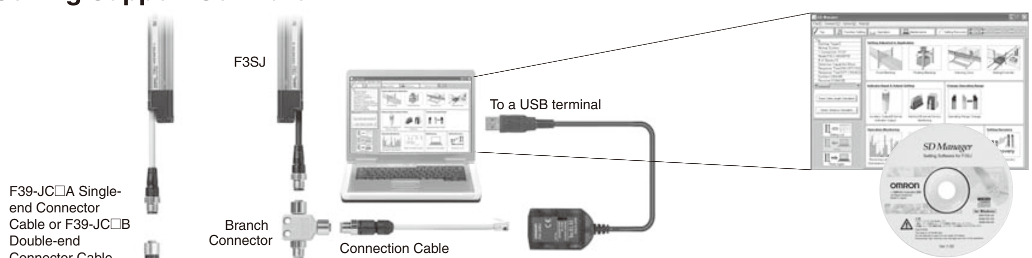
■ The lineup also includes models with S-mark certification.
■ New models for body protection or presence detection. *NEW*

⚠ Be sure to read the *"Safety Precautions"* on page 64 and the *"Precautions for All Safety Sensors"*.

Features

Choose from two new tools for setting parameters and checking the system status.

"SD Manager" PC Setting Support Software

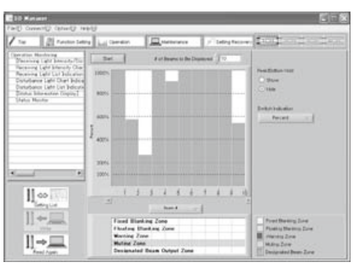


All parameters can be set and the system status can be checked with a personal computer. In addition to making it easy to monitor the beam alignment, the ambient incident light intensity can be displayed in bar graph form for an easy check of the system status.

F39-GWUM "SD Manager" PC Setting Support Software

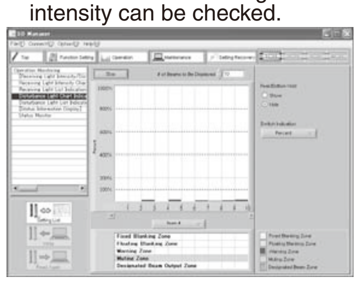
The "SD Manager" PC Setting Support Software helps reduce the time required for installing and troubleshooting the Safety Light Curtain.

● Beam alignment is easier.



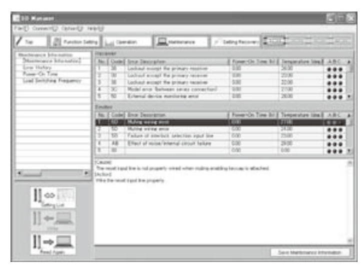
The incident light level can be displayed in a bar graph for each beam.

● The ambient incident light intensity can be checked.



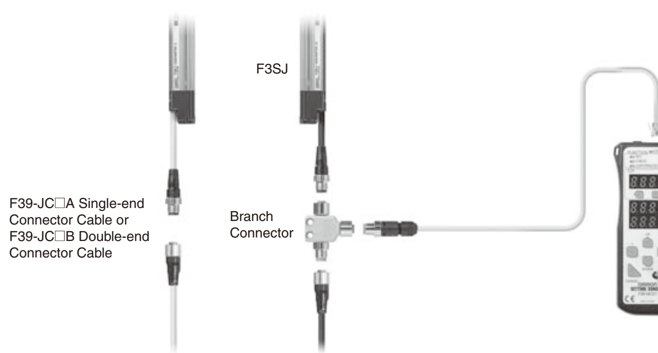
The incident light level when the light emission of the Safety Light Curtain is stopped is displayed in a bar graph.

● The error log can be displayed.



The cause of the errors and countermeasures are both displayed.

Setting Console



When you don't want to carry a personal computer onto the worksite, the Setting Console is a handy way to set parameters and check the system status.

F39-MC21
Setting Console for the F3SJ

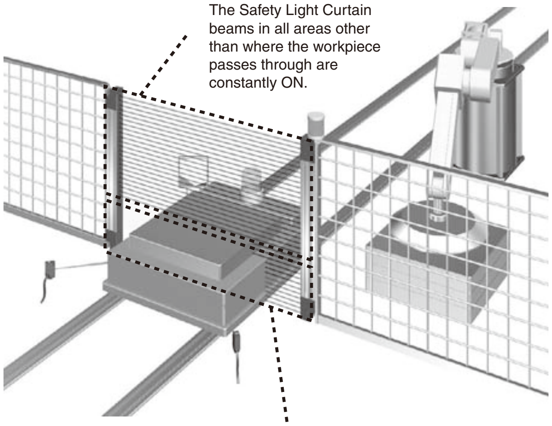
Note: The range of parameter setting and system status checking capabilities is different for the PC Setting Support Software and the Setting Console.

New functions respond to a variety of safety needs.

Two new functions have been added to the muting function.

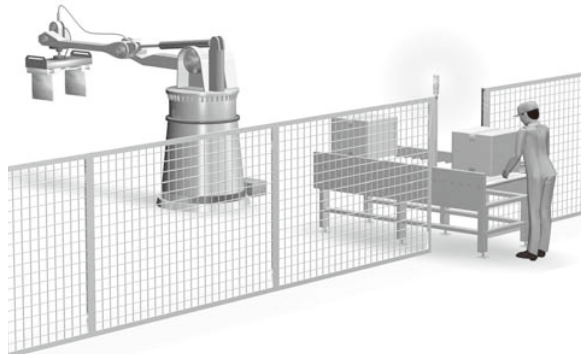
Partial muting

Partial muting raises safety by muting only the beams of the Safety Light Curtain in the area where the workpiece passes through, while preventing muting in all other areas.



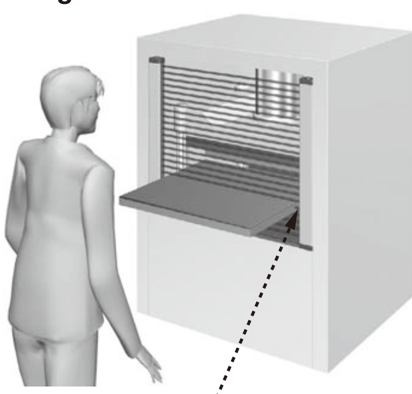
Position detection muting

This is used in applications where the workpiece is set in position each time by an operator, and then a turntable or positioning robot moves the workpiece to the area where the work is done. A limit switch or other means is used to detect when the robot is in a safe position, and muting is then applied.

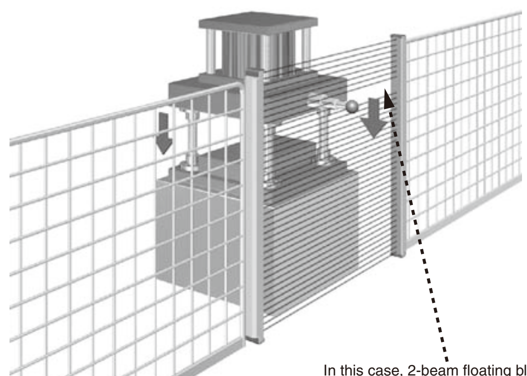


The blanking function disables specific beams of the Safety Light Curtain.

Fixed blanking

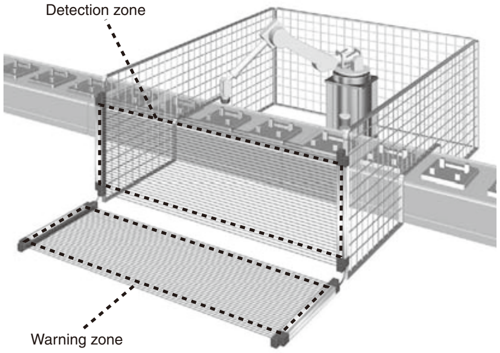


Floating blanking

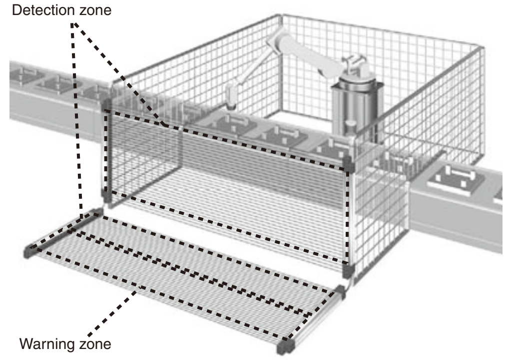


A warning zone can be set to alert people before they enter a danger zone.

Dividing the zone between series-connected sensors



A single sensor can also be divided



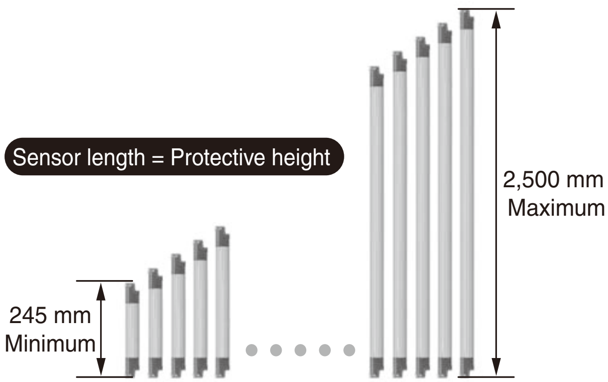
Selecting a device is as easy as 1-2-3.

The F3SJ Safety Light Curtain is a Type 4 safety sensor that can be used to configure a Category 4 safety circuit.
This means that there is no need to worry about the safety of the resulting circuit. Use the following three easy steps to select the best model for your system design.

Step 1 Select the required sensor length.

The F3SJ incorporates the "perfect fit" concept that is a feature of OMRON's other Safety Light Curtains. With a line-up of products in 1-beam increments, you can find the sensor that fits your setup perfectly. Refer to the list of sensor models on pages 7 and 9 to select the minimum sensor length required to cover the area you want to protect.

Note: We can also manufacture sensors with lengths not included in the list of models. For details, please consult your OMRON sales representative.



Step 2 Select the output transistor.

Choose the PNP type when installing in safety system configurations that comply with the Machinery Directive or when using with a dedicated controller (F3SP-B1P or F3SX). NPN types are also available as standard products when replacing existing area sensors.

Step 3 Select the application. *NEW*

In addition to finger protection, hand protection, and hand/arm protection models, new models have been added that detects a leg or the presence of a person.
For areas where there is only a short distance to the source of danger, select a finger protection model. For areas where there is some distance to the hazardous point and where the machinery stops with sufficient time to spare, choose an economical hand/arm/body protection model.

Finger-protection Detection
Capability: 14 mm diameter
(Beam gap: 9 mm)

Hand-protection Detection
Capability: 20 mm diameter
(Beam gap: 15 mm)

Hand/arm-protection Detection
Capability: 30 mm diameter
(Beam gap: 25 mm)

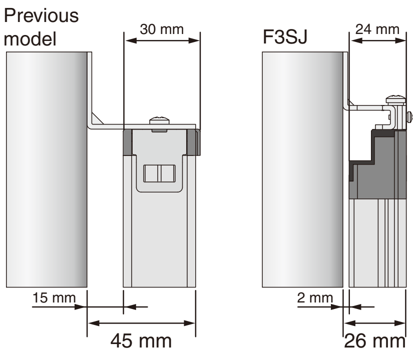
Leg/body-protection and Presence Detection
Capability: 55 mm diameter
(Beam gap: 50 mm)

Step 1	Step 2	Step 3
F3SJ-A □□□□	P ← PNP output N ← NPN output	14 ← Finger 20 ← Hand 30 ← Hand/arm/body 55 ← Leg/body-protection and Presence Detection *NEW*
Protective height (0245 to 2,500 mm)	Output type	Detection type

Easier to install, easier to use.

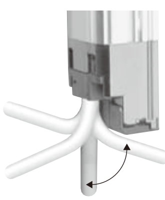
The thin sensor saves valuable space.

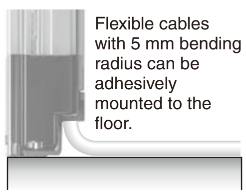
The sensor is 6 mm thinner than our previous models.
When you include the newly designed mounting brackets, which also enable beams to be aligned after the sensor is mounted, the total thickness is 26 mm - a reduction of 19 mm compared to previous models. The low profile means the sensor will not get in the way when adding safety applications to existing equipment.



Flexible cable with a 5 mm bending radius makes wiring a snap.

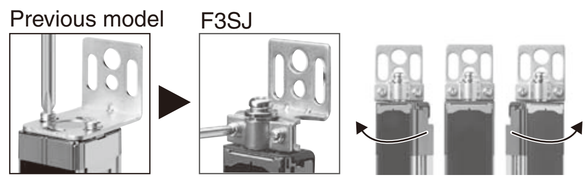
The F3SJ cables (0.3 m) have M12 connectors and can be routed in any direction. Problems with connector compatibility have been eliminated.





The included standard mounting brackets are easier than ever to use.

The included mounting brackets, which are suitable for general use, have been redesigned with ease of use in mind.
The new design allows easy screwdriver access, even when mounting in tight spaces. Also, after aligning the beams, screws can be tightened while oriented perpendicular to the lens surface, just like the panel mounting screws.
On previous models, the carefully adjusted beam angles would sometimes come out of alignment when tightening the final screws. This problem has been solved with the F3SJ, because the screw-tightening direction is different from the angle adjustment direction. The result is reduced installation time.

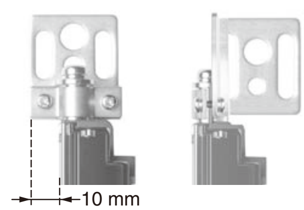


The direction of all screws can be oriented perpendicular to the lens surface. Easy screwdriver access.

The sensor can be rotated along its axis. Beam alignment can be fine-tuned, even when mounted side by side on a surface.

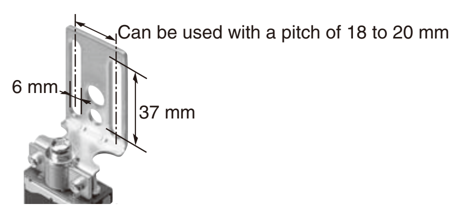
Side-mounting in tight spaces is simple.

When using standard mounting brackets to mount a sensor on its side, the bracket protrudes outward in front of the lens surface. When this protrusion is of concern, use the F39-LJ2 side-mounting brackets (sold separately).



Easy to change from previous models.

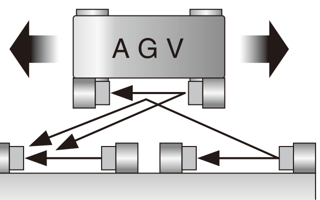
When replacing your previous standard multiple-beam area sensor, use the F39-LJ4 top / bottom mounting bracket B (sold separately), which features enlarged mounting holes.



A variety of features are provided for easier use.

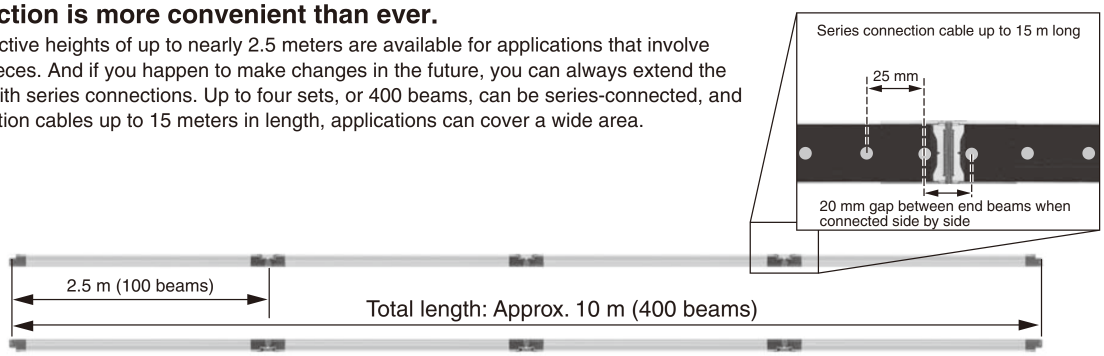
Resistant to mutual interference. No wiring between sensors and no interference for up to three sets.

OMRON has developed a unique interference light prevention algorithm that automatically prevents malfunction, even when light is received from three sets. This feature is ideal for applications where it is not possible to perform wiring with an interference sensor, such as between an AGV and installed equipment.
Also, the Setting Tool can be used to adjust the emitted light intensity to minimize the effect of light on other devices.
(Updated function)



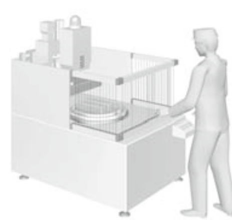
Maximum protective height of 2,500 mm. Series connection is more convenient than ever.

Sensors with protective heights of up to nearly 2.5 meters are available for applications that involve large-sized workpieces. And if you happen to make changes in the future, you can always extend the protective height with series connections. Up to four sets, or 400 beams, can be series-connected, and with series connection cables up to 15 meters in length, applications can cover a wide area.

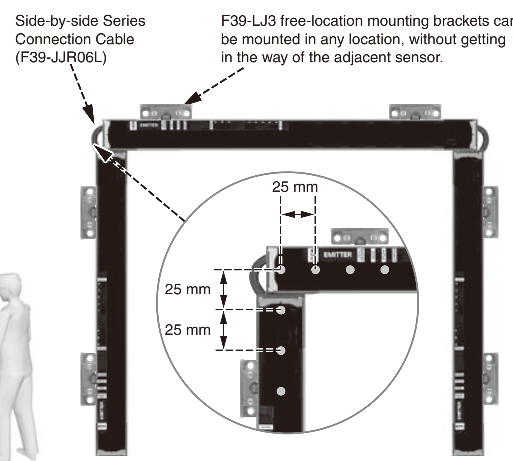


No bottlenecks in workflow. Free-location brackets make vertical installation easy.

To create "perfect fit" installations with no dead zones or extra space when making series connections in L- or U-shaped configurations, use the F39-LJ3 free-location mounting brackets (sold separately) and F39-JJR06L or F39-JJR15L Side-by-side Series Connection Cable.



Application example
U-shaped configuration



Keep a 25-mm beam gap in L-shaped installations. The cable (F39-JJR06L) does not get in the way when used in series connections.

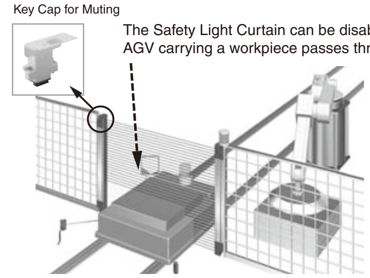
New functions for extra reliability.

Combine safety and productivity with a controller-less muting function.

The muting function temporarily disables the light curtain when an object must pass through the detection zone, such as when supplying a workpiece to your equipment. In the past, this function required a dedicated muting controller, but now it is built into the F3SJ.
To use the muting function, purchase the F39-CN6 Key Cap for Muting (sold separately). The muting function is enabled simply by replacing the Unit's cap with this Key Cap. In addition, a muting sensor that determines the muting timing, as well as a muting lamp that communicates the muting status to other operators, should be connected to the F3SJ.

Built-in muting function

No controller required. Simply attach the Key Cap (sold separately) to the sensor.



A measure to prevent you from forgetting to connect a series connection cable.

The connectors for series connection feature an intelligent design. To connect a series connection cable to the F3SJ, remove the Key Cap that is required when the sensor is used by itself.
If you should happen to forget to connect the series connection cable, the sensor will not operate by itself without the Key Cap.
This solves the problem of sensors operating independently when a series connection cable is accidentally left unconnected, such as when equipment is moved.

Operates as a single sensor when the Key Cap is attached.

Does not operate without the Key Cap.

Complies with the latest international safety standards and regulations.

Like previous Type 4 Safety Light Curtains, the F3SJ conforms to the latest required safety standards and regulations. Since the F3SJ also complies with IEC61508, the international standard for functional safety, safety is ensured regardless of where it is used.

International standards	IEC61496-1, IEC61496-2, IEC61508 1998 (SIL3)
EU legislation EN standards	Machinery Directive, EMC Directive, EN61496-1, prEN61496-2, EN61508 2001 (SIL3)
JIS standards	JIS B9704-1, B9704-2
North American standards	UL61496-1, UL61496-2, UL508, UL1998, CAN/CSA22.2 NO.14, CAN/CSA22.2 NO.0.8

Can also be used with equipment subject to US OSHA standards (29 CFR 1910.212).
Satisfies the requirements of the ANSI/RIA R15.06-1999 standards for industrial robots.

CE JIS IEC OSHA ANSI/RIA cUL

Ordering Information

Main Units

Safety Light Curtain F3SJ-A (Type 4)

▭ Infrared light

Application	Detection capability	Beam gap	Appearance	Operating range	Number of beams	Protective height (mm)	Model	
							PNP Output	NPN Output
Finger protection	14-mm-dia.	9 mm		0.2 to 9 m	26 to 180	245 to 1,631	F3SJ-A□□□□P14 *1	F3SJ-A□□□□N14
Hand protection	20-mm-dia.	15 mm		0.2 to 9 m	16 to 100	245 to 1,505	F3SJ-A□□□□P20 *1	F3SJ-A□□□□N20
				0.2 to 7 m	110 to 166	1,655 to 2,495		
				0.2 to 9 m	16 to 100	245 to 1,505	F3SJ-A□□□□P20-TS *2	---
				0.2 to 7 m	110 to 166	1,655 to 2,495		
	25 mm-dia.	20 mm		0.2 to 9 m	13 to 82	260 to 1,640	F3SJ-A□□□□P25-TS *2 *4	--- *4
				0.2 to 7 m	83 to 125	1,660 to 2,500		
Hand/arm protection	30-mm-dia.	25 mm		0.2 to 9 m	10 to 65	245 to 1,620	F3SJ-A□□□□P30 *1	F3SJ-A□□□□N30
				0.2 to 7 m	70 to 100	1,745 to 2,495		
Leg/body protection, Presence Detection	55 mm-dia.	50 mm		0.2 to 9 m	6 to 33	270 to 1,620	F3SJ-A□□□□P55 *1	--- *3
				0.2 to 7 m	34 to 50	1,670 to 2,470		

Note: Connection cables are not included with the products and are to be purchased separately, as needed. You must purchase optional connector cable.

*1. Models with S-mark certification have an "-S" at the end of the model number. Example: F3SJ-A0245P14-S

*2. Models with fixed auto reset (-TS). Parameters cannot be set using the F39-MC21 Setting Console or F39-GWUM "SD Manager" Setting Support Software for F3SJ. See the *Ratings and Performance* data for other differences between this and standard models.

*3. Models with NPN output can also be manufactured. Consult your OMRON representative for details.

*4. F3SJ-A□□□□P25 and F3SJ-A□□□□N25 are also available. Please contact your OMRON sales representative for details.

Safety Light Curtain Model List

Products other than those listed below are also available. Please contact your OMRON sales representative for details.

F3SJ-A14 Series (9 mm gap)

Model		No. of Beams	Protective Height (mm) *
PNP Output	NPN Output		
F3SJ-A0245P14	F3SJ-A0245N14	26	245
F3SJ-A0263P14	F3SJ-A0263N14	28	263
F3SJ-A0281P14	F3SJ-A0281N14	30	281
F3SJ-A0299P14	F3SJ-A0299N14	32	299
F3SJ-A0317P14	F3SJ-A0317N14	34	317
F3SJ-A0335P14	F3SJ-A0335N14	36	335
F3SJ-A0353P14	F3SJ-A0353N14	38	353
F3SJ-A0371P14	F3SJ-A0371N14	40	371
F3SJ-A0389P14	F3SJ-A0389N14	42	389
F3SJ-A0407P14	F3SJ-A0407N14	44	407
F3SJ-A0425P14	F3SJ-A0425N14	46	425
F3SJ-A0443P14	F3SJ-A0443N14	48	443
F3SJ-A0461P14	F3SJ-A0461N14	50	461
F3SJ-A0479P14	F3SJ-A0479N14	52	479
F3SJ-A0497P14	F3SJ-A0497N14	54	497
F3SJ-A0515P14	F3SJ-A0515N14	56	515
F3SJ-A0533P14	F3SJ-A0533N14	58	533
F3SJ-A0551P14	F3SJ-A0551N14	60	551
F3SJ-A0569P14	F3SJ-A0569N14	62	569
F3SJ-A0587P14	F3SJ-A0587N14	64	587

Model		No. of Beams	Protective Height (mm) *
PNP Output	NPN Output		
F3SJ-A0605P14	F3SJ-A0605N14	66	605
F3SJ-A0623P14	F3SJ-A0623N14	68	623
F3SJ-A0659P14	F3SJ-A0659N14	72	659
F3SJ-A0695P14	F3SJ-A0695N14	76	695
F3SJ-A0731P14	F3SJ-A0731N14	80	731
F3SJ-A0767P14	F3SJ-A0767N14	84	767
F3SJ-A0803P14	F3SJ-A0803N14	88	803
F3SJ-A0839P14	F3SJ-A0839N14	92	839
F3SJ-A0875P14	F3SJ-A0875N14	96	875
F3SJ-A0911P14	F3SJ-A0911N14	100	911
F3SJ-A0983P14	F3SJ-A0983N14	108	983
F3SJ-A1055P14	F3SJ-A1055N14	116	1055
F3SJ-A1127P14	F3SJ-A1127N14	124	1127
F3SJ-A1199P14	F3SJ-A1199N14	132	1199
F3SJ-A1271P14	F3SJ-A1271N14	140	1271
F3SJ-A1343P14	F3SJ-A1343N14	148	1343
F3SJ-A1415P14	F3SJ-A1415N14	156	1415
F3SJ-A1487P14	F3SJ-A1487N14	164	1487
F3SJ-A1559P14	F3SJ-A1559N14	172	1559
F3SJ-A1631P14	F3SJ-A1631N14	180	1631

* Protective Height (mm) = Total sensor length

F3SJ-A20 Series (15-mm gap), F3SJ-A20-TS Series (15-mm gap) *1

Model		No. of Beams	Protective Height (mm) *2
PNP Output *1	NPN Output		
F3SJ-A0245P20	F3SJ-A0245N20	16	245
F3SJ-A0275P20	F3SJ-A0275N20	18	275
F3SJ-A0305P20	F3SJ-A0305N20	20	305
F3SJ-A0335P20	F3SJ-A0335N20	22	335
F3SJ-A0365P20	F3SJ-A0365N20	24	365
F3SJ-A0395P20	F3SJ-A0395N20	26	395
F3SJ-A0425P20	F3SJ-A0425N20	28	425
F3SJ-A0455P20	F3SJ-A0455N20	30	455
F3SJ-A0485P20	F3SJ-A0485N20	32	485
F3SJ-A0515P20	F3SJ-A0515N20	34	515
F3SJ-A0545P20	F3SJ-A0545N20	36	545
F3SJ-A0575P20	F3SJ-A0575N20	38	575
F3SJ-A0605P20	F3SJ-A0605N20	40	605
F3SJ-A0635P20	F3SJ-A0635N20	42	635
F3SJ-A0665P20	F3SJ-A0665N20	44	665
F3SJ-A0695P20	F3SJ-A0695N20	46	695
F3SJ-A0725P20	F3SJ-A0725N20	48	725
F3SJ-A0755P20	F3SJ-A0755N20	50	755
F3SJ-A0785P20	F3SJ-A0785N20	52	785
F3SJ-A0815P20	F3SJ-A0815N20	54	815
F3SJ-A0845P20	F3SJ-A0845N20	56	845
F3SJ-A0875P20	F3SJ-A0875N20	58	875
F3SJ-A0905P20	F3SJ-A0905N20	60	905
F3SJ-A0935P20	F3SJ-A0935N20	62	935
F3SJ-A0965P20	F3SJ-A0965N20	64	965
F3SJ-A0995P20	F3SJ-A0995N20	66	995
F3SJ-A1025P20	F3SJ-A1025N20	68	1025
F3SJ-A1055P20	F3SJ-A1055N20	70	1055
F3SJ-A1085P20	F3SJ-A1085N20	72	1085
F3SJ-A1115P20	F3SJ-A1115N20	74	1115
F3SJ-A1145P20	F3SJ-A1145N20	76	1145
F3SJ-A1175P20	F3SJ-A1175N20	78	1175
F3SJ-A1205P20	F3SJ-A1205N20	80	1205
F3SJ-A1235P20	F3SJ-A1235N20	82	1235
F3SJ-A1265P20	F3SJ-A1265N20	84	1265
F3SJ-A1325P20	F3SJ-A1325N20	88	1325
F3SJ-A1385P20	F3SJ-A1385N20	92	1385
F3SJ-A1445P20	F3SJ-A1445N20	96	1445
F3SJ-A1505P20	F3SJ-A1505N20	100	1505
F3SJ-A1655P20	F3SJ-A1655N20	110	1655
F3SJ-A1805P20	F3SJ-A1805N20	120	1805
F3SJ-A1955P20	F3SJ-A1955N20	130	1955
F3SJ-A2105P20	F3SJ-A2105N20	140	2105
F3SJ-A2255P20	F3SJ-A2255N20	150	2255
F3SJ-A2405P20	F3SJ-A2405N20	160	2405
F3SJ-A2495P20	F3SJ-A2495N20	166	2495

*1. The suffix "-TS" is attached to the model number of models with fixed auto reset.
*2. Protective Height (mm) = Total sensor length

F3SJ-A25-TS Series (20-mm gap) *1

Model	No. of Beams	Protective Height (mm) *2
PNP output		
F3SJ-A0260P25-TS	13	260
F3SJ-A0300P25-TS	15	300
F3SJ-A0340P25-TS	17	340
F3SJ-A0380P25-TS	19	380
F3SJ-A0420P25-TS	21	420
F3SJ-A0460P25-TS	23	460
F3SJ-A0500P25-TS	25	500
F3SJ-A0540P25-TS	27	540
F3SJ-A0580P25-TS	29	580
F3SJ-A0620P25-TS	31	620
F3SJ-A0660P25-TS	33	660
F3SJ-A0700P25-TS	35	700
F3SJ-A0740P25-TS	37	740
F3SJ-A0780P25-TS	39	780
F3SJ-A0820P25-TS	41	820
F3SJ-A0860P25-TS	43	860
F3SJ-A0900P25-TS	45	900
F3SJ-A0940P25-TS	47	940
F3SJ-A0980P25-TS	49	980
F3SJ-A1020P25-TS	51	1020
F3SJ-A1060P25-TS	53	1060
F3SJ-A1100P25-TS	55	1100
F3SJ-A1140P25-TS	57	1140
F3SJ-A1180P25-TS	59	1180
F3SJ-A1220P25-TS	61	1220
F3SJ-A1260P25-TS	63	1260
F3SJ-A1300P25-TS	65	1300
F3SJ-A1340P25-TS	67	1340
F3SJ-A1380P25-TS	69	1380
F3SJ-A1420P25-TS	71	1420
F3SJ-A1460P25-TS	73	1460
F3SJ-A1500P25-TS	75	1500
F3SJ-A1540P25-TS	77	1540
F3SJ-A1580P25-TS	79	1580
F3SJ-A1620P25-TS	81	1620
F3SJ-A1660P25-TS	83	1660
F3SJ-A1700P25-TS	85	1700
F3SJ-A1740P25-TS	87	1740
F3SJ-A1780P25-TS	89	1780
F3SJ-A1820P25-TS	91	1820
F3SJ-A1860P25-TS	93	1860
F3SJ-A1900P25-TS	95	1900
F3SJ-A1940P25-TS	97	1940
F3SJ-A1980P25-TS	99	1980
F3SJ-A2020P25-TS	101	2020
F3SJ-A2060P25-TS	103	2060
F3SJ-A2100P25-TS	105	2100
F3SJ-A2140P25-TS	107	2140
F3SJ-A2180P25-TS	109	2180
F3SJ-A2220P25-TS	111	2220
F3SJ-A2260P25-TS	113	2260
F3SJ-A2300P25-TS	115	2300
F3SJ-A2340P25-TS	117	2340
F3SJ-A2380P25-TS	119	2380
F3SJ-A2420P25-TS	121	2420
F3SJ-A2460P25-TS	123	2460
F3SJ-A2500P25-TS	125	2500

*1. The models in the F3SJ-A25-TS Series have only an auto reset.
*2. Protective Height (mm)= Total sensor length

F3SJ-A30 Series (25-mm gap)

Model		No. of Beams	Protective Height (mm) *
PNP Output	NPN Output		
F3SJ-A0245P30	F3SJ-A0245N30	10	245
F3SJ-A0270P30	F3SJ-A0270N30	11	270
F3SJ-A0295P30	F3SJ-A0295N30	12	295
F3SJ-A0320P30	F3SJ-A0320N30	13	320
F3SJ-A0345P30	F3SJ-A0345N30	14	345
F3SJ-A0370P30	F3SJ-A0370N30	15	370
F3SJ-A0395P30	F3SJ-A0395N30	16	395
F3SJ-A0420P30	F3SJ-A0420N30	17	420
F3SJ-A0445P30	F3SJ-A0445N30	18	445
F3SJ-A0470P30	F3SJ-A0470N30	19	470
F3SJ-A0495P30	F3SJ-A0495N30	20	495
F3SJ-A0520P30	F3SJ-A0520N30	21	520
F3SJ-A0545P30	F3SJ-A0545N30	22	545
F3SJ-A0570P30	F3SJ-A0570N30	23	570
F3SJ-A0595P30	F3SJ-A0595N30	24	595
F3SJ-A0620P30	F3SJ-A0620N30	25	620
F3SJ-A0645P30	F3SJ-A0645N30	26	645
F3SJ-A0670P30	F3SJ-A0670N30	27	670
F3SJ-A0695P30	F3SJ-A0695N30	28	695
F3SJ-A0720P30	F3SJ-A0720N30	29	720
F3SJ-A0745P30	F3SJ-A0745N30	30	745
F3SJ-A0770P30	F3SJ-A0770N30	31	770
F3SJ-A0795P30	F3SJ-A0795N30	32	795
F3SJ-A0820P30	F3SJ-A0820N30	33	820
F3SJ-A0845P30	F3SJ-A0845N30	34	845
F3SJ-A0870P30	F3SJ-A0870N30	35	870
F3SJ-A0895P30	F3SJ-A0895N30	36	895
F3SJ-A0920P30	F3SJ-A0920N30	37	920
F3SJ-A0945P30	F3SJ-A0945N30	38	945
F3SJ-A0970P30	F3SJ-A0970N30	39	970
F3SJ-A0995P30	F3SJ-A0995N30	40	995
F3SJ-A1020P30	F3SJ-A1020N30	41	1020
F3SJ-A1045P30	F3SJ-A1045N30	42	1045
F3SJ-A1070P30	F3SJ-A1070N30	43	1070
F3SJ-A1095P30	F3SJ-A1095N30	44	1095
F3SJ-A1120P30	F3SJ-A1120N30	45	1120
F3SJ-A1145P30	F3SJ-A1145N30	46	1145
F3SJ-A1170P30	F3SJ-A1170N30	47	1170
F3SJ-A1195P30	F3SJ-A1195N30	48	1195
F3SJ-A1220P30	F3SJ-A1220N30	49	1220
F3SJ-A1245P30	F3SJ-A1245N30	50	1245
F3SJ-A1270P30	F3SJ-A1270N30	51	1270
F3SJ-A1295P30	F3SJ-A1295N30	52	1295
F3SJ-A1395P30	F3SJ-A1395N30	56	1395
F3SJ-A1495P30	F3SJ-A1495N30	60	1495
F3SJ-A1620P30	F3SJ-A1620N30	65	1620
F3SJ-A1745P30	F3SJ-A1745N30	70	1745
F3SJ-A1870P30	F3SJ-A1870N30	75	1870
F3SJ-A1995P30	F3SJ-A1995N30	80	1995
F3SJ-A2120P30	F3SJ-A2120N30	85	2120
F3SJ-A2245P30	F3SJ-A2245N30	90	2245
F3SJ-A2370P30	F3SJ-A2370N30	95	2370
F3SJ-A2495P30	F3SJ-A2495N30	100	2495

* Protective Height (mm)= Total sensor length

F3SJ-A55 Series (50-mm gap)

Model		No. of Beams	Protective Height (mm) *2
PNP Output	NPN Output *1		
F3SJ-A0270P55		6	270
F3SJ-A0320P55		7	320
F3SJ-A0370P55		8	370
F3SJ-A0420P55		9	420
F3SJ-A0470P55		10	470
F3SJ-A0520P55		11	520
F3SJ-A0570P55		12	570
F3SJ-A0620P55		13	620
F3SJ-A0670P55		14	670
F3SJ-A0720P55		15	720
F3SJ-A0770P55		16	770
F3SJ-A0820P55		17	820
F3SJ-A0870P55		18	870
F3SJ-A0920P55		19	920
F3SJ-A0970P55		20	970
F3SJ-A1020P55		21	1020
F3SJ-A1070P55		22	1070
F3SJ-A1120P55		23	1120
F3SJ-A1170P55		24	1170
F3SJ-A1220P55		25	1220
F3SJ-A1270P55		26	1270
F3SJ-A1320P55		27	1320
F3SJ-A1370P55	---	28	1370
F3SJ-A1420P55		29	1420
F3SJ-A1470P55		30	1470
F3SJ-A1520P55		31	1520
F3SJ-A1570P55		32	1570
F3SJ-A1620P55		33	1620
F3SJ-A1670P55		34	1670
F3SJ-A1720P55		35	1720
F3SJ-A1770P55		36	1770
F3SJ-A1820P55		37	1820
F3SJ-A1870P55		38	1870
F3SJ-A1920P55		39	1920
F3SJ-A1970P55		40	1970
F3SJ-A2020P55		41	2020
F3SJ-A2070P55		42	2070
F3SJ-A2120P55		43	2120
F3SJ-A2170P55		44	2170
F3SJ-A2220P55		45	2220
F3SJ-A2270P55		46	2270
F3SJ-A2320P55		47	2320
F3SJ-A2370P55		48	2370
F3SJ-A2420P55		49	2420
F3SJ-A2470P55		50	2470

*1. Models with NPN output can also be manufactured.
*2. Protective Height (mm)= Total sensor length

Accessories (Optional)

Single-end Connector Cable (2 cables per set, for emitter and receiver)

For wiring with safety circuit such as single safety relay, safety relay unit, and safety controller

Appearance	Cable length	Specifications	Model
	3 m	M12 connector (8-pin)	**F39-JC3A**
	7 m		**F39-JC7A**
	10 m		**F39-JC10A**
	15 m		**F39-JC15A**
	20 m		**F39-JC20A**

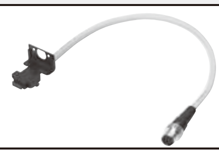
Double-end Connector Cable (2 cables per set, for emitter and receiver)

For connection with F3SP-B1P control unit, and for extension when series-connected *

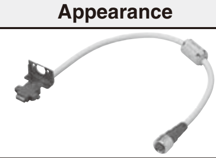
Appearance	Cable length	Specifications	Model
	0.5 m	M12 connector (8-pin)	**F39-JCR5B**
	1 m		**F39-JC1B**
	3 m		**F39-JC3B**
	5 m		**F39-JC5B**
	7 m		**F39-JC7B**
	10 m		**F39-JC10B**
	15 m		**F39-JC15B**
	20 m		**F39-JC20B**

* To extend the cable length under series connection, use F39-JJR3W and F39-JC□B in combination.

Power Cable (Included with the main unit) (2 cables per set, for emitter and receiver)

Appearance	Cable length	Model
	0.3 m	**F39-JJR3K**

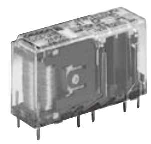
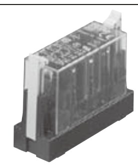
Series Connection Cable (2 cables per set, for emitter and receiver)

Type	Appearance	Cable length	Model	Application
Series connection cable		0.3 m	**F39-JJR3W**	For series connection *1 When using the Water-resistant Case. *2
Extension cable		0.5 to 15 m	**F39-JC□B**	To change series connection length in combination with F39-JJR3W
Side-by-side Series connection cable		0.06 m	**F39-JJR06L**	Dedicated series connection cable with minimum length, used in place of the sensor's cable with connector
		0.15 m	**F39-JJR15L**	

*1. Total cable length of series connection is 0.6 m to connect to connector cable of the main sensor unit.
For series connection with minimum length, use the F39-JJR06L or F39-JJR15L.

*2. When using the F39-EJ□□□□-L/D Water-resistant Case in series connection configurations, use the special series connection cables for the Water-resistant Case. Refer to page 14 for details.

Relays with Forcibly Guided Contacts

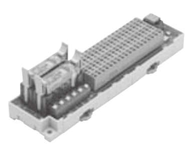
Type	Appearance	Specifications	Model	Remarks
G7SA Relays with Forcibly Guided Contacts		• No. of contacts: 4 • Contact type: 2NO+2NC • Rated switch load: 250 VAC 6 A, 30 VDC 6 A	**G7SA-2A2B**	For other models and functions, refer to G7SA and Socket models.
		• No. of contacts: 4 • Contact type: 3NO+1NC • Rated switch load: 250 VAC 6 A, 30 VDC 6 A	**G7SA-3A1B**	
G7S-☐-E Relays with Forcibly Guided Contacts		• No. of contacts: 6 • Contact type: 4NO+2NC • Rated switch load: 250 VAC 10 A, 30 VDC 10 A	**G7S-4A2B-E**	For other models and functions, refer to G7S-☐-E and Socket models.
		• No. of contacts: 6 • Contact type: 3NO+3NC • Rated switch load: 250 VAC 10 A, 30 VDC 10 A	**G7S-3A3B-E**	

Control unit (Can not be used as a muting system) (Dedicated PNP output type) *

Appearance	Output	Model	Remarks
	Relay, 3NO+1NC	**F3SP-B1P ***	For connection with F3SJ-A, use an F39-JC☐B double-end connector cable

* F3SJ for NPN output type cannot be connected.

Wire-saving Devices

Type	Appearance	Specifications	Model	Remarks
Connector Terminal Box/Muting Terminals *1		Model with PNP Muting Sensor Output	**F39-TC5P01**	Significantly reduces amount of wiring between Safety Light Curtains and Muting Sensors IP67 model for mounting at Sensor installation site Refer to F39-TC5
		Model with PNP Override Input	**F39-TC5P02**	
		Model with NPN Muting Sensor Output	**F39-TC5N01**	
		Model with NPN Override Input	**F39-TC5N02**	
Safety Terminal Relays *2		PNP output relay, SPDT-NO	**F3SP-T01**	Significantly reduces amount of wiring between Safety Light Curtains and Muting Sensors Refer to F3SP-T01

*1. For the F3SJ-A.
*2. For the F3SJ-A☐P☐.

Dedicated External Indicator Set (Can be connected to either an emitter or a receiver)

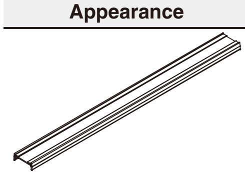
Appearance	Color	Model	Remarks
	Red	**F39-A01PR-PAC**	Indicator (red), mounting bracket (1 set), and dedicated connection cable (0.1 m)
	Green	**F39-A01PG-PAC**	Indicator (green), mounting bracket (1 set), and dedicated connection cable (0.1 m)
	Yellow	**F39-A01PY-PAC**	Indicator (yellow), mounting bracket (1 set), and dedicated connection cable (0.1 m)

Note: For indication timing (operation mode) see *"Specifications"* on page 15.

General External Indicator Cable

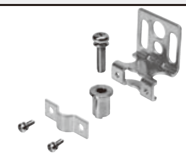
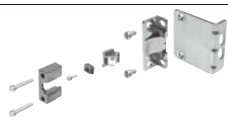
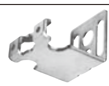
Appearance	Cable length	Specifications	Model
	3 m	Cable to connect top of the main unit and an off-the shelf external indicator (2-wire)	**F39-JJ3N**

Spatter Protection Cover (Includes two pieces for emitter and receiver) (Each unit reduces the operating range by 10%)

Appearance	Applicable sensor	Model
	F3SJ-A series	**F39-HJ□□□□ ***

* The same 4-digit numbers as the protective heights (□□□□ in the light curtain type names) are substituted by □□□□ in the model names.

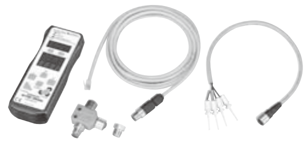
Sensor Mounting Bracket (Sold separately)

Appearance	Specifications	Model	Application	Remarks
	Standard mounting bracket (for top/bottom)	**F39-LJ1**	(included in the main unit)	2 for emitter, 2 for receiver (total of 4 per set)
	Flat side mounting bracket	**F39-LJ2**	Use these small-sized brackets when performing side mounting with standard mounting brackets, so that they do not protrude from the detection surface.	2 for emitter, 2 for receiver (total of 4 per set)
	Free-location mounting bracket (also used as standard intermediate bracket)	**F39-LJ3**	Use these brackets for mounting on any place without using standard bracket.	1 set with 2 pieces
	F3SN Intermediate Bracket Replacement Spacers	**F39-LJ3-SN**	When replacing the F3SN with the F3SJ, the mounting hole pitches in the Intermediate Brackets are not the same. This Spacer is placed between the mounting holes to mount the F3SJ.	1 set with 2 pieces
	Top/bottom mounting bracket B (mounting hole pitch 19 mm)	**F39-LJ4**	Mounting bracket used when replacing existing area sensors (other than F3SN or F3WN) with the F3SJ. For front mounting. Suitable for mounting hole pitch of 18 to 20 mm.	2 for emitter, 2 for receiver (total of 4 per set)
	Bracket for replacing short-length F3SN	**F39-LJ5**	Mounting bracket used when an F3SN with protective height of 300 mm or less is replaced by an F3SJ.	2 for emitter, 2 for receiver (total of 4 per set)
	Space-saving mounting bracket	**F39-LJ8**	Use these brackets to mount facing inward. Length is 12 mm shorter than the standard F39-LJ1 bracket.	2 for emitter, 2 for receiver (total of 4 per set)
	Mounting bracket used when replacing an F3W-C.	**F39-LJ9**	Mounting bracket used when replacing existing F3W-C series area sensors with the F3SJ. For front mounting or side mounting. Mounting hole pitch 16 mm.	2 for emitter, 2 for receiver (total of 4 per set)
	Top/bottom mounting bracket C (mounting hole pitch 13 mm)	**F39-LJ11**	Mounting bracket used when replacing existing area sensors having a mounting pitch of 13 mm with the F3SJ.	2 for emitter, 2 for receiver (total of 4 per set)

Key cap for muting

Appearance	Model	Remarks
	**F39-CN6**	Cap attaches to the main unit to enable muting function. Attach it to either an emitter or a receiver. (Case: orange)

Setting Tools *1

Type	Appearance	Model	Remarks
"SD Manager" Setting Support Software for the F3SJ		**F39-GWUM**	Accessories: SD Manager CD-ROM (1), F39-CN1 Branch Connector (1), Connector Cap (1), 2-m Dedicated Cable (1), 0.3-m Dedicated Cable with Plug (1), Instruction Manual
Setting Console		**F39-MC21 *2**	Accessories: F39-CN1 Branch Connector (1), Connector Cap (1), 2-m Dedicated Cable (1), 0.3-m Dedicated Cable with Plug (1), Instruction Manual

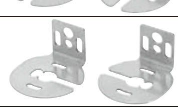
*1. The setting tools described above can be connected only to F3SJ-A models with built-in software of Ver. 2 or later.
Note that the setting tools cannot be used with products shipped prior to December 2005. The setting tools cannot be used for setting parameters on the F3SJ-A□-TS series, but the monitoring function can be used.
*2. This product is for use only with the F3SJ-A. It cannot be connected to conventional models of the F3SN-A series.
Similarly, the F39-MC11 and F39-MT11 Dedicated Consoles for the F3SN-A cannot be connected to the F3SJ-A series.

Protector (Main unit mounting bracket (1) and a rear mounting bracket set) *1

Type	Appearance	Model	Remarks
Protector Set		**F39-PJ□□□□-S *2**	Rear Mounting Brackets (2), including intermediate brackets to match protective height (0 to 2).
Intermediate brackets for side mounting		**F39-PJ-MS**	For side mounting, order to suit the desired protective height. Protective height of up to 1,000 mm: 0 intermediate brackets Protective height of 1,001 to 2,000 mm: 1 intermediate bracket Protective height of 2,001 mm or more: 2 intermediate brackets

*1. When using for both emitter and receiver, order two sets.
*2. The same four digits indicating protective height that are used in the Sensor model number (□□□□) are used in the □□□□ part of the Protector model number.

Water-resistant Case (Set of 1 tube, packing, and dedicated connector cable) *1 *4

Appearance	Specifications	Model	Remarks
	For emitter	**F39-EJ□□□□-L *2**	Includes gray cable for emitter.
	For receiver	**F39-EJ□□□□-D *2**	Includes black cable for receiver.
	Rear Mounting Brackets	**F39-EJ-R *3**	Top/bottom 1 each, total of 2
	Side Mounting Brackets	**F39-EJ-S *3**	Top/bottom 1 each, total of 2
---	Series connection cable (for emitter)	**F39-JJR3WE-L**	Purchase additionally for series connection when using the Water-resistant Case.
	Series connection cable (for receiver)	**F39-JJR3WE-D**	

*1. When using for both emitter and receiver, order two sets.
*2. The same four digits indicating protective height that are used in the Sensor model number (□□□□) are used in the □□□□ part of the Case model number.
*3. Be sure to purchase brackets with the Case to match the mounting direction (rear or side).
*4. There are restrictions to the application conditions depending on the protective height of the Curtain. Refer to the Water-resistant Case on page 22.

Specifications (For details, refer to the instruction manual or User's manual.)

Main Units

F3SJ-A□□□□P14/P20/P30/P55/N14/N20/N30

Model					
Model	PNP outputs	F3SJ-A□□□□P14	F3SJ-A□□□□P20	F3SJ-A□□□□P30	F3SJ-A□□□□P55
	NPN outputs	F3SJ-A□□□□N14	F3SJ-A□□□□N20	F3SJ-A□□□□N30	---
Sensor type		Type 4 safety light curtain			
Software version		Ver. 2			
Setting tool connection		Connectable			
Applicable safety category		Category 4, 3, 2, 1, or B			
Detection capability		Opaque objects 14 mm in diameter	Opaque objects 20 mm in diameter	Opaque objects 30 mm in diameter	Opaque objects 55 mm in diameter
Beam gap (P)		9 mm	15 mm	25 mm	50 mm
Number of beams (n)		26 to 180	16 to 166	10 to 100	6 to 50
Protective height (PH)		245 to 1,631 mm	245 to 2,495 mm		270 to 2,470 mm
Lens diameter		Diameter 5 mm			
Operating range		0.2 to 9 m (protective height 1,640 mm max.), 0.2 to 7 m (protective height 1,655 mm min.) (Depending on the setting tool, the detection distance can be shortened to 0.5 m.)			
Response time (For details, see "Response Time" on page 20.)	ON to OFF	1 set, 0245 to 983: 11 ms to 17.5 ms max. 1,055 or higher: 20 ms to 25 ms max.	1 set, 0245 to 1,205: 10 ms to 15 ms max. 1,235 or higher: 17.5 ms to 22.5 ms max.	1 set: 10 ms to 17.5 ms max.	1 set: 10 ms to 13 ms max.
	OFF to ON	1 set, 0245 to 983: 44 ms to 70 ms max. 1,055 or higher: 80 ms to 100 ms max.	1 set, 0245 to 1,205: 40 ms to 60 ms max. 1,235 or higher: 70 ms to 90 ms max.	1 set: 40 ms to 70 ms max.	1 set: 40 ms to 52 ms max.
Startup waiting time		2 s max. (2.2 s max. for series connection)			
Power supply voltage (Vs)		24 VDC ±20% (ripple p-p10% max.)			
Current consumption (no load)	Emitter	Up to 50 beams: 76 mA max., 51 to 100 beams: 106 mA max., 101 to 150 beams: 130 mA max., 151 to 180 beams: 153 mA max., 201 to 234 beams: 165 mA max.			
	Receiver	Up to 50 beams: 68 mA max., 51 to 100 beams: 90 mA max., 101 to 150 beams: 111 mA max., 151 to 180 beams: 128 mA max., 201 to 234 beams: 142 mA max.			
Light source (emitted wavelength)		Infrared LED (870 nm)			
Effective aperture angle (EAA)		Based on IEC61496-2. Within ±2.5° for both emitter and receiver when the detection distance is 3 m or over			
Control outputs (OSSD)	PNP outputs	Two PNP transistor outputs, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), allowable capacity load 2.2 μF, leak current 1 mA max. (This can be different from traditional logic (ON/OFF) because safety circuit is used.)			
	NPN outputs	Two NPN transistor outputs, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), allowable capacity load 2.2 μF, leak current 2 mA max. (This can be different from traditional logic (ON/OFF) because safety circuit is used.)			---
Auxiliary output 1 (non-safety output)	PNP output	One PNP transistor output, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), leak current 1 mA max.			
	NPN output	One NPN transistor output, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), leak current 1 mA max.			---
Auxiliary output 2 (non-safety output, basic system functions)	PNP output	One PNP transistor output, load current 50 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), leak current 1 mA max.			
	NPN output	One NPN transistor output, load current 50 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), leak current 1 mA max.			---
External indicator output (non-safety output)		Available indicators • Incandescent lamp: 24 VDC, 3 to 7 W • LED lamp: Load current 10 mA to 300 mA max., leak current 1 mA max. (To use an external indicator, an F39-JJ3N universal indicator cable or an F39-A01P□-PAC dedicated external indicator kit is required.)			
Output operation mode	Receiver	Control outputs 1, 2:ON when receiving light Auxiliary output 1:Inverse of control output signals (Operating mode can be changed with the setting tool.) External indicator output 1:Inverse of control output signals for a basic system (Operating mode can be changed with the setting tool.) ON when muting/override for a muting system (Operating mode can be changed with the setting tool.)			
	Emitter	Auxiliary output 2: Turns ON when the point of 30,000 operating hours is reached (Operating mode can be changed with the setting tool.) External indicator output 2:ON when lock-out for a basic system (Operating mode can be changed with the setting tool.) ON when muting/override for a muting system (Operating mode can be changed with the setting tool.)			

Model					
Model	PNP outputs	F3SJ-A□□□□P14	F3SJ-A□□□□P20	F3SJ-A□□□□P30	F3SJ-A□□□□P55
	NPN outputs	F3SJ-A□□□□N14	F3SJ-A□□□□N20	F3SJ-A□□□□N30	---
Input voltage	PNP output	Test input, interlock selection input, reset input, and muting input are all ON voltage:9 to 24 V (Vs) (sink current: 3 mA max.) OFF voltage:0 to 1.5 V, or open External device monitoring input ON voltage:9 to 24 V (Vs) (sink current: 5 mA max.) OFF voltage:0 to 1.5 V, or open			
	NPN output	Test input, interlock selection input, reset input, and muting input are all ON voltage:0 to 1.5 V (short-circuit current 3 mA max.) OFF voltage:9 to 24 V, or open External device monitoring input ON voltage:0 to 1.5 V (short-circuit current 5 mA max.) OFF voltage:9 to 24 V, or open			---
Internal indicators	Emitter	Light intensity level indicators (green LED × 2, orange LED × 3): ON based on the light intensity Error mode indicators (red LED × 3): Blink to indicate error details Power indicator (green LED × 1): ON while power is on Interlock indicator (yellow LED × 1): ON while under interlock, ON while under interlock, blinks at lockout. External device monitoring indicator (muting input 1 indicator), Blanking/test indicator (muting input 2 indicator) (green LED × 2): ON/flash according to function			
	Receiver	Light intensity level indicators (green LED × 2, orange LED × 3): ON based on the light intensity Error mode indicators (red LED × 3): Blink to indicate error details OFF output indicator (red LED × 1): ON when safety output is OFF, blinks at lockout. ON output indicator (green LED × 1): ON while safety output is ON muting error indicator, Blanking /test indicator (green LED × 2): ON/flash according to function			
Mutual interference prevention function		Interference light prevention algorithm, detection distance change function			
Series connection		Time division emission by series connection • Number of connections: up to 4 sets • Total number of beams: up to 400 beams • Maximum cable length for 2 sets: no longer than 15 m • Response time under connection: See page 20			
Test functions		• Self test (when power is turned ON and while power is supplied) • External test (emission stop function by test input)			
Safety functions		• Start interlock, restart interlock (Must be set with a setting tool when the muting function is used.) • External device monitor • Muting (Lamp burnout detection, override function included. F39-CN6 key cap for muting is required.) • Fixed blanking (must be set by a setting tool) • Floating blanking (must be set by a setting tool)			

Model					
Model	PNP outputs	F3SJ-A□□□□P14	F3SJ-A□□□□P20	F3SJ-A□□□□P30	F3SJ-A□□□□P55
	NPN outputs	F3SJ-A□□□□N14	F3SJ-A□□□□N20	F3SJ-A□□□□N30	---
Connection type		Connectors (M12, 8-pin)			
Protective circuits		Output short-circuit protection, and power supply reverse polarity protection			
Ambient temperature		Operating: −10 to 55°C (no icing), Storage: −30 to 70°C			
Ambient humidity		Operating: 35% to 85% (no condensation), Storage: 35% to 95%			
Ambient operating light intensity		Incandescent lamp: 3,000 lx max. (light intensity on the receiver surface), Sunlight: 10,000 lx max. (light intensity on the receiver surface)			
Insulation resistance		20 MΩ min. (at 500 VDC)			
Dielectric strength		1,000 VAC 50/60 Hz, 1 min			
Degree of protection		IP65 (IEC60529)			
Vibration resistance		Malfunction: 10 to 55 Hz, 0.7-mm double amplitude, 20 sweeps in X, Y, and Z directions			
Shock resistance		Malfunction: 100 m/s^2, 1,000 times each in X, Y, and Z directions			
Connection cable, Series connection cable (F39-JJR□L, F39-JJR3W)		6-mm-dia., 8-wire cable (0.15 mm^2 × 8) with braided shield, allowable bending radius R5 mm			
Extension cable (F39-JC□A, F39-JC□B)		6.6-mm-dia., 8-wire cable (0.3 mm^2 × 4P, resistance 0.058 Ω/m), with braided shield, allowable bending radius R36 mm (To extend a cable length, use an equivalent or higher-performance cable. Do not place it in the same duct as high-voltage cables or power cables.) For available length for extension (cable extension length), see page 21.			
Materials		Casing (including metal parts on both ends): Aluminum, zinc die-cast Cap: ABS resin Optical cover: PMMA resin (acrylic) Cable: Oil resistant PVC			
Weight (packed state)		Calculate using the following equations: (1) For F3SJ-A□□□□P14, weight (g)=(protective height) × 1.7 + α (2) For F3SJ-A□□□□P20/F3SJ-A□□□□P30, weight (g)=(protective height) × 1.5 + α (3) For F3SJ-A□□□□P55, weight (g)=(protective height) × 1.4 + α The values for α are as follows: Protected height 245 to 596 mm: α = 1,100 protected height 1667 to 2180 mm: α = 2,400 Protected height 605 to 1,130 mm: α = 1,500 protected height 2195 to 2495 mm: α = 2,600 Protected height 1,136 to 1,658 mm: α = 2,000			
Accessories		Test rod (*1), instruction manual, mounting brackets (top and bottom), mounting brackets (intermediate) (*2), error mode label, User's Manual (CD-ROM) *1. The F3SJ-A□□□□P55 is not included. *2. Number of intermediate mounting brackets depends on protective height of F3SJ. • For protective height from 605 to 1,130 mm: 1 set for each of the emitter and receiver is included • For protective height from 1,136 to 1,658 mm: 2 sets for each of the emitter and receiver are included • For protective height from 1,667 to 2,180 mm: 3 sets for each of the emitter and receiver are included • For protective height from 2,195 to 2,495 mm: 4 sets for each of the emitter and receiver are included			
Applicable standards		IEC61496-1, EN61496-1 UL61496-1, Type 4 ESPE (Electro-Sensitive Protective Equipment) IEC61496-2, prEN61496-2, UL61496-2, Type 4 AOPD (Active Opto-electronic Protective Devices) IEC61508, EN61508 SIL3			

F3SJ-A□□□□P20-TS/P25-TS

Model		F3SJ-A□□□□P20-TS	F3SJ-A□□□□P25-TS
Sensor type		Type 4 safety light curtain	
Software version		Ver. 2	
Setting tool connection		Parameter setting: Not possible Monitoring: Possible	
Applicable safety category		Category 4, 3, 2, 1, or B	
Detection capability		Opaque objects 20 mm in diameter	Opaque objects 25 mm in diameter
Beam gap (P)		15 mm	20 mm
Number of beams (n)		16 to 166	13 to 125
Protective height (PH)		245 to 2,495 mm	260 to 2,500 mm
Lens diameter		Diameter 5 mm	
Operating range		0.2 to 9 m (protective height 1,640 mm max.), 0.2 to 7 m (protective height 1,655 mm max.)	
Response time (For details, see "Response Time" on page 20.)	ON to OFF	1 set, 0245 to 1,205: 10 ms to 15 ms max. 1,220 or higher: 17.5 ms to 22.5 ms max. 3 sets (240 beams): 45.5 ms	1 set, 0260 to 1,600: 10 ms to 15 ms max. 1,620 or higher: 17.5 ms to 20.0 ms max. 3 sets (240 beams): 45.5 ms
	OFF to ON	1 set, 0245 to 1,205: 40 ms to 60 ms max. 1,220 or higher: 70 ms to 90 ms max. 3 sets (240 beams): 200 ms	1 set, 0260 to 1,600: 40 ms to 60 ms max. 1,620 or higher: 70 ms to 80 ms max. 3 sets (240 beams): 200 ms
Startup waiting time		2 s max. (2.2 s max. for series connection)	
Power supply voltage (Vs)		24 VDC ±20% (ripple p-p10% max.)	
Current consumption (no load)	Emitter	Up to 50 beams: 76 mA max., 51 to 100 beams: 106 mA max., 101 to 150 beams: 130 mA max., 151 to 166 beams: 153 mA max	
	Receiver	Up to 50 beams: 68 mA max., 51 to 100 beams: 90 mA max., 101 to 150 beams: 111 mA max., 151 to 166 beams: 128 mA max.	
Light source (emitted wavelength)		Infrared LED (870 nm)	
Effective aperture angle (EAA)		Based on IEC61496-2. Within ±2.5° for both emitter and receiver when the detection distance is 3 m or over	
Control outputs (OSSD)		Two PNP transistor outputs, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), allowable capacity load 2.2 μF, leak current 1 mA max. (This can be different from traditional logic (ON/OFF) because safety circuit is used.)	
Auxiliary output 1 (non-safety output)		One PNP transistor output, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension), leak current 1 mA max.	
External indicator output (non-safety output)		Available indicators • Incandescent lamp: 24 VDC, 3 to 7 W • LED lamp: Load current 10 mA to 300 mA max., leak current 1 mA max. (To use an external indicator, an F39-JJ3N universal indicator cable or an F39-A01P□-PAC dedicated external indicator kit is required.)	
Output operation mode	Receiver	Control outputs 1, 2: ON when receiving light Auxiliary output 1: Inverse of control output signals (Operating mode can be changed with the setting tool.) External indicator output 1: Inverse of control output signals for a basic system (Operating mode can be changed with the setting tool.) ON when muting/override for a muting system (Operating mode can be changed with the setting tool.)	
	Emitter	External indicator output 2: ON when lock-out for a basic system (Operating mode can be changed with the setting tool.) ON when muting/override for a muting system (Operating mode can be changed with the setting tool.)	
Input voltage		Test input, reset input, and muting input are all ON voltage:9 to 24 V (Vs) (sink current: 3 mA max.) OFF voltage:0 to 1.5 V, or open External device monitoring input ON voltage:9 to 24 V (Vs) (sink current: 5 mA max.) OFF voltage:0 to 1.5 V, or open	
Internal indicators	Emitter	Light intensity level indicators (green LED × 2, orange LED × 3): ON based on the light intensity Error mode indicators (red LED × 3): Blink to indicate error details Power indicator (green LED × 1): ON while power is on Lockout indicator (yellow LED × 1): Blinks to indicate lockout. External device monitoring indicator (muting input 1 indicator), Test indicator (muting input 2 indicator) (green LED × 2): ON/flash according to function	
	Receiver	Light intensity level indicators (green LED × 2, orange LED × 3): ON based on the light intensity Error mode indicators (red LED × 3): Blink to indicate error details OFF output indicator (red LED × 1): ON when safety output is OFF, blinks at lockout. ON output indicator (green LED × 1): ON while safety output is ON muting error indicator, Test indicator (green LED × 2): ON/flash according to function	

Model	F3SJ-A□□□□P20-TS	F3SJ-A□□□□P25-TS
Mutual interference prevention function	Interference light prevention algorithm	
Series connection	Time division emission by series connection • Number of connections: up to 3 sets • Total number of beams: up to 240 beams • Maximum cable length for 2 sets: no longer than 15 m • Response time under connection: See page 20	
Test functions	• Self test (when power is turned ON and while power is supplied) • External test (emission stop function by test input)	
Safety functions	• External device monitor • Muting (Override function included. F39-CN6 Key Cap for muting is required.) Lockout occurs under either of the following conditions: • When more than 3 Units are connected in series. • When the total number of beams connected in series exceeds 240. • When any model other than a "-TS" model is included in a series connection.	
Connection type	Connectors (M12, 8-pin)	
Protective circuits	Output short-circuit protection, and power supply reverse polarity protection	
Ambient temperature	Operating: –10 to 55°C (no icing), Storage: –30 to 70°C	
Ambient humidity	Operating: 35% to 85% (no condensation), Storage: 35% to 95%	
Ambient operating light intensity	Incandescent lamp: 3,000 lx max. (light intensity on the receiver surface), Sunlight: 10,000 lx max. (light intensity on the receiver surface)	
Insulation resistance	20 MΩ min. (at 500 VDC)	
Dielectric strength	1,000 VAC 50/60 Hz, 1 min	
Degree of protection	IP65 (IEC60529)	
Vibration resistance	Malfunction: 10 to 55 Hz, 0.7-mm double amplitude, 20 sweeps in X, Y, and Z directions	
Shock resistance	Malfunction: 100 m/s^2, 1,000 times each in X, Y, and Z directions	
Connection cable, Series connection cable (F39-JJR□L, F39-JJR3W)	6-mm-dia., 8-wire cable (0.15 mm^2 × 8) with braided shield, allowable bending radius R5 mm	
Extension cable (F39-JC□A, F39-JC□B)	6.6-mm-dia., 8-wire cable (0.3 mm^2 × 4P, resistance 0.058 Ω/m), allowable bending radius R36 mm (To extend a cable length, use an equivalent or higher-performance cable. Do not place it in the same duct as high-voltage cables or power cables.) For available length for extension (cable extension length), see page 21.	
Materials	Casing (including metal parts on both ends): Aluminum, zinc die-cast Cap: ABS resin Optical cover: PMMA resin (acrylic) Cable: Oil resistant PVC	
Weight (packed state)	Calculate using the following equations: For F3SJ-A□□□□P□□-TS, weight (g)=(protective height) × 1.5 + α The values for α are as follows: Protected height 245 to 590 mm: α = 1,100 protected height 1,660 to 2,180 mm: α = 2,400 Protected height 600 to 1,130 mm: α = 1,500 protected height 2,195 to 2,500 mm: α = 2,600 Protected height 1,140 to 1,655 mm: α = 2,000	
Accessories	Test rod, instruction manual, mounting brackets (top and bottom), mounting brackets (intermediate) (*), error mode label, User's Manual (CD-ROM) * Number of intermediate mounting brackets depends on protective height of F3SJ. • For protective height from 600 to 1,130 mm: 1 set for each of the emitter and receiver is included • For protective height from 1,140 to 1,655 mm: 2 sets for each of the emitter and receiver are included • For protective height from 1,660 to 2,180 mm: 3 sets for each of the emitter and receiver are included • For protective height from 2,195 to 2,500 mm: 4 sets for each of the emitter and receiver are included	
Applicable standards	IEC61496-1, EN61496-1 UL61496-1, Type 4 ESPE (Electro-Sensitive Protective Equipment) IEC61496-2, prEN61496-2, UL61496-2, Type 4 AOPD (Active Opto-electronic Protective Devices) IEC61508, EN61508 SIL3	

Response Time

Model	Protective Height (mm)	Number of Beams	Response time ms (ON to OFF)	Response time ms (OFF to ON)
F3SJ-A□14 series	245 to 263	26 to 28	11	44
	281 to 389	30 to 42	12	48
	407 to 497	44 to 54	13	52
	515 to 605	56 to 66	14	56
	623 to 731	68 to 80	15	60
	767 to 983	84 to 108	17.5	70
	1,055 to 1,271	116 to 140	20	80
	1,343 to 1,559	148 to 172	22.5	90
	1,631	180	25	100
F3SJ-A□20 series F3SJ-A□P20-TS series	245	16	10	40
	275 to 425	18 to 28	11	44
	455 to 635	30 to 42	12	48
	665 to 815	44 to 54	13	52
	845 to 995	56 to 66	14	56
	1,025 to 1,205	68 to 80	15	60
	1,235 to 1,655	82 to 110	17.5	70
	1,805 to 2,105	120 to 140	20	80
	2,255 to 2,495	150 to 166	22.5	90
F3SJ-A□P25-TS series	260 to 320	13 to 16	10	40
	340 to 580	17 to 29	11	44
	600 to 840	30 to 42	12	48
	860 to 1100	43 to 55	13	52
	1120 to 1340	56 to 67	14	56
	1360 to 1600	68 to 80	15	60
	1620 to 2240	81 to 112	17.5	70
	2260 to 2500	113 to 125	20.0	80
F3SJ-A□30 series	245 to 395	10 to 16	10	40
	420 to 720	17 to 29	11	44
	745 to 1,045	30 to 42	12	48
	1,070 to 1,295	43 to 52	13	52
	1,395 to 1,620	56 to 65	14	56
	1,745 to 1,995	70 to 80	15	60
	2,120 to 2,495	85 to 100	17.5	70
F3SJ-A□55 series	270 to 770	6 to 16	10	40
	820 to 1420	17 to 29	11	44
	1470 to 2070	30 to 42	12	48
	2120 to 2470	43 to 50	13	52

Note: Use the following expressions for series connection.

For 2-set series connection:
- Response time (ON to OFF): Response time of the 1st unit + Response time of the 2nd unit - 1 (ms)
- Response time (OFF to ON): Response time calculated by the above x 4 (ms)

For 3-set series connection:
- Response time (ON to OFF): Response time of the 1st unit + Response time of the 2nd unit + Response time of 3rd unit - 5 (ms)
- Response time (OFF to ON): Response time calculated by the above x 5 (ms)
  (For models with the "-TS" suffix, multiply the response time obtained by the above x 5 (ms), or use 200 ms, whichever is less.)

For 4-set series connection:
- Response time (ON to OFF): Response time of the 1st unit + Response time of the 2nd unit + Response time of the 3rd unit + Response time of the 4th unit - 8 (ms)
- Response time (OFF to ON): Response time calculated by the above x 5 (ms)

Cable Extension Length

Total cable extension length must be no greater than the lengths described below.

When the F3SJ and an external power supply are directly connected, or when the F3SJ is connected to a G9SA-300-SC.

Condition	1 set	2 sets	3 sets	4 sets
Using incandescent lamp for auxiliary output and external indicator output	45 m	40 m	30 m	20 m
Not using incandescent lamp	100 m	60 m	45 m	30 m

When connected to the F3SP-B1P.

<table>
<tr><th>Condition</th><th>1 set</th><th>2 sets</th><th>3 sets</th><th>4 sets</th></tr>
<tr><td>Using incandescent lamp for external indicator output 2</td><td>40 m</td><td>30 m</td><td>25 m</td><td>20 m</td></tr>
<tr><td>Using incandescent lamp for external indicator output 1</td><td rowspan="2">60 m</td><td rowspan="2">45 m</td><td rowspan="2">30 m</td><td rowspan="2">20 m</td></tr>
<tr><td>Using incandescent lamp for auxiliary output 1</td></tr>
<tr><td>Not using incandescent lamp</td><td>100 m</td><td>60 m</td><td>45 m</td><td>30 m</td></tr>
</table>

Note: Keep the cable length within the rated length. Failure to do so is dangerous as it may prevent safety functions from operating normally.

Accessories

Control Unit

Item	Model	F3SP-B1P
Applicable sensor		F3SJ-A (Only for PNP output type) *
Power supply voltage		24 VDC±10%
Power consumption		DC1.7 W max. (not including sensor's current consumption)
Operation time		100 ms max. (not including sensor's response time)
Response time		10 ms max. (not including sensor's response time)
Relay output	Number of contacts	3NO+1NC
	Rated load	25 VAC 5 A (cosϕ= 1), 30 VDC 5 A L/R = 0 ms
	Rated current	5 A
Connection type	Between sensors	M12 connector (8-pin)
	Others	Terminal block
Weight (packed state)		Approx. 280 g
Accessories		Instruction manual

* NPN output type cannot be connected. Also, the system cannot be used as a muting system.

Dedicated External Indicator Set

Item / Model	F39-A01PR-PAC	F39-A01PG-PAC	F39-A01PY-PAC
Applicable sensor	F3SJ-A (Common for PNP/NPN output type. Can be attached to emitters and/or receivers)		
Light source	Red LED	Green LED	Yellow LED
Power supply voltage	24 VDC±10% (supplied by sensor)		
Consumption current	50 mA max. (supplied by sensor)		
Connection type	Dedicated accessory connector cable (Sensor side: Dedicated 10-pin connector, Indicator side: M12 8-pin connector)		
Set contents	Indicator (red), Dedicated connector cable (0.1 m), Dedicated mounting brackets (1 for each)	Indicator (green), Dedicated connector cable (0.1 m), Dedicated mounting brackets (1 for each)	Indicator (yellow), Dedicated connector cable (0.1 m), Dedicated mounting brackets (1 for each)

Water-resistant Case

Item / Model	F39-EJ□□□□-L, F39-EJ□□□□-D	
Applicable sensor	F3SJ-series Curtains with a protective height of 600 mm max.	F3SJ-series Curtains with a protective height of 605 mm min.
Ambient temperature	-10 to 55°C (operation and storage)	13 to 33°C (operation and storage)
Mounting direction	No restrictions	Vertical direction only (see following diagram)
Operating range	0.2 to 7 m (for a protective height of 1,631 mm max.), 0.2 to 5 m (for a protective height of 1,655 mm min.)	
Degree of protection	IP67 (IEC60529) (When assembled according to the application precautions)	
Materials	Case: Acrylic resin, Rubber: Nitrile rubber, M5 bolt: SUSXM7, M4 bolt: SUS316L, Cable: Oil-resistant PVC, Plate: SUS304, Mounting Bracket (optional): SUS304	
Weight (packed state)	Calculation formula: Weight (g) = 1.5 x □□□□ + 300 (□□□□ stands for the four digits of the model number (protective height)) (The optional Mounting Brackets come in a set of two, and weigh 120 g. This weight is not included in the above formula.)	

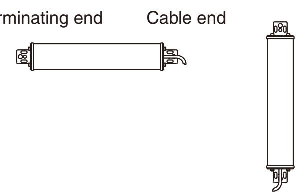
Note: 1. Vibration
When using Curtains with a protective height of 605 mm or more, the vibration performance of the applicable sensor is reduced.
Do not use these Curtains in locations that are subject to vibration.

2. Protective height
When using these cases, the protective height of the applicable sensor is reduced.
Check the rating and performance prior to use.

3. Mounting direction
When using Curtains with a protective height of 605 mm or more, some slackness occurs due to the weight of the Curtain.
For this reason, mount these Curtains only in the vertical direction.

Mounting direction
(the cable end and terminating end can be positioned in either direction)

Horizontal direction **Vertical direction**



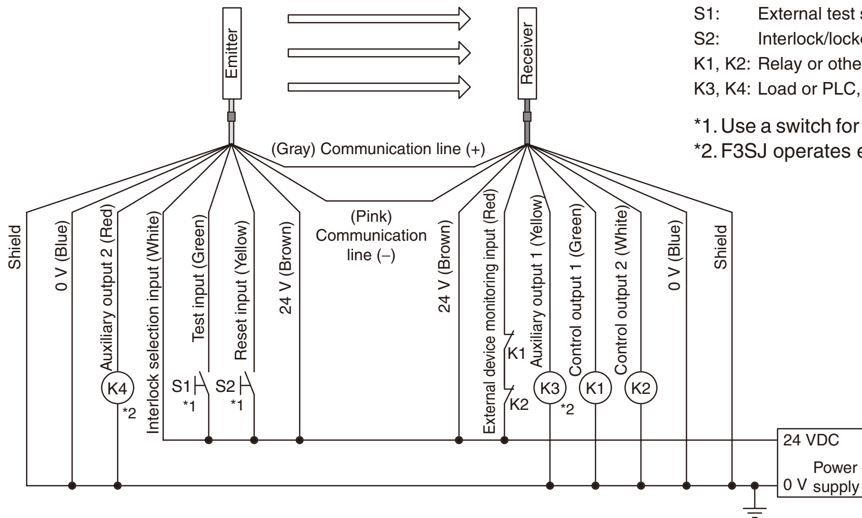
Connections

Basic Connection for Basic System

"Basic system" refers to the F3SJ with its default factory settings. The basic system provides basic safety light curtain functions.
Most functions can be used without performing additional configuration.

For PNP output (See page 24 for NPN output wiring.)

Wiring when using manual reset mode, external device monitoring

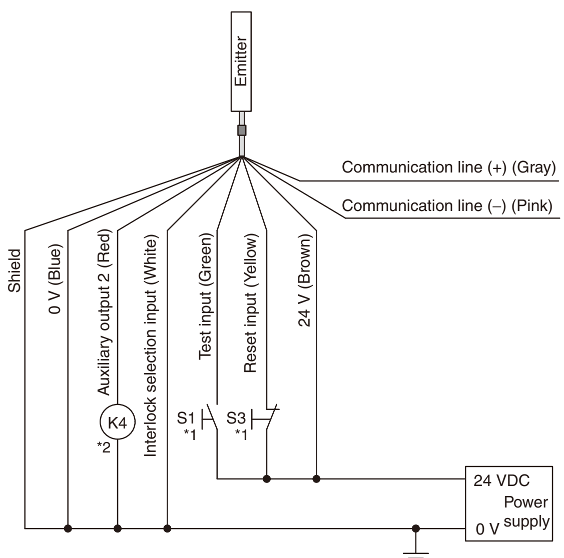


S1: External test switch (connect to 0 V if the switch is not necessary.)
S2: Interlock/lockout reset switch
K1, K2: Relay or other device that controls hazardous parts of the machine
K3, K4: Load or PLC, etc. (for monitoring)

*1. Use a switch for micro loads (Input specifications: 24 V, 1.8 mA).
*2. F3SJ operates even when K3 and K4 are not connected.

Wiring for auto reset mode

- The auto reset mode will be enabled when the emitter is wired as shown below.

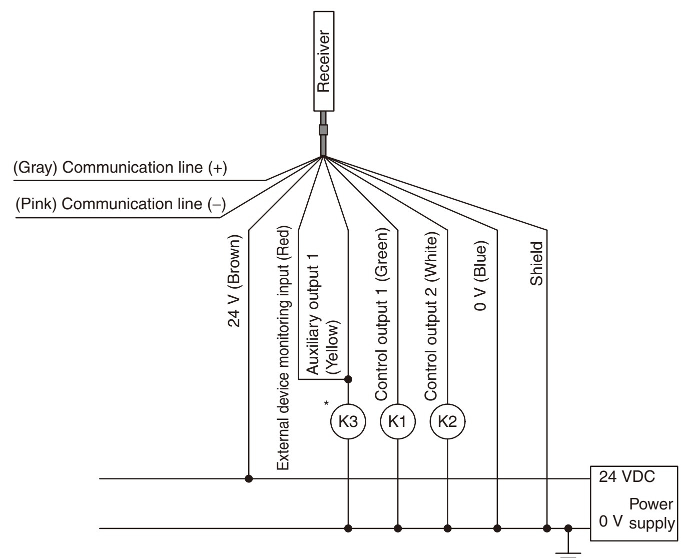


S1: External test switch (connect to 0 V if the switch is not necessary.)
S3: Lockout reset switch (connect to 24 V if the switch is not necessary)
K4: Load or PLC, etc. (for monitoring)

*1. Use a switch for micro loads (Input specifications: 24 V, 1.8 mA).
*2. F3SJ operates even when K4 is not connected.

Wiring when the external device monitoring function will not be used

- Use a setting tool to set the external device monitoring function to "Disabled."
- When using an auxiliary output 1 that has not been changed (output operation mode is "control output data," and inverse of control output signals is "Enabled), the external device monitoring function will be disabled when auxiliary output 1 and the external device monitoring input are connected as shown below.



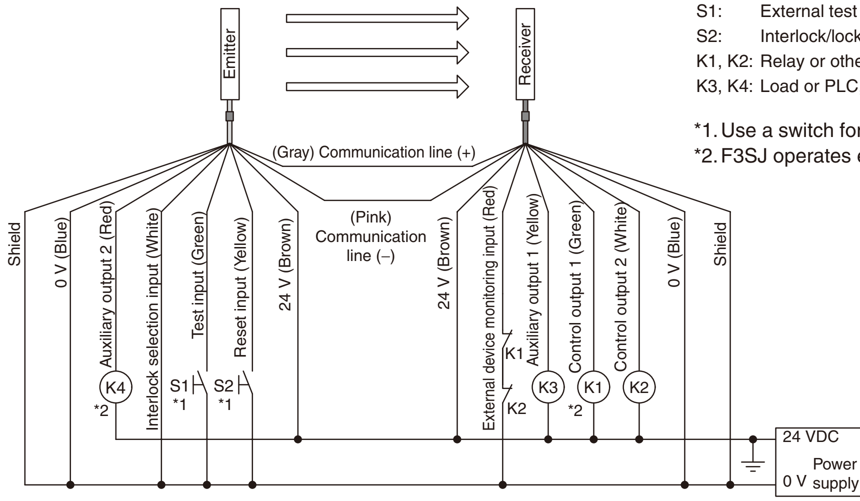
K1, K2: Relay or other device that controls hazardous parts of the machine
K3: Load or PLC, etc. (for monitoring)

* The F3SJ operates even when K3 is not connected. When K3 is not necessary, connect auxiliary output 1 only to the external device monitoring input.

For NPN output (See page 23 for PNP output wiring.)

(See page 23 for PNP output wiring.)

Wiring when using manual reset mode, external device monitoring

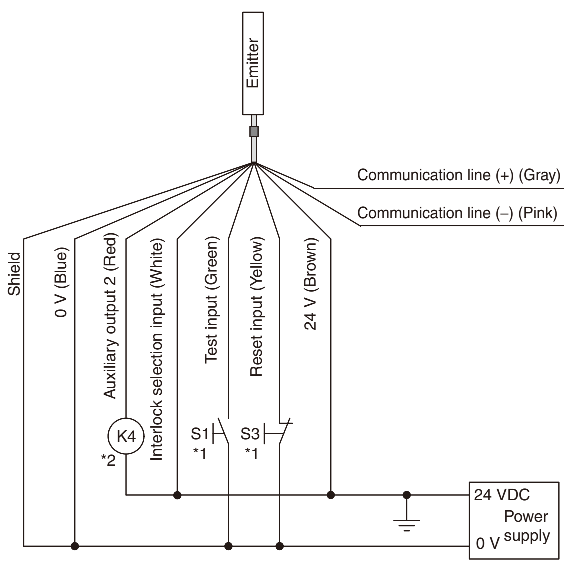


S1: External test switch (connect to 24 V if the switch is not necessary.)
S2: Interlock/lockout reset switch
K1, K2: Relay or other device that controls hazardous parts of the machine
K3, K4: Load or PLC, etc. (for monitoring)

*1. Use a switch for micro loads (Input specifications: 5 V, 1 mA).
*2. F3SJ operates even when K3 and K4 are not connected.

Wiring for auto reset mode

- The auto reset mode will be enabled when the emitter is wired as shown below.

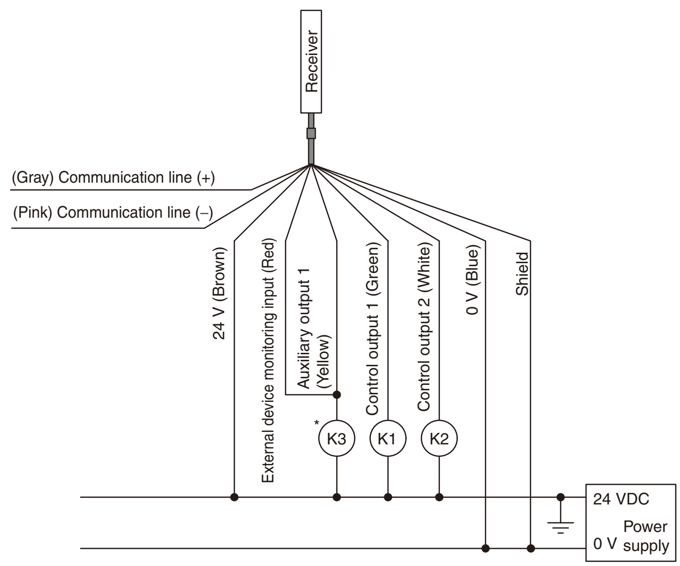


S1: External test switch (connect to 24 V if the switch is not necessary.)
S3: Lockout reset switch (connect to 0 V if the switch is not necessary)
K4: Load or PLC, etc. (for monitoring)

*1. Use a switch for micro loads (Input specifications: 5 V, 1 mA).
*2. F3SJ operates even when K4 is not connected.

Wiring when the external device monitoring function will not be used

- Use a setting tool to set the external device monitoring function to "Disabled."
- When using an auxiliary output 1 that has not been changed (output operation mode is "control output data," and inverse of control output signals is "Enabled), the external device monitoring function will be disabled when auxiliary output 1 and the external device monitoring input are connected as shown below.



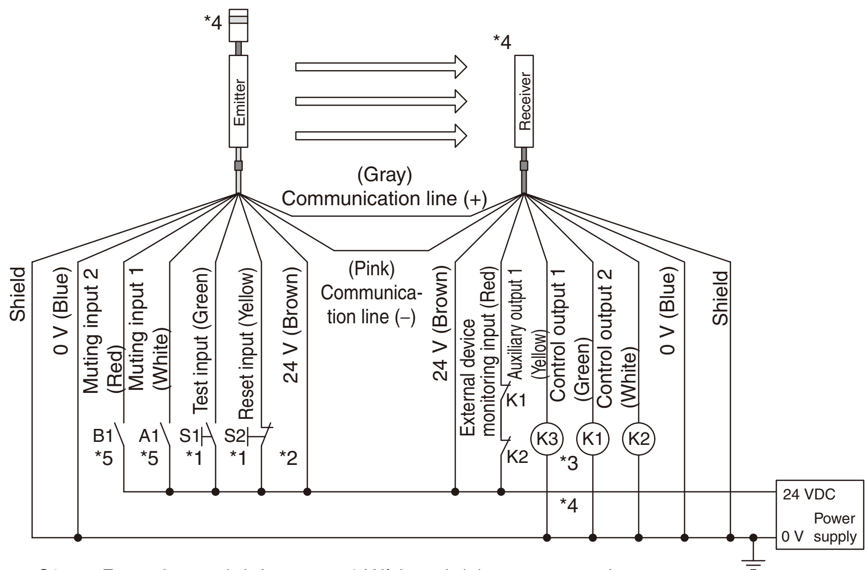
K1, K2: Relay or other device that controls hazardous parts of the machine
K3: Load or PLC, etc. (for monitoring)

* The F3SJ operates even when K3 is not connected. When K3 is not necessary, connect auxiliary output 1 only to the external device monitoring input.

Basic Connection for Muting System

For PNP output (See page 26 for NPN output wiring.)

Wiring when using muting and external device monitoring functions

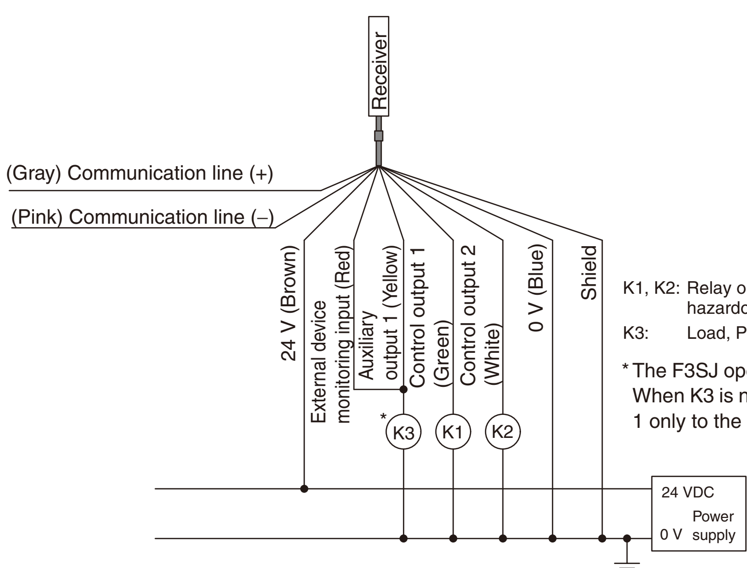


S1: External test switch (connect to 0 V if the switch is not necessary.)
S2: Lockout reset switch (connect to 24 V if the switch is not necessary.)
A1: Contact by muting sensor A1
B1: Contact by muting sensor B1
K1, K2: Relay or other device that controls hazardous parts of the machine
K3: Load or PLC, etc. (for monitoring)
M1: Muting lamp

*1. Use a switch for small loads (input specifications: 24 V, 1.8 mA)
*2. When using the interlock function, this also functions as an interlock reset switch. (Must be set with a setting tool.)
*3. The F3SJ will operate even if K3 is not connected.
*4. Connect the muting lamp to either the external indicator output or auxiliary output 1 for the emitter or the receiver. When connecting the muting lamp to auxiliary output 1, the parameter must be changed with a setting tool.
*5. Two-wire sensors cannot be used.

Wiring when the external device monitoring function will not be used

- Use a setting tool to set the external device monitoring function to "Disabled."
- When using an auxiliary output 1 that has not been changed (output operation mode is "control output data," and inverse of control output signals is "Enabled"), the external device monitoring function will be disabled when auxiliary output 1 and the external device monitoring input are connected as shown below.

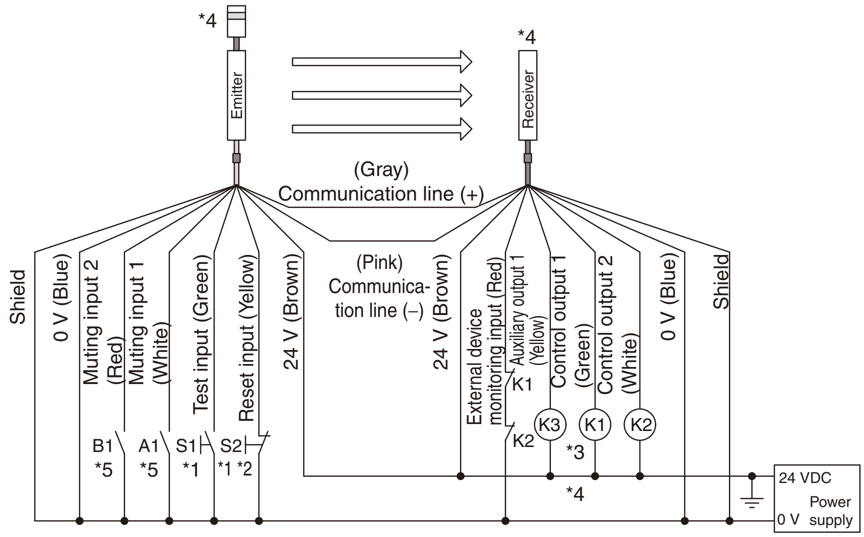


K1, K2: Relay or other device that controls hazardous parts of the machine
K3: Load, PLC, etc. (for monitoring)

* The F3SJ operates even when K3 is not connected. When K3 is not necessary, connect auxiliary output 1 only to the external device monitoring input.

For NPN output (See page 25 for PNP output wiring.)

Wiring when using muting and external device monitoring functions

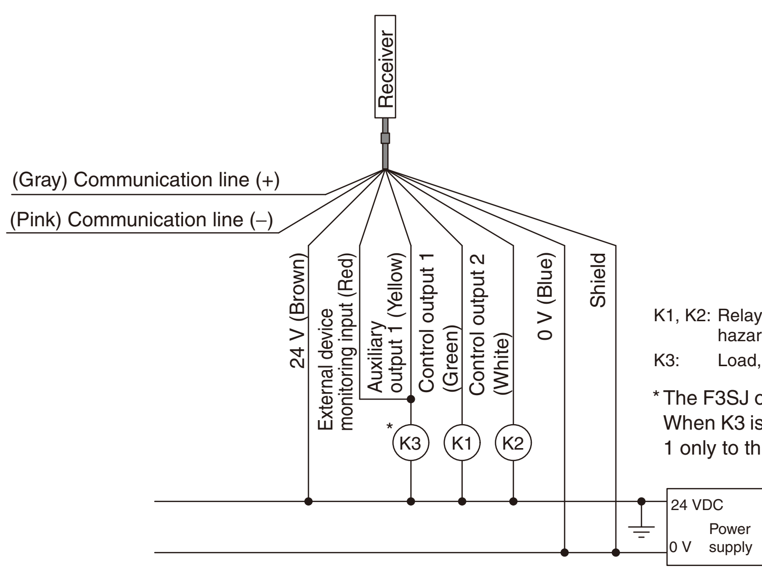


S1: External test switch (connect to 24 V if the switch is not necessary.)
S2: Lockout reset switch (connect to 0 V if the switch is not necessary.)
A1: Contact by muting sensor A1
B1: Contact by muting sensor B1
K1, K2: Relay or other device that controls hazardous parts of the machine
K3: Load or PLC, etc. (for monitoring)
M1: Muting lamp

*1. Use a switch for small loads (input specifications: 5 V, 1 mA).
*2. When using the interlock function, this also functions as an interlock reset switch. (Must be set with a setting tool.)
*3. The F3SJ operates even when K3 is not connected.
*4. Connect the muting lamp to either the external indicator output or auxiliary output 1 for the emitter or the receiver. When connecting the muting lamp to auxiliary output 1, the parameter must be changed with a setting tool.
*5. Two-wire sensors cannot be used.

Wiring when the external device monitoring function will not be used

- Use a setting tool to set the external device monitoring function to "Disabled."
- When using an auxiliary output 1 that has not been changed (output operation mode is "control output data," and inverse of control output signals is "Enabled"), the external device monitoring function will be disabled when auxiliary output 1 and the external device monitoring input are connected as shown below.



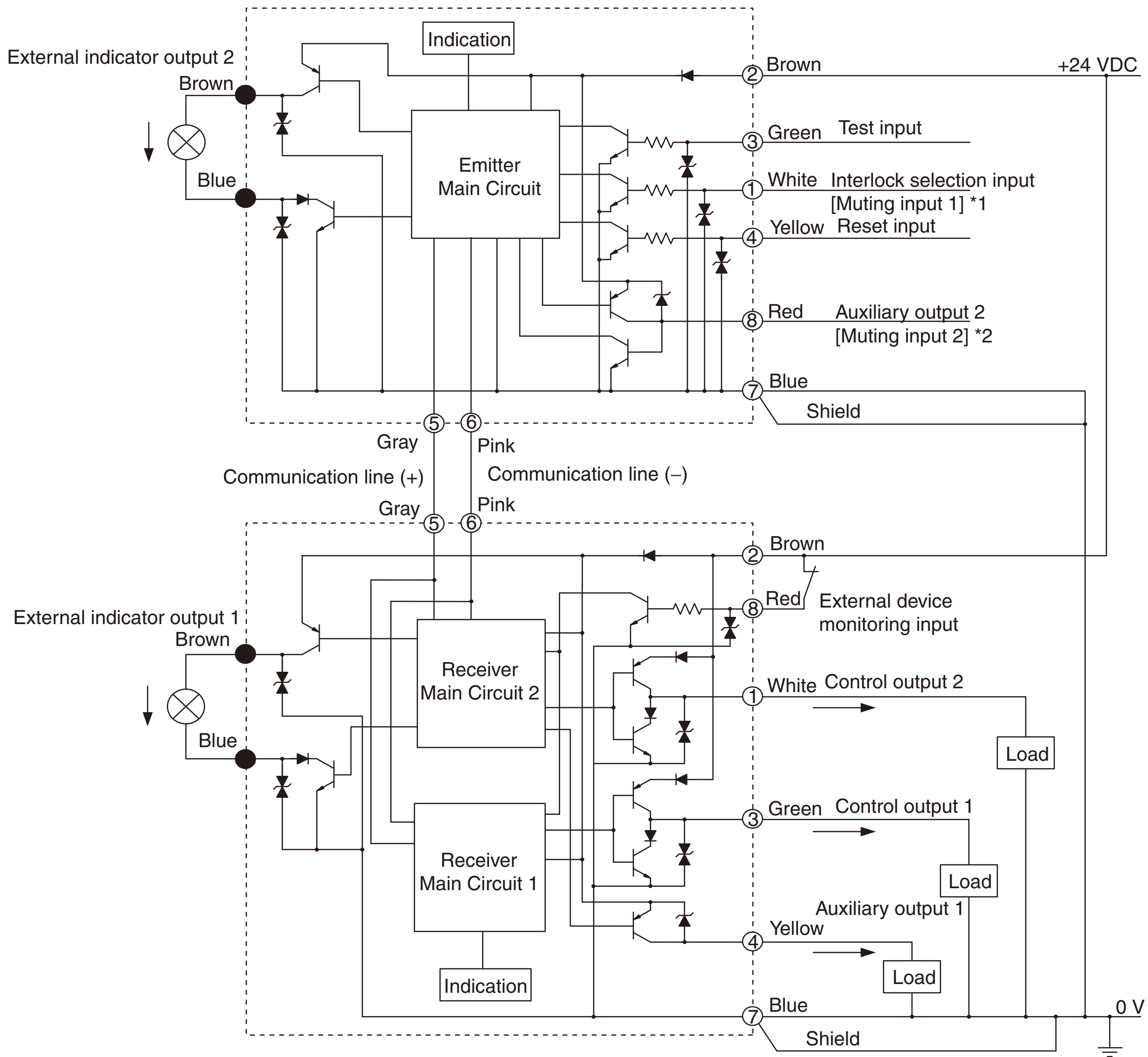
K1, K2: Relay or other device that controls hazardous parts of the machine
K3: Load, PLC, etc. (for monitoring)

* The F3SJ operates even when K3 is not connected. When K3 is not necessary, connect auxiliary output 1 only to the external device monitoring input.

I/O Circuit Diagrams

PNP Output Type

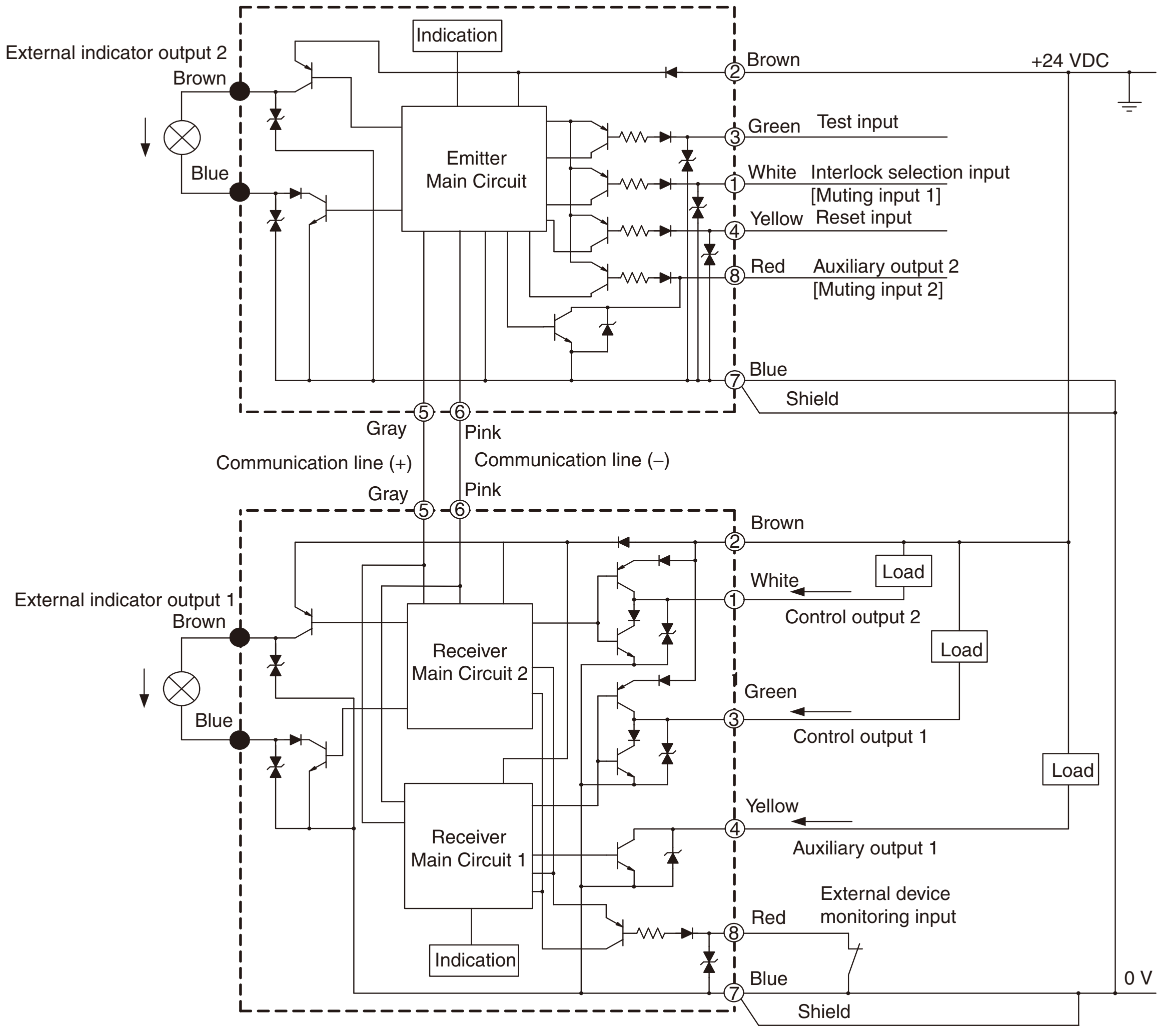
The numbers in white circles indicate the connector's pin numbers.
The black circles indicate connectors for series connection.
The words in brackets ([ ]) indicate the signal name for muting system.



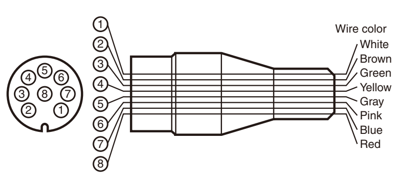
*1. Open or muting input 1 for models with the "-TS" suffix.
*2. Open or muting input 2 for models with the "-TS" suffix.

NPN Output Type

The numbers in white circles indicate the connector's pin numbers.
The black circles indicate connectors for series connection.
The words in brackets ([ ]) indicate the signal name for muting system.



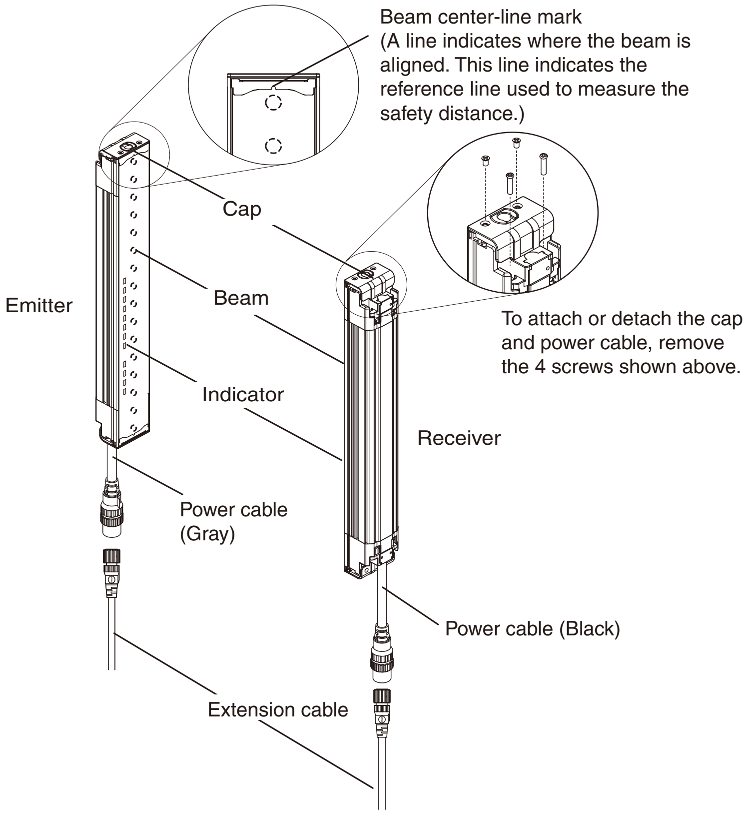
Single-end Connector Cable

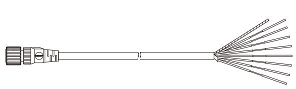
Model	Internal wiring	Pin No.	Wire color	Signal Name			
				Basic system *1		Muting system *1	
				Receiver	Emitter	Receiver	Emitter
F39-JC3A (3 m) F39-JC7A (7 m) F39-JC10A (10 m) F39-JC15A (15 m)		(1)	White	Safety output 2	Interlock selection input *2	Safety output 2	Muting input 1
		(2)	Brown	+24 VDC	+24 VDC	+24 VDC	+24 VDC
		(3)	Green	Control output 1	Test Input	Control output 1	Test Input
		(4)	Yellow	Auxiliary output 1	Reset input	Auxiliary output 1	Reset input
		(5)	Gray	Communication line (+)	Communication line (+)	Communication line (+)	Communication line (+)
		(6)	Pink	Communication line (-)	Communication line (-)	Communication line (-)	Communication line (-)
		(7)	Blue	0 V	0 V	0 V	0 V
		(8)	Red	External device monitoring input	Auxiliary output 2 *2	External device monitoring input	Muting input 2

*1. Basic system indicates a system with default factory settings.
Muting system indicates a system attached with a muting keycap (F39-CN6) to enable muting function.
*2. N.C. for models with the "-TS" suffix.

Nomenclature

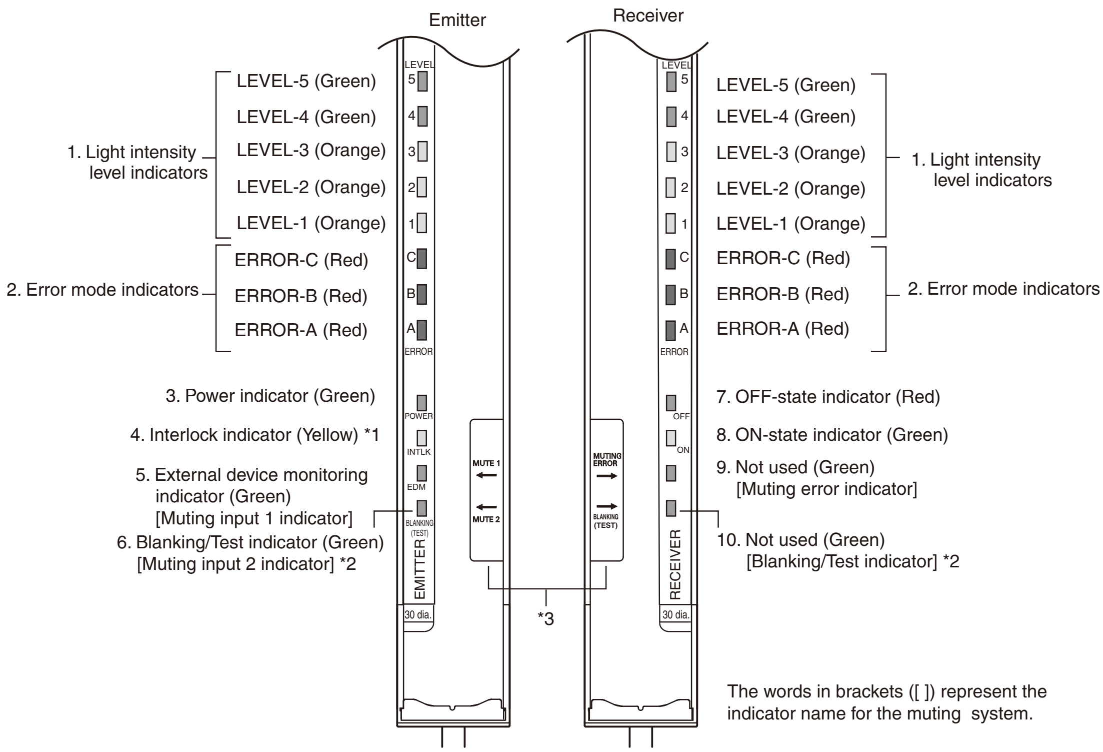
Main Unit and Cables



Component		Model	Description
Emitter, receiver		F3SJ-A□□□□P□□ or F3SJ-A□□□□N□□	Select a type name based on the required protective height and detection capability. (Cap and power cable are included) The type name can be understood as follows: F3SJ-A□□□□P□□-□ 1 2 3 4 1: Protective height (mm) 2: Output type (P=PNP output type, N=NPN output type) 3: Diameter of detection capability (mm) 4: L is emitter, D is receiver, and a blank is emitter/receiver set. For models with fixed auto reset, the suffix "-L-TS" is an emitter, "-D-TS" is a receiver, and "-TS" is an emitter/receiver set.
Extension cable	Single-end connector cable 	F39-JC□A	This extension cable is used to connect to a terminal block controller (e.g. F3SX, G9SA, G9SB, G9SX) or to a safety processing system (e.g. DeviceNet safety).
	Double-end connector cable 	F39-JC□B	This extension cable is used when the length of the connection cable is insufficient, or when connecting to an F3SP-B1P controller. The length can be specified.

Internal Indicators

Total View



No.	Internal Indicators		Description	
			For basic system	For muting system
1	Light intensity level indicators (LEVEL-1 to 5) (refer to page 31.)	ON	Indication status of LEVEL-1 to 5 shows the light intensity level status of the F3SJ.	
2	Error mode indicators (ERROR-A to C) (refer to page 31.)	ON/ Blinking	Turns ON or blinks only on the sensor where the error occurred when the F3SJ enters lockout. The error mode indicators turn OFF on sensors (emitters or receivers) where an error did not occur, or on other series-connected sensors. The indication status of ERROR-A to C shows the cause of the error. Affix the error mode label (included) near the F3SJ to allow for quick troubleshooting when errors occur.	
3	Power indicator (POWER)	ON	Turns ON while the power is ON.	
		Blinking	Blinks when in maintenance mode.	
4	Interlock indicator (INTLK) *1	ON	Turns ON when F3SJ is in interlock state.	
		Blinking	Blinks when under lockout.	
5	External device monitoring indicator (EDM) Muting input 1 indicator (MUTE1)	ON	Turns ON when an input is given to external device monitoring input.	Turns ON when an input is given to muting input 1.
		Blinking	Not used	Blinks during muting override.
6	Blanking/Test indicator (BLANKING/TEST) *2 Muting input 2 indicator (MUTE2)	ON	Turns ON when the blanking function and warning zone function are enabled.	Turns ON when an input is given to muting input 2.
		Blinking	Blinks when external test is being performed.	Blinks during muting override.
7	OFF output indicator (OFF)	ON	Turns ON when control output is OFF.	
		Blinking	Blinks in the following states: • Lockout state • One or more beams are blocked in maintenance mode	
8	ON output indicator (ON)	ON	Turns ON when safety output is ON.	
		Blinking	Blinks when no beams are blocked in maintenance mode	
9	Muting error indicator (MUTING ERROR)	ON	Not used	Turns ON when a muting error occurs.
10	Blanking/Test indicator (BLANKING/TEST) *2	ON	Not used	Turns ON when the blanking function is enabled.
		Blinking	Not used	Blinks when external test is being performed.

*1. Lockout indicator (LOCKOUT) for models with the "-TS" suffix.
*2. In the TS model, this is a test indicator labeled TEST.
*3. This label is included with the F39-CN6 key cap for muting. Affix the label when the muting function is used.

Indication Patterns and Intensity Levels of the Light Intensity Level Indicators (LEVEL-1 to 5)

ON OFF

1	2	3	4	5	Light intensity level
ON	ON	ON	ON	ON	170% or higher of control output ON level
ON	ON	ON	ON	OFF	From 130 to 170% of control output ON level
ON	ON	ON	OFF	OFF	From 100 to 130% of control output ON level
ON	ON	OFF	OFF	OFF	From 75 to 100% of control output ON level
ON	OFF	OFF	OFF	OFF	From 50 to 75% of control output ON level
OFF	OFF	OFF	OFF	OFF	Less than 50% of control output ON level

Note: Operation is possible with light intensity level of 100% or more, but to ensure stability, operate when at least 5 of the indication lamps are ON.

Error Mode Indication Patterns and Cause of Errors (ERROR-A to C)

OFF Blinking ON

A	B	C	Cause of error
ON	OFF	Blinking	Mutual interference or ambient incident light.
ON	Blinking	ON	Power supply voltage of F3SJ is out of the rated range. Insufficient current capacity of power supply.
ON	ON	OFF	Incident light to blanking beams.
ON	Blinking	OFF	Failure in communication line.
ON	Blinking	Blinking	Emitter and receiver have different F3SJ type names or number of series connections.
Blinking	Blinking	OFF	Outside the effective range of parameters set by setting tool.
Blinking	ON	ON	Cap is not attached.
OFF	Blinking	OFF	External device monitor failure.
Blinking	OFF	OFF	Failure in interlock selection input line or reset input line.
Blinking	ON	OFF	Muting wiring failure.
OFF	OFF	Blinking	Failure in control output wiring.
OFF	Blinking	Blinking	Failure in series connection cable wiring.
OFF	ON	Blinking	Failure in wiring of external display lamp output.
ON	ON	Blinking	Failure in wiring of auxiliary output.
Blinking	OFF	Blinking	Broken series connection cable.
ON	OFF	OFF	Wiring error or broken communications wire.
Blinking	Blinking	Blinking	Influence of electrical noise, or failure in a series-connected F3SJ.

Safety-related Functions

Interlock Function

The F3SJ turns the safety outputs OFF when the power is turned ON or when a beam is interrupted, and maintains this state until a reset signal is applied. This state is called "interlock".
You can reset this interlock by 2 methods; “auto reset that auto matically turns safety output ON when an interrupting object is removed” and “manual reset mode that keeps safety output OFF until a reset signal is provided if the interrupting object is removed”.

Auto Reset Mode

When an interrupting object is removed, safety output automatically turns ON. Auto reset is used on machines where a worker is not able to enter the area between the detection zone and the hazardous part of the machine.

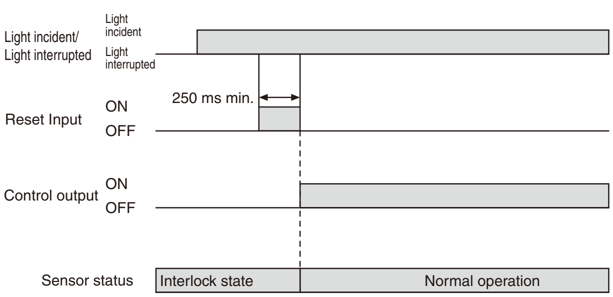
Note: Auto reset is always used in the F3SJ-A□-TS series.

Auto reset wiring procedure:

For PNP output	For NPN output
1. Open the interlock selection input line, or short-circuit it to 0 to 1.5 V (pin 1/white). **2.** Short-circuit the reset input line to 9 to 24 V (pin 4/yellow). **3.** Turn ON the power of F3SJ.	**1.** Open the interlock selection input line, or short-circuit it to 9 to 24 V (pin 1/white). **2.** Short-circuit the reset input line to 0 to 1.5 V (pin 4/yellow). **3.** Turn ON the power of F3SJ.

Manual Reset Mode

When a reset input is given while no interrupting object exists in a detection zone, the safety outputs turn ON. This allows the machine to be manually reset using a reset switch after ensuring safety, preventing unexpected startup.



A sensor enters interlock state when:

- The power is turned ON (start interlock). This is useful if you want to keep the machine stopped until start inspection is completed after the power is turned ON.
- F3SJ is interrupted (restart interlock). After F3SJ is interrupted and the machine stops, the machine can be restarted after safety is ensured.

Manual Reset Wiring Procedure:

For PNP output	For NPN output
1. Connect the interlock selection input line to 9 to 24 V (pin 1/white). **2.** Connect the reset input line to 9 to 24 V via the reset switch (NO-contact) (pin 4/yellow). **3.** Keep the reset switch contact open, and turn the power of F3SJ ON.	**1.** Connect the interlock selection input line to 0 to 1.5 V (pin 1/white). **2.** Connect the reset input line to 0 to 1.5 V via the reset switch (NO-contact) (pin 4/yellow). **3.** Keep the reset switch contact open, and turn the power of F3SJ ON.

To reset:

For PNP output	For NPN output
Apply voltage of 9 to 24 V for 250 ms or longer to the reset input line, and set it open or to 0 to 1.5 V.	Apply voltage of 0 to 1.5 V for 250 ms or longer to the reset input line, and set it open or to 9 to 24 V.

Note: Install the reset switch outside the hazardous area, where the operator can clearly see the hazardous area.

Interlock Function in a Muting System

Because the interlock selection input line is used as muting input 1 when using the muting function, the default setting is auto reset. Use a setting tool for manual reset.

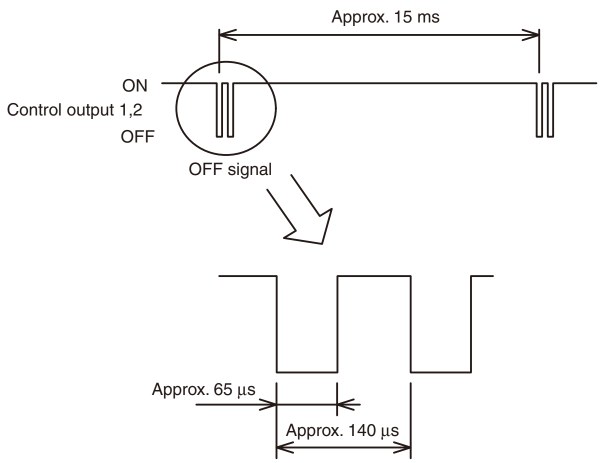
Diagnostic Functions

Self-test

A self-test is performed to check for errors when the power is turned ON (within 2 seconds / within 2.2 seconds when series connected). Also, the self-test is regularly performed (within the response time) while operating.

Waveform of Control Outputs

When the F3SJ is receiving light, the control outputs cyclically turn OFF as shown below to test the output circuit. When this OFF signal is fed back, the output circuit is diagnosed as normal. If the output signal does not include an OFF pulse signal, the receiver determines that a failure has occurred with the output circuit or wiring, and enters lockout state. (Refer to the following illustration.)



External Test

This function performs a test to ensure that the safety system stops properly when the F3SJ is interrupted, by using an external signal to forcibly stop emission.
To stop emission, apply 9 to 24 V for PNP output types or 0 to 1.5 V for NPN output types to the test input line of the emitter. Apply the voltage for a minimum of 4 x the safety output response time.

Lockout

If an error is found in the self-test, the sensor enters lockout state, keeps the safety output in the OFF state, and indicates the error at the same time.

Resetting Lockout

When a cause of lockout is removed, you can release the lockout by using either of the following methods.

- Cycle the power back ON
- Reset input

[For PNP output]
After manual reset, apply voltage of 9 to 24 V for 100 ms or longer to the reset input line, and set it open or apply 0 to 1.5 V.
After auto reset, apply voltage of 0 to 1.5 V for 100 ms or longer to the reset input line, and set it open or apply 9 to 24 V.

[For NPN output]
After manual reset, apply voltage of 0 to 1.5 V for 100 ms or longer to the reset input line, and set it open or apply 9 to 24 V.
After auto reset, apply voltage of 9 to 24 V for 100 ms or longer to the reset input line, and set it open or apply 0 to 1.5 V.

External Device Monitoring Function

This function detects malfunctions, such as welded contacts in external relays (or contactors) that control the hazardous area of a machine.
This function constantly monitors that a specified voltage is applied to the receiver's external device monitoring input line, and enters lockout state when an error occurs. The relay's operational delay can be up to 300 ms without being evaluated as an error.
For example, if a specified voltage is not applied to the external device monitoring line because the normally closed (NC) contact is not closed within 300 ms after the control outputs turn from ON to OFF, it is evaluated as an error and enters a lockout state.
To utilize this function properly, use safety relays and contactors that have forcibly guided or mechanically linked contact structure.

Other Functions

Auxiliary Output (Non-safety output)

The auxiliary output is used to monitor the status of the F3SJ.
This output can be connected to a device such as a relay, indication lamp, programmable controller, etc.
There are two auxiliary outputs: Auxiliary output 1 and auxiliary output 2.

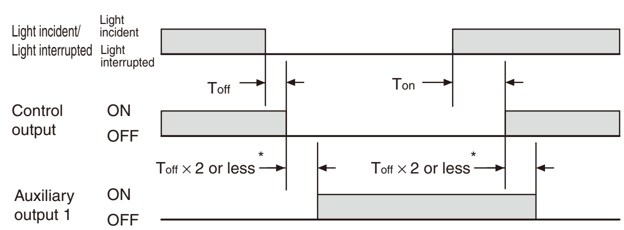
- Auxiliary output 1: Control output inversion signal
- Auxiliary output 2: Turns ON when the point of 30,000 operating hours is reached

The auxiliary output modes can be changed with a setting tool. See the User's Manual for details on the modes that can be set.

⚠ WARNING

Do not use the auxiliary output or external indicator output for safety applications.
Failure of these outputs may prevent detection of people and result in serious injury.

Note: 1. Auxiliary output 1 has a load current of 300 mA max., and auxiliary output 2 has a load current of 50 mA.
2. The timing when auxiliary output 1 is set as a control output inversion signal is shown in the diagram below.

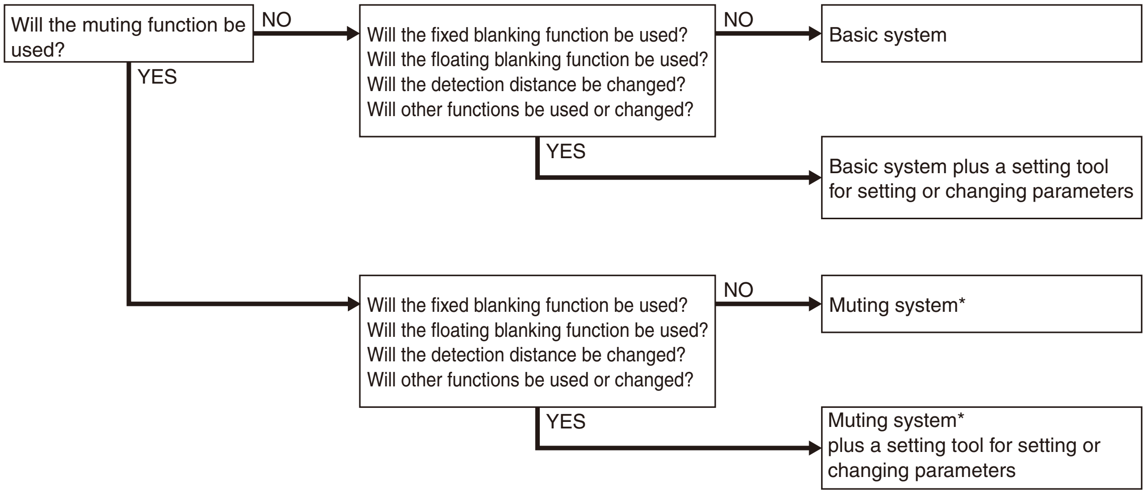


Toff: Response time of control output's ON to OFF, Ton: Response time of control output's OFF to ON
* When auxiliary output 2 is set as a control output inversion signal, the response delay for control output becomes Toff x 3 max.

Selecting the System Configuration

Selection Flowchart

The necessary system configuration varies depending on the functions to be used.
Use the following flowchart to decide what kind of system is required.



*F39-CN6 Key Cap for muting is required.

Note: Refer to the User's Manual to determine whether the functions can be used in combination or not.

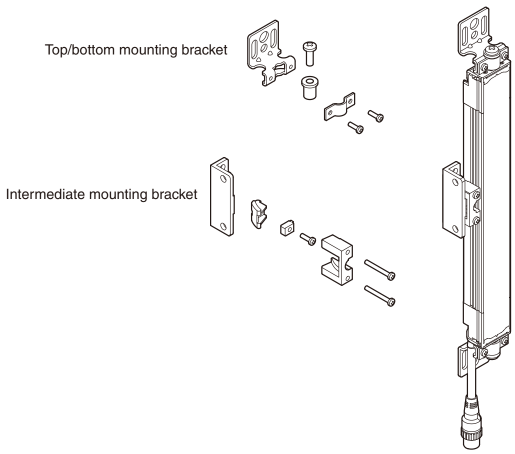
Dimensions

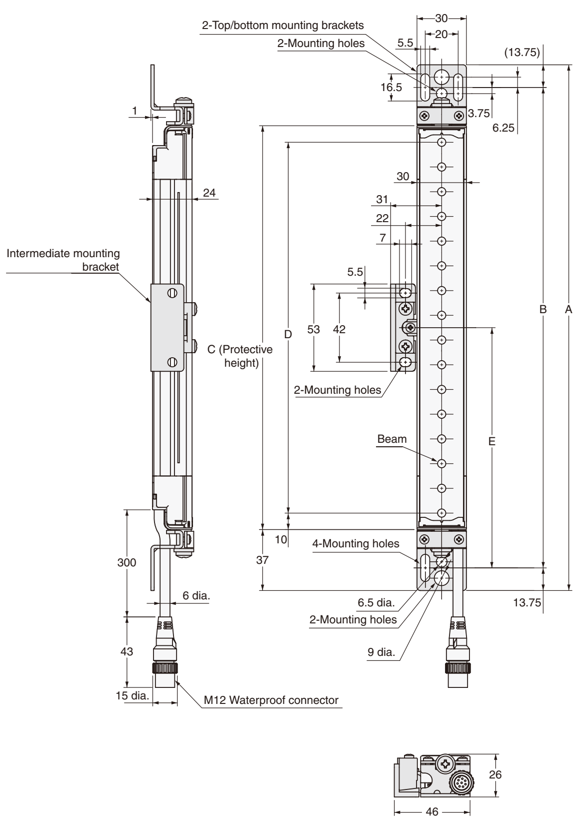
(Unit: mm)

Main Units

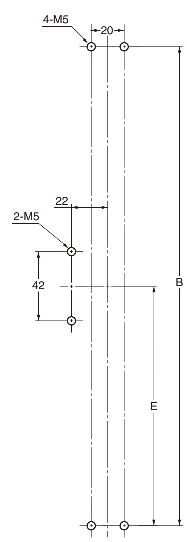
When Using Standard Mounting Brackets

Backside mounting





Mounting screw holes

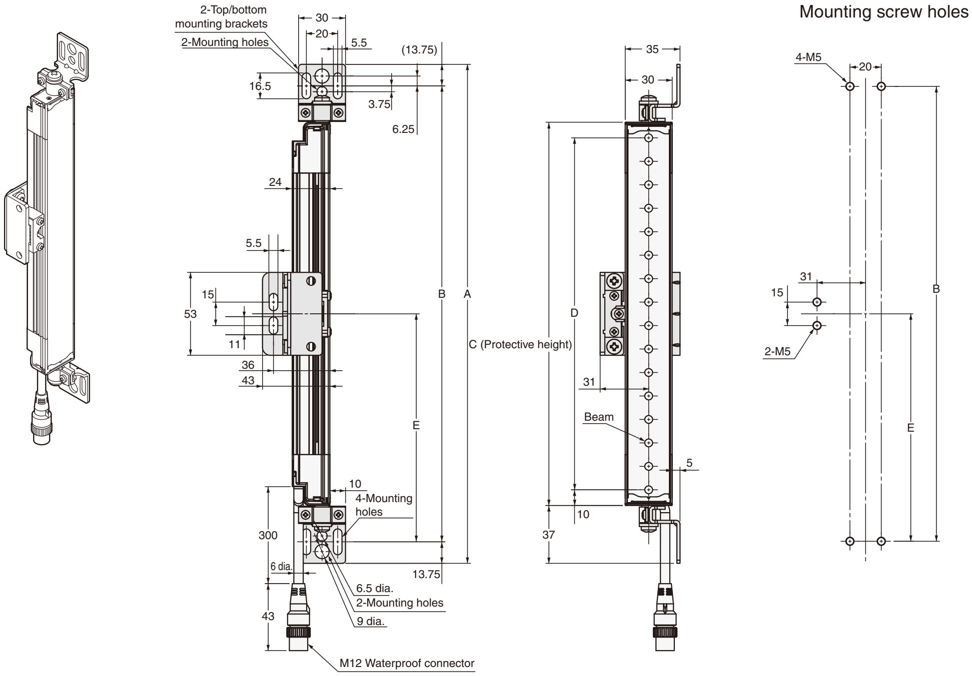


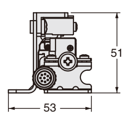
C (protective height): 4-digit number in the table
A = C + 74, B = C + 46.5
D = C - 20, E = See table below.

Protective height	Number of intermediate brackets	E *
0245 to 0596	0	---
0600 to 1130	1	E = B / 2
1136 to 1658	2	E = B / 3
1660 to 2180	3	E = B / 4
2195 to 2500	4	E = B / 5

* Use E = 530 or less when none of the E values shown above are used.

Side mounting



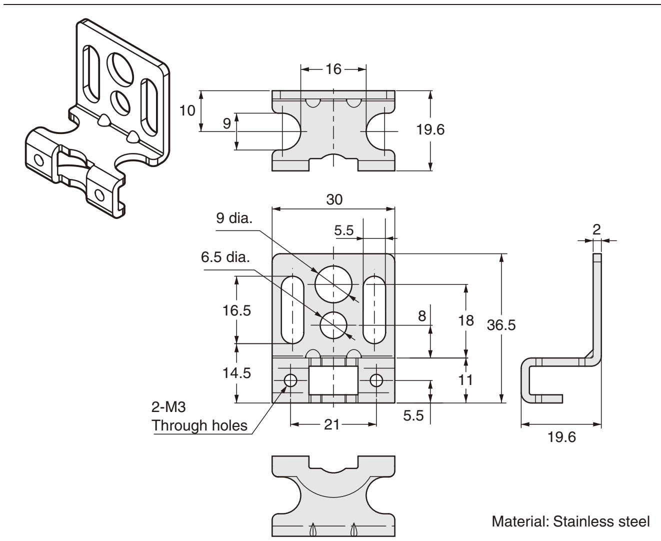


C (protective height): 4-digit number in the table
A = C + 74, B = C + 46.5
D = C - 20, E = See table below.

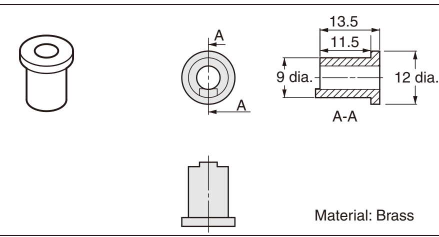
Protective height	Number of intermediate brackets	E *
0245 to 0596	0	---
0600 to 1130	1	E = B / 2
1136 to 1658	2	E = B / 3
1660 to 2180	3	E = B / 4
2195 to 2500	4	E = B / 5

* Use E = 530 or less when none of the E values shown above are used.

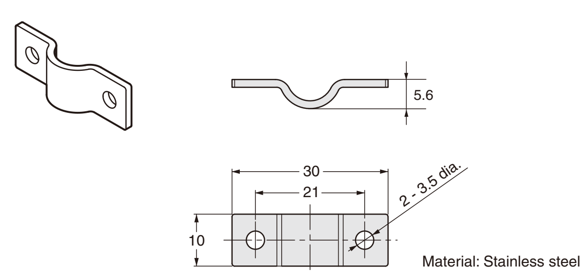
F39-LJ1 Detailed Dimensions of Bracket



Material: Stainless steel

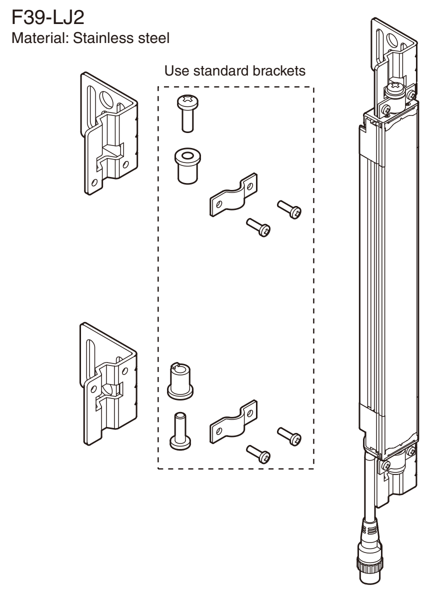


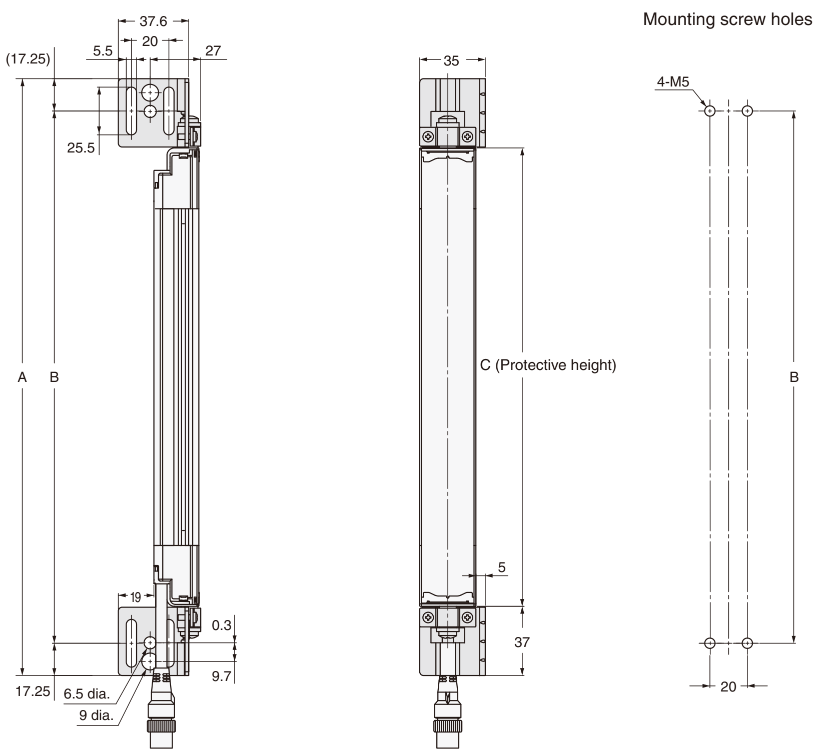
Material: Brass

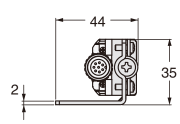


Material: Stainless steel

Using Side Flat Mounting Bracket (F39-LJ2)







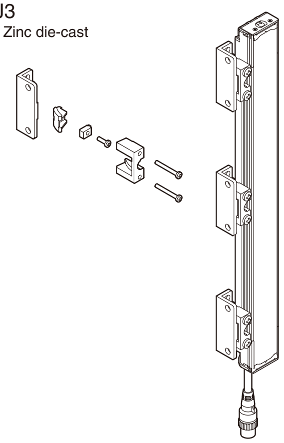
Dimensions A to C

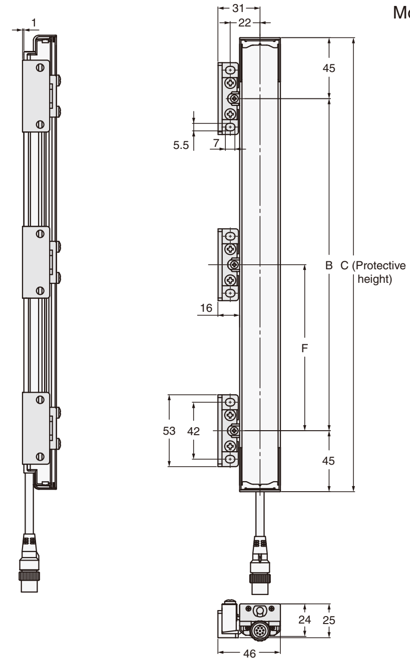
A	C + 74
B	C + 39.5
C	4-digit number of the model name (protective height)

Using Free Location Mounting Bracket (F39-LJ3)

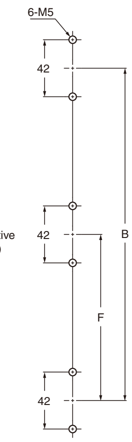
Backside mounting

F39-LJ3
Material: Zinc die-cast



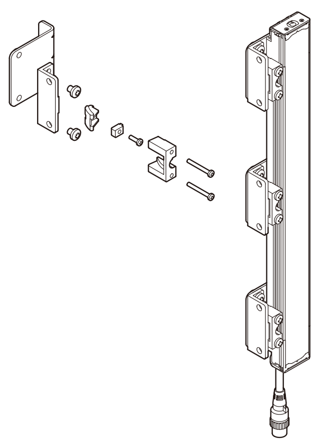


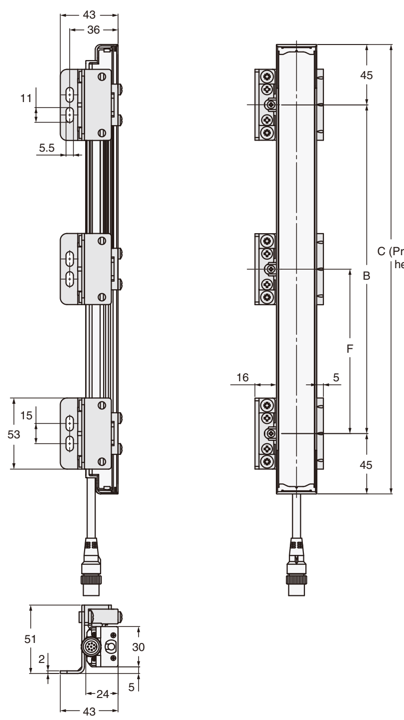
Mounting screw holes



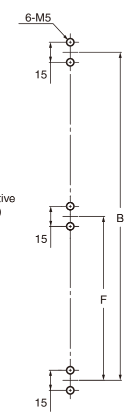
Side mounting

F39-LJ3
Material: Zinc die-cast/stainless





Mounting screw holes



Dimensions B, C, and F

B	C - 90
C	4-digit number of the model name (protective height)
F	Depends on the protective height. See the table on the right.

Dimension F

Protective height	Number of intermediate mounting brackets	F *
0245 to 0440	2	---
0443 to 0785	3	B / 2
0794 to 1140	4	B / 3
1145 to 1490	5	B / 4
1495 to 1840	6	B / 5
1845 to 2180	7	B / 6
2195 to 2500	8	B / 7

* Use F = 350 or less when none of the F values shown above are used.

When only F39-LJ3 free-location mounting brackets are used without standard brackets, allow a space of at least 350 mm between the brackets. The number of brackets required varies according to the protective height. For details about the number of required brackets, refer to the table below.
The standard included intermediate mounting brackets are the same as the F39-LJ3 free-location mounting brackets. Purchase brackets as necessary if there are fewer intermediate mounting brackets than required. When intermediate mounting brackets are included, they can be used as free-location mounting brackets.

Required number of F39-LJ3 free-location mounting brackets for 1 F3SJ set (emitter/receiver) (2 pieces are included with F39-LJ3)

Protective height	Number of included free location brackets as intermediate brackets	Number of free location brackets to mount F3SJ	Number of free location brackets to be purchased
0245 to 0440	0	4	2 sets
0443 to 0596	0	6	3 sets
0600 to 0785	2	6	2 sets
0794 to 1130	2	8	3 sets
1136 to 1140	4	8	2 sets
1145 to 1490	4	10	3 sets
1495 to 1658	4	12	4 sets
1660 to 1840	6	12	3 sets
1845 to 2180	6	14	4 sets
2195 to 2500	8	16	4 sets

Guide to Replacing F3SN Models with F3SJ Models

F3SN replacement correspondence table (F3SN mounting holes can be used without modification)

When replacing F3SN-□□□□P(N)14 with F3SJ-A□□□□P(N)14

(1) For F3SN models with a protective height of 225 mm max.

F3SN		Replacement F3SJ		Replacement method using F39-LJ5
Model	Protective height	Model	Protective height	
F3SN-□0153P(N)14	153	---	---	---
F3SN-□0180P(N)14	180	F3SJ-A0245P(N)14	245	Inward-facing mounting
F3SN-□0189P(N)14	189	F3SJ-A0245P(N)14	245	Inward-facing mounting
F3SN-□0198P(N)14	198	F3SJ-A0245P(N)14	245	Inward + outward-facing mounting
F3SN-□0207P(N)14	207	F3SJ-A0245P(N)14	245	Inward + outward-facing mounting
F3SN-□0216P(N)14	216	F3SJ-A0245P(N)14	245	Outward-facing mounting
F3SN-□0225P(N)14	225	F3SJ-A0245P(N)14	245	Outward-facing mounting

(2) For F3SN models with a protective height of 234 mm min.

Add 11 to the F3SN's 4-digit number and apply it as the F3SJ's 4-digit number, and then replace with the standard brackets included with the product.
[Selection example] F3SN-A0315P(N)14 becomes F3SJ-A0326P(N)14 (replace with standard brackets)

Note: 1. The protective height becomes 11 mm longer.
2. Replace with outward-facing mounting of F39-LJ5 when you want to set the detection surface height to be same as the F3SN. However, the F39-LJ5 and intermediate mounting brackets cannot be mounted simultaneously, so set the protective height to 600 mm or less.

When replacing F3SN-□□□□P (N)25 with F3SJ-A□□□□P (N)20

(1) For F3SN models with a protective height of 247 mm max.

F3SN		Replacement F3SJ		Replacement method using F39-LJ5
Model	Protective height	Model	Protective height	
F3SN-□0187P(N)25	187	---	---	---
F3SN-□0217P(N)25	217	F3SJ-A0260P(N)20	260	Inward-facing mounting
F3SN-□0232P(N)25	232	F3SJ-A0260P(N)20	260	Inward + outward-facing mounting
F3SN-□0247P(N)25	247	F3SJ-A0245P(N)20	245	Outward-facing mounting

(2) For F3SN models with a protective height of 262 mm min.

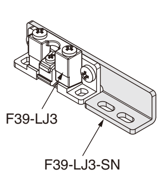
Subtract 17 from the F3SN's 4-digit number and apply it as the F3SJ's 4-digit number, and then replace with the standard brackets included with the product.
[Selection example] F3SN-A0322P(N)25 becomes F3SJ-A0305P(N)20 (replace with standard brackets)

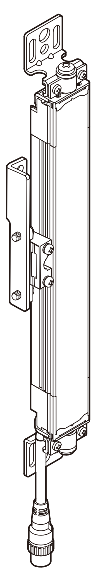
Note: 1. The protective height gets 17 mm shorter.
2. Replace with outward-facing mounting of F39-LJ5 when you want to set the detection surface height to be same as the F3SN. However, the F39-LJ5 and intermediate mounting brackets cannot be mounted simultaneously, so set the protective height to 600 mm or less.

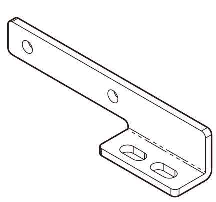
When using intermediate mounting brackets to replace a rear mounted F3SN with an F3SJ

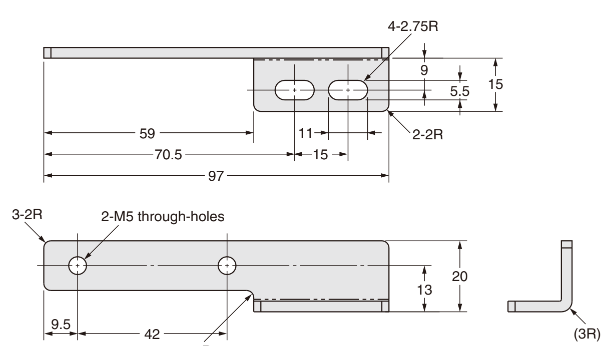
Because the pitch of the mounting holes for the intermediate mounting brackets are different (F3SN: 15 mm, F3SJ: 42 mm), use F39-LJ3-SN Spacers for F3SN intermediate mounting bracket replacement.

F39-LJ3-SN
Material: Stainless steel



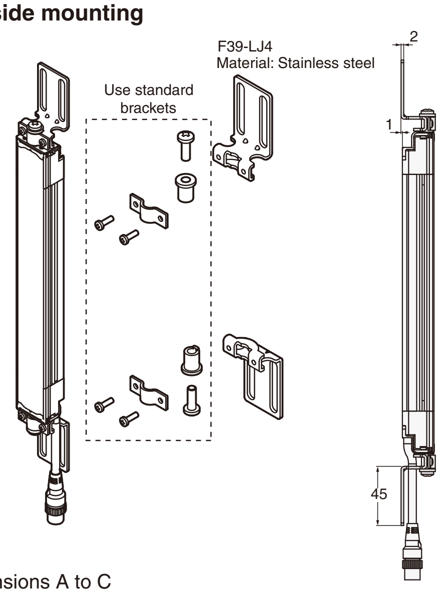


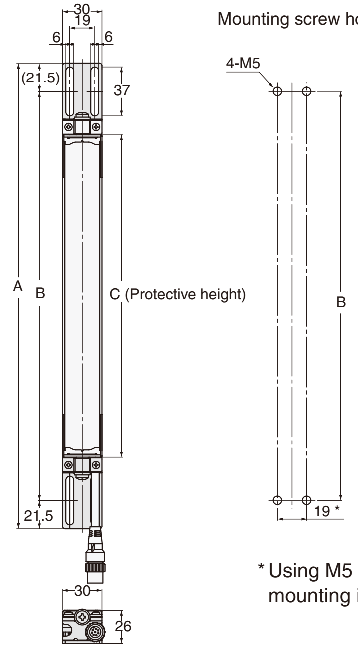




Using Top/Bottom Mounting Bracket B (F39-LJ4)

Backside mounting





* Using M5 bolt, available range for mounting is 18 to 20.

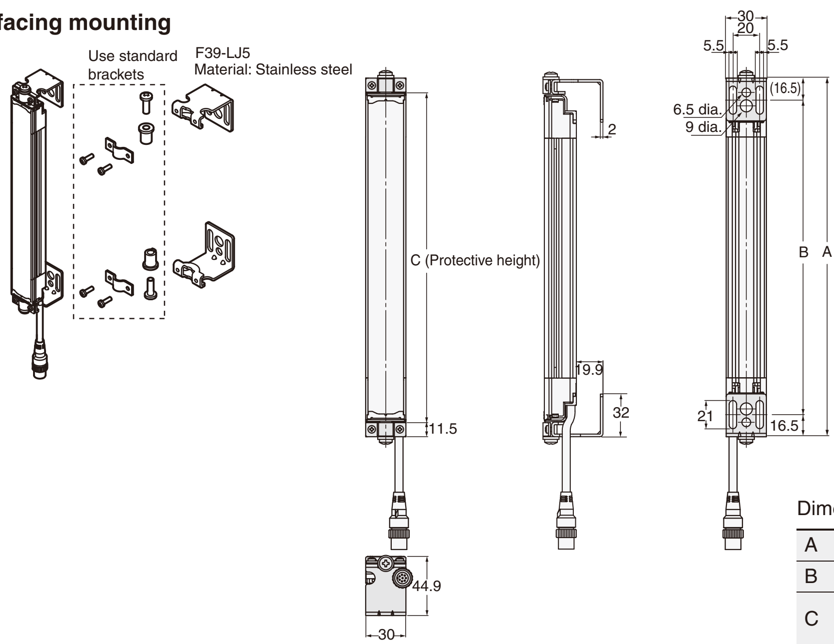
Dimensions A to C

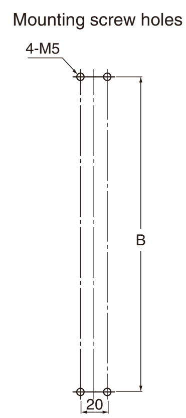
A	C + 109
B	C + 66
C	4-digit number of the model name (protective height)

Note: Refer to the *User's Manual* (Cat. No. SCHG-718 and SCHG-719) for the dimensions for side mounting.

Using Mounting Bracket for Short-length F3SN (F39-LJ5)

Inward-facing mounting

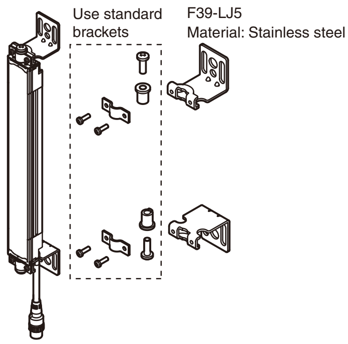


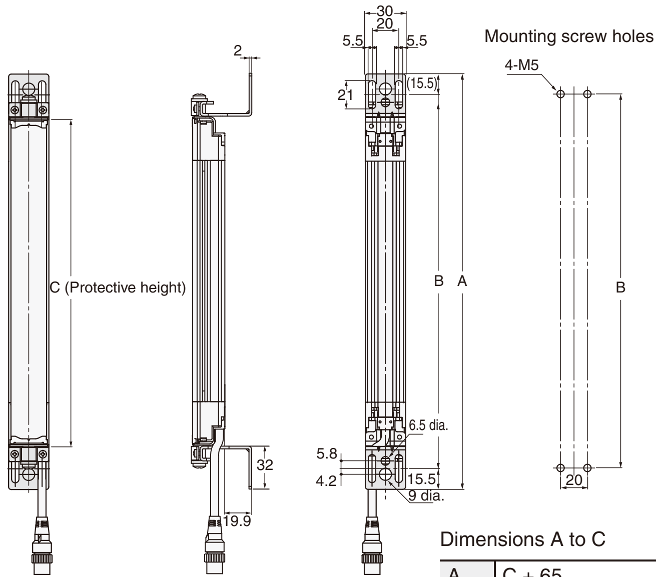


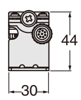
Dimensions A to C

A	C + 23
B	C – 10
C	4-digit number of the model name (protective height)

Outward-facing mounting



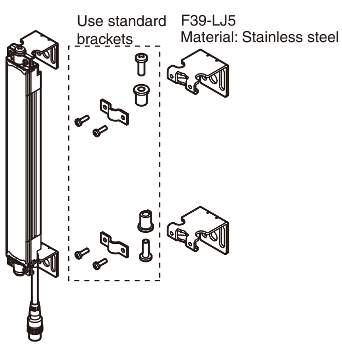


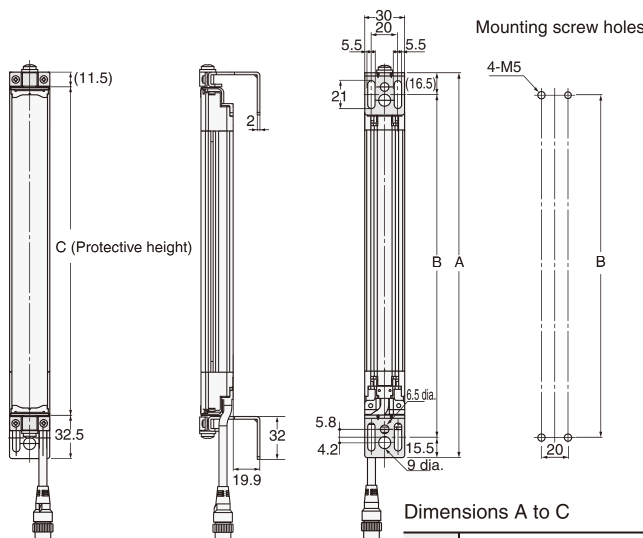


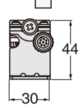
Dimensions A to C

A	C + 65
B	C + 34
C	4-digit number of the model name (protective height)

Inward + outward-facing mounting







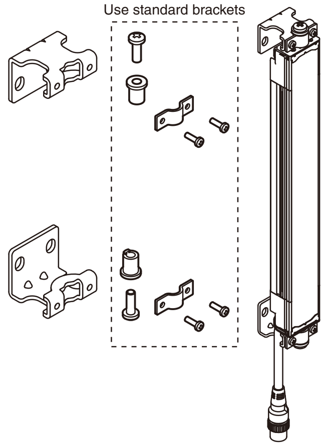
Dimensions A to C

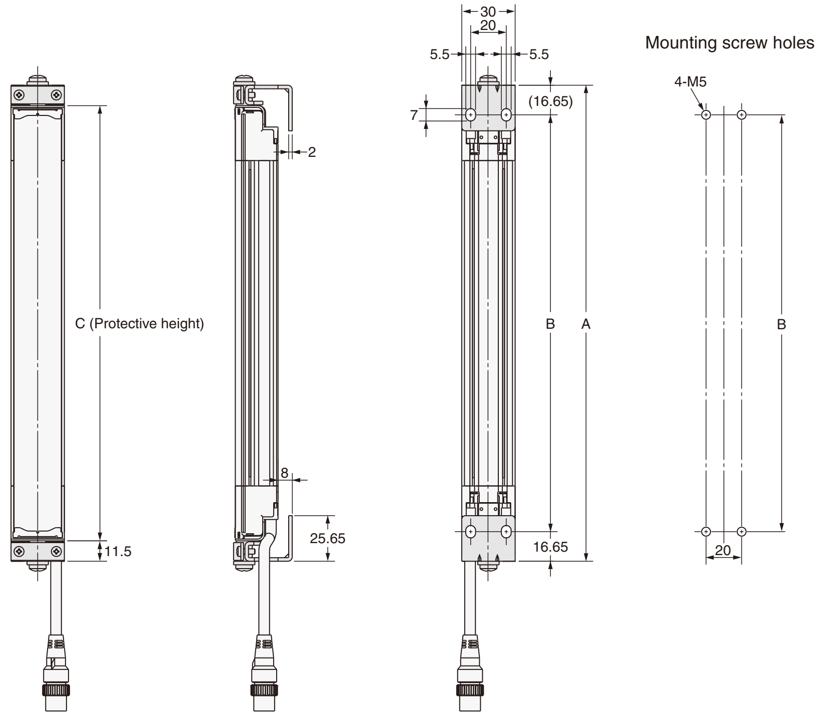
A	C + 44
B	C + 12
C	4-digit number of the model name (protective height)

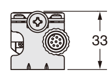
Using Space-saving Mounting Bracket (F39-LJ8)

Backside mounting

F39-LJ8
Material: Stainless steel







Dimensions A to C

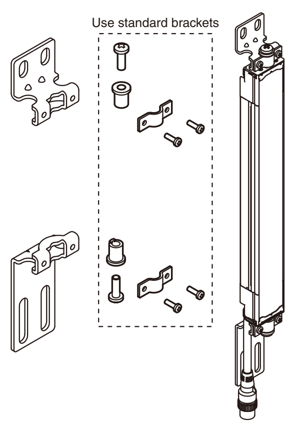
A	C + 23
B	C – 10.3
C	4-digit number of the model name (protective height)

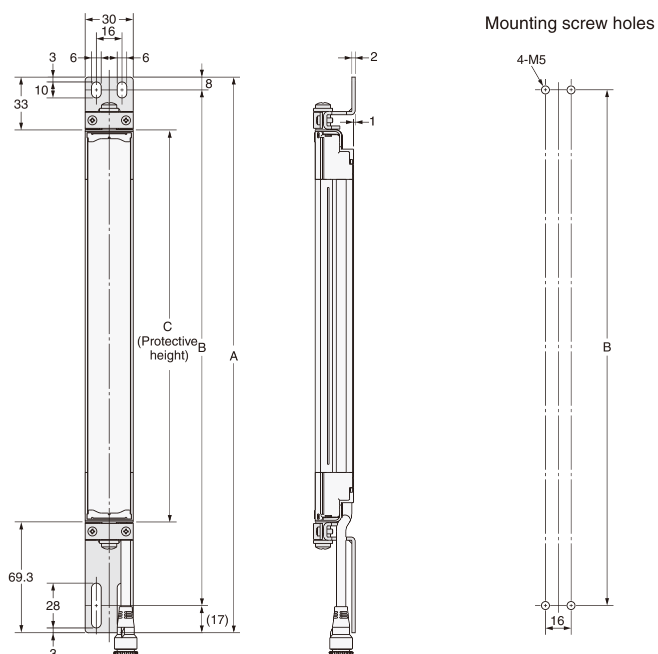
Note: Because the F39-LJ8 cannot be mounted together with an intermediate bracket, keep the protective height at 600 mm max.

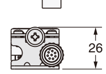
Mounting Bracket (F39-LJ9) Used when Replacing an F3W-C.

Backside mounting

F39-LJ9
Material: Stainless steel







Dimensions A to C

A	C + 102.3
B	C + 77.3
C	4-digit number of the model name (protective height)

Note: Refer to the *User's Manual* (Cat. No. SCHG-718 and SCHG-719) for the dimensions for side mounting.

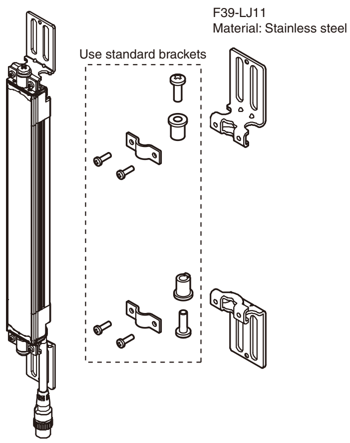
F3W-C replacement correspondence table (F3W-C mounting holes can be used without modification)

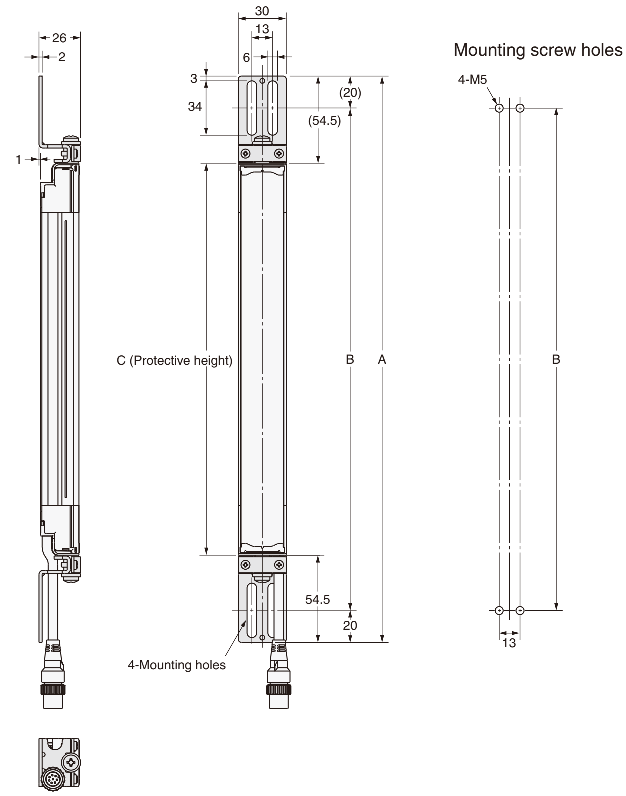
When replacing F3W-C□□□ with F3SJ-A□□□□□30

F3W-C		Replacement F3SJ	
Model	Protective height	Model	Protective height
F3W-C044	120	---	---
F3W-C084	280	F3SJ-A0320□30	320
F3W-C124	440	F3SJ-A0470□30	470
F3W-C164	600	F3SJ-A0620□30 *	620
F3W-C204	760	F3SJ-A0795□30 *	795
F3W-C244	920	F3SJ-A0945□30 *	945

* New holes must be drilled for the intermediate bracket.

Using Top/Bottom Mounting Bracket C (F39-LJ11)





Dimensions A to C

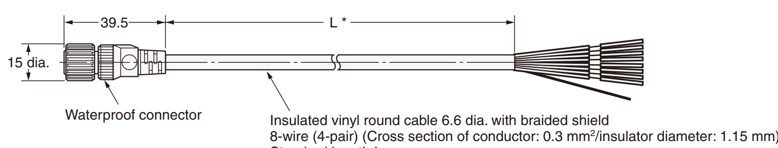
A	C + 109
B	C + 69
C	4-digit number of the model name (protective height)

Accessories

Single-end Connector Cable

F39-JC3A (L = 3 m)
F39-JC7A (L = 7 m)
F39-JC10A (L = 10 m)
F39-JC15A (L = 15 m)
F39-JC20A (L = 20 m)

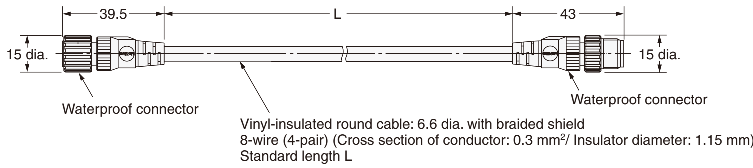
Color: Emitter (gray)
Receiver (black)



* Cables with L=3, 7, 10, 15, and 20 m are available.

Cables with Connectors on Both Ends

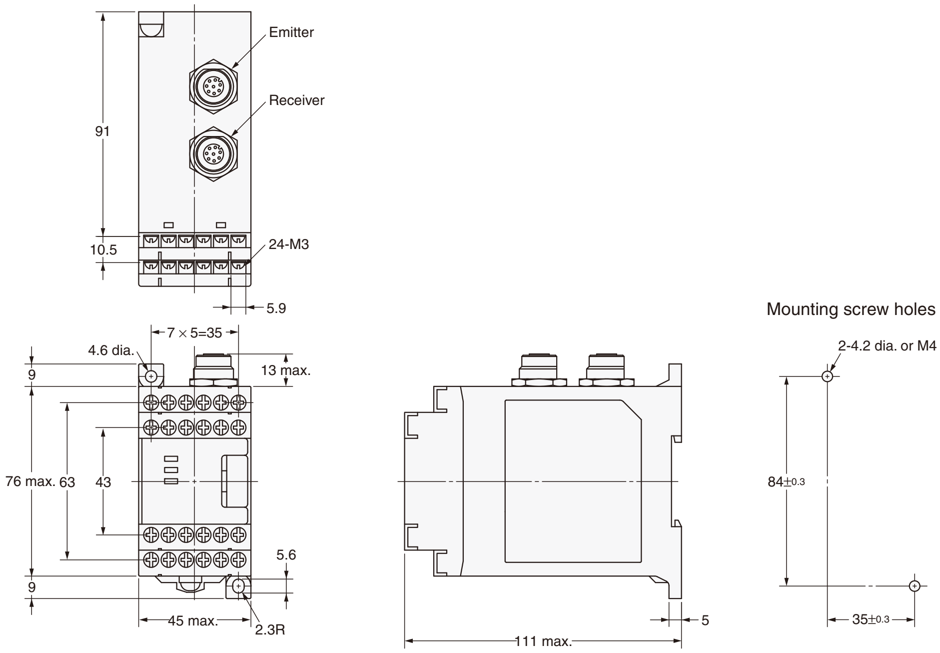
F39-JCR5B (L = 0.5 m) **F39-JC7B (L = 7 m)**
F39-JC1B (L = 1 m) **F39-JC10B (L = 10 m)**
F39-JC3B (L = 3 m) **F39-JC15B (L = 15 m)**
F39-JC5B (L = 5 m) **F39-JC20B (L = 20 m)**



Color: Emitter (gray)
Receiver (black)

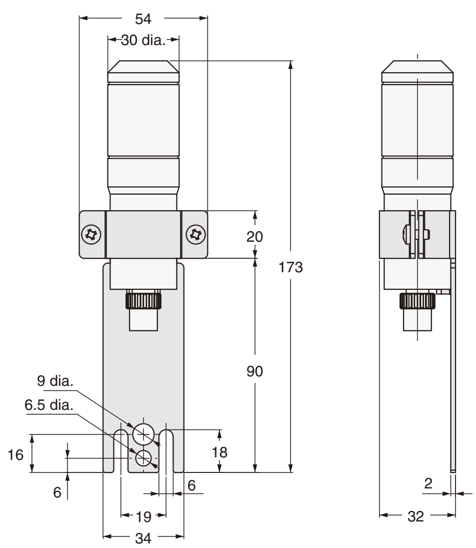
Control Unit

F3SP-B1P



Dedicated External Indicator Set

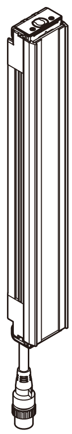
F39-A01□-PAC

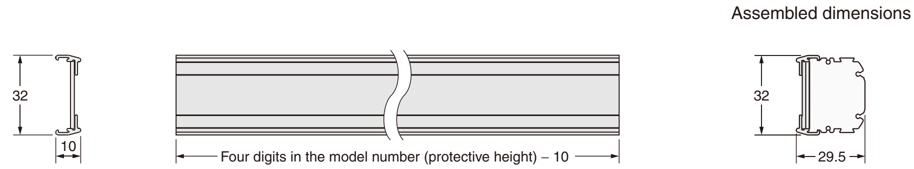


Material: Stainless steel

Spatter Protection Cover

F39-HJ□□□□

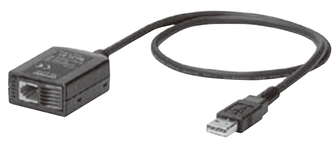


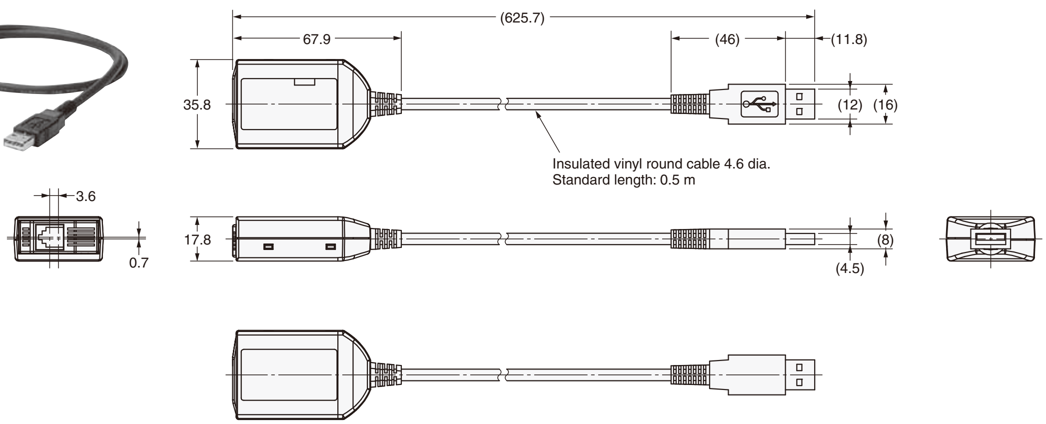


Material: polycarbonate (for the protective cover)

Setting Support Software for the F3SJ

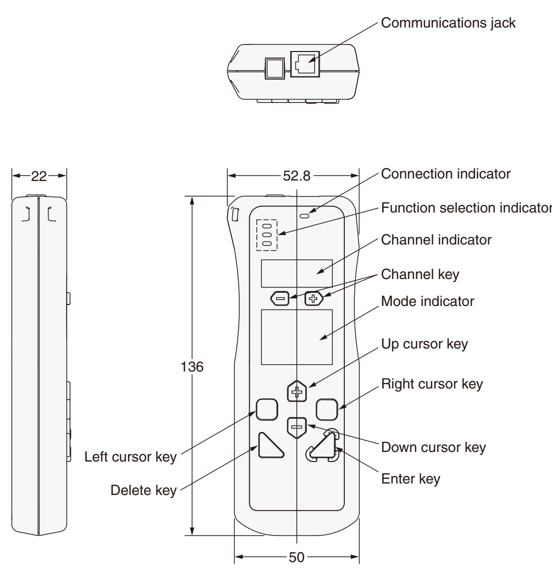
F39-GWUM





Setting Console

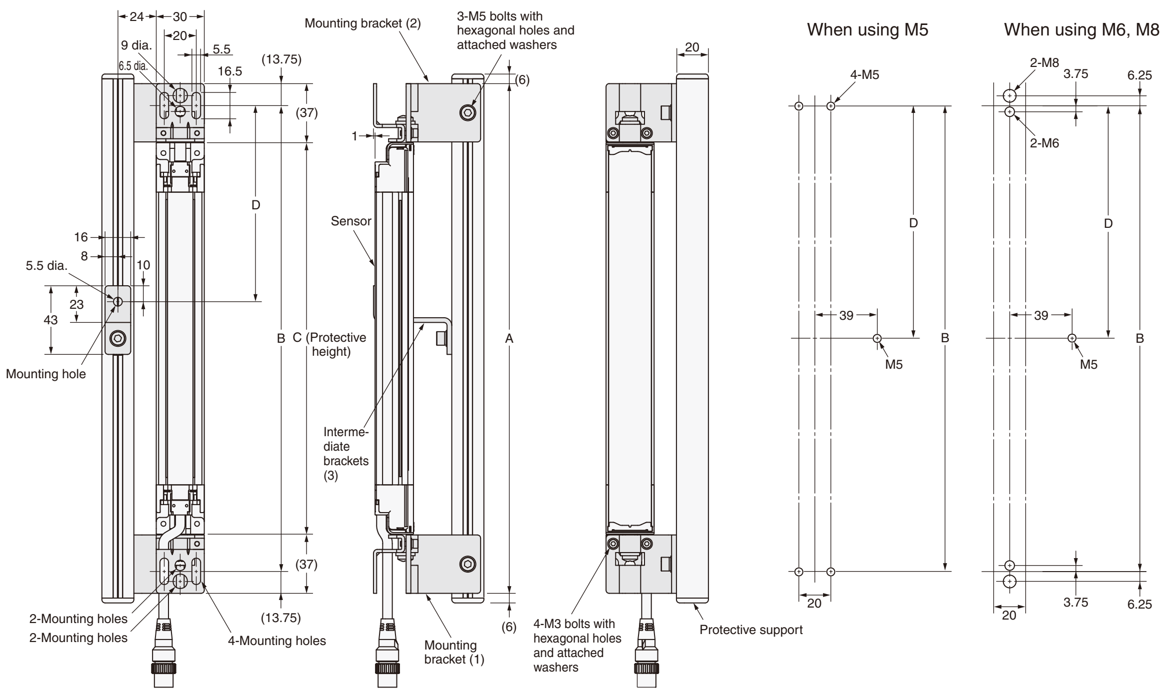
F39-MC21

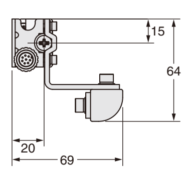


Protective Bar

F39-PJ□□□□-S
Backside mounting

Mounting screw holes



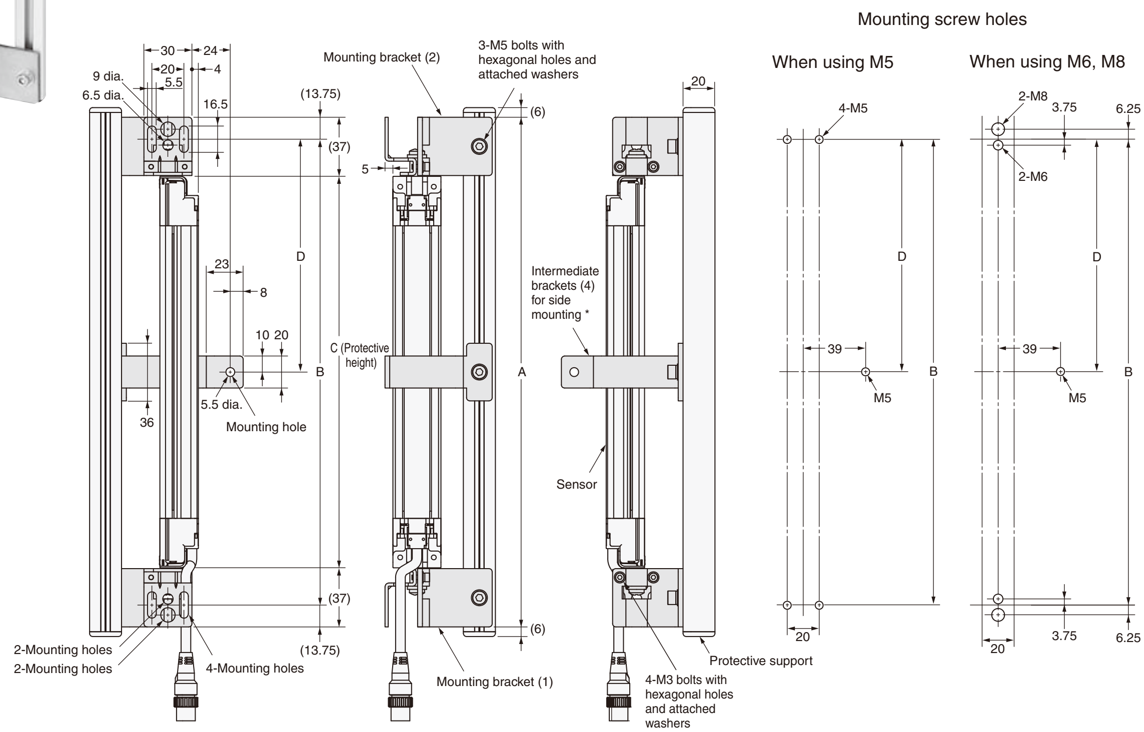


C (protective height): 4-digit number in the table
A = C + 74, B = C + 46.5

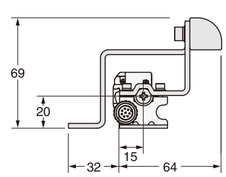
Protective height	Number of intermediate brackets used (3)	D
0245 to 0995	0	---
1001 to 2000	1	B/2
2009 to 2500	2	B/3

Note: For reference, D is the dimension that will not interfere with the intermediate bracket on the Safety Light Curtain body.

Side mounting



* The four intermediate brackets (F39-PJ-MS) for side mounting are not provided.



C (protective height): 4-digit number in the table
A = C + 74, B = C + 46.5

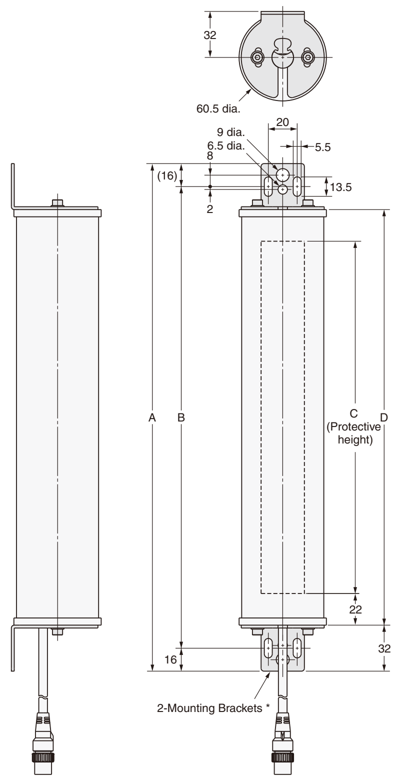
Protective height	Number of protective brackets used (4)	D
0245 to 0995	0	---
1001 to 2000	1	B/2
2009 to 2500	2	B/3

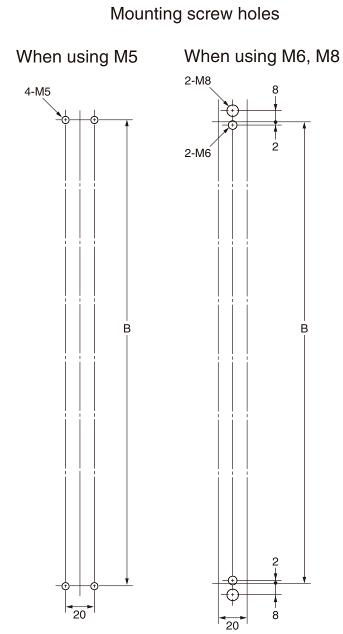
Note: For reference, D is the dimension that will not interfere with the intermediate bracket on the Safety Light Curtain body.

Water-resistant Case

F39-EJ□□□□-L(D)

Backside mounting



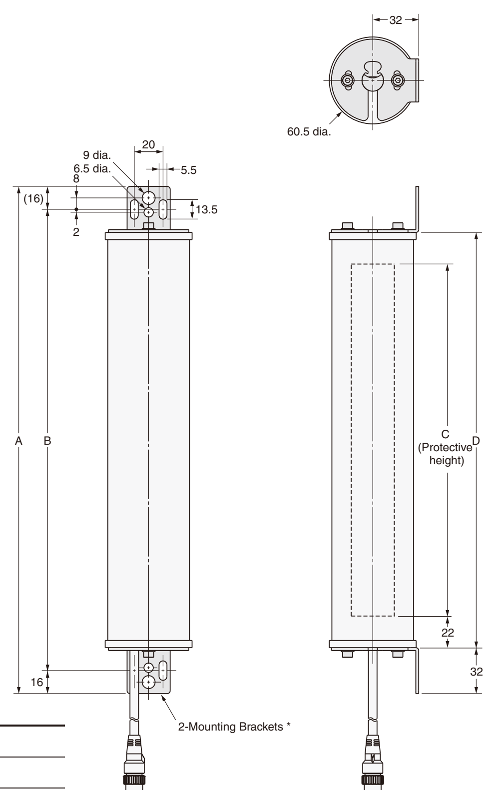


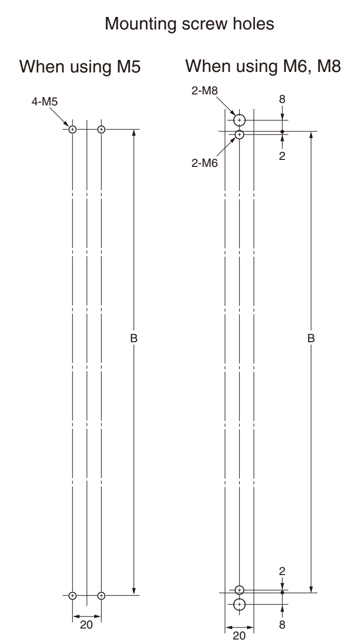
Dimensions A to D

A	C + 108
B	C + 76
C	4-digit number of the model name (protective height)
D	C + 44

* The Mounting Brackets (F39-EJ-R) are sold separately.

Side mounting





Dimensions A to D

A	C + 108
B	C + 76
C	4-digit number of the model name (protective height)
D	C + 44

* The Mounting Brackets (F39-EJ-S) are sold separately.

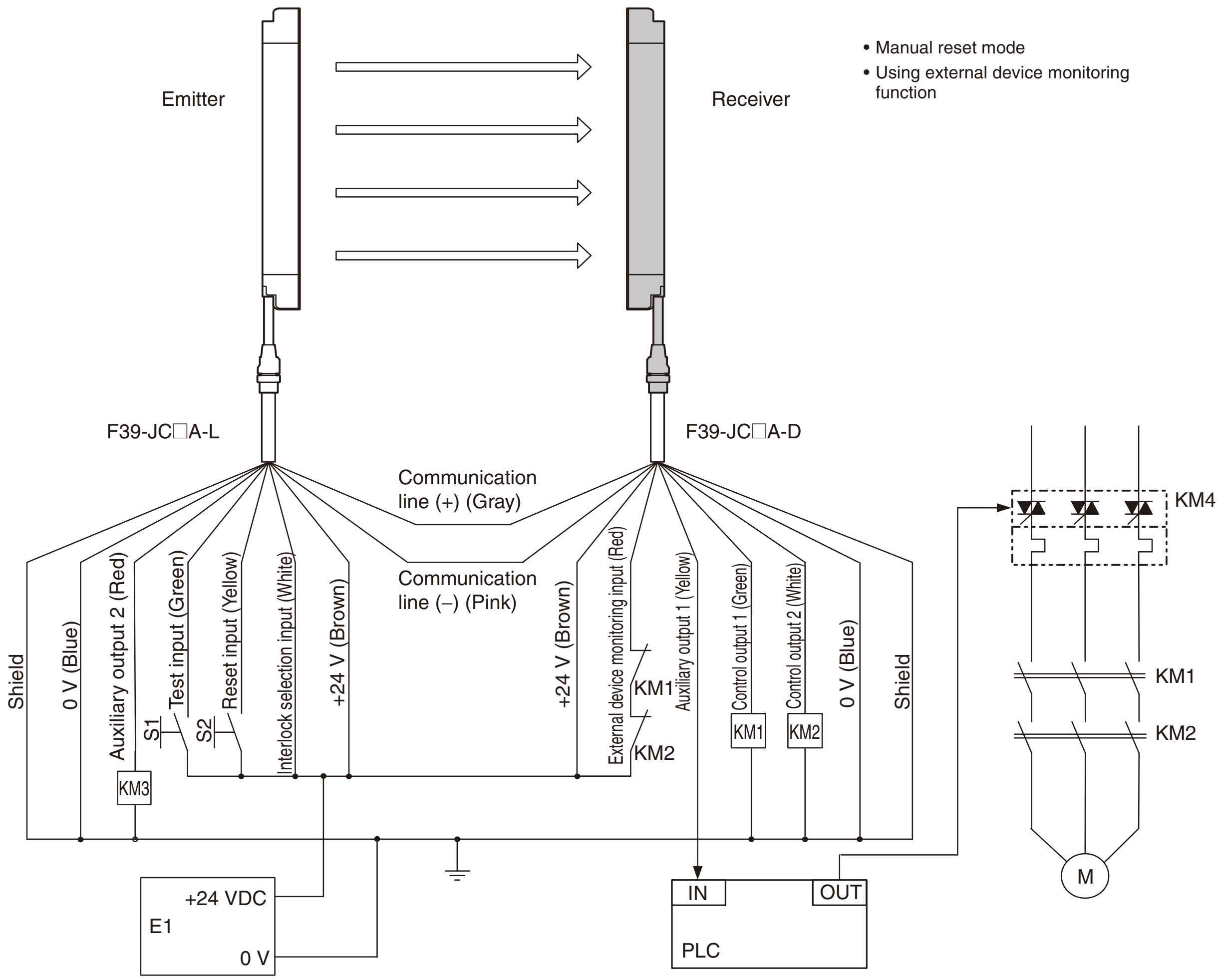
Connection Circuit Examples

Examples of Safety Circuits

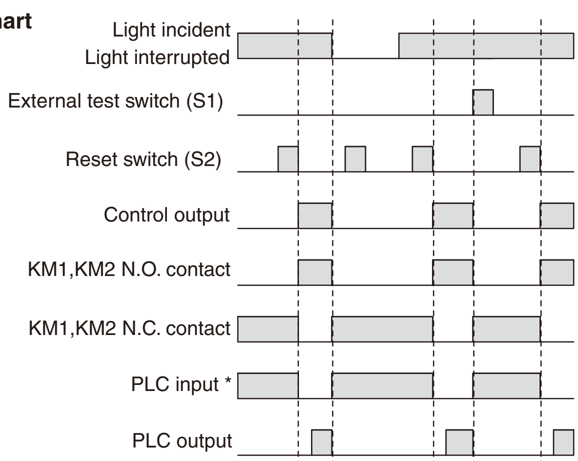
For PNP output (See page 55 for NPN output wiring.)

Wiring for single F3SJ application (category 4)

- Use of welded relay contact detection and interlock is possible without a controller or relay unit.



Timing Chart

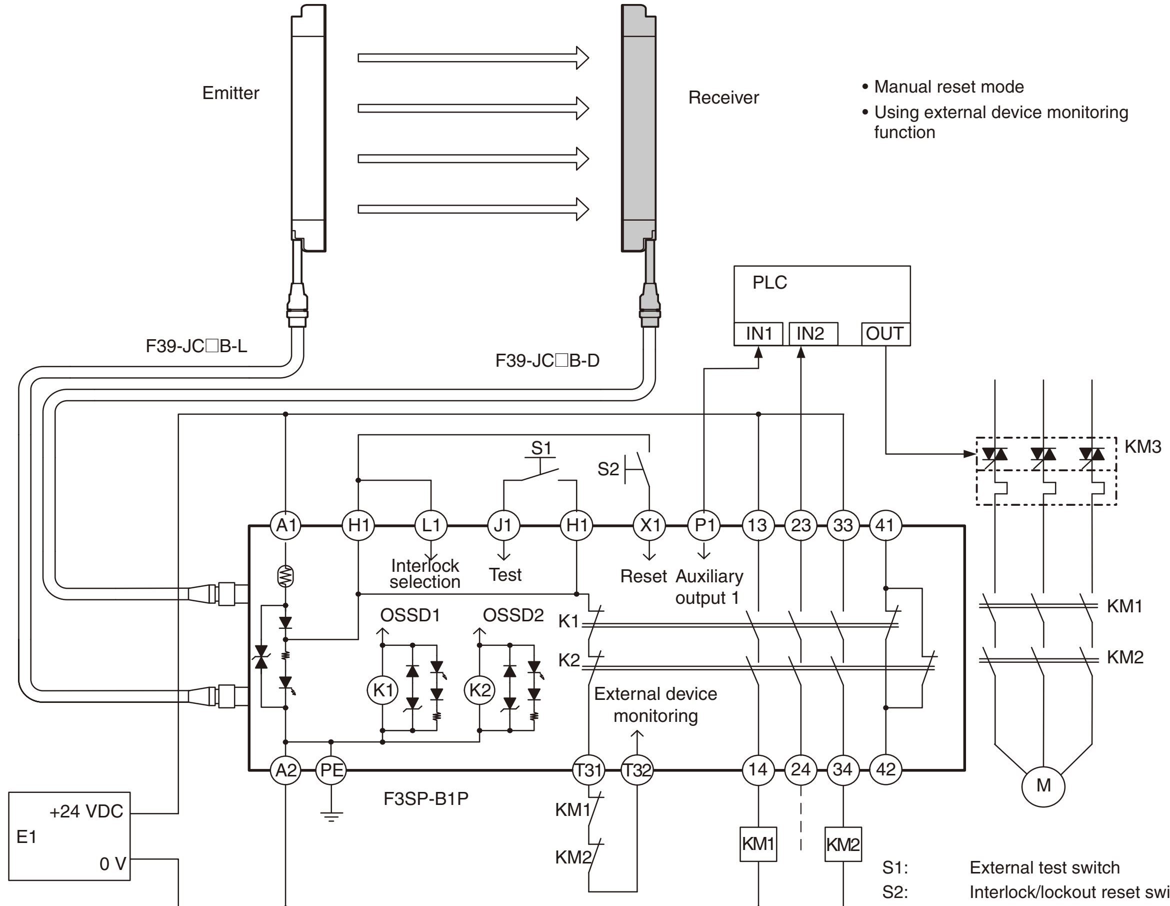


* The output operation mode for auxiliary output 1 is control output data/inverse of control output signals enabled (default setting).

S1:	External test switch (connect to 0 V if the switch is not necessary.)
S2:	Interlock/lockout reset switch
KM1, KM2:	Safety relay with forcibly-guided contacts (G7SA) or magnetic contactor
KM3:	Load, PLC (for monitor)
KM4:	Solid state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring -- not related to safety system)

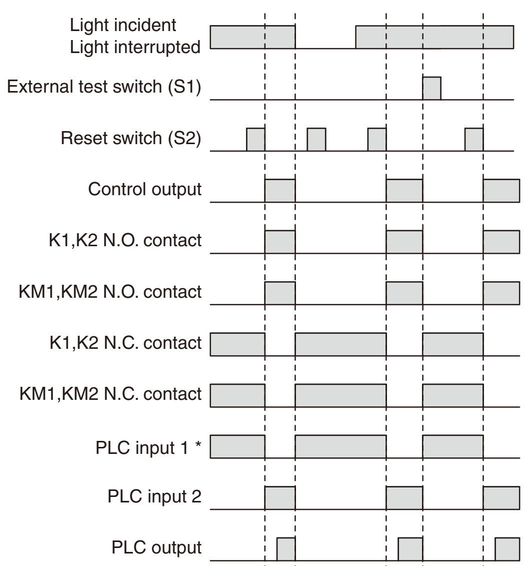
Wiring for connection with a controller F3SP-B1P (category 4) (PNP models only)

- Reduced wiring due to connector connection
- Safety relay included

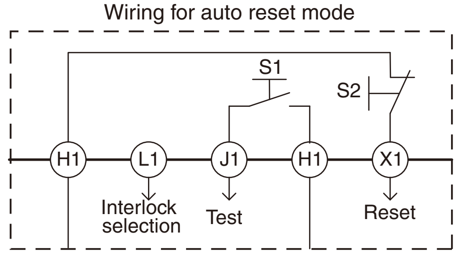


S1: External test switch
S2: Interlock/lockout reset switch
KM1, KM2: Magnetic contactor
KM3: Solid state contactor (G3J)
M: 3-phase motor
E1: 24 VDC power supply (S82K)
PLC: Programmable controller (Used for monitoring -- not related to safety system)

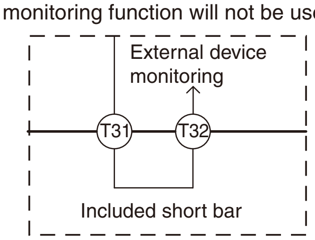
Timing Chart



Wiring for auto reset mode



Wiring when the external device monitoring function will not be used



*The output operation mode for auxiliary output 1 is control output data/inverse of control output signals enabled (default setting).

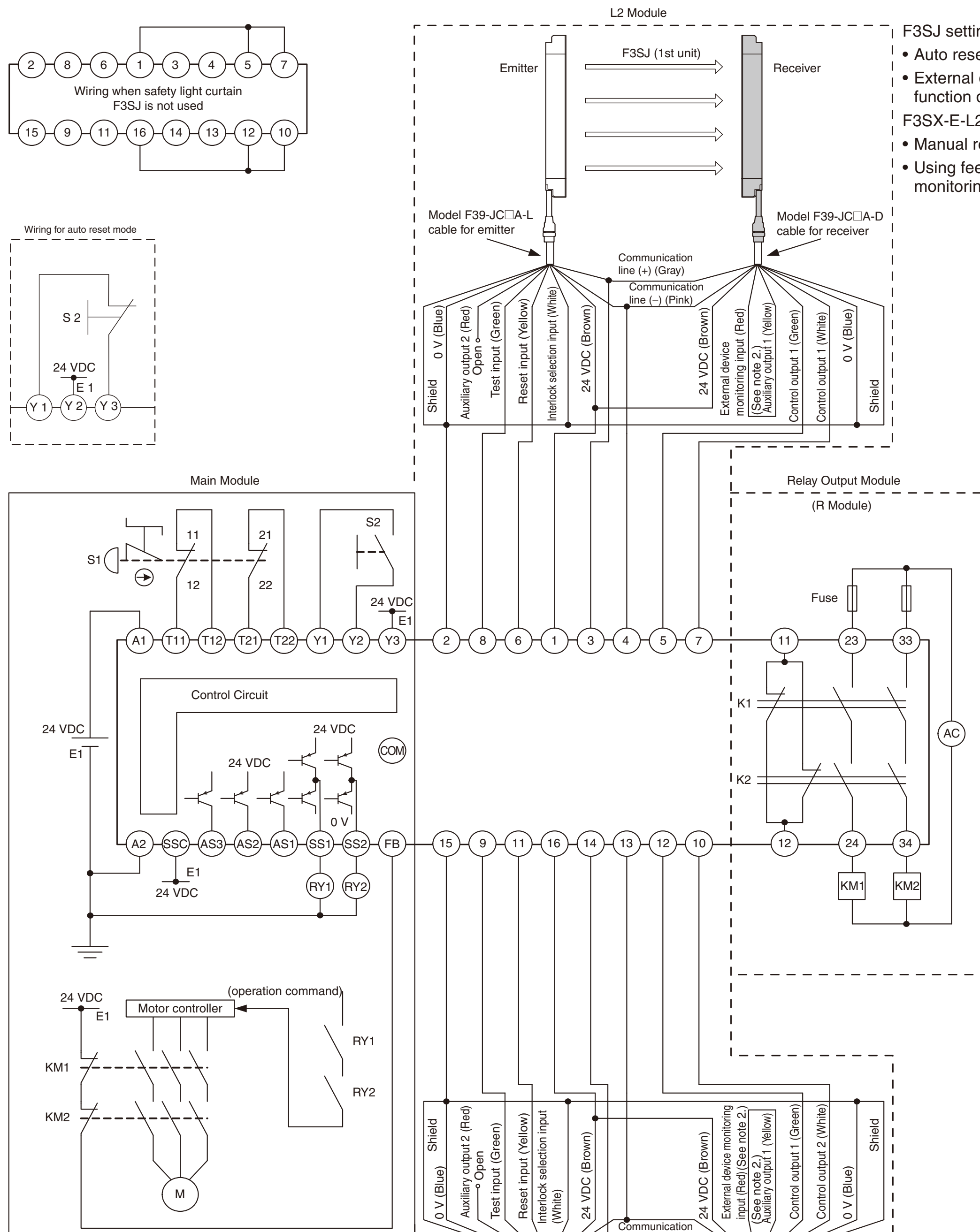
Note: When the F3SP-B1P is used, the system cannot be used as a muting system.

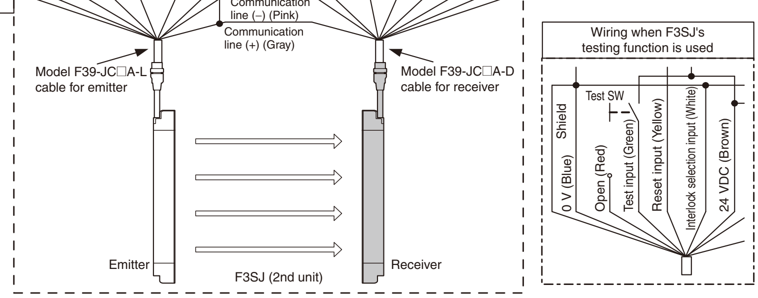
Wiring for connection with a controller F3SX-E-L2R (category 4) (PNP models only)

- Emergency stop switch can be connected.
- Door switch, two hand control, single beam, or relay unit can be used in combination with F3SX.
- Various settings can be changed and input/output terminals can be monitored using the setting support software for F3SX.

F3SJ settings
- Auto reset mode
- External device monitoring function disabled

F3SX-E-L2R settings
- Manual reset mode
- Using feedback time monitoring function

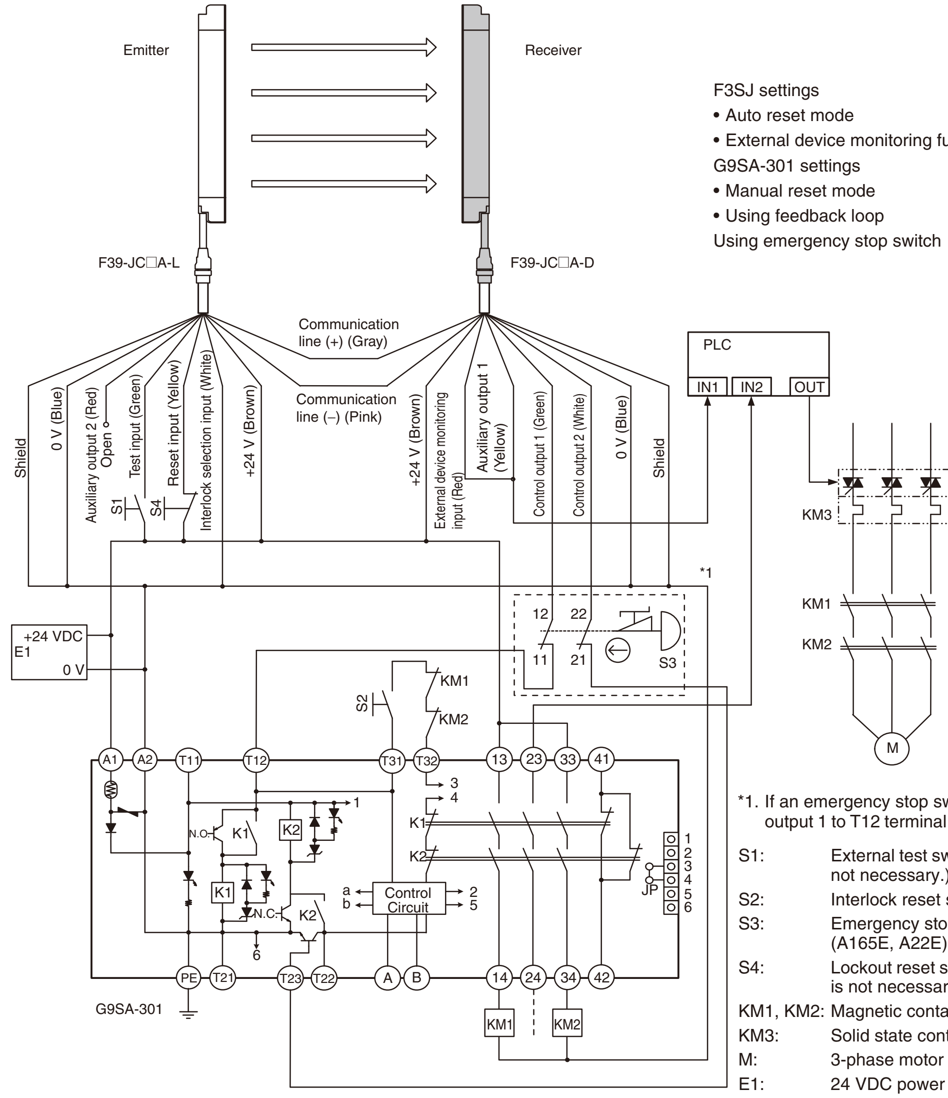




S1: Emergency stop switch (direct opening contacts)(A165E, A22E)
S2: Reset switch
KM1, KM2: Magnetic contactor (LC1D)
RY1, RY2: Relay
M: 3-phase motor
E1: 24 VDC power supply (S82K)

Note:
1. This wiring example is for category 4.
2. This example shows the connection when auxiliary output 1 is in the standard setting (ON when light is interrupted).
3. When the F3SJ is series-connected, or 5 or more sets are connected to the total system of F3SX, power must be supplied to F3SJ from external source. For details, see instruction manual of F3SX.

Wiring for connection with a controller G9SA-301 (category 4) (PNP models only)



F3SJ settings
- Auto reset mode
- External device monitoring function disabled

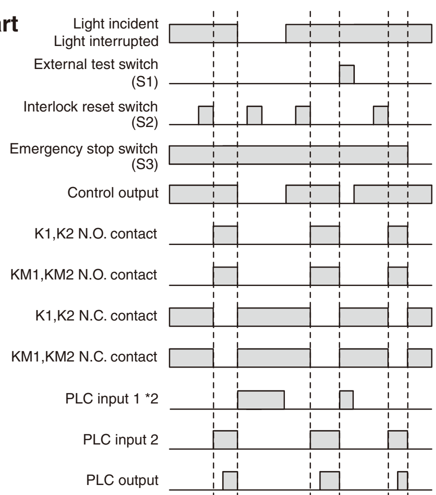
G9SA-301 settings
- Manual reset mode
- Using feedback loop

Using emergency stop switch

*1. If an emergency stop switch is not used, connect control output 1 to T12 terminal and control output 2 to T23 directly.

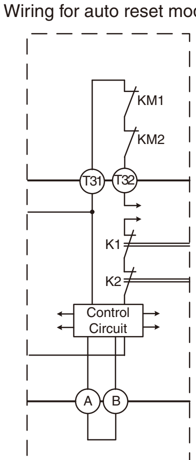
S1:	External test switch (connect to 0 V if the switch is not necessary.)
S2:	Interlock reset switch
S3:	Emergency stop switch (direct opening contacts) (A165E, A22E)
S4:	Lockout reset switch (connect to 24 V if the switch is not necessary.)
KM1, KM2:	Magnetic contactor
KM3:	Solid state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring -- not related to safety system)

Timing Chart



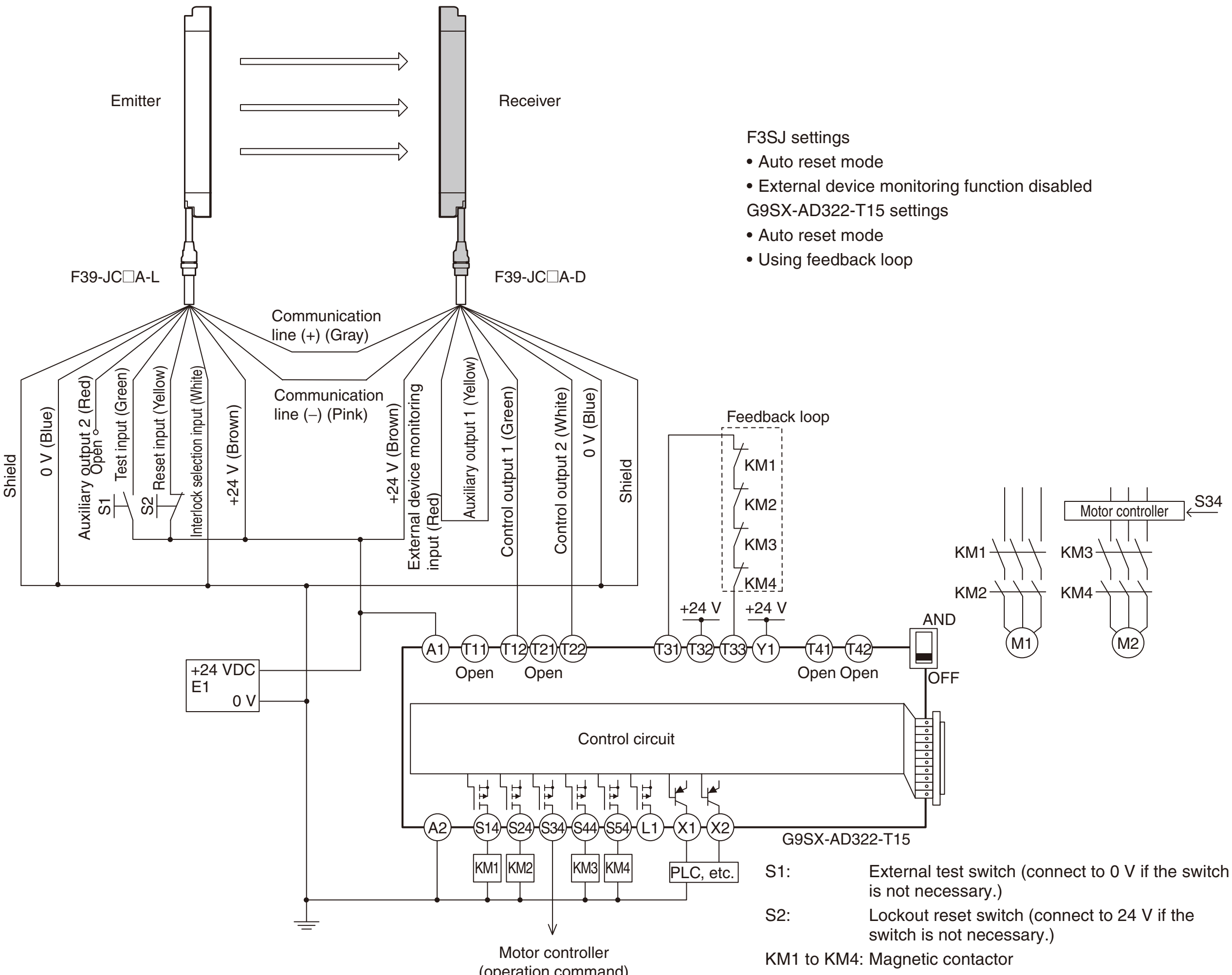
*2. The output operation mode for auxiliary output 1 is control output data/inverse of control output signals enabled (default setting).

Wiring for auto reset mode



Wiring for connection with a controller G9SX-AD322-T15 (category 4) (PNP models only)

- Can be configured for partial control and total control.
- Can be extended to connect a door switch or a relay unit.

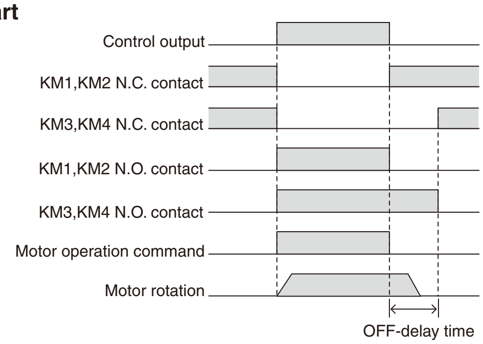


F3SJ settings
- Auto reset mode
- External device monitoring function disabled

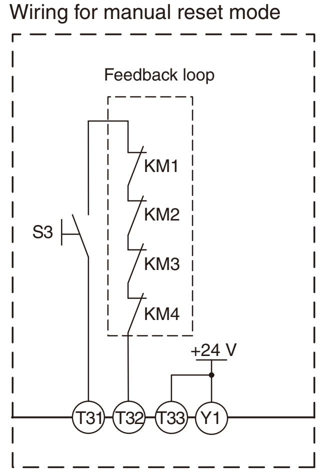
G9SX-AD322-T15 settings
- Auto reset mode
- Using feedback loop

S1:	External test switch (connect to 0 V if the switch is not necessary.)
S2:	Lockout reset switch (connect to 24 V if the switch is not necessary.)
KM1 to KM4:	Magnetic contactor
M1, M2:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring -- not related to safety system)

Timing Chart



Wiring for manual reset mode

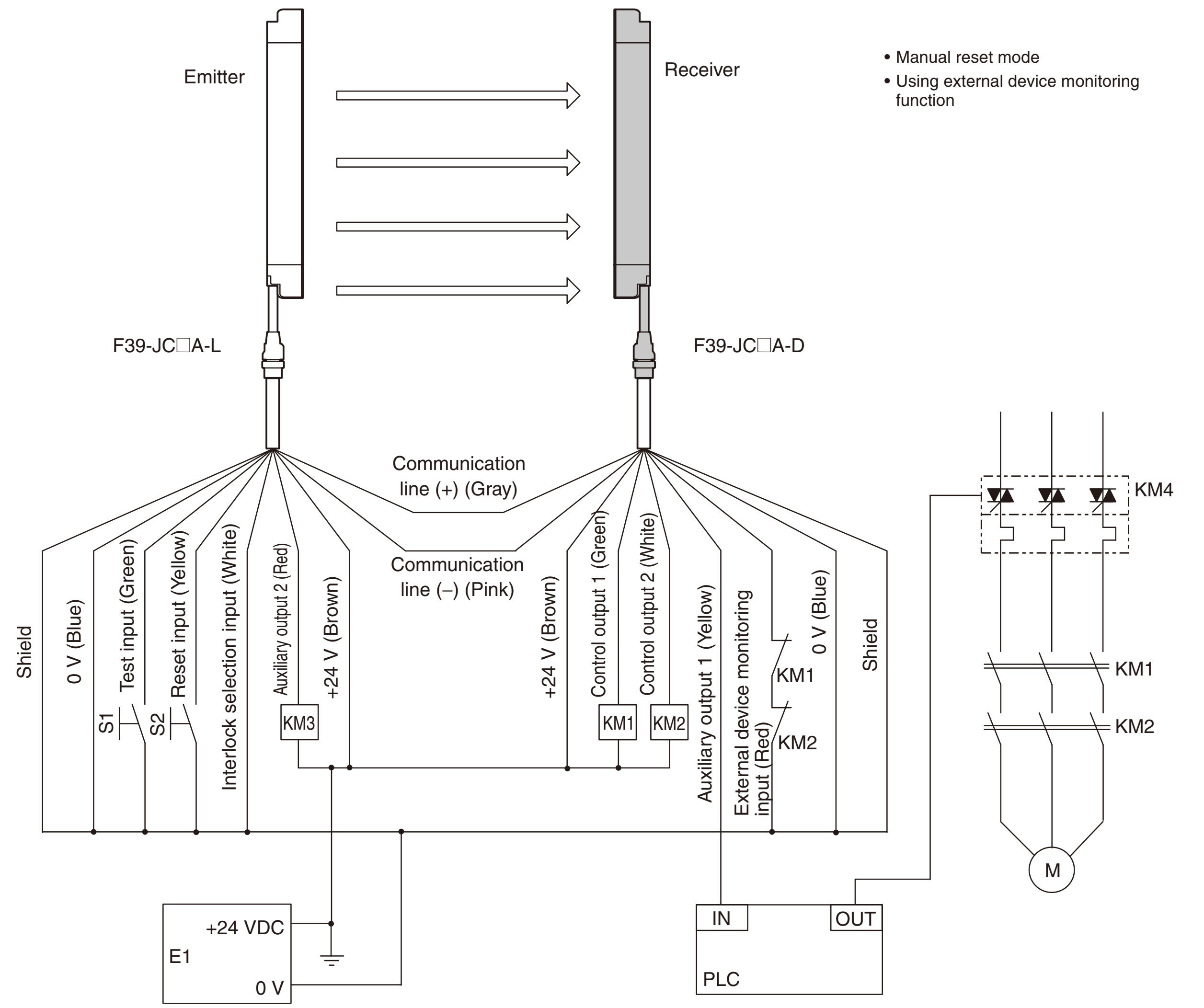


S3: Reset switch

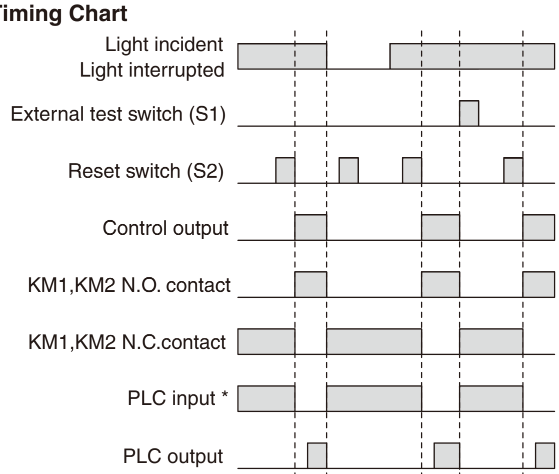
For NPN output (See page 50 for PNP output wiring.)

Wiring for single F3SJ application (category 4)

- Use of relay welded relay contact detection and interlock is possible without a controller or relay unit.



Timing Chart



* The output operation mode for auxiliary output 1 is control output data/ inverse of control output signals enabled (default setting).

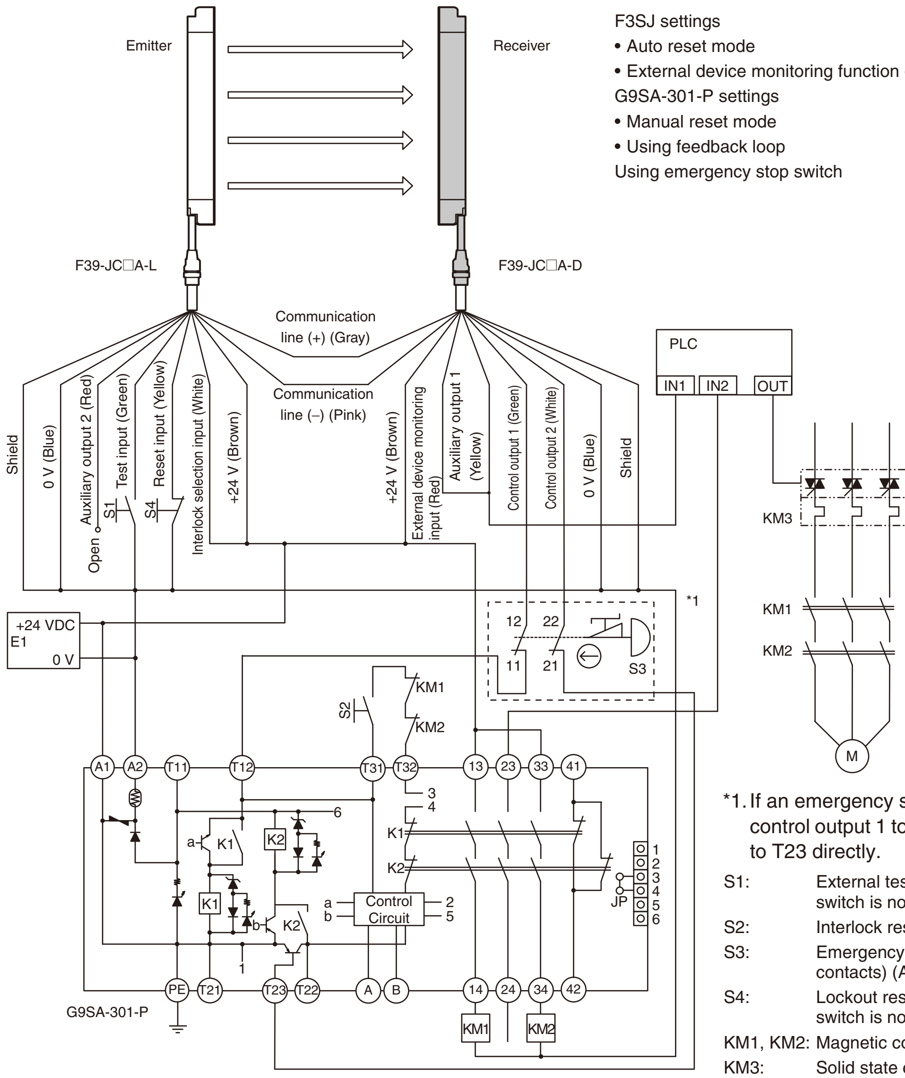
S1:	External test switch (connect to 24 V if the switch is not necessary.)
S2:	Interlock/lockout reset switch
KM1, KM2:	Safety relay with forcibly-guided contacts (G7SA) or magnetic contactor
KM3:	Load, PLC (for monitor)
KM4:	Solid state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring -- not related to safety system)

Wiring for connection with a controller G9SA-301-P (category 4) (NPN models only)

F3SJ settings
- Auto reset mode
- External device monitoring function disabled

G9SA-301-P settings
- Manual reset mode
- Using feedback loop

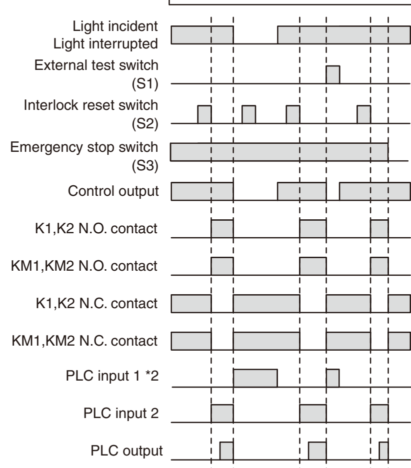
Using emergency stop switch



*1. If an emergency stop switch is not used, connect control output 1 to T12 terminal and control output to T23 directly.

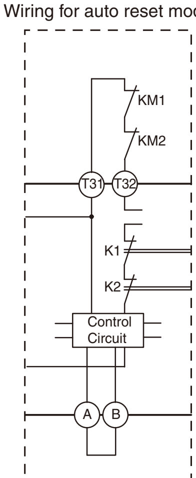
S1:	External test switch (connect to 24 V if the switch is not necessary.)
S2:	Interlock reset switch
S3:	Emergency stop switch (direct opening contacts) (A165E, A22E)
S4:	Lockout reset switch (connect to 0 V if the switch is not necessary.)
KM1, KM2:	Magnetic contactor
KM3:	Solid state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring -- not related to safety system)

Timing Chart



*2. The output operation mode for auxiliary output 1 is control output data/inverse of control output signals enabled (default setting).

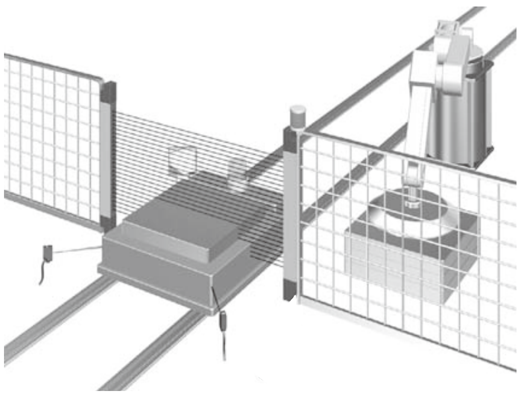
Wiring for auto reset mode



System Configuration and Connection (Muting system)

Muting System

The muting function temporarily disables the safety function of the F3SJ, keeping the control outputs ON even if beams are interrupted. This makes it possible to install safety light curtains for AGV passage, enabling both safety and productivity.
When muting, the muting lamp (external indicator) blinks to notify people in the surrounding area that the safety functions are disabled.



⚠ WARNING

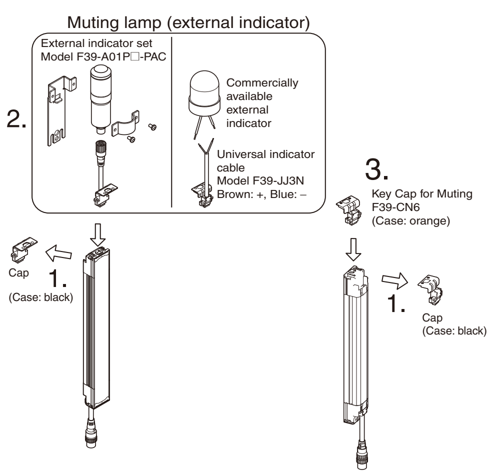
The muting and override functions disable the safety functions of the device. Additional safety measures must be taken to ensure safety while these functions are working.

Install muting sensors so that they can distinguish between the object that is being allowed to be pass through the detection zone and a person.
If the muting function is activated by the detection of a person, it may result in serious injury.

Muting lamps (external indicators) that indicate the state of the muting and override functions must be installed where they are clearly visible to workers from all the operating positions.

Upgrading F3SJ for Muting System

1. Remove the caps of the emitter and receiver.
   (A screwdriver is included with the key cap for muting.)
2. Install a muting lamp (external indicator) on either the emitter or receiver.
3. Attach the key cap for muting to the emitter/receiver on which the muting lamp (external indicator) was not installed.



Muting Sensor

A muting sensor is the sensor that is the trigger for temporarily disabling the safety functions of F3SJ. You can use a through-beam or retro-reflective photoelectric switch, a proximity sensor, or a limit switch as the muting sensor. (OMRON's E3Z-series, E2E-series (3-wire), and D4N-series Sensors are recommended.) For an F3SJ model with PNP output, use a sensor with a 3-wire PNP transistor output or a NO contact output. For an F3SJ model with NPN output, use a sensor with a 3-wire NPN transistor output or a NO contact output.
Two-wire sensors cannot be used.

Muting Lamp (External indicator)

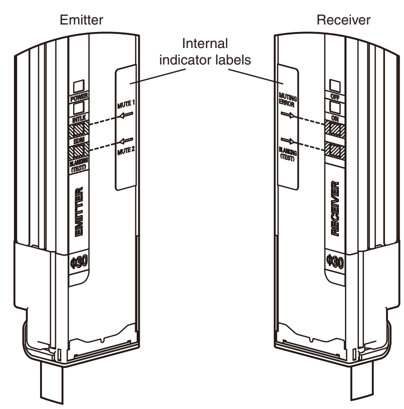
To notify workers that the muting function is working, external lamp(s) must be installed. Use the F39-A01P□-PAC external indicator set or an F39-JJ3N universal indicator cable with a commercially available external indicator.

F3SJ Internal Indicators

- The muting input 1 indicator turns ON when input is applied to muting input 1.
- The muting input 2 indicator turns ON when input is applied to muting input 2.
- The muting input 1 indicator and muting input 2 indicator blink under muting override.
- The muting error indicator on the receiver side turns ON when there is a muting error.

Attachment Positions for Included Labels

Internal indicator labels are included with the F39-CN6 Key Cap for Muting. When using a muting system, attach the internal indicator labels so the arrows will be in line with the positions of the indicators, as shown by the shading below.



Standard Muting Mode

The F3SJ is set to this operation mode when it is shipped from the factory. The muting function is enabled by providing a time lag between muting inputs 1 and 2. Use a separately purchased setting tool to change parameters related to muting time, or to select other muting operation modes.

Start Conditions

If both of the following 2 conditions are present, muting is activated.

1. No interrupting object is found in the F3SJ's detection zone, and control output is ON.

2. After muting input 1 is turned ON (connected to 9 to 24 V for PNP types, or to 0 to 1.5 V for NPN types), muting input 2 is turned ON (connected to 9 to 24 V for PNP types, or to 0 to 1.5 V for NPN types) within the muting input time limit T1 min. to T1 max. (0.03 to 3 s).

Once the conditions in item 2 above are met, the muting function will be enabled in 0.15 s max.

When condition 1 is satisfied but time condition of 2 is not, a muting sequence error occurs and receiver's muting error indicator turns ON. However, the F3SJ safety functions will continue operating and the F3SJ will operate normally even during a muting error.

A muting error is released when either of the following occurs:

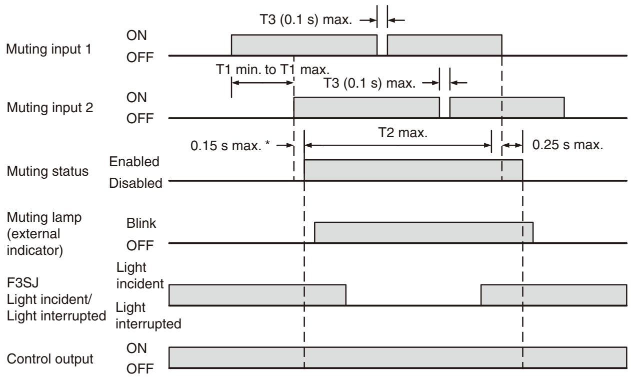
- When muting is started using a proper procedure
- When power is turned on while muting inputs 1 and 2 are OFF

End Conditions

If either of the following conditions are satisfied, the muting state is released.

1. Muting input 1 or 2 turns OFF for T3 (0.1 s) or longer.

2. When the muting continuation time exceeds the muting time limit of T2 (60 s) (a setting tool can be used to change the limit in the range of 1 to 600 s, or to eliminate the time limit)



* This value is the time when the F3SJ is used singly. When used in a series, this time is as shown in the table below.

Number of Connected Units	* Time (s)
1	0.15
Series of 2	0.26
Series of 3	0.29
Series of 4	0.32

- T1 min: Muting input time limit (min.)
  This is the minimum input time lag between muting inputs 1 and 2, and is set to 0.03 s. If the time lag between muting inputs 1 and 2 are shorter than this value, a muting error is generated.
- T1 max: Muting input time limit (max.)
  This is the maximum input time lag between muting inputs 1 and 2, and is set to 3 s. The minimum value must be less than the maximum value (min. < max.).
- T2: Muting time limit
  This is the continuous time of the muting function, and is set to 60 s. If the muting status exceeds this time, muting is cancelled.
- T3: Allowable pulse-change time for muting input signals
  This is the maximum time allowed for a change in the waveform pulse of muting inputs 1 and 2 while in the muting status.

Note: The muting status can be released even when the system enters lockout.

The following values can be changed using the Setting Support Software for the F3SJ:

- T1 min: Muting input time limit (min.)
- T1 max: Muting input time limit (max.)
- T2: Muting time limit

The following values can be changed using the Setting Console:

- T2: Muting time limit

Installation Standard for Muting Sensors

- Set the muting sensors so that they can detect all of the passing detection objects (palettes, automobiles, etc.). Do not install in a position so that only the front or rear end of the detection object is detected.
- Set the muting sensors so that they detect the objects even when they are loaded on palettes or other transport devices.
- Install the F3SJ and muting sensors so that each object passes through all muting sensors before the next object arrives at the first muting sensor. Also, install all F3SJ and muting sensors so that no person is able to accidentally enter the hazardous area while the muting function is enabled.
- When objects pass through the muting area at different speeds, consider limiting the muting time.
- For a muting sensor installation example, see the instruction manual.
- For details about the override function, see the instruction manual.

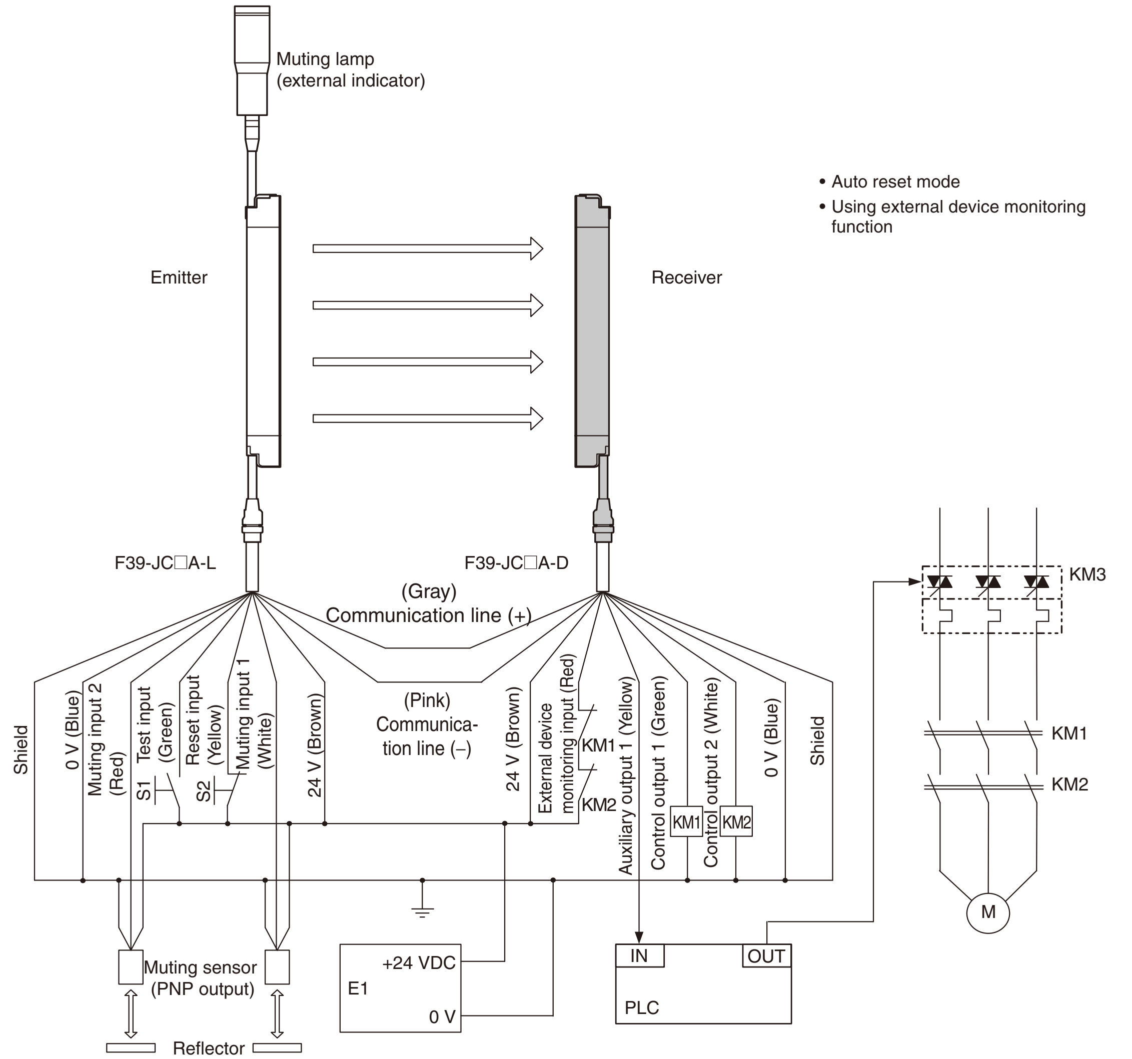
Example of a Safety Circuit with the Muting System

For PNP output

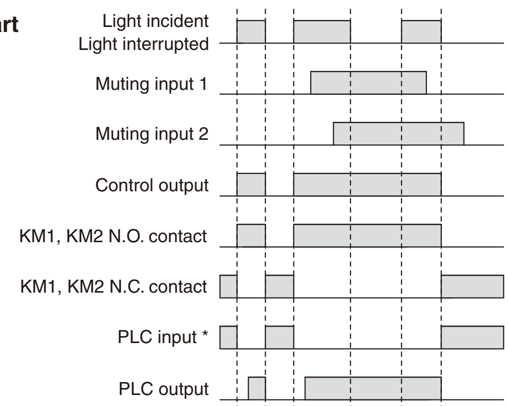
Wiring for muting function with single F3SJ application (category 4)

When two muting sensors are connected

- Attaching a keycap for muting (F39-CN6) enables the muting function to be used.



Timing Chart



S1:	External test switch (connect to 0 V if the switch is not necessary.)
S2:	Lockout reset switch (connect to 24 V if the switch is not necessary.)
KM1, KM2:	Safety relay with forcibly-guided contacts (G7SA) or magnetic contactor
KM3:	Solid state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring -- not related to safety system)

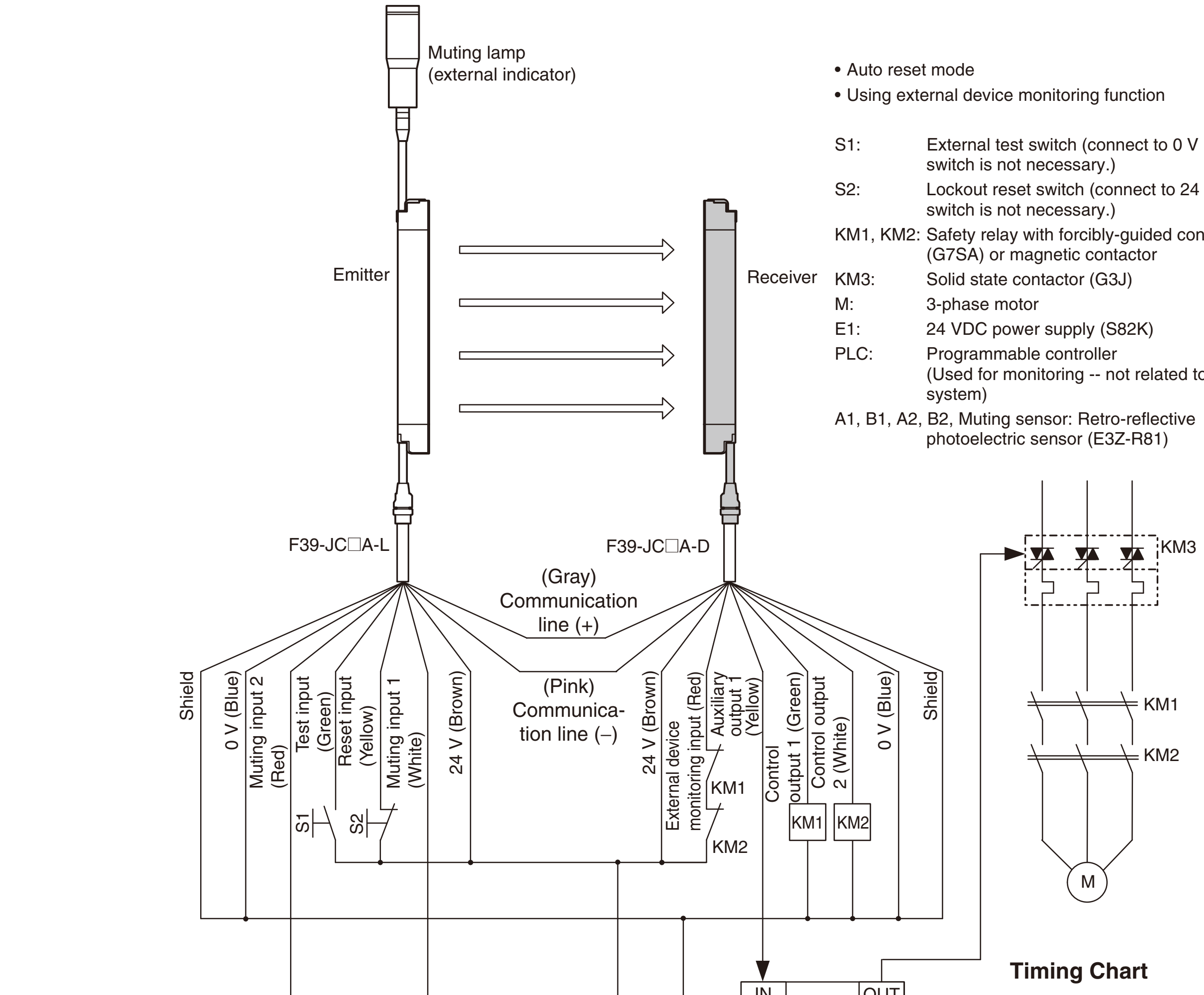
Muting sensor: Retro-reflective photoelectric sensor (E3Z-R81)

* The output operation mode for auxiliary output 1 is control output data/inverse of control output signals enabled (default setting).

Note: Start interlock and restart interlock can be used with a setting tool.

When four muting sensors are connected

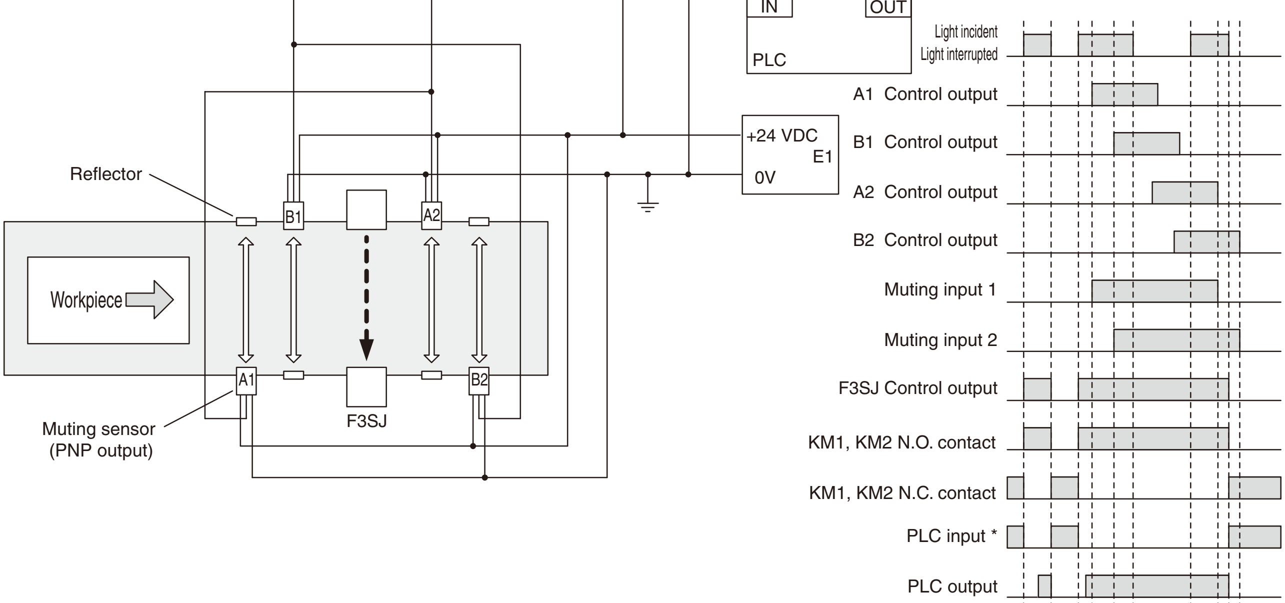
- The muting function can be used by attaching the F39-CN6 Key Cap.



- Auto reset mode
- Using external device monitoring function

S1:	External test switch (connect to 0 V if the switch is not necessary.)
S2:	Lockout reset switch (connect to 24 V if the switch is not necessary.)
KM1, KM2:	Safety relay with forcibly-guided contacts (G7SA) or magnetic contactor
KM3:	Solid state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring -- not related to safety system)
A1, B1, A2, B2,	Muting sensor: Retro-reflective photoelectric sensor (E3Z-R81)

Timing Chart



* The output operation mode for auxiliary output 1 is control output data/inverse of control output signals enabled (default setting).

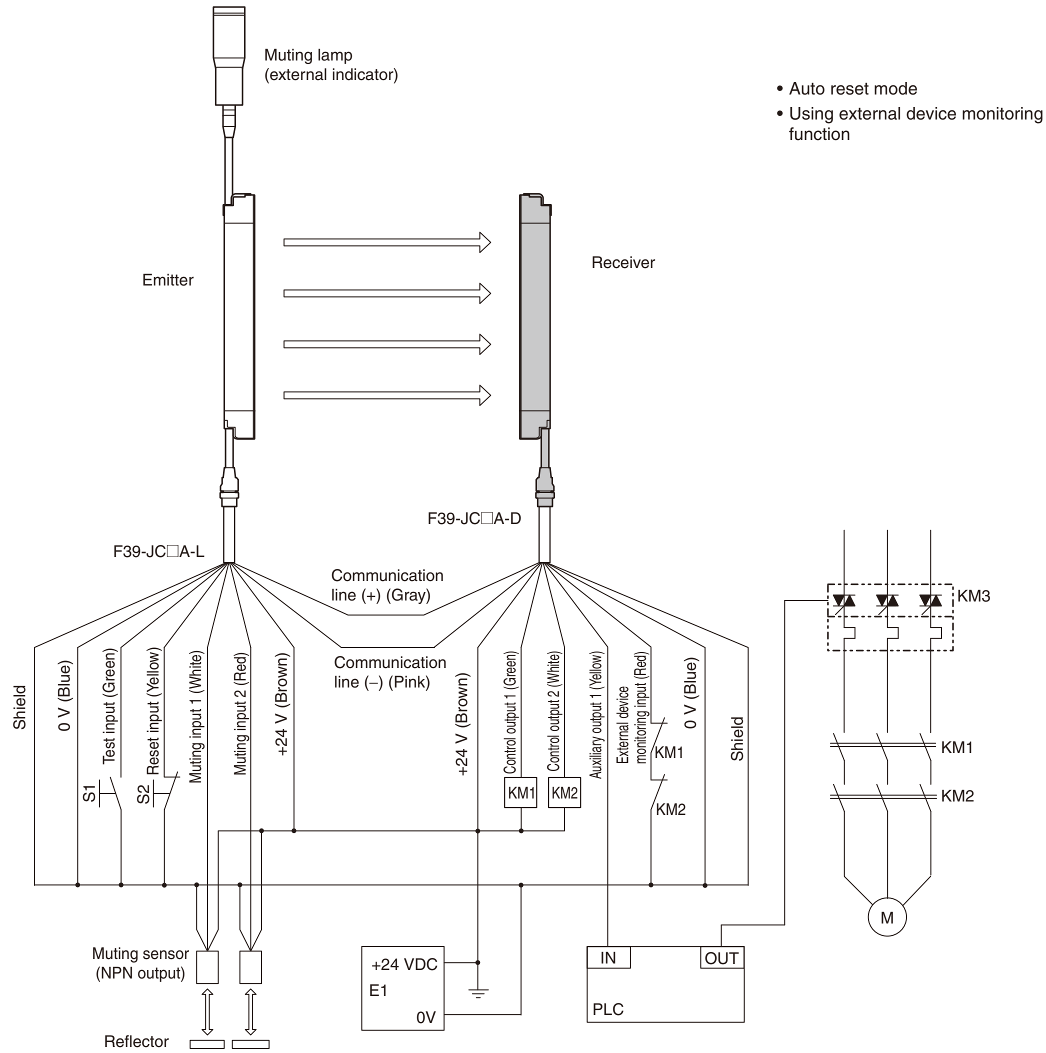
Note: Start interlock and restart interlock can be used with a setting tool.

For NPN output

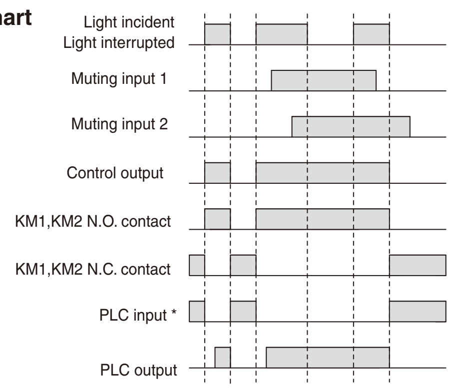
Wiring for muting function with single F3SJ application (category 4)

When two muting sensors are connected

- Attaching a keycap for muting (F39-CN6) enables the muting function to be used.



Timing Chart



S1:	External test switch (connect to 24 V if the switch is not necessary.)
S2:	Lockout reset switch (connect to 0 V if the switch is not necessary.)
KM1, KM2:	Safety relay with forcibly-guided contacts (G7SA) or magnetic contactor
KM3:	Solid state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring -- not related to safety system)

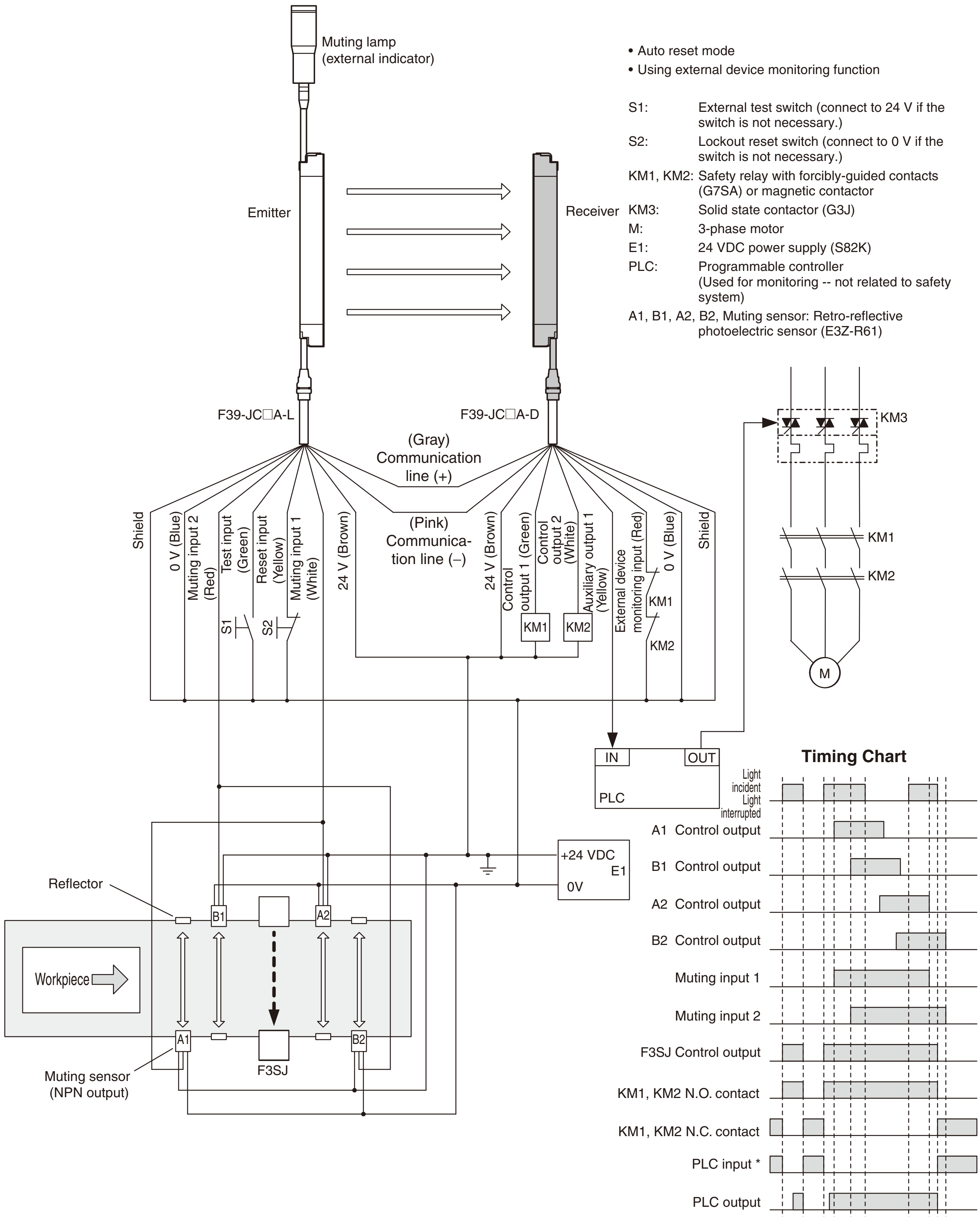
Muting sensor: Retro-reflective photoelectric sensor (E3Z-R61)

* The output operation mode for auxiliary output 1 is control output data/ inverse of control output signals enabled (default setting).

Note: Start interlock and restart interlock can be used with a setting tool.

When four muting sensors are connected

- The muting function can be used by attaching the F39-CN6 Key Cap.

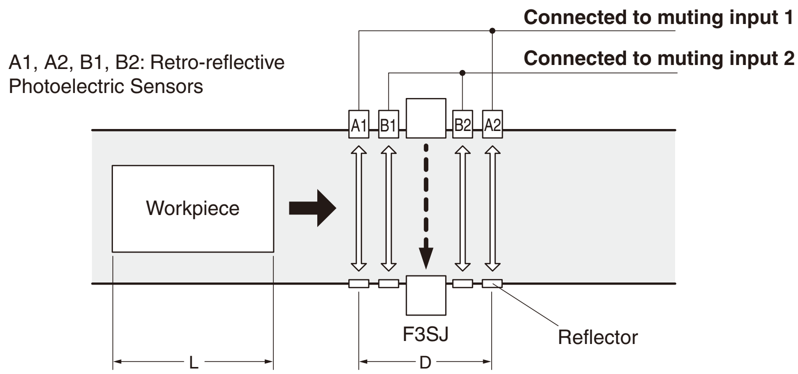


* The output operation mode for auxiliary output 1 is control output data/inverse of control output signals enabled (default setting).

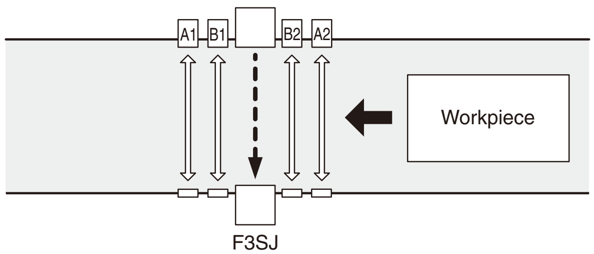
Note: Start interlock and restart interlock can be used with a setting tool.

Setting Bi-directional Muting

- Connect the outer muting sensors A1 and A2 to muting input 1 and the inner muting sensors B1 and B2 to muting input 2.
- When muting sensors A1 and then B1 (or A2 and then B2) turn ON in that order, the F3SJ will enter the muting state.



- Muting from the opposite direction is also possible.



Note: 1. This example arrangement uses E3Z-R□□ Retro-reflective Photoelectric Sensors as the muting sensors. Mutual interference must be taken into account when installing these Sensors.

2. The muting sensors must be installed so that distance D between muting sensors A1 and A2 is smaller than workpiece length L.

3. Through-beam or Retro-reflective Photoelectric Sensors, Proximity Sensors, or Limit Switches can be used as the muting sensors. Two-wire sensors cannot be used.

Safety Precautions

This catalog is intended as a guide for product selection. Be sure to use the instruction manual provided with the product for actual operation.

Regulations and Standards

1. Application of an F3SJ-A sensor alone cannot receive type certification provided by Article 44-2 of the Labour Safety and Health Law of Japan. It is necessary to apply it in a system. Therefore, when using the F3SJ-A in Japan as a "safety system for pressing or shearing machines" prescribed in Article 42 of that law, the system must receive type certification.

2. The F3SJ-A is electro-sensitive protective equipment (ESPE) in accordance with European Union (EU) Machinery Directive Index Annex IV, B, Safety Components, Item 1.

3. The F3SJ-A complies with the following legislation and standards:
1. EU Regulations
   Machinery Directive: Directive 98/37/EC
   EMC Directive: Directive 89/336/EEC
2. European standards:
   EN61496-1 (TYPE 4 ESPE),
   prEN61496-2 (TYPE 4 AOPD),
   EN61508-1 to -7 (SIL3)
3. International standards:
   IEC61496-1 (TYPE 4 ESPE),
   IEC61496-2 (TYPE 4 AOPD),
   EN61508-1 to -7 (SIL3)
4. JIS standards:
   JIS B9704-1 (TYPE 4 ESPE),
   JIS B9704-2 (TYPE 4 AOPD)

4. The F3SJ-A received the following certification from the EU-accredited body, TÜV SÜD Product Service GmbH:
- EC type test based on machinery directive
  Type 4 ESPE (EN61496-1),
  Type 4 AOPD(prEN61496-2)
- EMC Competent Body Certificate (Test power supply: OMRON's S82K)
- TÜV SÜD Product Service Type Certification
  Type 4 ESPE (EN61496-1),
  Type 4 AOPD (prEN61496-2),
- SIL1, 2, 3 (EN61508-1 to -7)
  Application: EN954-1 categories B, 1, 2, 3, 4

5. The F3SJ-A has received certificates of UL listing for US and Canadian safety standards from the Third Party Assessment Body UL.
- Type 4 ESPE (UL61496-1),
  Type 4 AOPD (UL61496-2)

6. The F3SJ-A is designed according to the standards listed below. To make sure that the final system complies with the following standards and regulations, you are asked to design and use it in accordance with all other related standards, laws, and regulations. If you have any questions, consult with specialized organizations such as the body responsible for prescribing and/or enforcing machinery safety regulations in the location where the equipment is to be used.
- European Standards: EN415-4, EN692, EN693
- US Occupational Safety and Health Administration: OSHA 29 CFR 1910.212
- US Occupational Safety and Health Administration: OSHA 29 CFR 1910.217
- American National Standard Institute: ANSI B11.1 to B11.19
- American National Standard Institute ANSI/RIA 15.06
- Canadian Standards Association CSA Z142, Z432, Z434
- SEMI standard SEMI S2
- Japanese Ministry of Health, Labour and Welfare Announcement: "Guidelines for Comprehensive Safety Standards of Machinery" Announcement No.501, June 1, 2001

Precautions for Safe Use

Indication and meaning for safe use
Meanings of Signal Words
To ensure safe use of the F3SJ-A, signal words and an alert symbol are used in this catalog to indicate safety-related instructions. Because these instructions describe details very important to your safety, it is extremely important that you understand and follow the instructions. The signal words and alert symbol used in this catalog are shown below.

⚠ WARNING

Indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, or may result in serious injury or death. Additionally, there may by significant property damage.

⚠ CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or in property damage.

Definition of Symbol

	Prohibited Indicates a prohibited action.

Warning Labels

For users

⚠ WARNING

The FS3J must be installed, set, and integrated into the mechanical control system by a qualified technician who has received the appropriate training. Failure to make correct settings may prevent detection of people and result in serious injury.

When changing parameters with a setting tool (F39-GWUM or F39-MC21), the change must be made and the contents of the change must be managed by the person in charge of the system. Unintentional or mistaken parameter changes may prevent detection of people and result in serious injury.

For machines

⚠ WARNING

Do not use this sensor for machines that cannot possibly be stopped by electrical control. For example, do not use it for a pressing machine that uses full-rotation clutch. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Do not use the auxiliary output or external indicator output for safety applications. Failure of the F3SJ may cause a person to go undetected, resulting in serious injury.

For mounting

⚠ WARNING

Make sure to test the operation of the F3SJ after installation to verify that the F3SJ operates as intended. Do not operate the machine until the test has been completed and F3SJ operation has been verified. Unintended function settings may cause a person to go undetected, resulting in serious injury.

Make sure to secure the safety distance between the F3SJ and the hazardous parts. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas. If a person is able to step into the hazardous area of a machine and remain behind the F3SJ's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

Install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

The F3SJ cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

When detection of an area has been disabled by the fixed blanking function, provide a protective structure around the entire area that will prevent a person from passing through it and reaching the hazardous part of the machinery. Failure to do so may prevent detection of people and result in serious injury.

After setting the fixed blanking function, be sure to confirm that a test rod is detected within all areas that require detection. Failure to do so may prevent detection of people and result in serious injury.

When the fixed blanking function or the floating blanking function is used, the diameter for the smallest detectable object becomes larger. Be sure to use the diameter for the smallest detectable object for the fixed blanking function or the floating blanking function when calculating the safety distance. Failure to do so may prevent the machinery from stopping before a person reaches the hazardous part of the machinery, and result in serious injury.

The muting and override functions disable the safety functions of the device. Additional safety measures must be taken to ensure safety while these functions are working.

Install muting sensors so that they can distinguish between the object that is being allowed to be pass through the detection zone and a person. If the muting function is activated by the detection of a person, it may result in serious injury.

Muting lamps (external indicators) that indicate the state of the muting and override functions must be installed where they are clearly visible to workers from all the operating positions.

Muting times must be precisely set according to the application by qualified personnel who have received appropriate training. In particular, if the muting time limit is to be set to infinity, the person who makes the setting must bear responsibility.

Use two independent input devices for the muting inputs.

Install the F3SJ, Muting Sensors, or a protective wall so that workers cannot enter hazardous areas while muting is in effect, and set muting times.

Position the switch that is used to activate the override function in a location where the entire hazardous area can be seen, and where the switch cannot be operated from inside the hazardous area. Make sure that nobody is in the hazardous area before activating the override function.

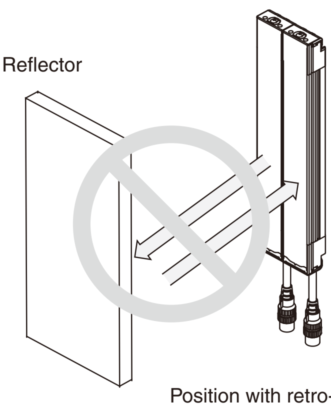
Install the sensor system so that it is not affected by reflective surfaces. Failure to do so may hinder detection, resulting in serious injury.

When using more than 1 set of F3SJ, install them so that mutual interference does not occur, such as by configuring series connections or using physical barriers between adjacent sets.

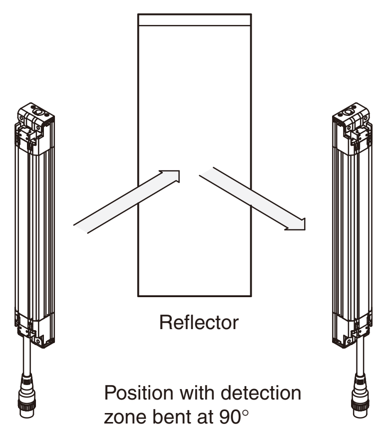
Make sure that the F3SJ is securely mounted and its cables and connectors are properly connected.

Make sure that no foreign material, such as water, oil or dust, enters the inside of the F3SJ while the cap is removed.

Do not use the sensor system with mirrors in as retro-reflective configuration. Doing so may hinder detection. It is possible to use mirrors to "bend" the detection zone to a 90-degree angle.



Position with retro-reflection



Position with detection zone bent at 90°

When using series connections, perform inspection of all connected F3SJs as instructed in the User's Manual.

For wiring

⚠ WARNING

For PNP output, connect the load between the output and 0 V line.

For NPN output, connect the load between the output and +24 V line. Connecting the load between the +24 V and 0 V lines results in a dangerous condition because the operation mode is reversed to "ON when light is interrupted".

[For PNP output]
Do not short-circuit an output line to +24 V line. Otherwise, the output is always ON, creating a dangerous situation. Also, 0 V of the power supply must be grounded so that output should not turn ON due to grounding of the output line.
[For NPN output]
Do not short-circuit an output line to 0 V line. Otherwise, the output is always ON, creating a dangerous situation. Also, the +24 V line of the power supply must be grounded so that output does not turn ON due to grounding of the output line.

Configure the system by using the optimal number of control outputs that satisfy the requirements of the necessary safety category.

Do not connect each line of F3SJ to a DC power supply higher than 24 V+20%. Also, do not connect to an AC power supply.
Failure to do so may result in electric shock.

For F3SJ to comply with IEC 61496-1 and UL 508, the DC power supply unit must satisfy all of the following conditions:

- Must be within rated power voltage (24 VDC±20%).
- Must have tolerance against the total rated current of devices if it is connected to multiple devices.
- Must comply with EMC directives (industrial environment)
- Double or enhanced insulation must be applied between the primary and secondary circuits.
- Automatic recovery of overcurrent protection characteristics (reversed L sagging)
- Output holding time must be 20 ms or longer.
- Must satisfy output characteristic requirements for class 2 circuit or limited voltage current circuit defined by UL508.
- Must comply with EMC, laws, and regulations of a country or a region where F3SJ is used. (Ex: In EU, the power supply must comply with EMC Low Voltage Directive.)

Double or enhanced insulation from hazardous voltage must be applied to all input and output lines. Failure to do so may result in electric shock.

The cable extension length must be no greater than the specified length. Otherwise, the safety functions may fail to work properly, resulting in danger.

Installation Conditions

Refer to *Precautions for All Safety Sensors* for installation conditions.

⚠ WARNING

Make sure to secure the safety distance (S) between the F3SJ and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Note: The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops.
Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

How to calculate the safety distance specified by International standard ISO13855-2002 (European standard EN999-1999) (Reference)

If a person approaches the detection zone of the F3SJ perpendicularly, calculate the safety distance as shown below.
S = K x T + C . . . Eq. (1)

- S: Safety distance
- K: Approach speed to the detection zone
- T: Total response time of the machine and F3SJ
- C: Additional distance calculated by the detection capability of the F3SJ

<System that has detection capability of 40 mm max.>
Use K = 2,000 mm/s and C = 8 x (d - 14 mm) in equation (1) for the calculation.
S = 2,000 mm/s x (Tm + Ts) + 8 x (d - 14 mm)

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the F3SJ from ON to OFF (s)
- d = Size of F3SJ's detection capability (mm)

[Calculation example]
When Tm = 0.05 s, Ts = 0.01 s, and d = 14 mm:
S = 2,000 mm/s x (0.05 s + 0.01 s) + 8 x (14 mm - 14 mm)
= 120 mm . . . Eq. (2)
If the result is less than 100 mm, use S = 100 mm.

If the result exceeds 500 mm, use the following equation where K = 1,600 mm/s.
S = 1,600 mm/s x (Tm + Ts) + 8 x (d - 14 mm) . . . Eq. (3)
If the result of this Eq. (3) is less than 500 mm, use S = 500 mm.

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 40 mm>
Assuming K = 1,600 mm/s and C = 850 mm, the following calculation is made using Eq. (1).
S = 1,600 mm/s x (Tm + Ts) + 850 … Eq. 4,

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the F3SJ from ON to OFF (s)

[Calculation example:]
When Tm = 0.05 s and Ts = 0.01 s,
S = 1,600 mm/s x (0.05 s + 0.01 s) + 850 mm = 946 mm

How to calculate the safety distance specified by American standard ANSI B11.19 (Reference)

If a person approaches the detection zone of the F3SJ perpendicularly, calculate the safety distance as shown below.
S = K x (Ts + Tc + Tr + Tbm) + Dpf

- S: Safety distance
- K: Approach speed to the detection zone (the value recommended by OSHA standard is 1,600 mm/s)

Approach speed K is not specified in the ANSI B.11.19 standard. To determine the value of K to apply, consider all factors, including the operator's physical ability.

- Ts = Machine's stop time (s)
- Tr = Response time of the F3SJ from ON to OFF (s)
- Tc = Machine control circuit's maximum response time required to activate its brake (s)
- Tbm = Additional time (s)

If a machine has a brake monitor, "Tbm = Brake monitor setting time - (Ts + Tc)". If it has no brake monitor, we recommend using 20% or more of (Ts + Tc) as additional time.

- Dpf = Additional distance

According to ANSI's formula, Dpf is calculated as shown below:
Dpf = 3.4 x (d - 7.0): Where d is the detection capability of the F3SJ (unit: mm)

[Calculation example]
When K = 1,600 mm/s, Ts + Tc = 0.06 s, brake monitor setting time = 0.1 s, Tr = 0.01 s, d = 14 mm:
Tbm = 0.1 - 0.06 = 0.04 s
Dpf = 3.4 x (14 - 7.0) = 23.8 mm
S = 1,600 x (0.06 + 0.01 + 0.04) + 23.8 = 199.8 mm

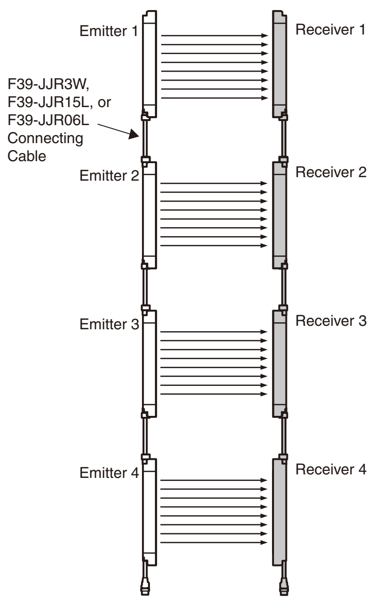
Prevention of Mutual Interference

Do not use a sensor system in a reflective configuration. Doing so may hinder detection. Mirrors can be used change the optical route.	⚠
When using more than 1 set of F3SJ, install them so that mutual interference does not occur, such as by configuring series connections or using physical barriers between adjacent sets.	⚠

Mutual interference from other F3SJ is prevented in up to 3 sets without series connection.

For series connection

Series connections can prevent mutual interference when multiple sensors are used. Up to 4 sets, 400 beams, can be connected (except for the F3SJ-A□-TS Series, for which up to 3 sets, 240 beams, can be connected). The emission of series-connected F3SJ is time-divided, so mutual interference does not occur and safety is ensured.



No Series Connections

Refer to *Precautions for All Safety Sensors* for information on preventing mutual interference of Safety Light Curtains that are not connected in series.

Using Setting Tools

The following setting tools (sold separately) can be purchased in order to change or confirm various F3SJ-series parameters.

- F39-MC21 Setting Console
- F39-GWUM SD Manager Setting Support Software for the F3SJ

The Setting Console cannot be used with the F3SJ-A□-TS Series.

⚠ WARNING

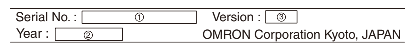
The FS3J must be installed, set, and integrated into the mechanical control system by a qualified technician who has received the appropriate training. Failure to make correct settings may prevent detection of people and result in serious injury.

F3SJ Versions

Setting tools can be used with Version 2 and later versions of the F3SJ. The setting tools cannot be used with Version 1.
The setting tools cannot be used even if a Version 1 F3SJ is combined in series with compatible F3SJ Units. (A communications error lockout will occur.)
Unfortunately, the F3SJ's version cannot be upgraded.
The F3SJ's version number appears on its label, as shown in the following diagram.

Location of the F3SJ's Version Number (Within Dashed-line Box)

Close-up View of Dashed-line Box



① : Serial number
② : Year of manufacture
③ : F3SJ's version number (Verify that the version is Version 2 or later.)

Functions Editable with Setting Tools

❍: Can be used.
×: Cannot be used.

Function or monitored item		F39-MC21 Setting Console	F39-GWUM SD Manager Setting Support Software for the F3SJ
Settings for individual applications	Fixed blanking function *1	❍	❍
	Floating braking function *1	❍	❍
	Warning zone function *1	❍	❍
	Muting function *2 (when using the muting system)	❍	❍
	Override function *2 (when using the muting system)	❍	❍
Indicator and I/O settings	Auxiliary output *2	❍	❍
	Specified light beam output function *1	×	❍
	External indicator output *2	❍	❍
	Interlock function *2	❍	❍
	External device monitoring function *2	❍	❍
Changing detection distance	Change detection distance function *1	❍	❍
Monitoring operation	Light intensity indicators *1	❍	❍
	Ambient light intensity indicators *1	❍	❍
	Status indicators *1	×	❍
Maintenance information	Error log *1	❍	❍
	Power ON time *1	❍	❍
	Number of load switching operations *1	❍	❍
Recovering settings	Recover settings function *1	❍	❍
Other functions	Safety distance calculation function *1	×	❍
	Power cable length calculation Function *1	×	❍
	Rated response time check *1	❍	❍

*1. These functions were newly added in Version 2. A setting tool can be used to enable these functions or read the function settings.
*2. These functions can be used even without a setting tool. A setting tool can be used to make more detailed settings.

Two Kinds of Setting Tools

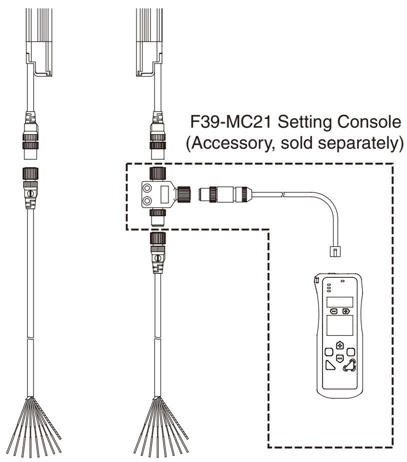
The following accessories (sold separately) can be purchased in order to use various F3SJ-series functions and change settings.
- F39-MC21 Setting Console
  A Setting Console can easily make settings onsite.
- F39-GWUM SD Manager Setting Support Software for the F3SJ
  With this software, a personal computer can be connected to make settings. The SD Manager Setting Support Software for the F3SJ can make more detailed settings than the Setting Console.

Setting Console

The following items are included with the F39-MC21 Setting Console.
- Setting Console
- Branch Connector (with Connector Cap)
- Special Cable
- Special Cable with Plug
- Error Mode Label
- Instruction Manual

Connecting the Setting Console

Connect the F3SJ to the Setting Console as shown in the following diagram. The Branch Connector can be used on either the emitter side or receiver side. After the F3SJ has been wired, turn ON the power and change parameters as required. If it is not possible to connect a branch connector because the connector is concealed by equipment or otherwise inaccessible, use the Special Cable with Plug to connect to the + and – communications lines. For details, refer to the F39-MC21 Instruction Manual.



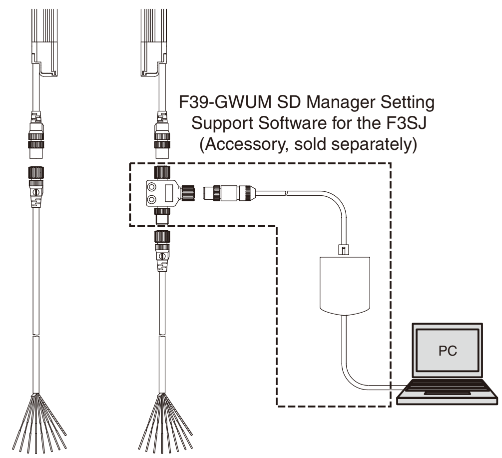
SD Manager Setting Support Software for the F3SJ

The following items are included with the F39-GWUM SD Manager Setting Support Software for the F3SJ.
- CD-ROM (SD Manager Setting Support Software for the F3SJ, Communications Unit Driver)
- Communications Unit
- Branch Connector (with Connector Cap)
- Special Cable
- Instruction Manual (Installation Guide)
- Special Cable with Plug

The F3SJ's operating status can be checked and its parameters can be changed in the SD Manager Setting Support Software for the F3SJ.

Connecting the SD Manager Setting Support Software

Connect the F3SJ, Communications Unit, and personal computer as shown in the following diagram. The branch connector can be used on either the emitter side or receiver side. After the F3SJ has been wired, turn ON the power and start the Setting Support Software. If it is not possible to connect a branch connector because the connector is concealed by equipment or otherwise inaccessible, use the Special Cable with Plug to connect to the + and - communications lines. For details, refer to the SD Manager's Help function.



Applications Supported by the Setting Tools

Fixed Blanking Function

Summary

Disables specific F3SJ light beams.

⚠ WARNING

When the fixed blanking function is used to disable detection in an area, install blocking structures or shielding to prevent passage into the entire hazardous area where detection has been disabled. Failure to do so may prevent detection of people and result in serious injury.

When an allowable range of light beams has been set for fixed blanking, the size of the smallest detectable object will be larger in the vicinity of interrupting objects. Calculate the safety distance to match the settings.

After setting the fixed blanking function, you must verify that the F3SJ detects a test rod at any position in the entire area where intrusion must be detected. Failure to do so may prevent detection of people and result in serious injury.

Example Application

In this example, there is always an object such as a conveyor belt in the detection area, and we want to ignore the conveyor belt.

Description of Functions

Fixed Blanking Function

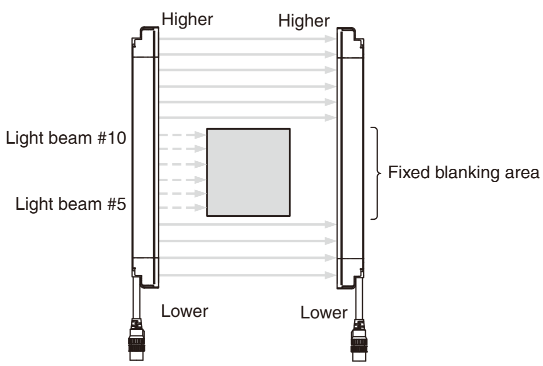
This function disables part of the F3SJ's detection area and maintains the control output's ON status even if there is an object in the disabled area.

The light beams set for fixed blanking must be one area of consecutive light beams and up to five areas can be set (areas 1 to 5). Fixed blanking cannot be set for all of the light beams.

Setting the Fixed Blanking Area

Set the area that will be subject to fixed blanking.

An interrupting object can be placed in the detection area to perform teaching and specify light beams for manual settings.



Note: 1. When the Setting Console is being used, only one area can be set as a fixed blanking area.

2. When the SD Manager Setting Support Software is being used, up to five areas can be set as fixed blanking areas.

Floating Blanking Function

Summary

Increases the diameter of the F3SJ's smallest detectable object and turns OFF the control output when multiple objects are detected.

⚠ WARNING

When the floating blanking function is used, it increases the diameter of the F3SJ's smallest detectable object. Always use the larger diameter when calculating the safety distance. If the incorrect diameter is used in the calculation, the machinery may fail to stop before an operator reaches the hazardous area, resulting in serious injury.

After setting the floating blanking function, always verify that the F3SJ system operates as expected. Serious injury may result if an individual is not detected.

Example Application

When there is a moving object with a fixed width in the detection area that we do not want to detect, the detection function can be disabled.

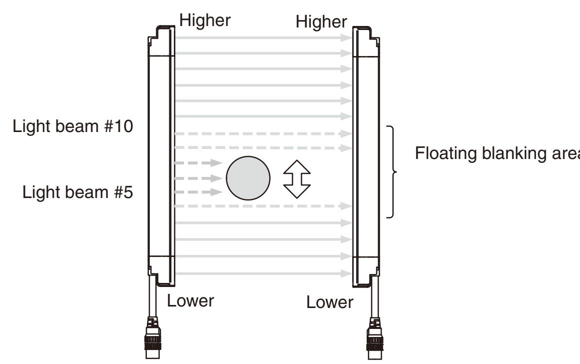
Description of Functions

Floating Blanking Function

This function increases the diameter of the smallest detectable object to allow passage of objects of a certain size or allow interrupting objects in multiple locations.

Setting the Floating Blanking Area

When the Setting Console is being used, all of the light beams are set as the floating blanking area. When the SD Manager Setting Support Software is being used, just one area can be set but the range of the area can be specified. In the following example, the floating blanking area is set from the 5th light beam to the 10th light beam (counting from the bottom). An interrupting object can be placed in the detection area to perform teaching and specify light beams for manual settings.



Floating Light Beams

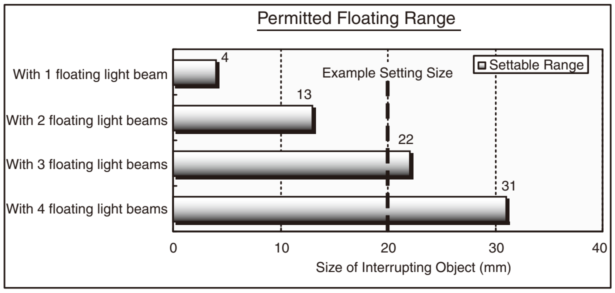
The following charts show the relationship between the number of floating light beams and the safety output operation (safety output not going OFF). Measure the size of the interrupting object (maximum diameter) and set the number of floating light beams so that the object's size is less than the corresponding dimension shown in the chart.

Example Setting

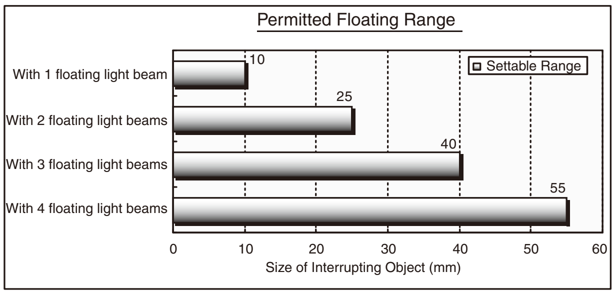
When an F3SJ-A□14 is being used with an interrupting object that is 20 mm in diameter, set three light beams as floating light beams. With this setting, the F3SJ's safety output will not turn OFF even if there is an interrupting object up to 22-mm wide in the floating blanking area.

Effective Range vs. Number of Floating Light Beams

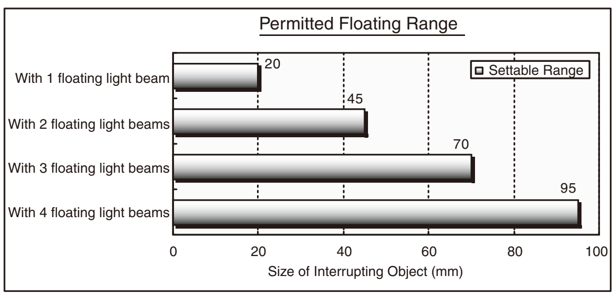
F3SJ-A□14 Series



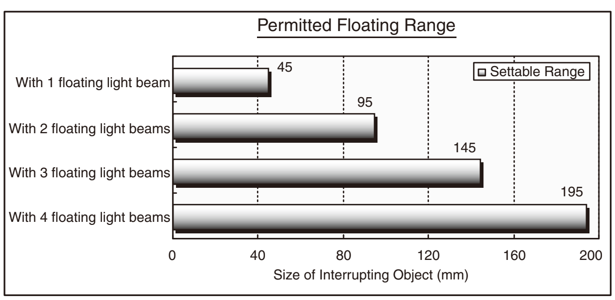
F3SJ-A□20 Series



F3SJ-A□30 Series



F3SJ-A□55 series



Floating Blanking Mode

The floating blanking function has two operation modes.

1. Continuous Light Beam Mode
   The safety output will not go OFF if the interrupting object is smaller than the set size, although the safety output will go OFF if objects pass through several areas in the detection area.
   The floating blanking monitor function can be set in this mode.
   Refer to the User's Manual for details.
2. Discontinuous Light Beam Mode
   A light blockage is detected when the number of light beams blocked in the area is equal to or greater than the preset number of light beams.

Warning Zone Function

Summary

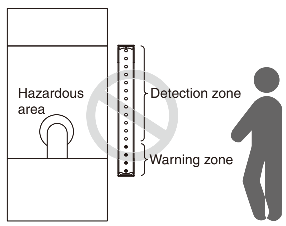
The detection zone can be divided into the detection zone and a warning zone.

⚠ WARNING

The warning zone output is not a safety output. Do not include this area in the safety distance calculation. Shortening the safety distance may result in serious injury.

The warning zone cannot be used for safety purposes. Always install the system so that the hazard is reached by passing through the detection zone.

The warning zone function can be used only when the F3SJ is installed horizontally. This function cannot be used when the F3SJ is installed vertically.



Example Application

When an individual enters, a warning lamp lights or buzzer sounds without stopping the equipment.

Description of Function

Warning Zone Function

Use teaching to set the light beams that you want to set as the warning zone or manually specify the light beams from the lowest or highest beam. (See figures 1 and 2.)
To indicate that the warning zone is blocked, allocate the auxiliary output or external indicator output as the warning zone information.
The following settings cannot be made:

- Setting all light beams as the warning zone (figure 4)
- Setting a warning zone that does not include one of the outer light beams (figure 5)

If Safety Light Curtains are connected in series, and at least one of an F3SJ's light beams is a normal light beam, all of a Light Curtain's light beams can be set as a warning zone (figure 3).

Example Warning Zone Settings (Figures 1 to 3)

Figure 1

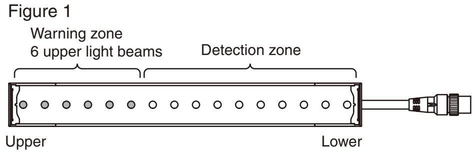


Figure 2

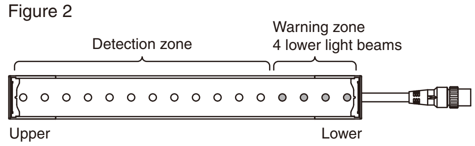
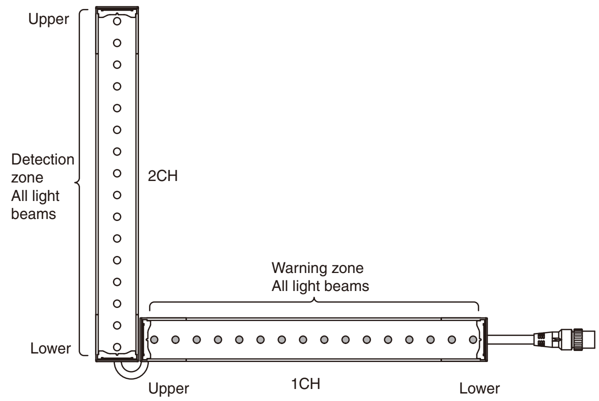


Figure 3



Examples of Unacceptable Warning Zone Settings (Figures 4 and 5)

Figure 4

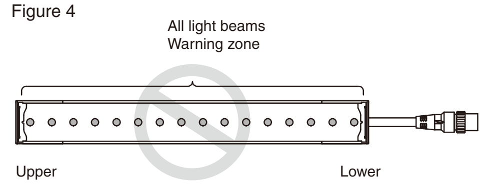
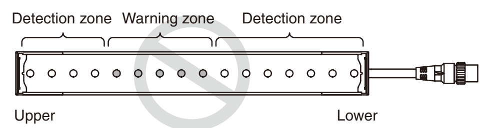
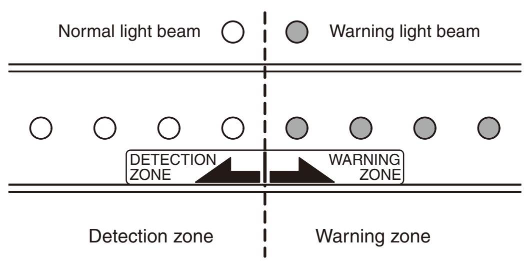


Figure 5



Warning Zone Display Label

When the warning zone is set, affix this label to indicate which areas belong to the normal detection zone and the warning zone.



Muting Function

Summary

Makes settings related to the muting function.

⚠ WARNING

The muting function disables the safety functions of the device. Additional safety measures must be taken to ensure safety while this function is working.

Install muting sensors so that they can distinguish between the object that is being allowed to be pass through the detection zone and a person.

Muting lamps (external indicators) that indicate the status of the muting function must be installed where they are clearly visible to workers from all the operating positions.

Muting times must be precisely set according to the application by qualified personnel who have received appropriate training. In particular, if the muting time limit is to be set to infinity, the person who makes the setting must bear responsibility.

Use two independent input devices for the muting inputs. (For the PNP output-type F3SJ, use a sensor with a PNP transistor output or N.O. contact. For the NPN output-type F3SJ, use a sensor with an NPN transistor output or N.O. type contact.)

To prevent a worker from entering the hazardous area while the muting function is engaged, install the F3SJ, muting sensor, and then a protective barrier and set a limited muting time.

Example Applications

- Allowing only work pieces to pass into the conveyor entrance
- Operating the muting function in a specific area only
- Setting a different muting mode when standard muting is not appropriate for the application

Description of Functions (See User's Manual for details.)

Operation Modes

When the SD Manager Setting Support Software is being used, any one of the following three operation modes can be selected for the muting function.

1. Standard Muting Mode
This is the default operation mode, which is set when the F3SJ is shipped from the factory.
The muting function is enabled by turning ON muting inputs 1 and 2 with a time lag.

Note: Settings such as the muting time limit value can be changed.

2. Specialized Exit Muting Mode (Can be set with the SD Manager Setting Support Software only.)
The muting function is enabled by turning ON muting inputs 1 and 2 with a time lag.
Installation of the muting input sensors is simpler than standard mode because the Safety Light Curtain's blocked light status is used to end muting.

3. Position Detection Muting Mode (Can be set with the SD Manager Setting Support Software only.)
Sensors such as limit switches are used for the muting inputs and the muting function is enabled by turning muting input from OFF to ON and then turning muting input 2 from ON to OFF within time difference T1 max. Use hybrid redundant inputs such as a combination of an N.O. contact input and an N.C. contact input. (When using a PNP-output photoelectric switch, use L/ON operation on one side and D/ON operation on the other side.)
This mode is useful when you want to disable the F3SJ temporarily, such as when a person is placing an object at the conveyor entrance.

Partial Muting (Muting area) Settings

The light beams controlled by the muting function can be specified with a setting tool. (When the F3SJ is shipped, all light beams are set.) The light beams can be specified by teaching/recording the blocked light beams as muting light beams or manually specifying the desired light beams.

Indicator and I/O Settings

Auxiliary Output (Non-safety) and External Indicator Output (Non-safety)

Summary

A setting tool can be used to change the allocation of auxiliary outputs 1 and 2, and external indicator outputs 1 and 2.

⚠ WARNING

Do not use the auxiliary outputs or external indicator outputs for safety purposes. Serious injury may result if an output fails and a person is not detected.

Example Applications

- Allocating a lockout output or warning zone output to an auxiliary output
- Connecting an external indicator to an auxiliary output and making it flash

An auxiliary output or external indicator output can be connected to an incandescent light to function as a broken-wire or short-circuit detector. Refer to the User's Manual for details.

Output Operation Modes (when allocated to an auxiliary output or external indicator output)

Output operation mode	Description of operation (Output will go ON in the following situation.)	Setting Console	SD Manager Setting Support Software
Control output	The control output is ON	❍	❍
Light intensity diagnosis *1	The F3SJ is ON and the received light intensity is 100% to 130% of the threshold value for more than 10 seconds.	❍	❍
Error/Lockout	The F3SJ is in error or lockout status.	❍	❍
Muting/Override	The F3SJ is in muting or override status.	❍	❍
Blanking/Warning Zone *2	The fixed blanking, floating blanking, or warning zone function is enabled.	❍	❍
Specified light beam output *3	A specified light beam is blocked.	×	❍
Power ON time	The power ON time has exceeded the threshold value.	❍	❍
Warning zone *4	Light is blocked in the warning zone.	❍	❍
Test input ON	The test input went ON.	❍	❍
Blanking light beam incident light	A fixed or floating light beam is receiving incident light.	❍	❍
Interlock	The F3SJ is in interlock status.	❍	❍
Muting error	The F3SJ is in muting error status.	❍	❍
Number of load switching operations exceeded	The number of load switching operations exceeded the threshold value.	❍	❍
Information trigger	An interlock, lockout, or muting error has occurred.	×	❍
Individual linked sensor output (channel 1)	Channel 1 control output is ON when Units are linked in series.	❍ (Auxiliary output 1 only)	❍ (Auxiliary output 1 only)
Individual linked sensor output (channel 2)	Channel 2 control output is ON when Units are linked in series.	❍ (Auxiliary output 1 only)	❍ (Auxiliary output 1 only)
Individual linked sensor output (channel 3)	Channel 3 control output is ON when Units are linked in series.	❍ (Auxiliary output 1 only)	❍ (Auxiliary output 1 only)
Individual linked sensor output (channel 4)	Channel 4 control output is ON when Units are linked in series.	❍ (Auxiliary output 1 only)	❍ (Auxiliary output 1 only)

Note: When "specified light beam output" is allocated as the output operation mode for auxiliary output 1 or 2 or external indicator output 1 or 2, that mode cannot be allocated to the other output operations.

*1. A light blockage was detected even though the output is not turned OFF because the blockage occurred at a light beam subject to fixed blanking, floating blanking, or muting. Blockages are also not processed during overrides.

*2. The fixed blanking light beams or floating blanking light beams must be set.

*3. The specified light beam must be set.

*4. The warning zone light beams must be set.

Changing the Detection Distance

Change detection distance function

Summary

The F3SJ's detection distance can be shortened.

Example Application

The F3SJ's detection distance can be shortened to avoid affecting other photoelectric sensors.
When devices are installed close together, shortening the detection distance can reduce mutual interference.

Description of Function

The detection distance can be set to 0.5 m, 1 m, 2 m, 3 m, 5 m, or MAX (either 7 m or 9 m).
The most suitable detection distance can be set to match the installation distance.

Note: MAX represents the rated detection distance.

Monitoring Operation

Received Light Intensity Indicator

Summary

It is possible to read the F3SJ's received light intensity.

Example Application

Adjust the light beams while checking the F3SJ's received light intensity.

Description of Function

Indicates the F3SJ's received light intensity.
The F3SJ's received light intensity level can be checked with a setting tool.

Ambient Light Intensity Indicator

Summary

It is possible to read the intensity of the light received by the F3SJ from ambient sources, such as other photoelectric sensors.

Example Application

Display the ambient light level while taking steps to reduce light interference form sources such as photoelectric switches in the area and neighboring F3SJ Units.

Description of Function

Indicates the ambient light level at the F3SJ from other light sources such as photoelectric sensors.
This function can help identify the photoelectric sensors that are the source of the light interference and identify the light beams being affected by the ambient light.

Other Functions

The F3SJ is also equipped with the following functions.
Refer to the User's Manual for details on using these functions.

- Status indicators
- Error log
- Power ON time
- Number of load switching operations
- Safety distance calculation function
- Power cable length calculation function
- Rated response time check function

Precautions for All Safety Sensors

Note: Refer to the "*Safety Precautions*" section for each Sensor for specific precautions applicable to each Sensor.

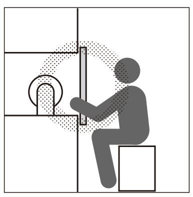
WARNING

Installation Conditions

Detection Zone and Intrusion Path

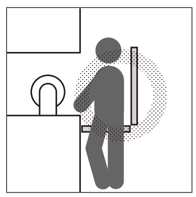
Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas.
If a person is able to step into the hazardous area of a machine and remain behind the Safety Light Curtain's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

Correct Installation



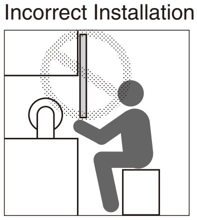
A person can only reach the hazardous part of the machinery by passing through the sensor's detection zone.

Correct Installation



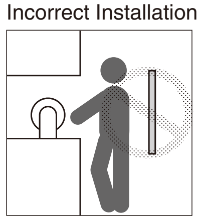
A person enters the detection zone during operation.

Incorrect Installation



A person can reach the hazardous part of the machinery without passing through the sensor's detection zone.

Incorrect Installation



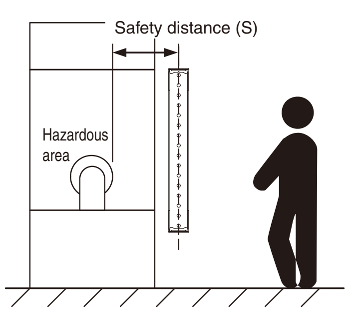
A person is between the sensor's detection zone and the hazardous part of the machinery.

Install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

The Safety Light Curtain cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

Safety Distance

The safety distance is the distance that must be set between the Safety Light Curtain and a machine's hazardous part to stop the hazardous part before a person or object reaches it. The safety distance varies according to the standards of each country and the individual specifications of each machine. In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the Safety Light Curtain. Always refer to relevant standards.



Make sure to secure the safety distance (S) between the Safety Light Curtain and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Note: The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops.
Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

How to calculate the safety distance specified by International standard ISO13855-2002 (European standard EN999-1999) (Reference)

If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.

S = K x T + C . . . Eq. (1)

- S: Safety distance
- K: Approach speed to the detection zone
- T: Total response time of the machine and Safety Light Curtain
- C: Additional distance calculated by the detection capability of the Safety Light Curtain

<System that has detection capability of 40 mm max.>
Use K = 2,000 mm/s and C = 8 x (d - 14 mm) in equation (1) for the calculation.

S = 2,000 mm/s x (Tm + Ts) + 8 x (d - 14 mm)

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s) *
- d = Size of Safety Light Curtain's detection capability (mm) *

* These values differ depending on the Switch. Refer to the "*Precautions for Correct Use*" for the Switch you are using.

[Calculation example]
When Tm = 0.05 s, Ts = 0.01 s, and d = 14 mm:
S = 2,000 mm/s x (0.05 s + 0.01 s) + 8 x (14 mm - 14 mm)
= 120 mm . . . Eq. (2)
If the result is less than 100 mm, use S = 100 mm.
If the result exceeds 500 mm, use the following equation where K = 1,600 mm/s.
S = 1,600 mm/s x (Tm + Ts) + 8 x (d - 14 mm) . . . Eq. (3)
If the result of this Eq. (3) is less than 500 mm, use S = 500 mm.

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 40 mm or Systems Using Multi-beam Safety Sensors>

Assuming K = 1,600 mm/s and C = 850 mm, the following calculation is made using Eq. (1).
S = 1,600 mm/s x (Tm + Ts) + 850 … Eq. 4,

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s)

Calculation example:
When Tm = 0.05 s and Ts = 0.01 s,
S = 1,600 mm/s x (0.05 s + 0.01 s) + 850 mm = 946 mm

How to calculate the safety distance specified by American standard ANSI B11.19
(Reference)

<Systems with a Smallest Detectable Object Size (Diameter) Less than 64 mm>
If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.
S = K x (Ts + Tc + Tr + Tbm) + Dpf

- S: Safety distance
- K: Approach speed to the detection zone (the value recommended by OSHA standard is 1,600 mm/s)

Approach speed K is not specified in the ANSI B.11.19 standard. To determine the value of K to apply, consider all factors, including the operator's physical ability.

- Ts = Machine's stop time (s)
- Tr = Response time of the Safety Light Curtain from ON to OFF (s)
- Tc = Machine control circuit's maximum response time required to activate its brake (s)
- Tbm = Additional time (s)

If a machine has a brake monitor, "Tbm = Brake monitor setting time - (Ts + Tc)". If it has no brake monitor, we recommend using 20% or more of (Ts + Tc) as additional time.

- Dpf = Additional distance

According to ANSI's formula, Dpf is calculated as shown below:
Dpf = 3.4 x (d - 7.0): Where d is the detection capability of the Safety Light Curtain (unit: mm)

[Calculation example]
When K = 1,600 mm/s, Ts + Tc = 0.06 s, brake monitor setting time = 0.1 s, Tr = 0.01 s, d = 14 mm:
Tbm = 0.1 - 0.06 = 0.04 s
Dpf = 3.4 x (14 - 7.0) = 23.8 mm
S = 1,600 x (0.06 + 0.01 + 0.04) + 23.8 = 199.8 mm

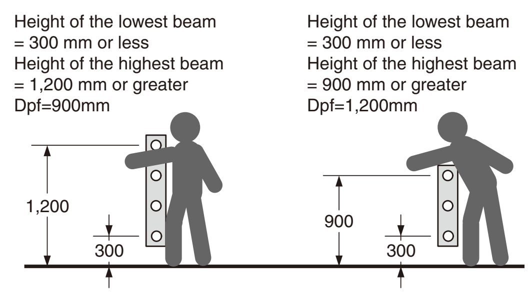
Method for Calculating the Safety Distance as Provided by ANSI/RIA R15.06 (USA)
(Reference)

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 64 mm and Less than 600mm>
The safety distance is calculated based on the following concepts when the human body intrudes perpendicular to the detection zone of the Safety Light Curtain.
S = K x (Ts + Tc + Tr) + Dpf

- S: Safety distance
- K = Intrusion speed into detection zone (1,600 mm/s min. recommended by OSHA)
- Ts = Stop time of machine/equipment (s)
- Tr = Light curtain ON-to-OFF response time (s)
- Tc = Maximum response time of the machine/equipment braking circuit required to operate the brake (s)
- Dpf = Additional distance (mm)

If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 1,200 mm or higher, the Dpf will be 900 mm.
If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 900 mm or higher, the Dpf will be 1,200 mm.

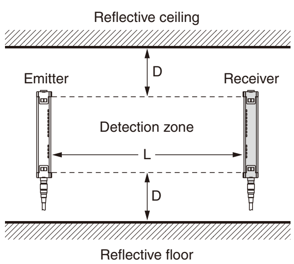
[Calculation example]
K = 1,600 mm/s, Ts + Tc = 0.06s,
If Tr = 0.01 s and Dpf = 900 mm:
S = 1,600 x (0.06 + 0.01) + 900 = 1,012 mm



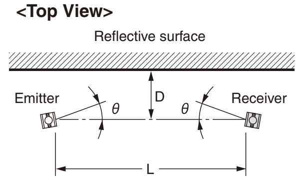
Distance from Glossy Surface

Install the sensor system so that it is not affected by reflection from a glossy surface. Failure to do so may hinder detection, resulting in serious injury.	⚠
Install the sensor system at distance D or further from highly reflective surfaces such as metallic walls, floors, ceilings, or workpieces, as shown below.	⚠

<Side View>



<Top View>



θ =5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ =10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.13 m	0.26 m
For 3 m or more	L/2 x tan5° = L x 0.044 (m)	L/2 x tan10° = L x 0.088 (m)

Others

To use the Safety Light Curtain in PSDI mode (restart of cycle operation by the sensor), you must configure an appropriate circuit between the Safety Light Curtain and the machine. For details about PSDI, refer to OSHA1910.217, IEC61496-1, and other relevant standards and regulations.	⚠
Do not try to disassemble, repair, or modify this product. Doing so may cause the safety functions to stop working properly.	⚠
Do not use the Safety Light Curtain in environments where flammable or explosive gases are present. Doing so may result in explosion.	⚠
Perform daily and 6-month inspections for the Safety Light Curtain. Otherwise, the system may fail to work properly, resulting in serious injury.	⚠

Installation

Prevention of Mutual Interference

The emitter and the receiver to be set facing each other should be a pair of the same set. Erroneous combination may create a zone where objects cannot be detected.	⚠
Do not use a sensor system in a reflective configuration. Doing so may hinder detection. Mirrors can be used change the optical route.	⚠
When using more than 1 set of Safety Light Curtain, install them so that mutual interference does not occur, such as by configuring series connections or using physical barriers between adjacent sets.	⚠

Precautions for Safe Use

Do not used the product in atmospheres or environments that exceed product ratings

Installation

Prevention of Mutual Interference

For series connection

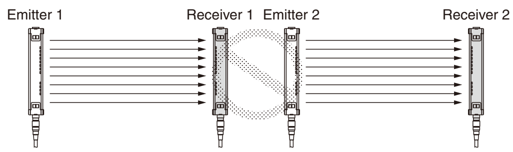
Refer to the "*Precautions for Correct Use*" for individual models for information on preventing mutual interference of linkable Safety Light Curtains.

For no series connection

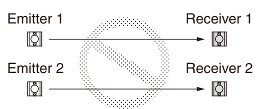
When installing two or more pairs of light curtains independently from each other due to inconvenience of wiring or other reason, take proper measures to prevent mutual interference. If mutual interference occurs, a lockout condition will result for the Safety Light Curtain.

- Installation which may cause mutual interference

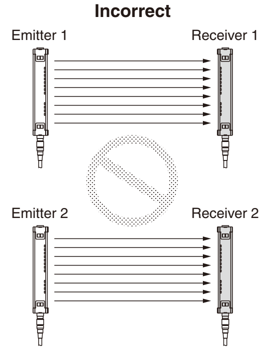
Incorrect



Incorrect



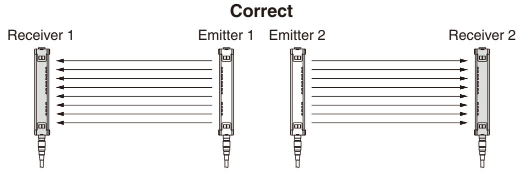
Incorrect



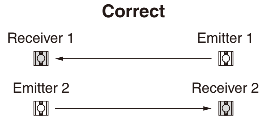
- Installation to prevent mutual interference

(1)Install so that the two light curtains emit in the opposite directions (staggered).

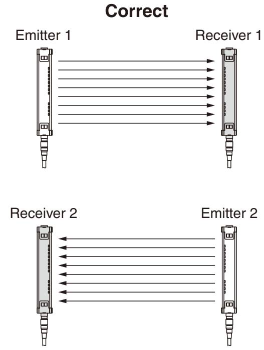
Correct



Correct

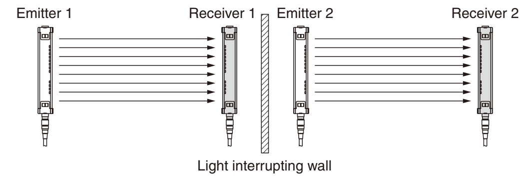


Correct



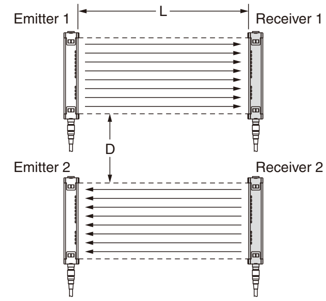
(2)Install a light interrupting wall in between sensors.

Correct

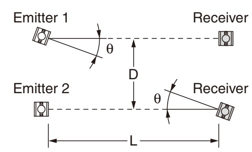


(3)Install the light curtains facing away from the one another to eliminate mutual interference.

Correct



Correct



θ= 5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ= 10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.26 m	0.52 m
For 3 m or more	L x tan5° = L x 0.088 (m)	L x tan10° = L x 0.18 (m)

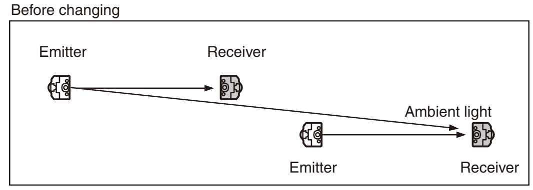
Operating range

Chattering may occur in the output when the distance between the emitter and the receiver is less than 0.2 m. Use only in the rated operating range.

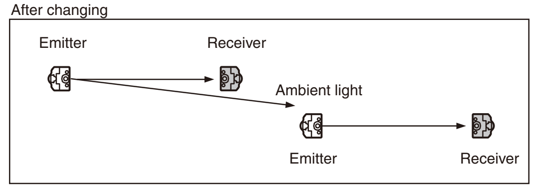
(4)Use a spatter protection slit cover. (F3SN and F3SH)

(5)Shorten the detection distance by setting with a setting tool. (F3SJ)

Before changing



After changing



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.2

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

F3SL

20-m long-distance detection. Safety light curtain (Type 4) is ideal for detection of intrusion of human bodies in large machines and conveyor lines.

- Complies with IEC standards, EN standards, and North American standards. EC-based certification from TÜV for EU machine directives. Can be used as a safety guard for satisfaction of OSHA requirements for on-site labor safety in North America.
- Special controller not needed. Detection of human body intrusion is possible using just the sensor unit.
- Includes “Start/restart interlock function” to prevent automatic reset of output.
- Includes floating blanking function (disables 1 or 2 unspecified beam) and channel select (fixed blanking: disables specified light)
- Built-in MPCE (external relay) monitor. Back-check is possible without a controller.

Be sure to read the *“Safety Precautions”* on page 6 and the *“Precautions for All Safety Sensors”* .

Ordering Information

Main Unit

Infrared

Sensor type	Appearance	Detecting distance	Operating mode	Detection width (mm)	Model
Through-beam		0.3 to 20 m	Light ON	351	**F3SL-A0351P30**
				523	**F3SL-A0523P30**
				700	**F3SL-A0700P30**
				871	**F3SL-A0871P30**
				1,046	**F3SL-A1046P30**
				1,219	**F3SL-A1219P30**
				1,394	**F3SL-A1394P30**
				1,570	**F3SL-A1570P30**
				1,746	**F3SL-A1746P30**
				1,920	**F3SL-A1920P30**
				2,095	**F3SL-A2095P30**

Accessories (Order Separately)

Special Cables (please order one each for the emitter and the receiver)

Cable length	Specifications	Model	
		For emitter	For receiver
10 m	Connector	**F39-JL10A-L**	**F39-JL10A-D**
15 m		**F39-JL15A-L**	**F39-JL15A-D**
30 m		**F39-JL30A-L**	**F39-JL30A-D**

Mirrors (12% detection distance attenuation)

Mirror material	Width (mm)	Thickness (mm)	Length (mm)	Model
Glass mirror	145	32	406	**F39-MLG0406**
			610	**F39-MLG0610**
			711	**F39-MLG0711**
			914	**F39-MLG0914**
			1,067	**F39-MLG1067**
			1,219	**F39-MLG1219**
			1,422	**F39-MLG1422**
			1,626	**F39-MLG1626**
			1,830	**F39-MLG1830**
			2,134	**F39-MLG2134**

Specifications

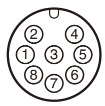
Item / Model	F3SL-A0351P30	F3SL-A0523P30	F3SL-A0700P30	F3SL-A0871P30	F3SL-A1046P30	F3SL-A1219P30	F3SL-A1394P30	F3SL-A1570P30	F3SL-A1746P30	F3SL-A1920P30	F3SL-A2095P30
Sensing distance	0.3 to 20 m										
Beam gap (P)	22 mm										
Number of beams (n)	16	24	32	40	48	56	64	72	80	88	96
Protective height (PH)	351 mm	523 mm	700 mm	871 mm	1,046 mm	1,219 mm	1,394 mm	1,570 mm	1,746 mm	1,920 mm	2,095 mm
Detection capability	Opaque objects, 30 mm in diameter or greater (52 mm or 74 mm in diameter when using floating blanking)										
Directional angle	Emitter/receiver: ±2.5° or less each (based on IEC61496-2 at detection distance of 3 m or greater)										
Light source (emitted wavelength)	Infrared LED (850 nm)										
Power supply voltage	24 VDC ±20% including 5% ripple (p-p)										
Startup waiting time	3 s max.										
Current consumption	Emitter: 285 mA or less, receiver: 1.4 mA or less (including load output current)										
Control outputs	Two PNP transistor outputs, load current 500 mA or less (residual voltage 2 V or less) (excluding voltage drop due to cable extension), Light ON										
Auxiliary output	Same signal as control output: one PNP transistor output (non-safety output), load current 100 mA or less (residual voltage 1 V or less) (excluding voltage drop due to cable extension)										
Protective circuits	Output load short circuit protection, reverse power connection protection										
Safety functions	• Start/restart interlock function (select enable/disable with switch) • Blanking functions (1) Channel select (fixed blanking) (2) Floating blanking (3) No blanking (initial setting) Select (1), (2), or (3) with switch. The beams for (1) blanking are determined by the teaching program.										
Diagnosis functions	• Self diagnosis functions when the power is turned on • External relay (MPCE) monitor function (connect external relay monitor input wire to contact b of external relay, 50 mA 24 V DC)										
Response time ON→OFF	20 ms max.				25 ms max.			30 ms max.		35 ms max.	
Ambient temperature	Operating/Storage: 0 to 55°C (with no icing or condensation)										
Ambient humidity	Operating/Storage: 35% to 95% (with no condensation)										
Vibration resistance	Malfunction/destruction: 10 to 50 Hz, 0.7-mm amplitude 20 sweeps each in X, Y, and Z directions										
Shock resistance	Malfunction: 100 m/s^2, 1,000 times each in X, Y, and Z directions										
Degree of protection	IEC Standard IP65										
Connection method	M12 Connector										
Weight (packed state)	11 kg max.										
Material Case	Aluminum										
Accessories	Test load, mounting clamps (upper/lower), Instruction Manual, special hex wrench for program button access, test load resistors (510 Ω, 2 resistors), surge protector (2)										
Applicable standards	IEC (EN) 61496-1 TYPE4 ESPE *1 , IEC61496-2 TYPE4 AOPD *2										

*1. ESPE (Electro-Sensitive Protective Equipment)
*2. AOPD (Active Opto-electronic Protective Devices)

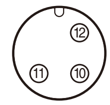
Connections

Wiring Method

Receiver Connector

Front view diagram	Pin No.	Signal name Receiver	Wire color of special cable
	1	Control output 1	Orange
	2	0 V	Brown
	3	Shielded	---
	4	+24 VDC	White
	5	Auxiliary output (AUXILIARY)	Purple
	6	MPCE monitor	Pink
	7	Start	Gray
	8	Control output 2	Yellow

Emitter Connector

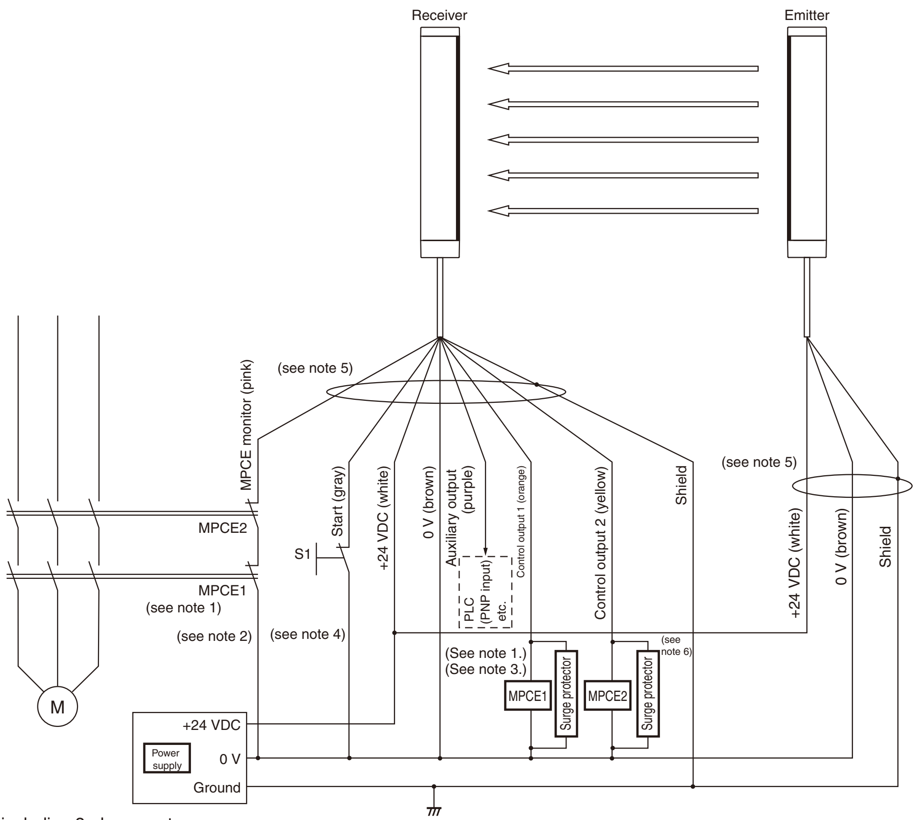
Front view diagram	Pin No.	Signal name Emitter	Wire color of special cable
	10	Shielded	---
	11	+24 VDC	White
	12	0 V	Brown

Special Cables (Purchase Separately)

For emitter (3-pin)		For receiver (8-pin)		Cable length
F39-JL10A-L	Black connector	F39-JL10A-D	Red connector	10 m
F39-JL15A-L		F39-JL15A-D		15 m
F39-JL30A-L		F39-JL30A-D		30 m

Note: Please order one each for the Emitter and the Receiver.

Wire the F3SL only after all power has been turned OFF.

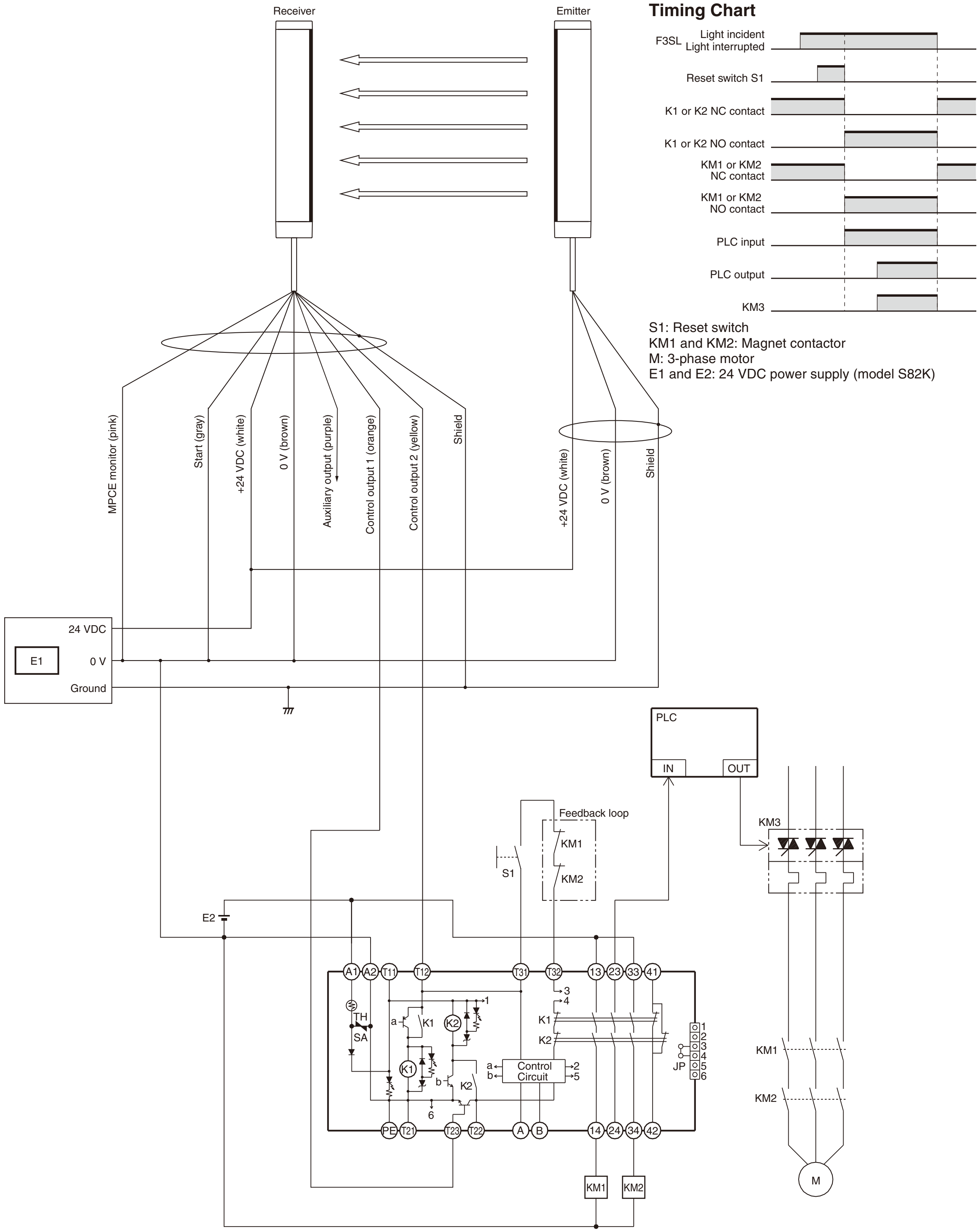


M: Mechanical drive unit including 3-phase motor
S1: Start switch for interlock reset (NC contact)
MPCE1, MPCE2: Contactor or relay with forcibly guide mechanism (G7SA is recommended)

Note: 1. Please use a relay with a forcibly guided contact (such as the G7SA) for MPCE1 and MPCE2, which are relays that perform ultimate control of the machine.
2. If you do not intend to use the MPCE monitor function, short the MPCE monitor line (pink) to power supply 0 V.
3. If a load is not connected to control output 1 and control output 2, an error will result and normal operation will not take place. For testing purposes during installation or at other times, connect the 510 Ω resistors included with the operation manual to the MPCE1 and MPCE2 positions.
4. If you intend to use auto start mode, short the start line (gray) to power supply 0 V.
5. Take care when wiring not to make any mistakes regarding the cable colors. In particular, the wire colors of the power supply line (+ 24 V DC: white, 0 V: brown) are different from the regular sensor wires.
6. Connect the provided surge protector in parallel with MPCE1 and MPCE2.

Connection with OMRON G9SA-301 Safety Relay Unit (Category 4)

When connecting the F3SL to the G9SA-301, disable the F3SL's start/restart interlock and the external relay (MPCE) monitoring functions, and use the equivalent functions in the G9SA-301 instead.



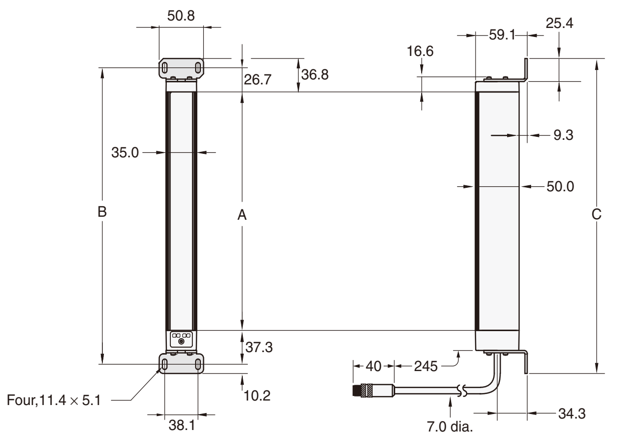
S1: Reset switch
KM1 and KM2: Magnet contactor
M: 3-phase motor
E1 and E2: 24 VDC power supply (model S82K)

Dimensions

(Unit: mm)

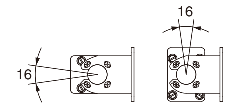
Main Unit

F3SL



A = Detection width B = A + 64.0 C = A + 84.3

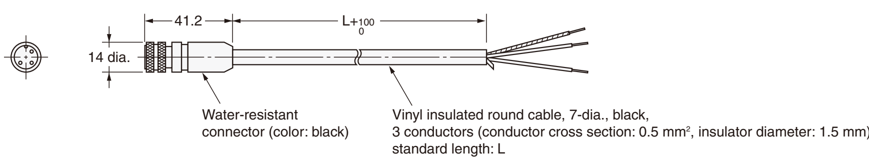
Mounting Bracket Adjustment Angles



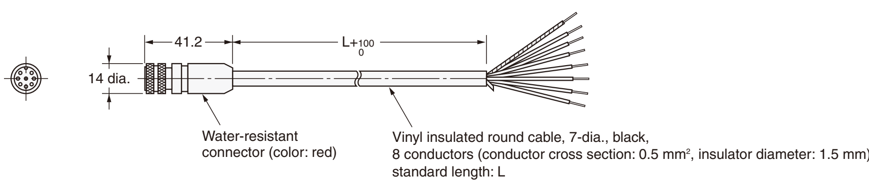
Model	A (mm)	B (mm)	C (mm)
F3SL-A0351P30	351	415	435.3
F3SL-A0523P30	523	587	607.3
F3SL-A0700P30	700	764	784.3
F3SL-A0871P30	871	935	955.3
F3SL-A1046P30	1,046	1,110	1,130.3
F3SL-A1219P30	1,219	1,283	1,303.3
F3SL-A1394P30	1,394	1,458	1,478.3
F3SL-A1570P30	1,570	1,634	1,654.3
F3SL-A1746P30	1,746	1,810	1,830.3
F3SL-A1920P30	1,920	1,984	2,004.3
F3SL-A2095P30	2,095	2,159	2,179.3

Accessories (Order Separately)

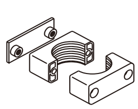
Special Cable (for emitter)
F39-JL10A-L (L = 10 m)
F39-JL15A-L (L = 15 m)
F39-JL30A-L (L = 30 m)



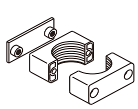
Special Cable (for receiver)
F39-JL10A-D (L = 10m)
F39-JL15A-D (L = 15m)
F39-JL30A-D (L = 30m)

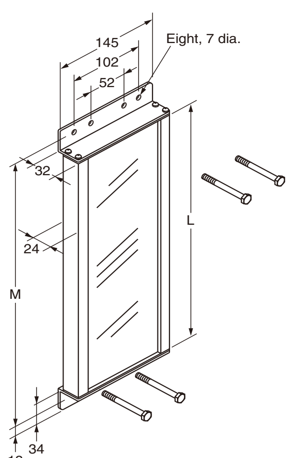


Mirrors
F39-MLG□



Post (42 ±1 dia.) mounting clamps (included)





Model	L (mm)	M (mm)
F39-MLG0406	445	487
F39-MLG0610	648	690
F39-MLG0711	749	792
F39-MLG0914	953	995
F39-MLG1067	1,105	1,148
F39-MLG1219	1,257	1,300
F39-MLG1422	1,461	1,503
F39-MLG1626	1,664	1,706
F39-MLG1830	1,867	1,910
F39-MLG2134	2,172	2,214

Safety Precautions

Regulations and Standards

- “Type Certification” specified in the Chapter 44. 2 of the Industrial Safety and Health Law in Japan does not apply to independent F3SL Sensors. This law applies to systems incorporating the Sensor. When using the F3SL Sensor in Japan as a “safety device for presses or shearing machines,” as specified in the Chapter 42 of the same law, apply for certification for the overall system.
- The F3SL is classified under electro-sensitive protective equipment (ESPE) in the European Union (EU) Machinery Directive Annex IV, B, Safety Components, Item 1.
- The following certification have been obtained for the F3SL from EU Certification Bodies: EC type certification (type 4 ESPE) under the Machinery Directive from TÜV Rheinland.

WARNING

Installation Conditions

Refer to “*Precautions for All Safety Sensors*” for installation conditions.

Safety Distance

Always maintain a safe distance (S) between the F3SL and a hazardous part of a machine.
Failure to do so causes the machine to fail to stop before an operator reaches the dangerous area and may result in serious injury.

<Reference>

Method for calculating safety distance as provided by International Standard ISO 13855-2002 (European Standard EN 999-1999) (for intrusion perpendicular to the detection zone)

Substitute K = 2,000 mm/s and C = 8 (d – 14 mm) in equation (1) and calculate as shown below.

S = 2,000 mm/s × (Tm + Ts) + 8 (d – 14 mm) .... (2)
Where: S = Safety distance (mm)
Tm = Machine response time (s) *1
Ts = Safety light curtain response time (s) *2
d = Detection capability of the safety light curtain (mm)

Example:
Tm = 0.05 s, Ts = 0.020 s, d = 30 mm:
S = 2,000 mm/s × (0.05 s + 0.020 s) + 8 (30 mm – 14 mm) = 268 mm

Use S = 100 mm if the result of equation (2) is less than 100 mm.
Recalculate using the following equation with K = 1,600 mm/s if the result is over 500 mm.

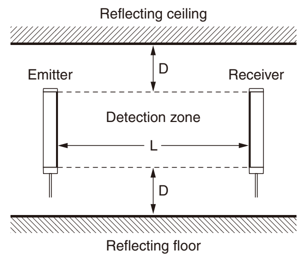
S = 1,600 mm/s × (Tm + Ts) + 8 (d – 14 mm) .... (3)
Use S = 500 mm if the result from equation (3) is less than 500 mm.

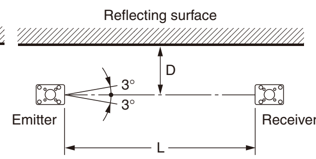
*1. The machine response time is the maximum time from the moment the machine receives a stop signal to the moment the hazardous part of the machine stops.
*2. The light curtain response time is the time required for output to change from ON to OFF.

Distances from Reflective Surfaces

Be sure to install the F3SL to minimize the effects of reflection from nearby surfaces.
Failure to do so may cause detection to fail and may result in serious injury.

Side view **Top view**





Install the F3SL with minimum Distance D shown above from reflective surfaces (highly reflective surfaces) such as metal walls, floors, ceilings, and work pieces.

Distance between emitter and receiver (Operating range L)	Minimum installation distance D
0.2 to 3 m	0.16 m
3 to 20 m	L × tan 3° = L × 0.052 (m)

Precautions for Correct Use

Do not used the product in atmospheres or environments that exceed product ratings
Refer to “*Precautions for All Safety Sensors*” for information on preventing mutual interference.

Safety Functions

Blanking Functions

The F3SL supports both floating blanking (a function that ignores one or two non-specific broken beams) and channel selection (also called fixed blanking, a function to disable specified beams). These functions are disabled in the factory settings.

Channel Selection: Fixed Blanking

This function disables specified beams, e.g., those that would be interrupted by jigs or tools. The beams to be disabled can be taught using built-in switches while interrupting the beams to be disabled. When the interrupting objects are removed from the disabled beams, the control output will turn OFF and safety can be maintained. The beams to be disabled can be selected from any or all of the beams in the detection area except for the bottom two beams (i.e., the beams closest to the cable). Depending on the beams that are disabled, the size of the smallest detectable object may increase.

Floating Blanking

Floating blanking can be used to disable one or two unspecified beams except for the bottom two beams (i.e., the beams closest to the cable). This function is useful when part of the machine or workpieces interrupts one or two beams during movement.
The smallest detectable object size is increased from a 30-mm diameter to a 52-mm diameter for one-beam floating and to a 74-mm diameter for 2-beam floating. This will increase the safety distance.

Start/Restart Interlocks

Auto-start (Factory Setting)

The Sensor will start in an OFF state when the power is turned ON and then the control output will be turned ON automatically after the Sensor has confirmed that none of the beams are interrupted. From then on, the Sensor will turn OFF the control output when beams are interrupted and turn ON the control output when beam interruption stops.

Start Interlock

The Sensor will start in an OFF state when the power is turned ON and remain interlocked in an OFF state. The control output will not be turned ON even if all of the beams are no longer interrupted. When the start switch (NC contact) is opened when there are no beams interrupted, the interlock status will be released and the control output will turn ON. From then on, the Sensor will turn OFF the control output when beams are interrupted and turn ON the control output when beam interruption stops. The interlock indicator lights yellow to show the interlock status.

Start/Restart Interlock

The Sensor will start in an OFF state when the power is turned ON or after beams are interrupted and remain interlocked in an OFF state. The control output will not be turned ON even if all of the beams are no longer interrupted. When the start switch (NC contact) is opened when there are no beams interrupted, the interlock status will be released and the control output will turn ON. The control output will never turn ON automatically. The interlock indicator lights yellow to show the interlock status.

Note: 1. Install the switch to release the interlock outside of the hazardous area but in a location where the hazardous area can be seen well.
2. Refer to the Instruction Manual (SCEE-712) for instructions on setting the mode switch.

Self-diagnosis Functions

Power ON Self Diagnosis

Self diagnosis is performed for 3 seconds after the power supply is turned ON to the F3SL. If no errors are found, normal operation will be started.

Errors

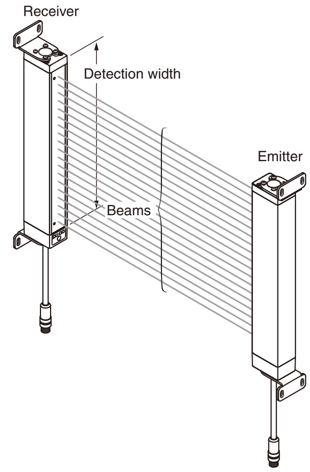
If an error is found in self diagnosis, the F3SL will immediately turn OFF the control output and the type of error will be shown on the indicators. When the cause of the error has been removed, the F3SL will clear the error status and return to normal operation unless an external relay monitor input error has occurred when the control output was ON. The power supply must be turned OFF and ON to clear these errors.

External Relay (MPCE) Monitoring (MPCE: Machine Primary Control Element)

This function monitors the state of the NC contact to detect fused relays or other operating faults in external relays or contactors controlling hazardous parts of machines. This function is provided as a standard feature on the F3SL. Connect the NC contact of the external relay to the MPCE monitor input line of the Receiver. The external relay monitor input will be constantly monitored and, if the correct logical relationship between the control output and the external relay monitor input is not kept, the F3SL will enter error status and immediately turn OFF the control output.
Although there is a delay (reset time) between the control output turning OFF and the NC contact closing, the F3SL will not treat any delay up to 300 ms as an error and will continue normal operation.
To ensure the correct usage of this function, a Safety Relay with forcibly guided contacts, such as the G7SA, must be used. A switch can be set to disable the MPCE function.

Detection Area (Detection Width)

The detection width extends to both ends of the filter on the front (i.e., to the caps on both ends of the Sensor.) There are light interruption indicates next to the top and bottom beams on the Receiver that light when the beams are interrupted. Use these as a guide for the detection width and when aligning beams.



Precautions for All Safety Sensors

Note: Refer to the "*Safety Precautions*" section for each Sensor for specific precautions applicable to each Sensor.

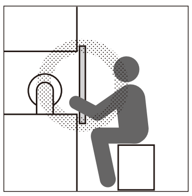
WARNING

Installation Conditions

Detection Zone and Intrusion Path

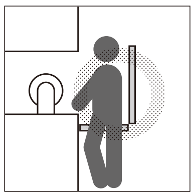
Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas.
If a person is able to step into the hazardous area of a machine and remain behind the Safety Light Curtain's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

Correct Installation



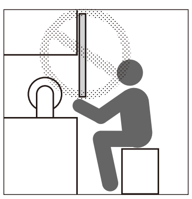
A person can only reach the hazardous part of the machinery by passing through the sensor's detection zone.

Correct Installation



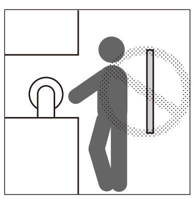
A person enters the detection zone during operation.

Incorrect Installation



A person can reach the hazardous part of the machinery without passing through the sensor's detection zone.

Incorrect Installation



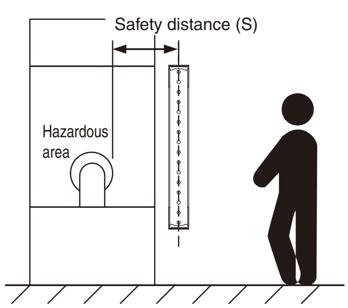
A person is between the sensor's detection zone and the hazardous part of the machinery.

Install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

The Safety Light Curtain cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

Safety Distance

The safety distance is the distance that must be set between the Safety Light Curtain and a machine's hazardous part to stop the hazardous part before a person or object reaches it. The safety distance varies according to the standards of each country and the individual specifications of each machine. In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the Safety Light Curtain. Always refer to relevant standards.



Make sure to secure the safety distance (S) between the Safety Light Curtain and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Note: The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops.
Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

How to calculate the safety distance specified by International standard ISO13855-2002 (European standard EN999-1999) (Reference)

If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.

S = K x T + C . . . Eq. (1)

- S: Safety distance
- K: Approach speed to the detection zone
- T: Total response time of the machine and Safety Light Curtain
- C: Additional distance calculated by the detection capability of the Safety Light Curtain

<System that has detection capability of 40 mm max.>
Use K = 2,000 mm/s and C = 8 x (d - 14 mm) in equation (1) for the calculation.
S = 2,000 mm/s x (Tm + Ts) + 8 x (d - 14 mm)

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s) *
- d = Size of Safety Light Curtain's detection capability (mm) *

* These values differ depending on the Switch. Refer to the "*Precautions for Correct Use*" for the Switch you are using.

[Calculation example]
When Tm = 0.05 s, Ts = 0.01 s, and d = 14 mm:
S = 2,000 mm/s x (0.05 s + 0.01 s) + 8 x (14 mm - 14 mm)
= 120 mm . . . Eq. (2)
If the result is less than 100 mm, use S = 100 mm.
If the result exceeds 500 mm, use the following equation where K = 1,600 mm/s.
S = 1,600 mm/s x (Tm + Ts) + 8 x (d - 14 mm) . . . Eq. (3)
If the result of this Eq. (3) is less than 500 mm, use S = 500 mm.

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 40 mm or Systems Using Multi-beam Safety Sensors>

Assuming K = 1,600 mm/s and C = 850 mm, the following calculation is made using Eq. (1).
S = 1,600 mm/s x (Tm + Ts) + 850 … Eq. 4,

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s)

Calculation example:
When Tm = 0.05 s and Ts = 0.01 s,
S = 1,600 mm/s x (0.05 s + 0.01 s) + 850 mm = 946 mm

How to calculate the safety distance specified by American standard ANSI B11.19
(Reference)

<Systems with a Smallest Detectable Object Size (Diameter) Less than 64 mm>
If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.
S = K x (Ts + Tc + Tr + Tbm) + Dpf

- S: Safety distance
- K: Approach speed to the detection zone (the value recommended by OSHA standard is 1,600 mm/s)

Approach speed K is not specified in the ANSI B.11.19 standard. To determine the value of K to apply, consider all factors, including the operator's physical ability.

- Ts = Machine's stop time (s)
- Tr = Response time of the Safety Light Curtain from ON to OFF (s)
- Tc = Machine control circuit's maximum response time required to activate its brake (s)
- Tbm = Additional time (s)

If a machine has a brake monitor, "Tbm = Brake monitor setting time - (Ts + Tc)". If it has no brake monitor, we recommend using 20% or more of (Ts + Tc) as additional time.

- Dpf = Additional distance

According to ANSI's formula, Dpf is calculated as shown below:
Dpf = 3.4 x (d - 7.0): Where d is the detection capability of the Safety Light Curtain (unit: mm)

[Calculation example]
When K = 1,600 mm/s, Ts + Tc = 0.06 s, brake monitor setting time = 0.1 s, Tr = 0.01 s, d = 14 mm:
Tbm = 0.1 - 0.06 = 0.04 s
Dpf = 3.4 x (14 - 7.0) = 23.8 mm
S = 1,600 x (0.06 + 0.01 + 0.04) + 23.8 = 199.8 mm

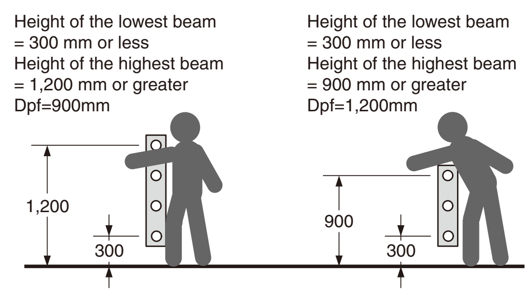
Method for Calculating the Safety Distance as Provided by ANSI/RIA R15.06 (USA)
(Reference)

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 64 mm and Less than 600mm>
The safety distance is calculated based on the following concepts when the human body intrudes perpendicular to the detection zone of the Safety Light Curtain.
S = K x (Ts + Tc + Tr) + Dpf

- S: Safety distance
- K = Intrusion speed into detection zone (1,600 mm/s min. recommended by OSHA)
- Ts = Stop time of machine/equipment (s)
- Tr = Light curtain ON-to-OFF response time (s)
- Tc = Maximum response time of the machine/equipment braking circuit required to operate the brake (s)
- Dpf = Additional distance (mm)

If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 1,200 mm or higher, the Dpf will be 900 mm.
If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 900 mm or higher, the Dpf will be 1,200 mm.

[Calculation example]
K = 1,600 mm/s, Ts + Tc = 0.06s,
If Tr = 0.01 s and Dpf = 900 mm:
S = 1,600 x (0.06 + 0.01) + 900 = 1,012 mm

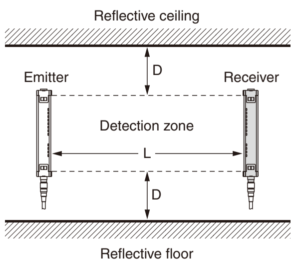


Distance from Glossy Surface

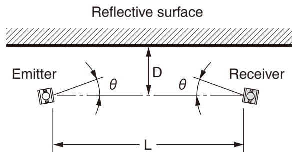
Install the sensor system so that it is not affected by reflection from a glossy surface. Failure to do so may hinder detection, resulting in serious injury.

Install the sensor system at distance D or further from highly reflective surfaces such as metallic walls, floors, ceilings, or workpieces, as shown below.

<Side View>



<Top View>



θ=5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ=10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.13 m	0.26 m
For 3 m or more	L/2 x tan5° = L x 0.044 (m)	L/2 x tan10° = L x 0.088 (m)

Others

To use the Safety Light Curtain in PSDI mode (restart of cycle operation by the sensor), you must configure an appropriate circuit between the Safety Light Curtain and the machine. For details about PSDI, refer to OSHA1910.217, IEC61496-1, and other relevant standards and regulations.

Do not try to disassemble, repair, or modify this product. Doing so may cause the safety functions to stop working properly.

Do not use the Safety Light Curtain in environments where flammable or explosive gases are present. Doing so may result in explosion.

Perform daily and 6-month inspections for the Safety Light Curtain. Otherwise, the system may fail to work properly, resulting in serious injury.

Installation

Prevention of Mutual Interference

The emitter and the receiver to be set facing each other should be a pair of the same set. Erroneous combination may create a zone where objects cannot be detected.

Do not use a sensor system in a reflective configuration. Doing so may hinder detection.
Mirrors can be used change the optical route.

When using more than 1 set of Safety Light Curtain, install them so that mutual interference does not occur, such as by configuring series connections or using physical barriers between adjacent sets.

Precautions for Safe Use

Do not used the product in atmospheres or environments that exceed product ratings

Installation

Prevention of Mutual Interference

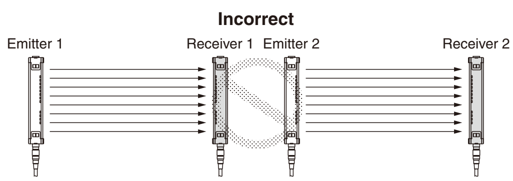
For series connection

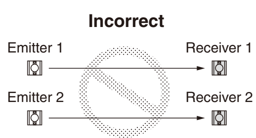
Refer to the "*Precautions for Correct Use*" for individual models for information on preventing mutual interference of linkable Safety Light Curtains.

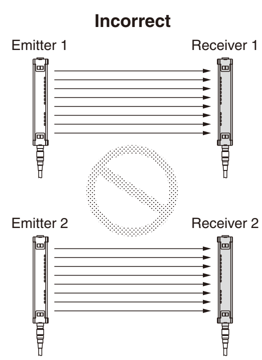
For no series connection

When installing two or more pairs of light curtains independently from each other due to inconvenience of wiring or other reason, take proper measures to prevent mutual interference. If mutual interference occurs, a lockout condition will result for the Safety Light Curtain.

- Installation which may cause mutual interference

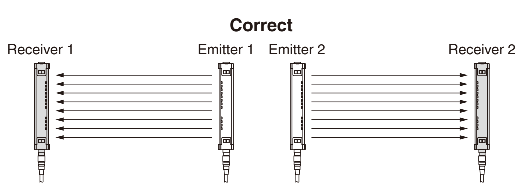


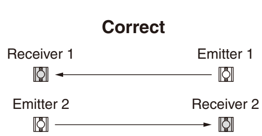


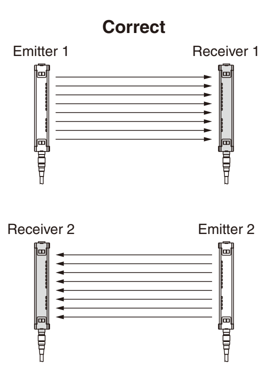


- Installation to prevent mutual interference

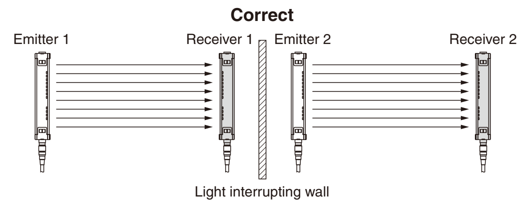
(1)Install so that the two light curtains emit in the opposite directions (staggered).



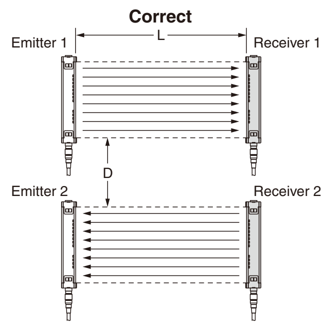


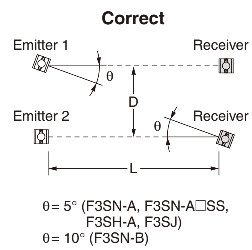


(2)Install a light interrupting wall in between sensors.



(3)Install the light curtains facing away from the one another to eliminate mutual interference.





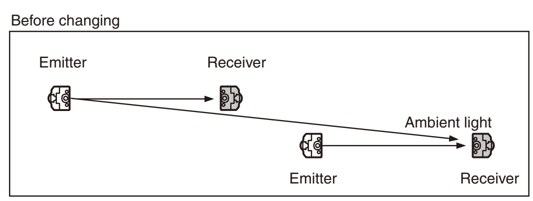
Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.26 m	0.52 m
For 3 m or more	L x tan5° = L x 0.088 (m)	L x tan10° = L x 0.18 (m)

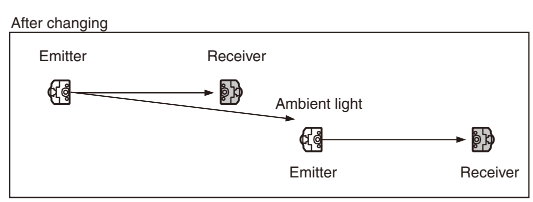
Operating range

Chattering may occur in the output when the distance between the emitter and the receiver is less than 0.2 m. Use only in the rated operating range.

(4)Use a spatter protection slit cover. (F3SN and F3SH)

(5)Shorten the detection distance by setting with a setting tool. (F3SJ)





WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.1

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Safety Light Curtain/Multi-beam Safety Sensor
F3SN-A/F3SN-B/F3SH-A

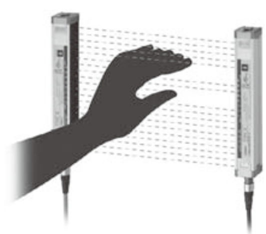
- Lineup includes Type-4 Sensors (F3SN-A/F3SH-A) and Type-2 Sensors (F3SN-B) with IEC, EN, and JIS standard certification.
  EC Machine Directive compliance (from DEMKO).
  USA UL compliance for applications for the USA or Canada.
- Protective height equals the Sensor length to perfectly meet user needs.
- Protective height: 189 to 1,822 mm
  Operating range: 7 or 10 m
- Setting Console enabling setting parameters for any model.
- LED bar for beam alignment or easy confirmation in error mode.
- A complete lineup of accessories.

⚠ Be sure to read the *"Safety Precautions"* on page 28 and the *"Precautions for All Safety Sensores"*.

Features

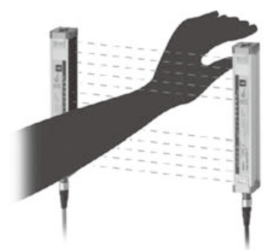
Two Forms of Safety from OMRON: Safety Light Curtains and Multibeam Safety Sensors

Safety Light Curtains for Finger Protection



F3SN-A□□□□P14
- Operating range: 7 m
- Smallest detectable object: 14 mm dia. (beam gap: 9 mm)
- Protective height: 189 to 1,125 mm

Safety Light Curtains for Hand Protection



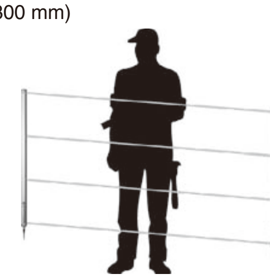
F3SN-A□□□□P25
F3SN-B□□□□P25
- Operating range: 10 m
- Smallest detectable object: 25 mm dia. (beam gap:15 mm)
- Protective height: 217 to 1,822 mm

Presence Detection in Danger Zones (Horizontal Installation)

F3SN-A□□□□P40/P70
F3SN-B□□□□P40/P70
- Operating range: 10 m
- Smallest detectable object: 40 mm dia. (beam gap: 30 mm) or 70 mm dia. (beam gap: 60 mm)
- Protective height:
  F3SN-A: 217 to 1,822 mm
  F3SN-B: 217 to 1,777 mm

Multi-beam Safety Sensor for Body Protection

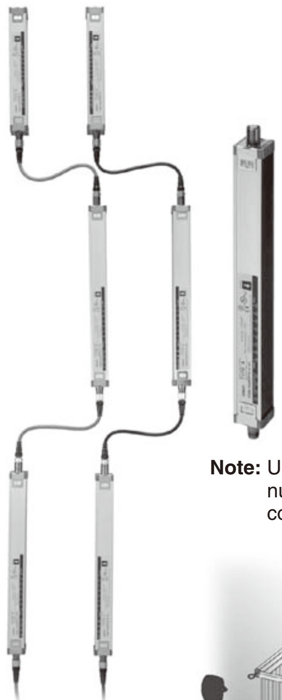
F3SN-A09P03
- Operating range: 10 m
- Number of beams: 4 (beam gap: 300 mm)



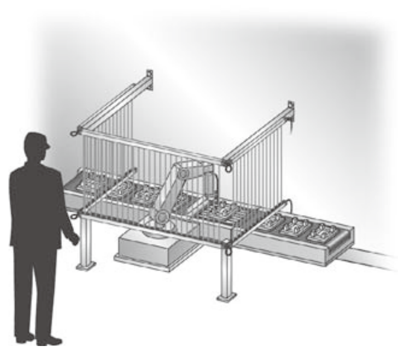
A New Concept to Meet User Needs

Connect Up To Three Sets in Series without Mutual Interference

Combine Standard Models with Linking Models with Connectors to connect up to three sets in series. Wiring is required only for one set instead of wiring all three sets, as would have been required previously, to enable protecting all sides of hazardous areas. Mutual interference protection is also provided.

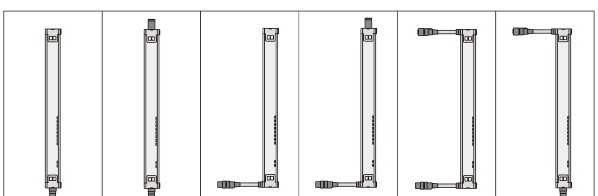


Note: Use models with the following model number suffixes for series connection: -01, -03, -04, and -05



Many Connector Variations

Select the type of connector that best suits the machine. (Consult your OMRON representative.)



Standard: No model No. suffix	Model No. suffix: -01	Model No. suffix: -02	Model No. suffix: -03	Model No. suffix: -04	Model No. suffix: -05

Various Safety Functions Built into the Sensor. Supports Many Safety Circuit Configurations

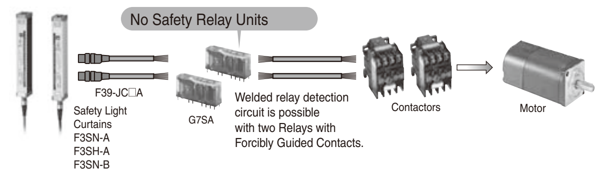
- Interlocks
- Auto-reset or manual reset
- External relay monitoring

Select the Safety Circuits for the Required Safety Standards

Build Circuits for Type 4 (F3SN-A/F3SH-A) or Type 2 (F3SN-B) with No Relay Units (2 Relays with Forcibly Guided Contacts)

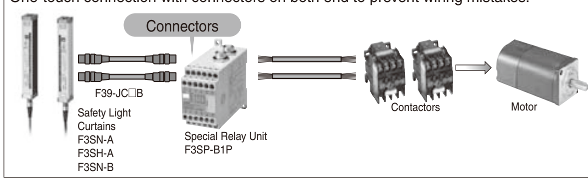
- Reduced Costs and Reduced Space Requirements

A built-in external relay monitor function eliminates the need for Safety Relay Units.



- Reduced Wiring and Easy Maintenance

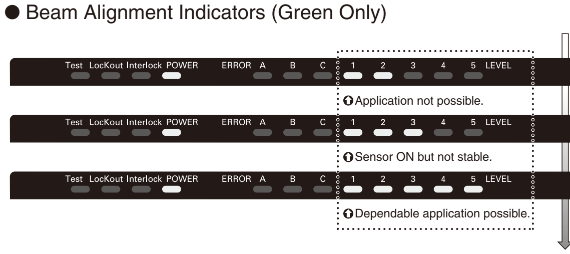
One-touch connection with connectors on both end to prevent wiring mistakes.



LED Bars for Easier Application

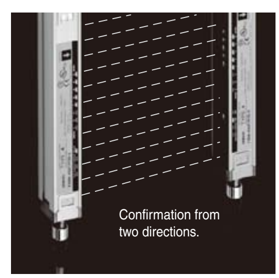
Align Beams with the LED Bar for Easier Installation

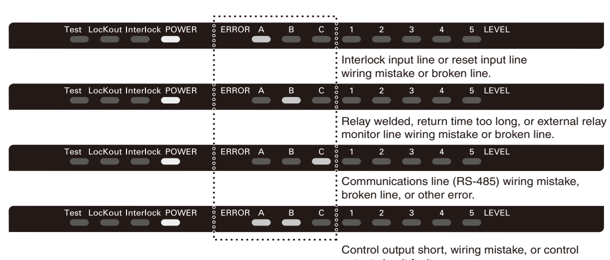
- Beam Alignment Indicators (Green Only)



Easily Discern Error Mode Displays to Back Up Safety

- Error Indication Example (Red Only)





Ordering Information

Main Units (Connecting Cables are not included with the Main Units. The connecting cables must be purchased separately.)

F3SN-A Safety Light Curtains (Type 4)

Infrared

Detection capability	Beam gap	Appearance	Operating range	Number of beams	Protective height	Connector for series-connection	Model *1 *2
14 mm-dia. (for finger protection)	9 mm		0.2 to 7 m	21 to 125 (odd numbers only)	189 to 1125 mm (every 18 mm)	No	**F3SN-A□□□□P14**
						Yes	**F3SN-A□□□□P14-01**
25 mm-dia. (for hand protection)	15 mm		0.2 to 10 m	13 to 120	217 to 1822 mm (every 15 mm)	No	**F3SN-A□□□□P25**
						Yes	**F3SN-A□□□□P25-01**
40 mm-dia. (for presence protection)	30 mm			7 to 60	217 to 1807 mm	No	**F3SN-A□□□□P40**
						Yes	**F3SN-A□□□□P40-01**
70 mm-dia. (for presence detection)	60 mm			5 to 30	277 to 1777 mm	No	**F3SN-A□□□□P70**
						Yes	**F3SN-A□□□□P70-01**

*1. The □□□□ in the model numbers indicates the protective height (in mm). Refer to *"Safety Light Curtain Model List"* on page 4 for model number details.
*2. Safety Light Curtains with model numbers ending in -02 through -05, provided with different connector configurations, are also available as options. Consult with your dealer or OMRON representative when ordering these models.

F3SN-B Safety Light Curtains (Type 2)

Infrared

Detection capability	Beam gap	Appearance	Operating range	Number of beams	Protective height	Output *1	Connector for series-connection	Model *2 *3
25 mm-dia. (for hand protection)	15 mm		0.2 to 10 m	13 to 119 (non-continuous)	217 to 1807 mm	PNP transistor output	No	**F3SN-B□□□□P25**
							Yes	**F3SN-B□□□□P25-01**
40 mm-dia. (for presence detection)	30 mm			7 to 60 (non-continuous)	217 to 1807 mm		No	**F3SN-B□□□□P40**
							Yes	**F3SN-B□□□□P40-01**
70 mm-dia. (for presence detection)	60 mm			5 to 30	277 to 1777 mm		No	**F3SN-B□□□□P70**
							Yes	**F3SN-B□□□□P70-01**

*1. Models with NPN transistor outputs are also available as options. For details on the method for securing safety by using an NPN transistor for output, contact your OMRON representative.
*2. The □□□□ in the model numbers indicates the protective height (in mm). Refer to *"Safety Light Curtain Model List"* on page 4 for model number details.
*3. Safety Light Curtains with model numbers ending in -02 through -05, provided with different connector configurations, are also available as options. Consult with your dealer or OMRON representative when ordering these models.

F3SH-A Multi-beam Safety Sensors (Type 4)

Infrared

Beam gap	Appearance	Operating range	Number of beams	Outermost beam gap	Connector for series-connection	Model *
300 mm (for whole body protection)		0.2 to 10 m	4	900 mm	No	**F3SH-A09P03**
					Yes	**F3SH-A09P03-01**

* Safety Light Curtains of model numbers ending in -02 through -05, provided with different connector configurations, are also available as options. Consult with your dealer or OMRON representative when ordering this model.

Safety Light Curtain Model List

: F3SN-B□□□□P□□ safety light curtains are also available.

F3SN-A□□□□P14(-01)

Model	Protective height	Number of beams
F3SN-A0189P14(-01)	189	21
F3SN-A0207P14(-01)	207	23
F3SN-A0225P14(-01)	225	25
F3SN-A0243P14(-01)	243	27
F3SN-A0261P14(-01)	261	29
F3SN-A0279P14(-01)	279	31
F3SN-A0297P14(-01)	297	33
F3SN-A0315P14(-01)	315	35
F3SN-A0333P14(-01)	333	37
F3SN-A0351P14(-01)	351	39
F3SN-A0369P14(-01)	369	41
F3SN-A0387P14(-01)	387	43
F3SN-A0405P14(-01)	405	45
F3SN-A0423P14(-01)	423	47
F3SN-A0441P14(-01)	441	49
F3SN-A0459P14(-01)	459	51
F3SN-A0477P14(-01)	477	53
F3SN-A0495P14(-01)	495	55

Model	Protective height	Number of beams
F3SN-A0513P14(-01)	513	57
F3SN-A0531P14(-01)	531	59
F3SN-A0549P14(-01)	549	61
F3SN-A0567P14(-01)	567	63
F3SN-A0585P14(-01)	585	65
F3SN-A0603P14(-01)	603	67
F3SN-A0621P14(-01)	621	69
F3SN-A0639P14(-01)	639	71
F3SN-A0657P14(-01)	657	73
F3SN-A0675P14(-01)	675	75
F3SN-A0693P14(-01)	693	77
F3SN-A0711P14(-01)	711	79
F3SN-A0729P14(-01)	729	81
F3SN-A0747P14(-01)	747	83
F3SN-A0765P14(-01)	765	85
F3SN-A0783P14(-01)	783	87
F3SN-A0801P14(-01)	801	89
F3SN-A0819P14(-01)	819	91

Model	Protective height	Number of beams
F3SN-A0837P14(-01)	837	93
F3SN-A0855P14(-01)	855	95
F3SN-A0873P14(-01)	873	97
F3SN-A0891P14(-01)	891	99
F3SN-A0909P14(-01)	909	101
F3SN-A0927P14(-01)	927	103
F3SN-A0945P14(-01)	945	105
F3SN-A0963P14(-01)	963	107
F3SN-A0981P14(-01)	981	109
F3SN-A0999P14(-01)	999	111
F3SN-A1017P14(-01)	1017	113
F3SN-A1035P14(-01)	1035	115
F3SN-A1053P14(-01)	1053	117
F3SN-A1071P14(-01)	1071	119
F3SN-A1089P14(-01)	1089	121
F3SN-A1107P14(-01)	1107	123
F3SN-A1125P14(-01)	1125	125

F3SN-A□□□□P25(-01), F3SN-B□□□□P25(-01)

Model	Protective height	Number of beams
F3SN-A0217P25(-01)	217	13
F3SN-A0232P25(-01)	232	14
F3SN-A0247P25(-01)	247	15
F3SN-A0262P25(-01)	262	16
F3SN-A0277P25(-01)	277	17
F3SN-A0292P25(-01)	292	18
F3SN-A0307P25(-01)	307	19
F3SN-A0322P25(-01)	322	20
F3SN-A0337P25(-01)	337	21
F3SN-A0352P25(-01)	352	22
F3SN-A0367P25(-01)	367	23
F3SN-A0382P25(-01)	382	24
F3SN-A0397P25(-01)	397	25
F3SN-A0412P25(-01)	412	26
F3SN-A0427P25(-01)	427	27
F3SN-A0442P25(-01)	442	28
F3SN-A0457P25(-01)	457	29
F3SN-A0472P25(-01)	472	30
F3SN-A0487P25(-01)	487	31
F3SN-A0502P25(-01)	502	32
F3SN-A0517P25(-01)	517	33
F3SN-A0532P25(-01)	532	34
F3SN-A0547P25(-01)	547	35
F3SN-A0562P25(-01)	562	36
F3SN-A0577P25(-01)	577	37
F3SN-A0592P25(-01)	592	38
F3SN-A0607P25(-01)	607	39
F3SN-A0622P25(-01)	622	40
F3SN-A0637P25(-01)	637	41
F3SN-A0652P25(-01)	652	42
F3SN-A0667P25(-01)	667	43
F3SN-A0682P25(-01)	682	44
F3SN-A0697P25(-01)	697	45
F3SN-A0712P25(-01)	712	46
F3SN-A0727P25(-01)	727	47
F3SN-A0742P25(-01)	742	48

Model	Protective height	Number of beams
F3SN-A0757P25(-01)	757	49
F3SN-A0772P25(-01)	772	50
F3SN-A0787P25(-01)	787	51
F3SN-A0802P25(-01)	802	52
F3SN-A0817P25(-01)	817	53
F3SN-A0832P25(-01)	832	54
F3SN-A0847P25(-01)	847	55
F3SN-A0862P25(-01)	862	56
F3SN-A0877P25(-01)	877	57
F3SN-A0892P25(-01)	892	58
F3SN-A0907P25(-01)	907	59
F3SN-A0922P25(-01)	922	60
F3SN-A0937P25(-01)	937	61
F3SN-A0952P25(-01)	952	62
F3SN-A0967P25(-01)	967	63
F3SN-A0982P25(-01)	982	64
F3SN-A0997P25(-01)	997	65
F3SN-A1012P25(-01)	1012	66
F3SN-A1027P25(-01)	1027	67
F3SN-A1042P25(-01)	1042	68
F3SN-A1057P25(-01)	1057	69
F3SN-A1072P25(-01)	1072	70
F3SN-A1087P25(-01)	1087	71
F3SN-A1102P25(-01)	1102	72
F3SN-A1117P25(-01)	1117	73
F3SN-A1132P25(-01)	1132	74
F3SN-A1147P25(-01)	1147	75
F3SN-A1162P25(-01)	1162	76
F3SN-A1177P25(-01)	1177	77
F3SN-A1192P25(-01)	1192	78
F3SN-A1207P25(-01)	1207	79
F3SN-A1222P25(-01)	1222	80
F3SN-A1237P25(-01)	1237	81
F3SN-A1252P25(-01)	1252	82
F3SN-A1267P25(-01)	1267	83
F3SN-A1282P25(-01)	1282	84

Model	Protective height	Number of beams
F3SN-A1297P25(-01)	1297	85
F3SN-A1312P25(-01)	1312	86
F3SN-A1327P25(-01)	1327	87
F3SN-A1342P25(-01)	1342	88
F3SN-A1357P25(-01)	1357	89
F3SN-A1372P25(-01)	1372	90
F3SN-A1387P25(-01)	1387	91
F3SN-A1402P25(-01)	1402	92
F3SN-A1417P25(-01)	1417	93
F3SN-A1432P25(-01)	1432	94
F3SN-A1447P25(-01)	1447	95
F3SN-A1462P25(-01)	1462	96
F3SN-A1477P25(-01)	1477	97
F3SN-A1492P25(-01)	1492	98
F3SN-A1507P25(-01)	1507	99
F3SN-A1522P25(-01)	1522	100
F3SN-A1537P25(-01)	1537	101
F3SN-A1552P25(-01)	1552	102
F3SN-A1567P25(-01)	1567	103
F3SN-A1582P25(-01)	1582	104
F3SN-A1597P25(-01)	1597	105
F3SN-A1612P25(-01)	1612	106
F3SN-A1627P25(-01)	1627	107
F3SN-A1642P25(-01)	1642	108
F3SN-A1657P25(-01)	1657	109
F3SN-A1672P25(-01)	1672	110
F3SN-A1687P25(-01)	1687	111
F3SN-A1702P25(-01)	1702	112
F3SN-A1717P25(-01)	1717	113
F3SN-A1732P25(-01)	1732	114
F3SN-A1747P25(-01)	1747	115
F3SN-A1762P25(-01)	1762	116
F3SN-A1777P25(-01)	1777	117
F3SN-A1792P25(-01)	1792	118
F3SN-A1807P25(-01)	1807	119
F3SN-A1822P25(-01)	1822	120

F3SN-A□□□□P40(-01), F3SN-B□□□□P40(-01)

Model	Protective height	Number of beams
F3SN-A0217P40(-01)	217	7
F3SN-A0247P40(-01)	247	8
F3SN-A0277P40(-01)	277	9
F3SN-A0307P40(-01)	307	10
F3SN-A0337P40(-01)	337	11
F3SN-A0367P40(-01)	367	12
F3SN-A0397P40(-01)	397	13
F3SN-A0427P40(-01)	427	14
F3SN-A0457P40(-01)	457	15
F3SN-A0487P40(-01)	487	16
F3SN-A0517P40(-01)	517	17
F3SN-A0547P40(-01)	547	18
F3SN-A0577P40(-01)	577	19
F3SN-A0607P40(-01)	607	20
F3SN-A0637P40(-01)	637	21
F3SN-A0667P40(-01)	667	22
F3SN-A0697P40(-01)	697	23
F3SN-A0727P40(-01)	727	24
F3SN-A0757P40(-01)	757	25
F3SN-A0787P40(-01)	787	26
F3SN-A0817P40(-01)	817	27
F3SN-A0847P40(-01)	847	28
F3SN-A0877P40(-01)	877	29
F3SN-A0907P40(-01)	907	30
F3SN-A0937P40(-01)	937	31
F3SN-A0967P40(-01)	967	32
F3SN-A0997P40(-01)	997	33

Model	Protective height	Number of beams
F3SN-A1027P40(-01)	1027	34
F3SN-A1057P40(-01)	1057	35
F3SN-A1087P40(-01)	1087	36
F3SN-A1117P40(-01)	1117	37
F3SN-A1147P40(-01)	1147	38
F3SN-A1177P40(-01)	1177	39
F3SN-A1207P40(-01)	1207	40
F3SN-A1237P40(-01)	1237	41
F3SN-A1267P40(-01)	1267	42
F3SN-A1297P40(-01)	1297	43
F3SN-A1327P40(-01)	1327	44
F3SN-A1357P40(-01)	1357	45
F3SN-A1387P40(-01)	1387	46
F3SN-A1417P40(-01)	1417	47
F3SN-A1447P40(-01)	1447	48
F3SN-A1477P40(-01)	1477	49
F3SN-A1507P40(-01)	1507	50
F3SN-A1537P40(-01)	1537	51
F3SN-A1567P40(-01)	1567	52
F3SN-A1597P40(-01)	1597	53
F3SN-A1627P40(-01)	1627	54
F3SN-A1657P40(-01)	1657	55
F3SN-A1687P40(-01)	1687	56
F3SN-A1717P40(-01)	1717	57
F3SN-A1747P40(-01)	1747	58
F3SN-A1777P40(-01)	1777	59
F3SN-A1807P40(-01)	1807	60

F3SN-A□□□□P70(-01), F3SN-B□□□□P70(-01)

Model	Protective height	Number of beams
F3SN-A0277P70(-01)	277	5
F3SN-A0337P70(-01)	337	6
F3SN-A0397P70(-01)	397	7
F3SN-A0457P70(-01)	457	8
F3SN-A0517P70(-01)	517	9
F3SN-A0577P70(-01)	577	10
F3SN-A0637P70(-01)	637	11
F3SN-A0697P70(-01)	697	12
F3SN-A0757P70(-01)	757	13
F3SN-A0817P70(-01)	817	14
F3SN-A0877P70(-01)	877	15
F3SN-A0937P70(-01)	937	16
F3SN-A0997P70(-01)	997	17
F3SN-A1057P70(-01)	1057	18
F3SN-A1117P70(-01)	1117	19
F3SN-A1177P70(-01)	1177	20
F3SN-A1237P70(-01)	1237	21
F3SN-A1297P70(-01)	1297	22
F3SN-A1357P70(-01)	1357	23
F3SN-A1417P70(-01)	1417	24
F3SN-A1477P70(-01)	1477	25
F3SN-A1537P70(-01)	1537	26
F3SN-A1597P70(-01)	1597	27
F3SN-A1657P70(-01)	1657	28
F3SN-A1717P70(-01)	1717	29
F3SN-A1777P70(-01)	1777	30

Accessories (Optional)

Control Unit

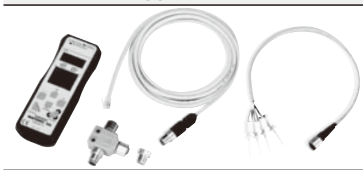
Appearance	Output	Model	Remarks
	Relay, 3NO + 1NC	**F3SP-B1P**	For connection with the F3SN-A, F3SN-B, and F3SH-A, use F39-JC□B cables fitted with connectors at both ends.

OMRON offers many Safety Application Controllers to help you build safety circuits.
Refer to Safety Application Controller Product Selection and specifications (Cat. No. Y106).

Setting Console

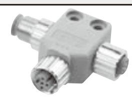
Appearance	Model	Accessories
	**F39-MC11**	Branching Connector (1), Connector Cap (1), Special Cable (2 m), Instruction Manual

Maintenance Tool *

Appearance	Model	Applicable Sensors	Accessories
	**F39-MT11**	F3SN-A series F3SN-B series F3SH-A series	Branching Connector (1), Connector Cap (1), Special Cable (2 m), Special Cable with Plug (0.3 m), Instruction Manual

* For detail, see the product datasheet (Cat. No. E355).

Branching Connector

Appearance	Model	Remarks
	**F39-CN1**	Purchase this connector when needed additionally for installing the F39-MC11.

Cable with Connector on One End (for Emitter and Receiver Set)

Appearance	Cable length	Specification	Model
	3 m	M12 connector (8 pin)	**F39-JC3A**
	7 m		**F39-JC7A**
	10 m		**F39-JC10A**
	15 m		**F39-JC15A**

Cables with Connectors on Both Ends (for Emitter and Receiver Set)

Appearance	Cable length	Specification	Model	Application
	0.2 m	M12 connector (8 pins)	**F39-JCR2B**	Series connection or connection with F3SP-B1P
	0.5 m		**F39-JCR5B**	
	3 m		**F39-JC3B**	
	5 m		**F39-JC5B**	Connection with F3SP-B1P *1
	7 m		**F39-JC7B**	
	10 m		**F39-JC10B**	
	15 m		**F39-JC15B**	
	20 m		**F39-JC20B**	
	0.2 m	M12 connector (8 pins)	**F39-JCR2C**	Connection with G9SA-300-SC *1 *2
	1 m		**F39-JC1C**	
	3 m		**F39-JC3C**	
	7 m		**F39-JC7C**	
	10 m		**F39-JC10C**	
	15 m		**F39-JC15C**	

*1. Cannot be used for series-connection purpose.
*2. When two or more cables have to be used for connection with the G9SA-300-SC, connect the necessary number of F39-JC☐B cables to one F39-JC☐C cable.
(Example) When a 35 m long cable is required, connect two F39-JC10B cables to one F39-JC15C.

External Indicators (Separate Models for Emitters and Receivers)

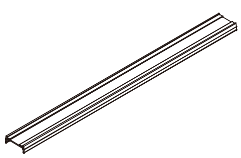
Appearance	Specification	Indicator	Type	Model
	M12 connector for PNP output	Red	Emitter	**F39-A01PR-L**
			Receiver	**F39-A01PR-D**
		Green	Emitter	**F39-A01PG-L**
			Receiver	**F39-A01PG-D**

Note: These indicators are used for connecting with series-connection type emitters/receivers (models ending in -01). (The Indicator must be secured separately for models ending in -04 or -05.) The desired turn-ON timing (type of signal) can be selected on setting console.

Mirrors (Reduce Operating Range by 12% with Each Unit)

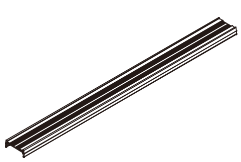
Mirror material	Width (mm)	Depth (mm)	Length (mm)	Model
Glass mirror	145	32	406	**F39-MLG0406**
			610	**F39-MLG0610**
			711	**F39-MLG0711**
			914	**F39-MLG0914**
			1,067	**F39-MLG1067**
			1,219	**F39-MLG1219**
			1,422	**F39-MLG1422**
			1,626	**F39-MLG1626**
			1,830	**F39-MLG1830**
			2,134	**F39-MLG2134**

Spatter Protection Covers (Include Two Pieces for Emitter and Receiver) (Reduces Operating Range by 10% with Each Unit)

Appearance	Applicable sensor	Model
	F3SN-A□□□□P14	**F39-HN□□□□-14**
	F3SN-A□□□□P25(-01) F3SN-A□□□□P40(-01) F3SN-A□□□□P70(-01) F3SN-B□□□□P25 F3SN-B□□□□P40 F3SN-B□□□□P70	**F39-HN□□□□-25**
	F3SH-A09P03(-01)	**F39-HH09-03**

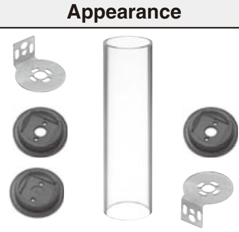
Note: The same 4-digit numbers as the protective heights (□□□□ in the light curtain type names) are substituted by □□□□ in the model names.

Spatter Protection Slit Covers (Include Two Pieces for Emitter and Receiver) *

Appearance	Applicable sensor	Model	
		Slit width: 1.15 mm	Slit width: 0.6 mm
	F3SN-A□□□□P14(-01)	**F39-HS□□□□A-14**	**F39-HS□□□□B-14**
	F3SN-A□□□□P25(-01) F3SN-A□□□□P40(-01) F3SN-A□□□□P70(-01) F3SN-B□□□□P25 F3SN-B□□□□P40 F3SN-B□□□□P70	**F39-HS□□□□A-25**	**F39-HS□□□□B-25**
	F3SH-A09P03(-01)	**F39-HSH09A-03**	**F39-HSH09B-03**

* Operating range will decrease substantially. Refer to *"Specifications"* on page 12 for details.

Environment-resistant Enclosures (Package of a Pipe, Gasket, and Bracket) *

Appearance	Applicable sensor	Model
	F3SN-A□□□□P14(-01)	**F39-HP□□□□-14**
	F3SN-A□□□□P25(-01) F3SN-A□□□□P40(-01) F3SN-A□□□□P70(-01) F3SN-B□□□□P25 F3SN-B□□□□P40 F3SN-B□□□□P70	**F39-HP□□□□-25**
	F3SH-A09P03(-01)	**F39-HPH09-03**

* Purchase 2 sets when using both an emitter and a receiver.

Multi-beam Sensor Support Stands/Mirror Stands

Appearance	Specification	Model	Remarks
	Stand unit Materials Base:STKM (base) SUS304 (leaf spring) Pipe, bolts and nuts: SUS304 Weight: 11.8 kg	**F39-ST1**	Minimum order quantity: 1 pc. (In total, 2 stands are required for each F3SH-A: one for the emitter and the other for the receiver.)
	Mounting bracket Materials: Aluminum Weight: 250 g	**F39-L22**	Minimum order quantity: 1 pc. (In total, 6 brackets are required for each F3SH-A: 3 units each for emitter and receiver. These brackets are not required for the F39-MLG series reflection mirrors, since these mirrors are supplied together with a specially designed adapter.)

Mounting Brackets for Sensors (Optional)

Appearance	Specification	Model	Remarks
	Wall mounting bracket Material: Iron (zinc plating) *	**F39-L18**	For emitter: 2 pcs. For receiver: 2 pcs. Total: 4pcs./set
	Free-location bracket Materials: Zinc die-cast (zinc plating) **Note:** Not provided with an angle deflection mechanism for beam control.	**F39-L19**	Minimum order quantity: 1 pc.
	Free-location bracket Materials Sensor fixing element: Zinc die-cast (zinc plating) Mounting bracket: Iron (zinc plating) **Note:** Provided with an angle deflection mechanism for beam control	**F39-L20**	Minimum order quantity: 1 pc.

* Use these brackets for sensors having an operating range where no intermediate bracket is required (with an operating range of less than 640 mm).

Test Rods (Optional)

Appearance	Applicable sensor	Specification	Model
	F3SN-A□□□□P14(-01)	14 mm-dia. (provided with the sensor)	**F39-TR14**
		Used for checking the setting condition of single-beam floating blanking	**F39-TR23**
		Used for checking the setting condition of two-beam floating blanking	**F39-TR32**
	F3SN-A□□□□P25(-01)	25 mm-dia. (provided with the sensor)	**F39-TR25 *1**
		Used for checking the setting condition of single-beam floating blanking	**F39-TR40 *2**

*1. Also provided with the F3SN-B□□□□P25.
*2. Also provided with the F3SN-A□□□□P40 and F3SN-B□□□□P40.

Specifications (For details, refer to the instruction manual.)

Main Units

F3SN-A/F3SH-A

Item / Model *8		F3SN-A□□□□P14 *1	F3SN-A□□□□P25 *1	F3SN-A□□□□P40 *1	F3SN-A□□□□P70 *1	F3SH-A09P03
	Series connection	F3SN-A□□□□P14-01 *1 *2	F3SN-A□□□□P25-01 *1	F3SN-A□□□□P40-01 *1	F3SN-A□□□□P70-01 *1	F3SH-A09P03-01
Sensor type		Type 4 Safety Light Curtain				
Applicable safety category		Category 4, 3, 2, 1, or B				
Operating range		0.2 to 7 m	0.2 to 10 m			
Beam gap (P)		9 mm	15 mm	30 mm	60 mm	300 mm
Number of beams (n)		21 to 125 (odd numbers only)	13 to 120	7 to 60	5 to 30	4
Protective height (PH)		189 to 1125 mm PH = n × P	217 to 1822 mm PH = (n – 1) × P + 37	217 to 1807 mm PH = (n – 1) × P + 37	277 to 1777 mm PH = (n – 1) × P + 37	---
Outermost beam gap		---				900 mm
Detection capability		Opaque objects: 14 mm in diameter	Opaque objects: 25 mm in diameter	Opaque objects: 40 mm in diameter	Opaque objects: 70 mm in diameter	---
Effective aperture angle (EAA)		Within ±2.5° for the emitter and receiver at a detection distance of at least 3 m according to IEC 61496-2				
Light source (emitted wavelength)		Infrared LED (870 nm)				
Power supply voltage (Vs)		24 VDC ±10% (ripple p-p 10% max.)				
Current consumption (no load)	Emitter	Up to 50 beams: 140 mA max., 51 to 85 beams: 155 mA max., 86 beams and more: 170 mA max.				140 mA max.
	Receiver	Up to 50 beams: 100 mA max., 51 to 85 beams: 110 mA max., 86 beams and more: 120 mA max.				100 mA max.
Control outputs (OSSD)		Two PNP transistor outputs, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension)				
Auxiliary output (non-safety output)		One PNP transistor output, load current 50 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension)				
External indicator output (non-safety output) *3		One PNP transistor output, load current 40 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension)				
Output operation mode		Control output: Light-ON Auxiliary output: Dark-ON (can be changed by the F39-MC11) External indicator output: Light-ON (can be changed by the F39-MC11) *3				
Input voltage		Test input, interlock selection input, reset input, and external relay monitor input voltages; ON voltage: 9 to 24 V (with a sink current 3 mA max.), OFF voltage: 0 to 1.5 V or open				
Test functions		• Self test (when power is turned ON and while power is supplied, one cycle during response time) • External test (emission stop function by test input)				
Mutual interference prevention function *3		Time-shared beam projection system by series connection • Number of series connected light curtains: Up to 3 sets • Number of beams: Up to 240 beams • Length of the series connection cable: 3 m max.				
Safety functions		• Auto-reset/manual reset (interlock) *4 • EDM (External Device Monitor) • Fixed blanking *5 • Floating blanking *5				• Auto-reset mode/ manual reset mode (interlock) *4 • EDM (External Device Monitor)
Protective circuits		Output short-circuit protection, power supply reverse polarity protection				
Response time (under stable light incident condition)		ON to OFF: 10 to 15.5 ms max. OFF to ON: 40 to 62 ms max.				ON to OFF: 10 ms max. OFF to ON: 40 ms max.
Startup waiting time		1 s max.				
Ambient operating light intensity		Incandescent lamp: 3000 lx max. (light intensity on the receiver surface) Sunlight: 10000 lx max. (light intensity on the receiver surface)				
Ambient temperature		Operating: –10 to 55°C, storage: –30 to 70°C (with no icing or condensation)				
Ambient humidity		Operating/storage: 35% to 95% (with no condensation)				
Insulation resistance		20 MΩ min. (at 500 VDC)				
Dielectric strength		1000 VAC 50/60 Hz 1 min.				
Vibration resistance (malfunction)		10 to 55 Hz, 0.7-mm double amplitude, 20 sweeps in X, Y and Z directions				
Shock resistance (malfunction)		100 m/s^2, 1000 times in X, Y and Z directions				
Degree of protection		IP65 (IEC60529)				
Connection method		M12 connector (8 pins)				

Item / Model *8	Stand-alone / Series connection				
Stand-alone		F3SN-A□□□□P14 *1	F3SN-A□□□□P25 *1	F3SN-A□□□□P40 *1	F3SN-A□□□□P70 *1	F3SH-A09P03
Series connection		F3SN-A□□□□P14-01 *1 *2	F3SN-A□□□□P25-01 *1	F3SN-A□□□□P40-01 *1	F3SN-A□□□□P70-01 *1	F3SH-A09P03-01
Weight (packed state)		Weight (g) = (Detection width) × 2.4 + α + β Detection width of 189 to 639 mm: α = 700, Detection width of 652 to 1,267 mm: α = 800, Detection width of 1,282 to 1,822 mm: α = 900, Model with no suffix or –01: β = 0, Model with suffix –02, –03, or –05: β = 100, Model with suffix –04: β = 200				
Materials		Case: Aluminum, cap: Zinc die-cast, optical cover: PMMA (acrylic resin), Cable: Oil-resistant PVC				
Accessories		Test rod *6, instruction manual, error mode label, mounting brackets (top and bottom), mounting brackets (intermediate) *7				
Applicable standards		IEC61496-1, EN61496-1 Type 4 ESPE (Electro-Sensitive Protective Equipment) IEC61496-2 Type 4 AOPD (Active Opto-electronic Protective Devices)				

*1. The 4 digits in □□□□ in the model number represent the protective height. Use the formula given in the information on protective height specifications to calculate the height.
For example, if the beam gap is 9 mm, and the No. of beams is 21, the protective height will be 9 × 21 = 189 mm. The model with this protective height is F3SN-A0189P14.
*2. F3SN-A□□□□P14-01 is a customized model. Consult with your dealer or OMRON representative when ordering this model.
*3. Only models ending in -01, -03, -04, or -05 have this output and functionality.
*4. For the factory setting, the manual reset mode is set to the “start/restart” interlock.
Using the F39-MC11 can select either the start interlock or the restart interlock.
*5. For the factory setting, the function is not set. It can be enabled with the F39-MC11.
*6. Not provided with the F3SN-A□□□□P70 and F3SH-A.
*7. The intermediate mounting bracket is supplied with the following types:
Types which have the total length of the light curtain from 640 mm to 1280 mm: 1 set for each of emitter and receiver.
Types which have the total length of the light curtain over 1280 mm: 2 sets for each of emitter and receiver.
*8. Models with different connector configurations are also available as options. Refer to *“Many Connector Variations”* on page 2.

F3SN-B (Different from specifications of F3SN-A)

Item / Model *6	F3SN-B□□□□P25	F3SN-B□□□□P40	F3SN-B□□□□P70
Sensor type	Type 2 Safety Light Curtain		
Applicable safety category	Category 2, 1, or B		
Operating range	0.2 to 10.0 m		
Beam gap (P)	15 mm	30 mm	60 mm
Number of beams (n)	13 to 119 (noncontinuous)	7 to 60 (noncontinuous)	5 to 30
Protective height (PH) (PH = (n – 1) × P + 37)	217 to 1807 mm	217 to 1807 mm	277 to 1777 mm
Detection capability	Opaque objects: 25 mm in diameter	Opaque objects: 40 mm in diameter	Opaque objects: 70 mm in diameter
Effective aperture angle (EAA) (beam spread angle)	Within ±5° for the emitter and receiver at a detection distance of at least 3 m according to IEC 61496-2		
Light source (emitted wavelength)	Infrared LED (870 nm)		
Power supply voltage (Vs)	24 VDC ±10% (ripple p-p 10% max.)		
Current consumption (no load): Emitter	Up to 50 beams: 140 mA max., 51 to 85 beams: 155 mA max., 86 beams and more: 170 mA max.		
Current consumption (no load): Receiver	Up to 50 beams: 100 mA max., 51 to 85 beams: 110 mA max., 86 beams and more: 120 mA max.		
Control outputs (OSSD) *1	Two PNP transistor outputs, load current 300 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension)		
Auxiliary output (non-safety output)	One PNP transistor output, load current 50 mA max., residual voltage 2 V max. (except for voltage drop due to cable extension)		
Output operation mode *1	Control output: Light-ON, Auxiliary output: Dark-ON		
Input voltage	For test input, interlock selection input, reset input, and external relay monitor input voltages; ON voltage: 9 to 24 V (sink current: 3 mA max.), OFF voltage: 0 to 1.5 V or open		
Test functions	• Self test (when power is ON and period is 1 s or less) • External test (light emission stop function by test input)		
Safety functions *2 *3	• Auto-reset/manual reset (start/restart interlock) • EDM (External Device Monitor)		
Protective circuits	Output short-circuit protection, reverse polarity protection		
Response time (under stable light incident condition)	ON to OFF: 10 to 15 ms max. OFF to ON: 40 to 60 ms max.		
Startup waiting time	1 s max.		
Ambient operating light intensity	Incandescent lamp: 3000 lx max. (light intensity on the receiver surface) Sunlight: 10000 lx max. (light intensity on the receiver surface)		
Ambient temperature	Operating: –10 to 55°C, storage: –30 to 70°C (with no icing or condensation)		
Ambient humidity	Operating/storage: 35% to 95% (with no condensation)		
Insulation resistance	20 MΩ min. (at 500 VDC)		
Dielectric strength	1000 VAC 50/60 Hz 1 min.		
Vibration resistance (malfunction)	10 to 55 Hz, 0.7-mm double amplitude, 20 sweeps in X, Y and Z directions		
Shock resistance (malfunction)	100 m/s^2, 1000 times in X, Y and Z directions		
Degree of protection	IP65 (IEC60529)		
Connection method	M12 connector (8 pins)		
Weight (packed state)	Weight (g) = (Detection width) × 2.4 + α + β Detection width of 189 to 639 mm: α = 700, Detection width of 652 to 1,267 mm: α = 800, Detection width of 1,282 to 1,822 mm: α = 900, Model with no suffix or –01: β = 0, Model with suffix –02, –03, or –05: β = 100, Model with suffix –04: β = 200		
Materials	Case: Aluminum, cap: Zinc die-cast, optical cover: PMMA (Acrylic resin)		
Accessories	Test rod *4, instruction manual, mounting brackets (top and bottom), mounting brackets (intermediate) *5, error mode label		
Use of setting console	Not permitted		
Applicable standards	IEC61496-1, EN61496-1 Type 2 ESPE (Electro-Sensitive Protective Equipment) IEC61496-2 Type 2 AOPD (Active Opto-electronic Protective Devices)		

*1. A safety circuit has been adopted. Please note that the control logic (ON/OFF) may differ from conventionally used logic.
*2. The manual reset mode is set to the “start/restart” interlock. It is impossible to select interlock only or restart interlock only.
*3. No floating blanking or fixed blanking function is provided.
*4. Not provided with the F3SN-B□□□□P70.
*5. The intermediate mounting bracket is supplied with the following types:
Types which have the total length of the light curtain from 640 mm to 1280 mm: 1 set for each of emitter and receiver.
Types which have the total length of the light curtain over 1280 mm: 2 sets for each of emitter and receiver.
*6. Models with different connector configurations are also available as options. Refer to *“Many Connector Variations”* on page 2.

Accessories

Control Units

Item / Model		F3SP-B1P	G9SA-300-SC *
Applicable sensor		F3SN-A, F3SN-B, F3SH-A	
Supply voltage		24 VDC ±10%	
Power consumption		1.7 W DC max. (does not include the sensor's current consumption)	24 VDC: 0.7 W DC max. (does not include the sensor's current consumption)
Operating time		100 ms max. (does not include the sensor's response time)	300 ms max. (does not include the sensor's response time and bounce time)
Response time		10 ms max. (does not include the sensor's response time)	10 ms max. (does not include the sensor's response time and bounce time)
Relay output	No. of contact	3 NO + 1 NC	3 NO
	Rated load	25 VAC, 5 A (cos diameter = 1), 30 VDC, 5 A L/R = 0 ms	250 VAC, 5 A
	Rated carry voltage	5 A	
Connection method	Between sensor's	M12 connector (8 pins)	
	Other	Terminal block	
Weight (packed state)		Approx. 280 g	Approx. 300 g
Accessory		Instruction manual	

* For further details on the G9SA-300-SC, refer to G9SA-300-SC.

Setting Console

Item / Model	F39-MC11
Applicable sensor	F3SN-A, F3SH-A
Supply voltage	24 VDC ±10% (provided from the sensor)
Connection method	Cable (included)
Weight (packed state)	360 g
Accessories	One branching connector, 2-m cable, one connector cap, instruction manual

For details on the setting console, refer to the instruction manual provided with the product.

External Indicators

Item / Model	F39-A01PR-L (Emitter) F39-A01PR-D (Receiver)	F39-A01PG-L (Emitter) F39-A01PG-D (Receiver)
Applicable sensor	F3SN-A□□□□P□□-01(-03, -04, -05) * F3SH-A09P03-01	
Light source	Red LED	Green LED
Supply voltage	24 VDC ±10% (provided from the sensor)	
Current consumption	50 mA max. (provided from the sensor)	
Connection method	M12 connector (8 pins)	
Weight (packed state)	Approx. 80 g	

* The indicator must be secured separately for models ending in "-04" or "-05." For the F3SN-B, only light-ON mode can be used.

Spatter Protection Slit Covers

Item / Model		F39-HS□□□□A-14	F39-HS□□□□B-14	F39-HS□□□□A-25 F39-HSH09A-03	F39-HS□□□□B-25 F39-HSH09B-03
Applicable sensor		F3SN-A□□□□P14(-01)		F3SN-A□□□□P□□(-01), F3SN-B□□□□P□□(-01), F3SH-A09P03(-01)	
Operating range (typical value) *	When one cover is used	3 m	2 m	5.5 m	3.5 m
	When two covers are used	1 m	0.5 m	2 m	1 m
Distance that does not cause mutual interference (typical value)	When one cover is used	6.5 m	4.8 m	12.2 m	7.8 m
	When two covers are used	2.4 m	1.2 m	4.4 m	2.1 m

* The maximum distance that can turn ON all of the five light intensity level indicators.

Environment-resistant Enclosures

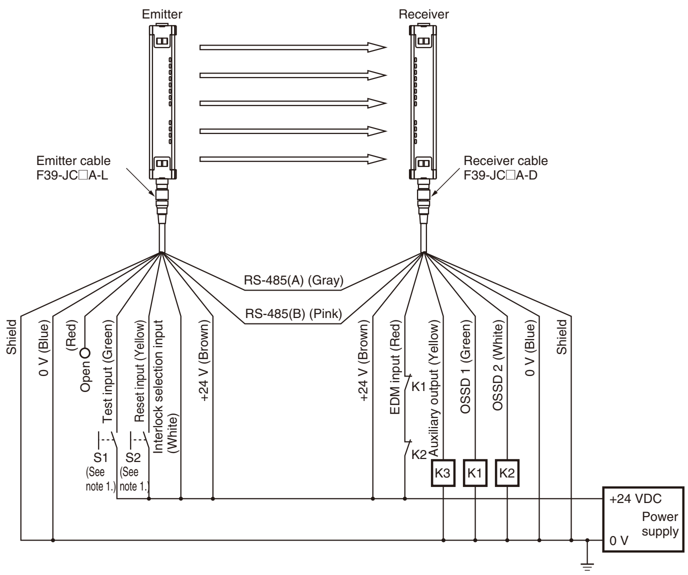
Item / Model	F39-HP□□□□-14	F39-HP□□□□-25 F39-HPH09-03
Applicable sensor	F3SN-A□□□□P14(-01)	F3SN-A□□□□P□□(-01), F3SN-B□□□□P□□(-01), F3SH-A09P03(-01)
Operating range characteristics	0.2 to 6 m	0.2 to 10 m
Degree of protection *	IP67 (IEC60529)	
Materials	Case: Acrylic resin, rubber: NBR60, mounting bracket: SUS316L, screw: SUS316L	

* To conform to IP67, tighten the screws according to the "Cautions for Use" as described in the manual packaged together with the product.

Connections

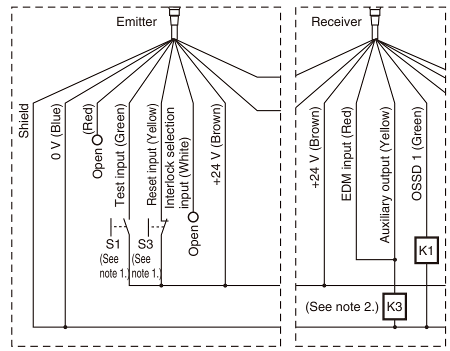
Wiring for Sensor Only Configuration

Wiring for the Manual Reset Mode and the EDM Function



S1: External test switch
S2: Interlock/lockout reset switch
S3: Lockout reset switch (If the switch is not necessary, connect between the reset input and +24 VDC.)
K1, K2: Relay that control the dangerous zone, etc.
K3: Load, PLC, etc. (used for monitoring)

Wiring for the Auto-reset Mode



When the EDM is Not Used

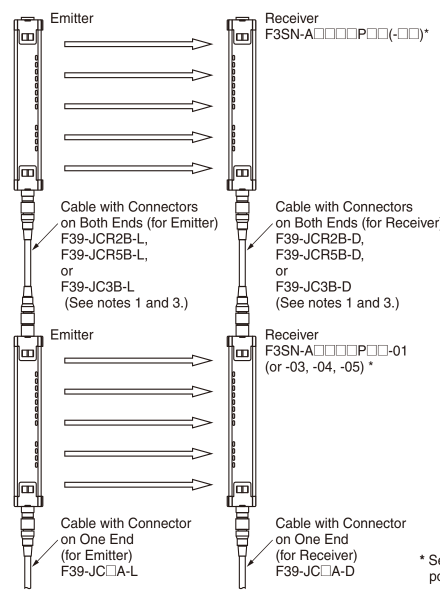
When the EDM is not necessary
(1) Use the F39-MC11 to disable the EDM.
or
(2) Disable the EDM by changing the wiring as shown in the figure below, when the auxiliary output is Dark ON.

Note: **1.** Use very low load type switches.
2. If K3 is not necessary, short-circuit the auxiliary output with the EDM input.

Series Connection (Up to 3 Sets)

Using series connection models (model numbers ending in -01, -03, -04, -05) enables series connection as shown in the figure at the right. Either stand-alone models and the series connection models can be used for the light curtains located at the top end.

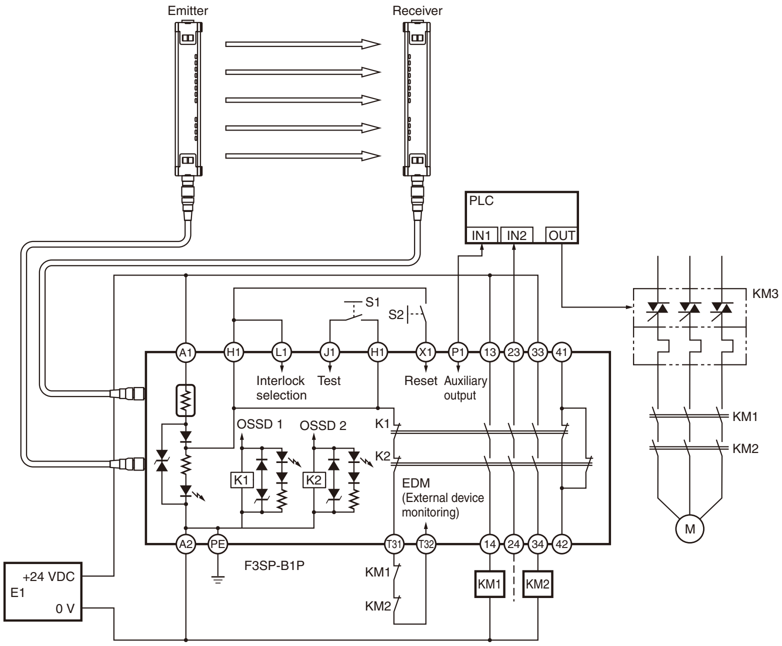
Note: 1. To maintain performance characteristics, use the F39-JCR2B or the F39-JC3B to connect light curtains in series. The F39-JC7B, F39-JC10B, or F39-JC15B cannot be connected in series.
2. The F3SN and F3SH cannot be connected in series.
3. Series connection is possible for model numbers ending in -04 or -05 (with 0.2 m cable with connectors). Refer to page 2.



* Series connection is possible for the F3SN-B.

An Example of Safety Circuits Where the F3SP-B1P Controller is Used

For category 4 rating (F3SN-A, F3SH-A)/category 2 rating (F3SN-B)



Applicable operation mode

• Manual reset mode

S1: External test switch

S2: Interlock/lockout reset switch

S3: Lockout reset switch (If the switch is not necessary, connect between X1 and H1.)

KM1, KM2: Magnetic contactor

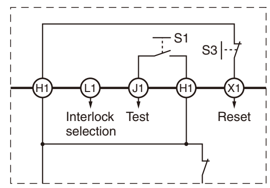
KM3: Solid-state contactor (G3J)

M: 3-phase motor

E1: 24 VDC power supply (S82K)

PLC: Programmable controller (Used for monitoring. This is not a part of a safety system.)

Wiring for the Auto-reset mode

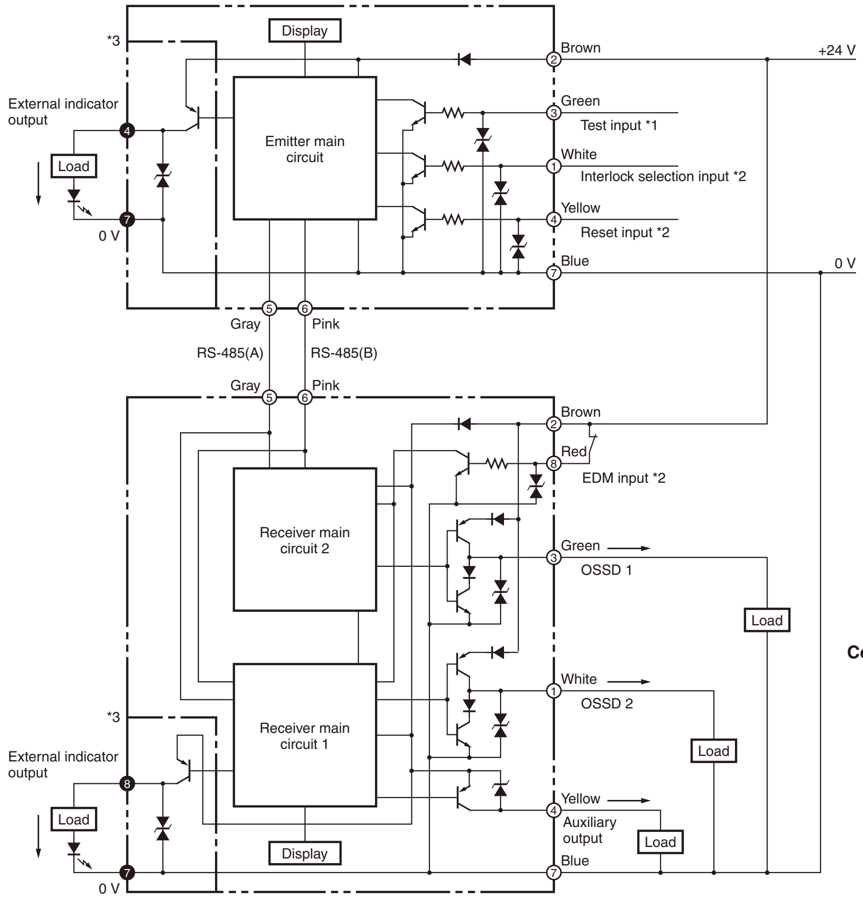


Note: 1. If the EDM is not necessary, short-circuit T31 and T32.

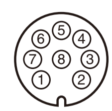
2. For the number and arrangement of all terminals on the F3SP-B1P, see the instruction manual packaged together with the F3SP-B1P.

I/O Circuit Diagrams

Internal Circuit Diagram

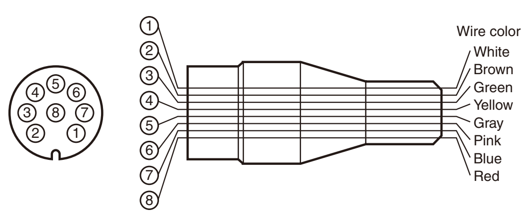


Connector Pins Arrangement



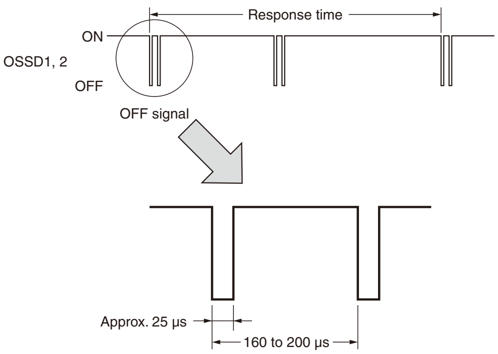
Note: The numbers in ❍ indicate pin numbers of the connectors.
The numbers in ● indicate pin numbers of the series connection connectors.
*1. Open: normal light emission, short to the +24 VDC: stops light emission
*2. Refer to *“Connections”, “Wiring for Sensor Only Configuration”* on page 13.
*3. The section encircled with the dashed line is applied for models ending in -01, -03, -04, or -05 only.

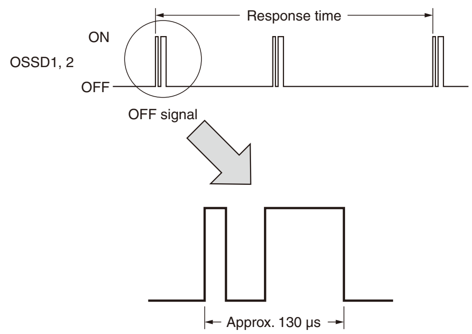
Cables with Connector on One End

Model	Internal wiring	Pin No.	Wire color	Signal name	
				Receiver	Emitter
F39-JC3A (3 m) F39-JC7A (7 m) F39-JC10A (10 m) F39-JC15A (15 m)		1	White	OSSD 2	Interlock selection input
		2	Brown	+24 V	+24 V
		3	Green	OSSD 1	Test input
		4	Yellow	Auxiliary output	Reset input
		5	Gray	RS-485(A)	RS-485(A)
		6	Pink	RS-485(B)	RS-485(B)
		7	Blue	0 V	0 V
		8	Red	EDM input	N.C.

Output waveform of the OSSD outputs

The OSSD outputs will be OFF as shown in the following figure in order to perform the OSSD circuit self-test when the light curtain is in the ON-state.
The OSSD circuit diagnosis is correct when this OFF signal is fed back. If the output signal does not contain an OFF signal, the receiver determines that there is an output circuit or wiring failure and goes into the lockout condition.
The number of OFF signals depends on the number of light curtains connected in series. (See the chart at left.)
In the same way, the OSSD outputs will be ON as shown in the following figure, to perform the OSSD circuit self-test when the light curtain is in the OFF-state. (See the chart below.)
Check the input response time of a machine connected to the F3SN-A carefully to ensure the machine will not malfunction due to the OFF signal.





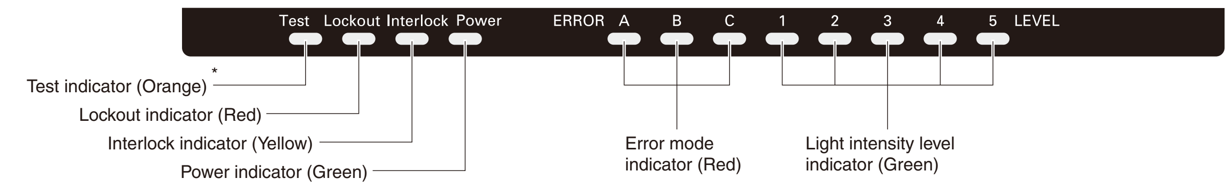
Note: This chart indicates the instance of 2 light curtains series connection.

No. of light curtains connected in series	No. of OFF signals within the response time
No	1
2 light curtains	2
3 light curtains	3

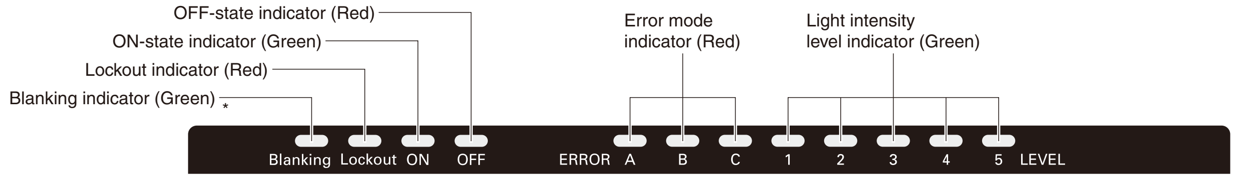
No. of light curtains connected in series	No. of ON signals within the response time
No	1
2 light curtains	2
3 light curtains	3

Names and Functions of Parts

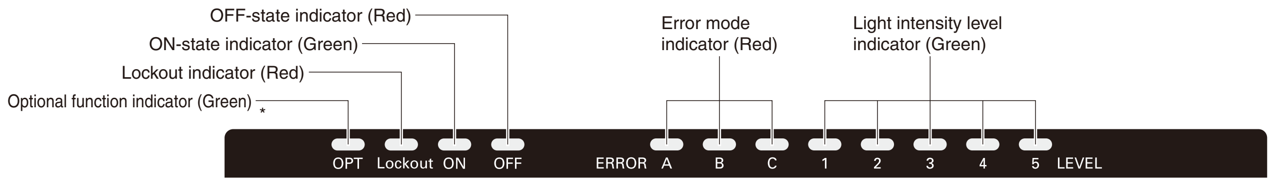
Emitter (F3SN-A/ F3SN-B/ F3SH-A)



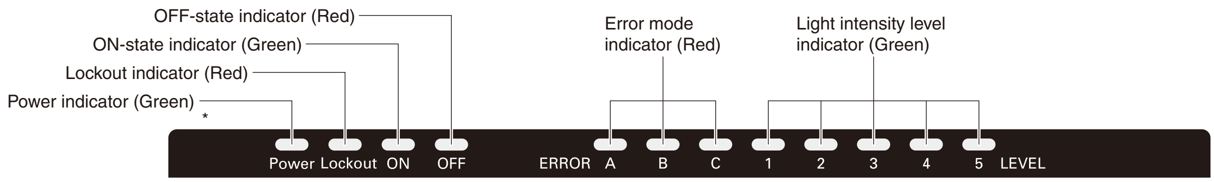
Receiver (F3SN-A)



Receiver (F3SN-B)



Receiver (F3SH-A)



* These indicators flash to indicate the need for preventive maintenance when the total ON time exceeds 30,000 hours. (Models without this flashing function are also available as options. An "-NT" to the model number. Ask your OMRON representative for details.)

Function

Power indicator	Lit when power is supplied (always lit): F3SN-A, F3SH-A Emitter Lit when power is supplied, flashing when the F39-MC11 is connected: F3SH-A Receiver *
Interlock indicator	Lit during interlock condition
Lockout indicator	Flashing during lockout condition
Test indicator	Lit during external test *
ON-state indicator	Lit when OSSD outputs are in ON-state
OFF-state indicator	Lit when OSSD outputs are in OFF-state
Blanking indicator (F3SN-A only)	Lit when blanking is set, flashing when the F39-MC11 is connected *
Optional function indicator (F3SN-B only)	Flashing after a lapse of 30,000 hours

* These indicators flash to indicate the need for preventive maintenance when the total ON time exceeds 30,000 hours. (Models without this flashing function are also available as options. An "-NT" to the model number. Ask your OMRON representative for details.)

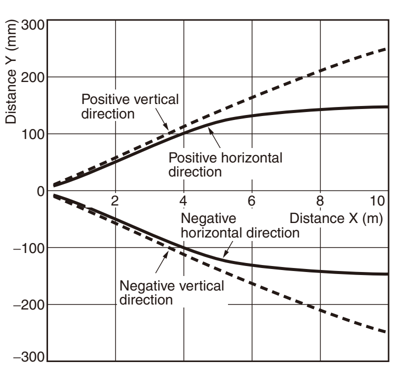
	1	2	3	4	5	Light intensity level
Light intensity level indicator ● Lit ○ Not lit	●	●	●	●	●	200% and above of ON threshold level
	●	●	●	●	○	150 to 200% of ON threshold level
	●	●	●	○	○	100 to 150% of ON threshold level
	●	●	○	○	○	75 to 100% of ON threshold level
	●	○	○	○	○	50 to 75% of ON threshold level
	○	○	○	○	○	Less than 50% of ON threshold level

	A	B	C	Cause of error
Error mode indicator ◐ Flashing ○ Not lit	◐	○	○	The Interlock selection input line or the reset input line is not wired correctly or became open.
	○	◐	○	Relay contact is welded. Releasing time of the relay takes too long. The EDM input line is not wired correctly or became open.
	○	○	◐	Communication line (RS-485) is not wired correctly, became open, or causes other errors.
	◐	◐	○	One of the OSSD outputs is shorted or is not wired correctly. Other failure in OSSD outputs.
	○	◐	◐	Mutual interference. Interference light is received.
	◐	○	◐	Types of the receiver and emitter are not the same. Numbers of the receiver and emitter connected in series are not the same.
	◐	◐	◐	External noise. Internal hardware failure of the receiver or the emitter.

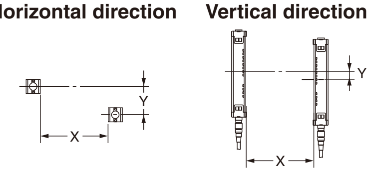
Engineering Data (Typical Examples)

Parallel operating range

F3SN-A1107P14

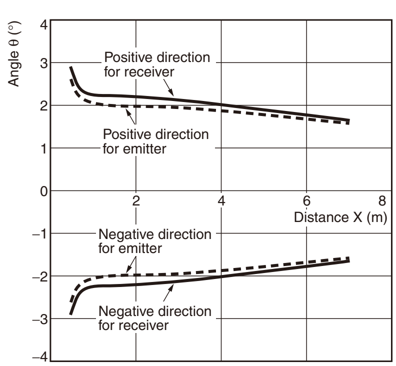


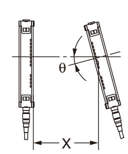
Horizontal direction **Vertical direction**



Angular range (Angle of elevation)

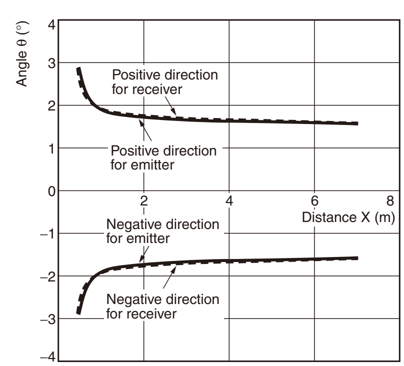
F3SN-A1107P14

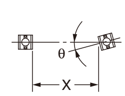




Angular range (Angle of rotation)

F3SN-A1107P14





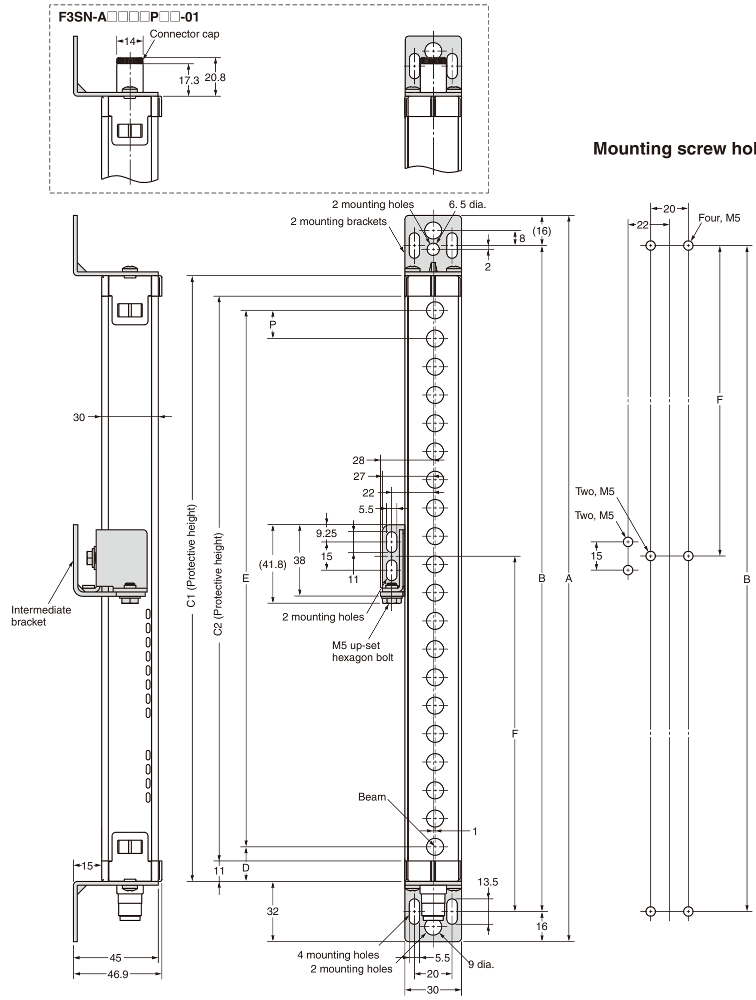
Dimensions

(Unit: mm)

Main Units

Refer to the User's Manual (SCEE-713) for the dimensions of models with different connector configurations (model numbers ending in "-02" to "-05").

F3SN-A□□□□P□□(-01)
F3SN-B□□□□P□□(-01)



Dimensions according to the model can be calculated by using the following equations.

- F3SN-A□□□□P14(-01)
  Dimension C2 (protective height): 4 digits in the model name
  Dimension A = C2 + 86
  Dimension B = C2 + 54
  Dimension D = 15.5
  Dimension E = C2 – 9
  Dimension F: See the table below.
  Dimension P = 9

C2 (protective height)	Number of intermediate Mounting Bracket	Dimension F (See note.)
to 0620	0	---
0621 to 1125	1	F = B/2

Note: If value F obtained from the above equation is not used, set F to 670 mm or less.

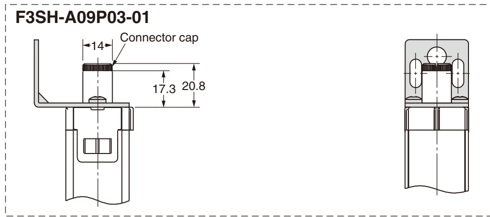
- F3SN-A□□□□P25(-01)/P40(-01)/P70(-01), F3SN-B□□□□P25(-01)/P40(-01)/P70(-01)
  Dimension C1 (protective height): 4 digits in the model name
  Dimension A = C1 + 64
  Dimension B = C1 + 32
  Dimension D = 18.5
  Dimension E = C1 – 37
  Dimension F: See the table below.

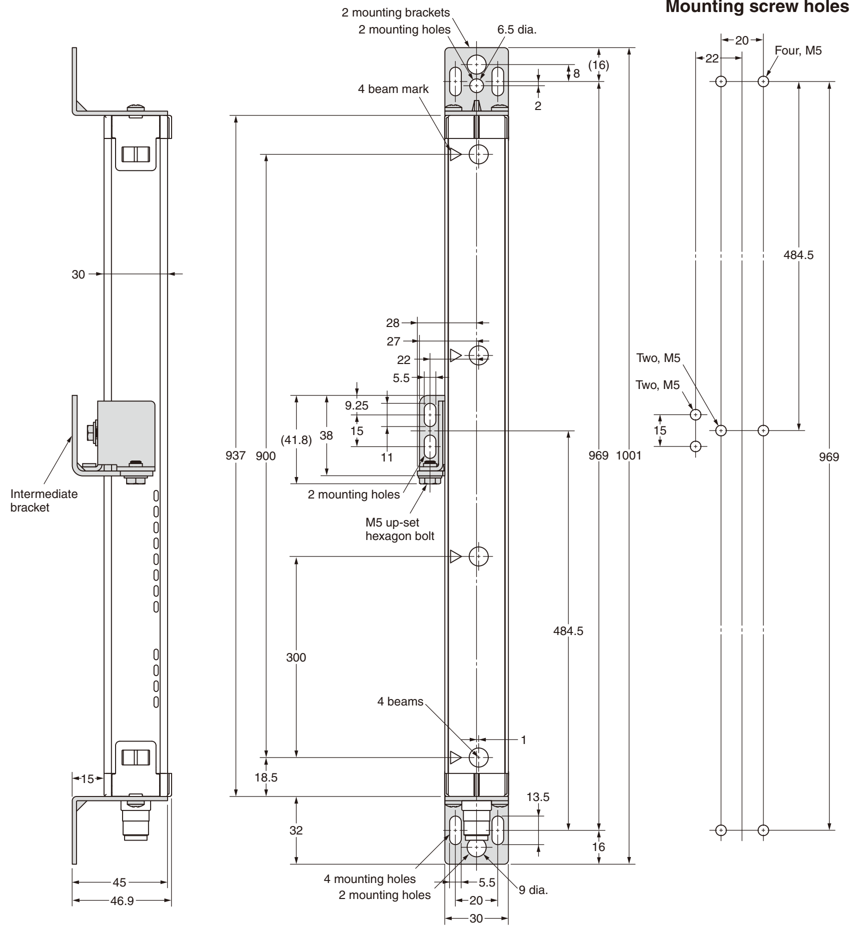
C1 (protective height)	Number of intermediate Mounting Bracket	Dimension F (See note.)
to 0640	0	---
0641 to 1280	1	F = B/2
1281 to 1822	2	F = B/3

Dimension P: See the table below.

Detection capability	Dimension P
25	15
40	30
70	60

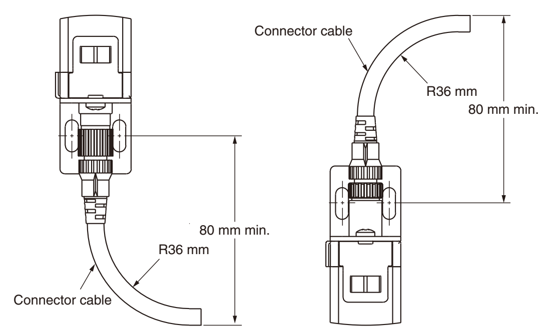
F3SH-A09P03
F3SH-A09P03-01





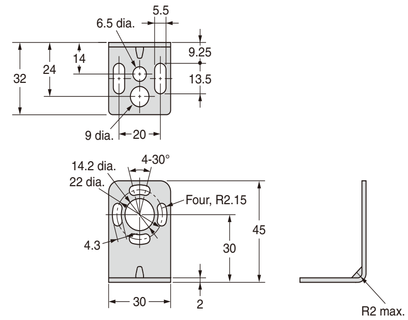
Mounting Precautions

1. The intermediate bracket (3) (see Mounting brackets (intermediate)) is shown on the left-hand side of the sensor as an example. If the intermediate bracket (3) is on the right-hand side of the sensor then the mounting holes must also be on the right-hand side.
2. When using with the cable bent, allow at least the dimensions shown on the right. (Minimum bending radius of cable: R36 mm.)



Accessories

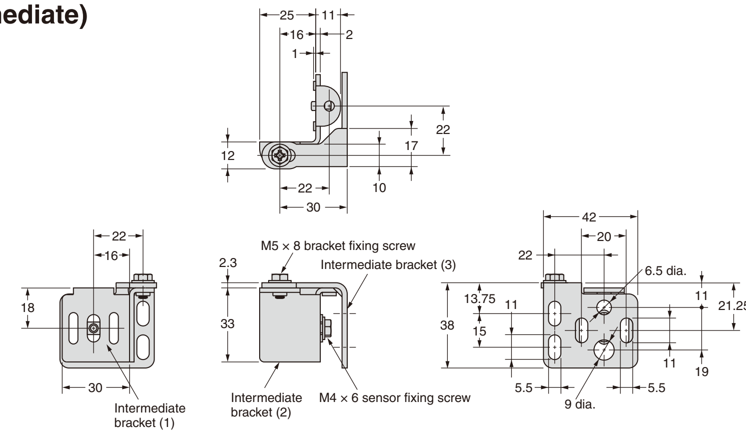
Mounting Bracket (Top and Bottom)



Material: Iron (zinc plating)

Note: Provided with the product.

Mounting Brackets (Intermediate)



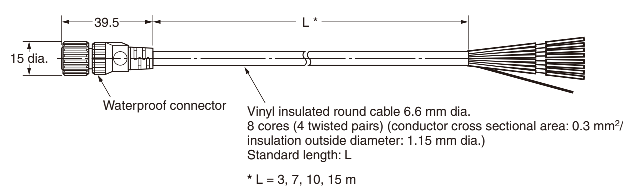
Material: Iron (zinc plating)

Note: Provided with the product.
The number of brackets required depends on the total length of the Sensor.

Accessories (Optional)

Cables with Connector on One End

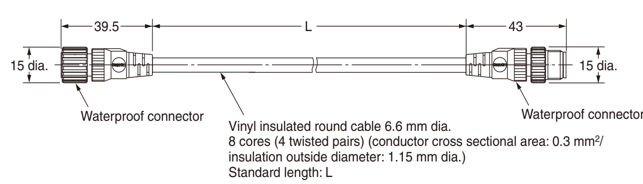
F39-JC3A (L = 3 m)
F39-JC7A (L = 7 m)
F39-JC10A (L = 10 m)
F39-JC15A (L = 15 m)



Color: Emitter (gray)
Receiver (black)

Cables with Connectors on Both Ends

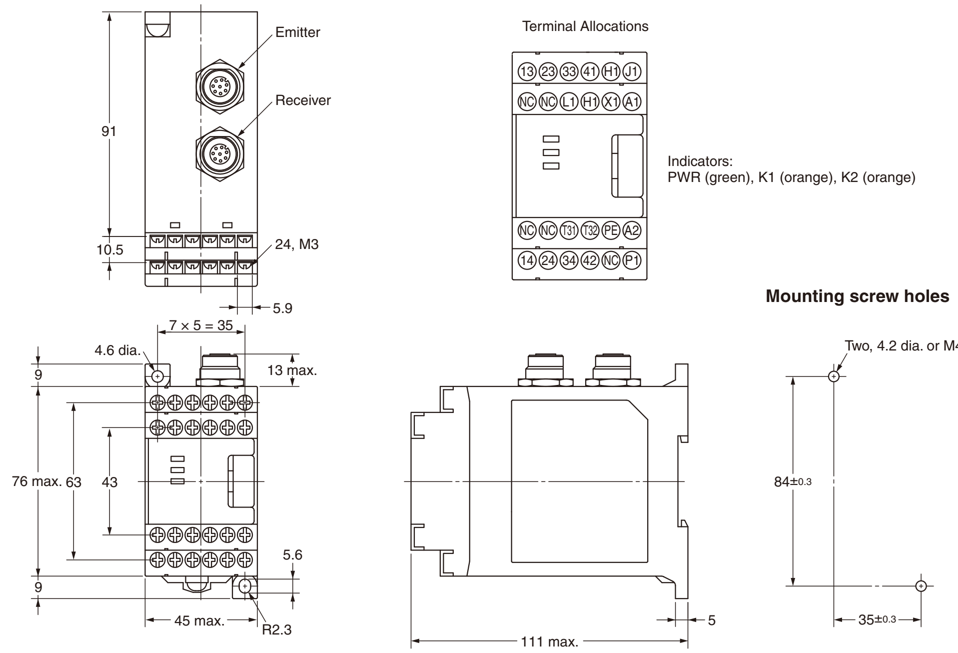
F39-JCR2B (L = 0.2 m)
F39-JCR5B (L = 0.5 m)
F39-JC3B (L = 3 m)
F39-JC5B (L = 5 m)
F39-JC7B (L = 7 m)
F39-JC10B (L = 10 m)
F39-JC15B (L = 15 m)
F39-JC20B (L = 20 m)
F39-JCR2C (L = 0.2 m)
F39-JC1C (L = 1 m)
F39-JC3C (L = 3 m)
F39-JC7C (L = 7 m)
F39-JC10C (L = 10 m)
F39-JC15C (L = 15 m)



Color: Emitter (gray)
Receiver (black)

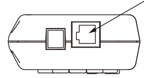
Control Unit

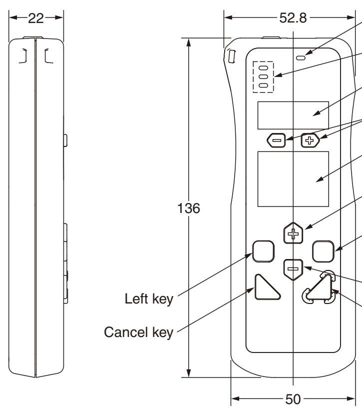
F3SP-B1P



Setting Console

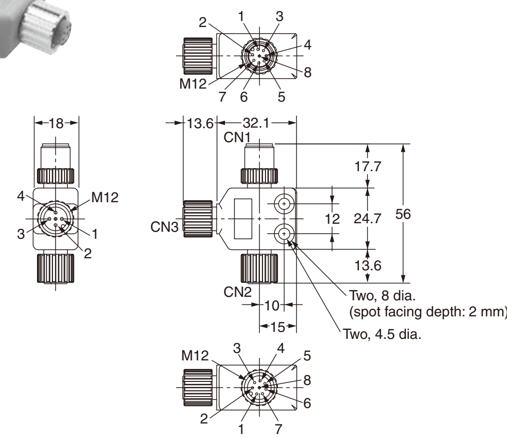
F39-MC11





Branching Connector (supplied with F39-MC11)

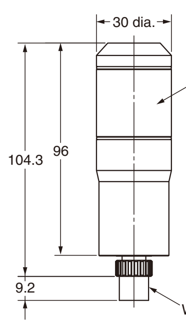
F39-CN1



CN1	Connector cable
CN2	Sensor
CN3	Setting console

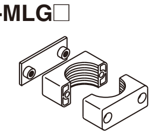
External Indicators

F39-A01PR-L/-D
F39-A01PG-L/-D

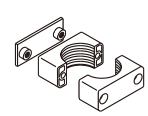


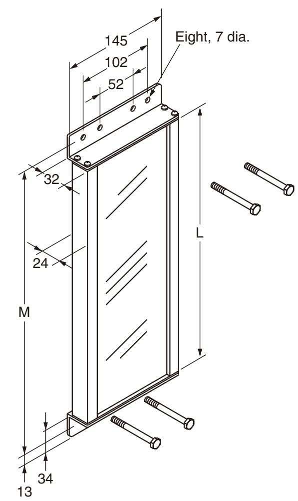
Mirrors

F39-MLG□



Can be fitted to the F39-ST1 cylindrical mounting rod (42 dia. ±1) (accessory).

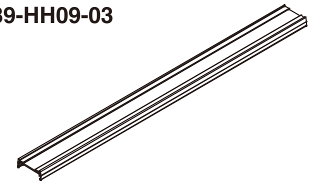




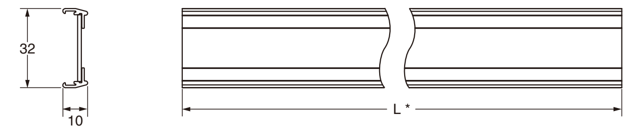
Model	L (mm)	M (mm)
F39-MLG0406	445	487
F39-MLG0610	648	690
F39-MLG0711	749	792
F39-MLG0914	953	995
F39-MLG1067	1105	1148
F39-MLG1219	1257	1300
F39-MLG1422	1461	1503
F39-MLG1626	1664	1706
F39-MLG1830	1867	1910
F39-MLG2134	2172	2214

Spatter Protection Covers

F39-HN□□□□-14
F39-HN□□□□-25
F39-HH09-03



Protection cover



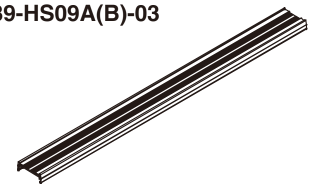
*L is as follows.

F39-HN□□□□-14 F39-HS□□□□A(B)-14	L = □□□□ mm
F39-HN□□□□-25 F39-HS□□□□A(B)-25	L = □□□□ – 22 mm
F39-HH09-03 F39-HS09A(B)-03	L = 915 mm

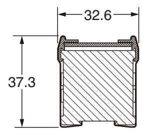
Materials: PC (transparent area)
ABS (non-transparent area)

Spatter Protection Slit Covers

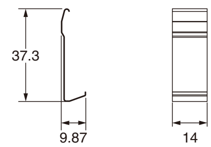
F39-HS□□□□A(B)-14
F39-HS□□□□A(B)-25
F39-HS09A(B)-03



Mounting dimensions



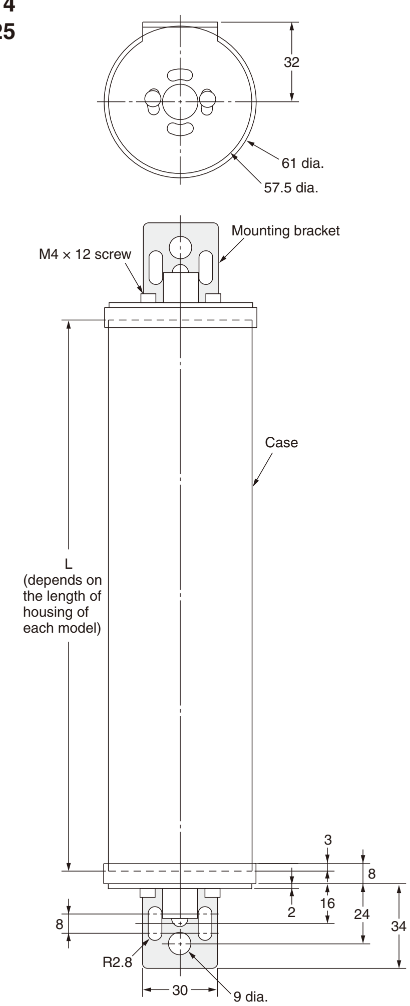
Fixing bracket



Materials: SUS

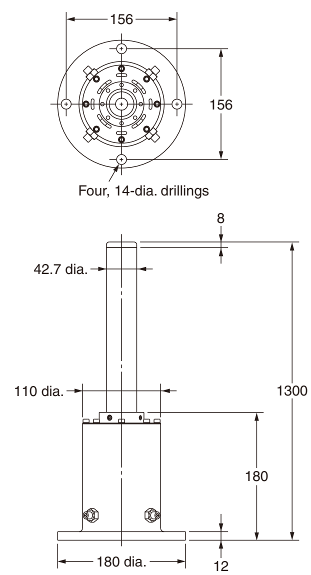
Water-resistant Case

F39-HP□□□□-14
F39-HP□□□□-25
F39-HPH09-03



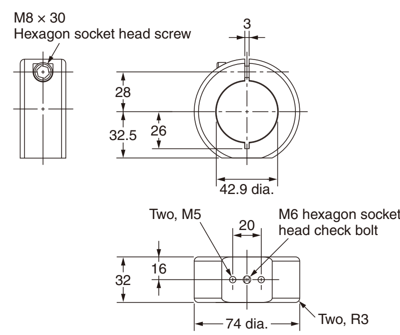
Multi-beam Sensor Support Stand/Mirror Stand

F39-ST1



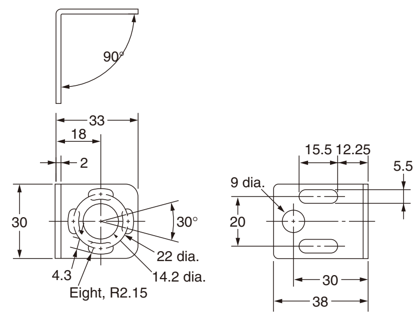
Mounting Bracket

F39-L22



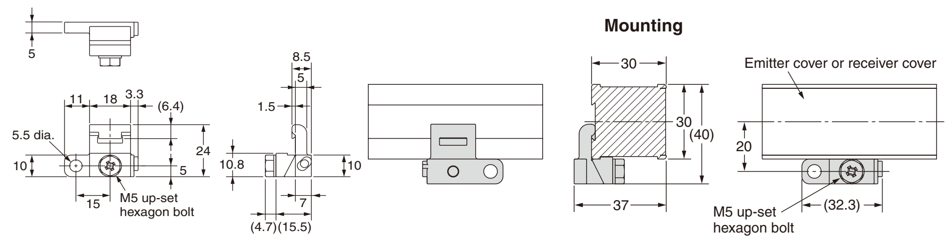
Wall Mounting Bracket

F39-L18



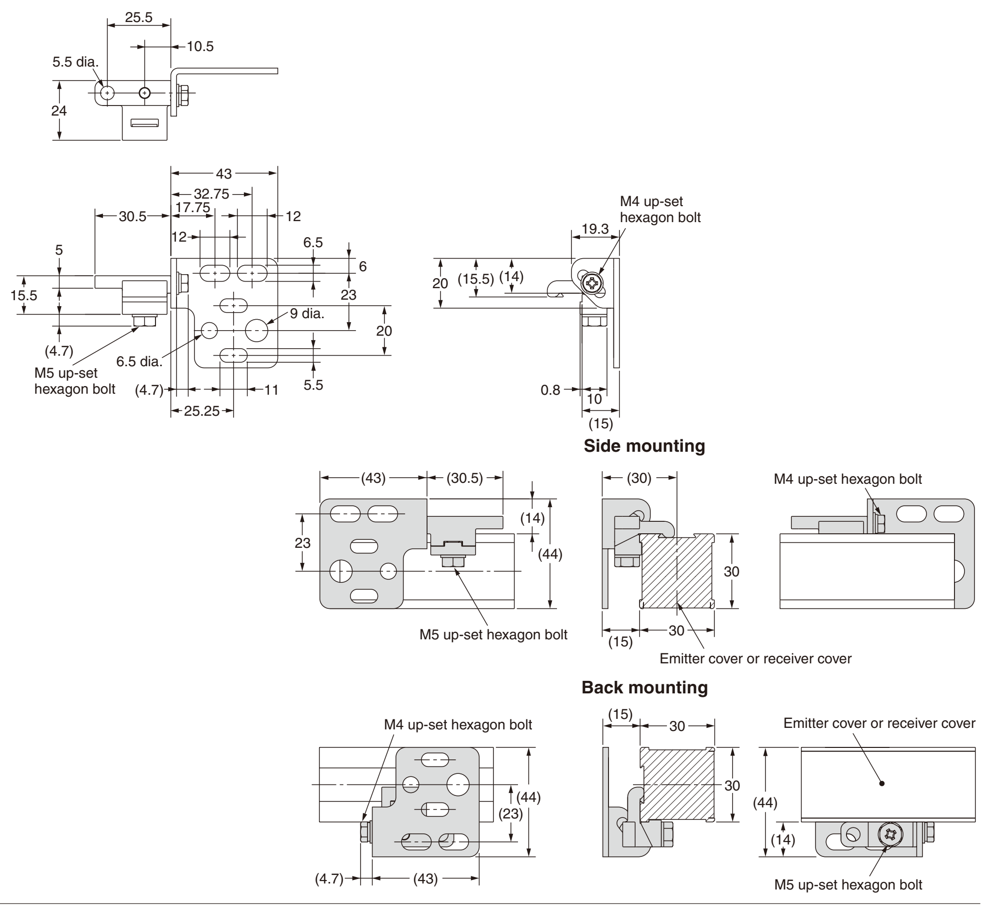
Free-location Bracket

F39-L19



Free-location Bracket

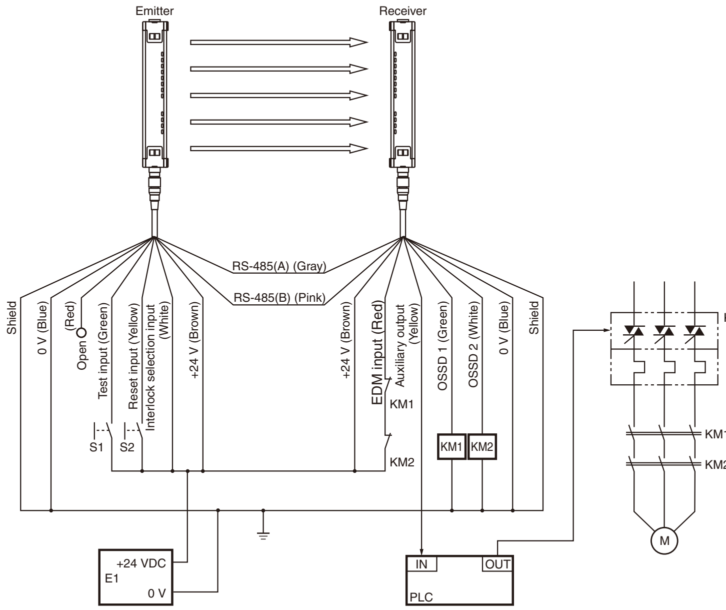
F39-L20



Connection Circuit Examples

An Example of Safety Circuits Where No Controller Is Used

For Category 4 Rating (F3SN-A, F3SH-A)/Category 2 Rating (F3SN-B)

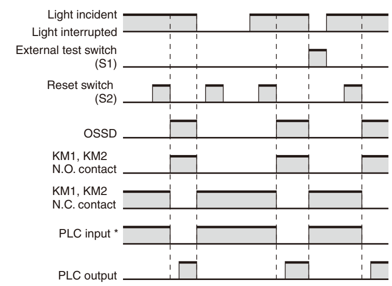


Applicable operation mode

- Manual reset mode
- Using the EDM function

S1:	External test switch
S2:	Interlock/lockout reset switch
KM1, KM2:	Safety relay with forcibly guided contacts (G7SA) or magnetic contactor
KM3:	Solid-state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring. This is not a part of a safety system.)

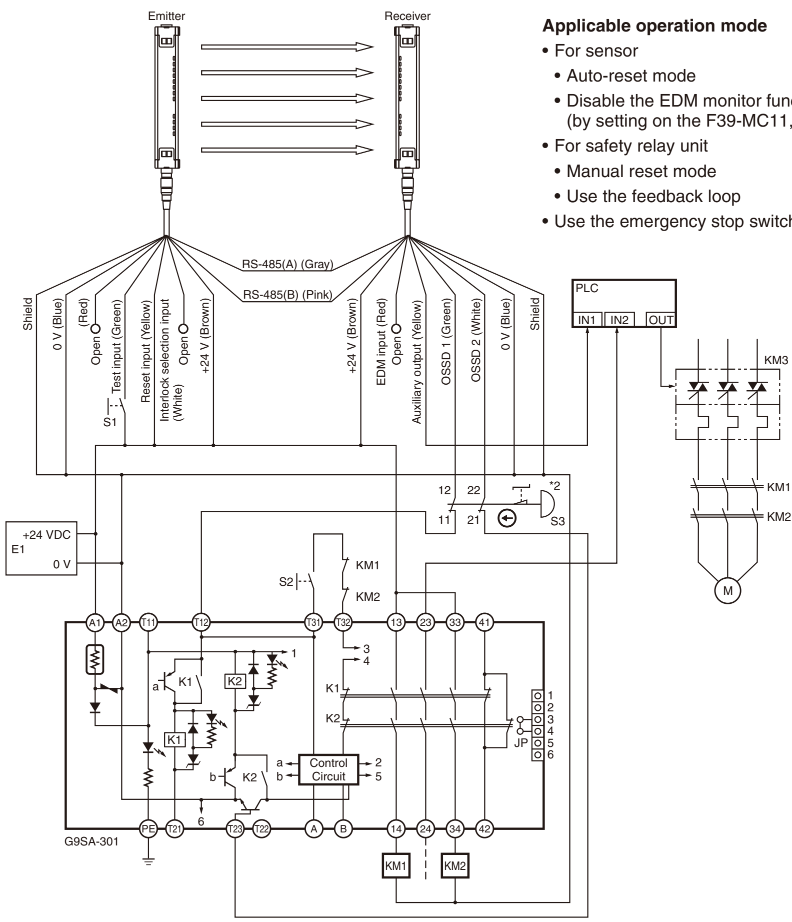
Timing Chart



* The output operation mode of the auxiliary output is the Dark-ON output mode.

An Example of Safety Circuits Where the G9SA-301 Safety Relay Unit is Connected

For category 4 rating (F3SN-A, F3SH-A)/category 2 rating (F3SN-B)



Applicable operation mode

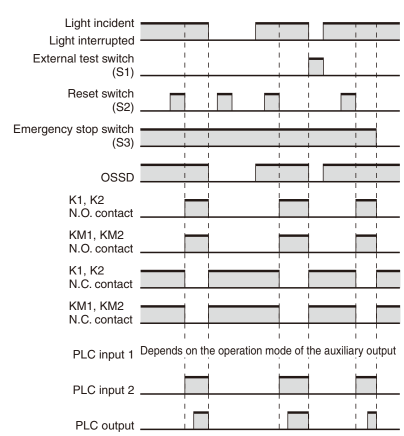
- For sensor
  - Auto-reset mode
  - Disable the EDM monitor function (by setting on the F39-MC11, *1.)
- For safety relay unit
  - Manual reset mode
  - Use the feedback loop
- Use the emergency stop switch *2

*1. The F39-MC11 setting console cannot be connected to the F3SN-B. Therefore, short-circuit the auxiliary output terminal and the EDM input.

*2. If emergency stop switch is not necessary, connect the OSSD 1 directly to T12 terminal and connect the OSSD 2 directly to T23 terminal.

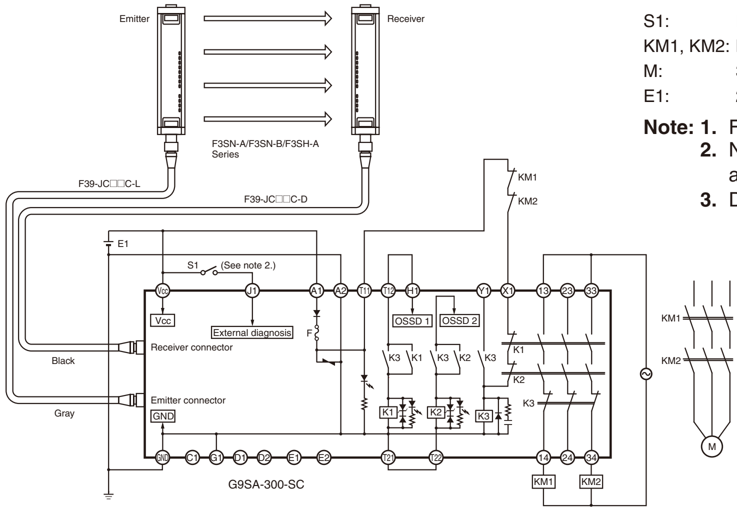
S1:	External test switch
S2:	Reset switch
S3:	Emergency stop switch (direct opening contacts) (A165E or A22E)
KM1, KM2:	Magnetic contactor
KM3:	Solid-state contactor (G3J)
M:	3-phase motor
E1:	24 VDC power supply (S82K)
PLC:	Programmable controller (Used for monitoring. This is not a part of a safety system.)

Timing Chart



Examples of Safety Circuits Where G9SA-300-SC Safety Relay Unit is Connected

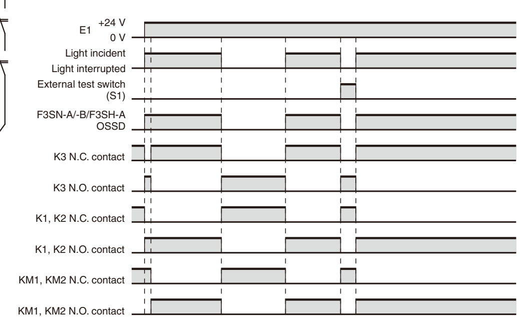
(1) For only safety light curtain in auto-reset mode
For category 4 rating (F3SN-A, F3SH-A)/category 2 rating (F3SN-B)



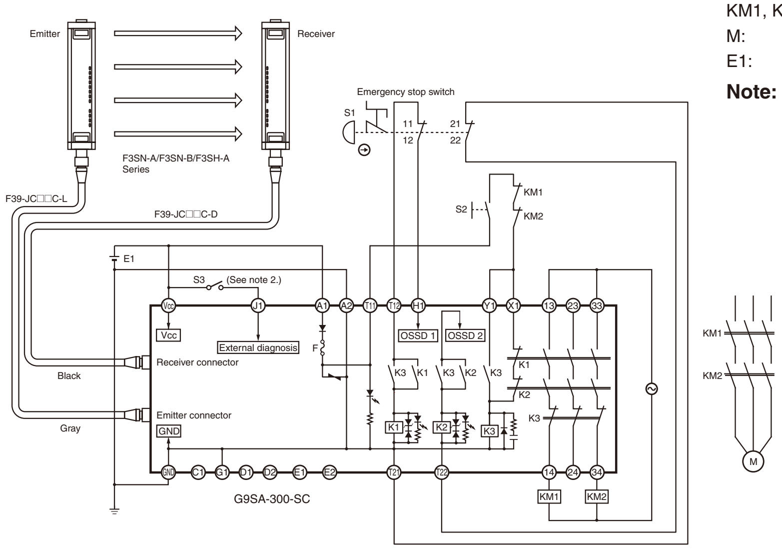
S1: External test switch
KM1, KM2: Magnetic contactor
M: 3-phase motor
E1: 24 VDC power supply (S82K)

Note: 1. F3SN-A's EDM function and auxiliary output cannot be used.
2. Normal operation is performed when the switch S1 is released, and external diagnosis is performed when it is short-circuited.
3. Do not connect anything to the C1, D1, D2, E1, and E2 terminals.

Timing Chart



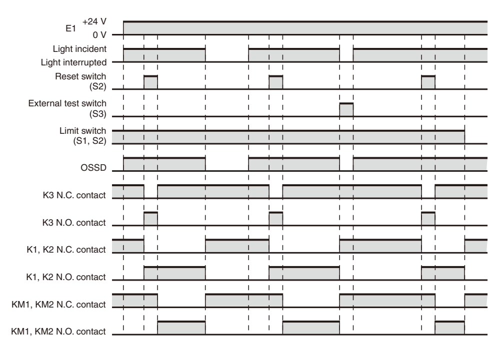
(2) Safety light curtain connected with two channel emergency stop switch inputs in manual reset mode
For category 4 rating (F3SN-A, F3SH-A)/category 2 rating (F3SN-B)



S1: Emergency stop switch
S2: Reset switch (momentary action switch)
S3: External test switch
KM1, KM2: Magnetic contactor
M: 3-phase motor
E1: 24 VDC power supply (S82K)

Note: 1. F3SN-A's EDM function and auxiliary output cannot be used.
2. Normal operation is performed when the switch S3 is released, and external diagnosis is performed when it is short-circuited.
3. Do not connect anything to the C1, D1, D2, E1, and E2 terminals.

Timing Chart



Safety Precautions

This catalog is intended as a guide for product selection. Be sure to use the instruction manual provided with the product for actual operation.

Regulations and Standards

F3SN-A/F3SH-A

1. "Type Certification" specified in the Chapter 44. 2 of the Industrial Safety and Health Law in Japan does not apply to independent F3SN-A/F3SH-A Sensors. This law applies to systems incorporating the Sensor. When using the F3SN-A/F3SH-A Sensor in Japan as a "safety device for presses or shearing machines," as specified in the Chapter 42 of the same law, apply for certification for the overall system.

2. (1) The F3SN-A/F3SH-A is electro-sensitive protective equipment (ESPE) in accordance with European Union (EU) Machinery Directive Annex IV, B, Safety Components, Item 1.

(2) The F3SN-A/F3SH-A complies with the following regulations and standards:

1. EU Regulations
   - Machinery Directive: Directive 98/37/EC
   - EMC Directive: Directive 89/336/EEC
2. European standards: EN61496-1 (TYPE 4 ESPE), prEN61496-2 (TYPE 4 AOPD)
3. International standards: IEC61496-1 (TYPE 4 ESPE), IEC61496-2 (TYPE 4 AOPD)
4. American standards: UL61496-1 (TYPE 4 ESPE), UL61496-2 (TYPE 4 AOPD), UL508, UL1998, CAN/CSA22.2 No. 14, CAN/CSA22.2 No. 0.8
5. JIS standards: JIS B9704-1 (TYPE 4 ESPE), JIS B9704-2 (TYPE 4 AOPD)

(3) The F3SN-A/F3SH-A received the following certification from the EU accredited body DEMKO A/S:

- EC Type-Examination in accordance with the EU Machinery Directive (TYPE 4 ESPE)
- Certificate of a competent body for EMC
- DEMKO Type Certification
  Type 4 ESPE (EN61496-1)
  Type 4 AOPD (prEN61496-2)

(4) The F3SN-A/F3SH-A received the following certification from the Third Party Assessment Body UL:

- Certificate of UL listing for US and Canadian safety standards
  Both of which are: TYPE 4 ESPE (UL61496-1),
  TYPE 4 AOPD (UL61496-2)

(5) The F3SN-A/F3SH-A received the following certification from BG-PRUFZERT of Germany:

- BG test and certification mark
  License
  Type 4 ESPE (EN61496-1)
  Type 4 AOPD (prEN61496-2)

3. The F3SN-A/F3SH-A is designed according to the following standards. To make sure that the F3SN-A/F3SH-A complies with the following standards and regulations, you are asked to design and use it as provided by any other related standards, laws, and regulations. (Underlined regulations are applicable to the F3SN-A only.)
Consult UL or other standardization bodies if you have any questions.

- EN415-4, <u>prEN691, EN692, prEN693</u> (European standards)
- OSHA 29 CFR 1910.212 (US Industrial Safety and Health Regulation)
- <u>OSHA 29 CFR 1910.217</u> (US Industrial Safety and Health Regulation)
- <u>ANSI B11.1 - B11.19</u> (US standard)
- ANSI/RIA 15.06 (US standard)
- Guideline Concerning Failsafe Methods for Control Mechanisms in Machine Tools, 28 July 1998 (The Announcement No. 464, Ministry of Health, Labour and Welfare)

F3SN-B

1. "Type Certification" specified in the Chapter 44. 2 of the Industrial Safety and Health Law in Japan does not apply to independent units of the F3SN-B sensor. This law applies to systems incorporated with the sensors.
When using the F3SN-B sensor in Japan as a "safety device for presses or shearing machines" as specified in the Chapter 42 of the same law, apply for certification as a system.

2. (1) The F3SN-B is electro-sensitive protective equipment (ESPE) in accordance with European Union (EU) Machinery Directive Annex IV, B, Safety Components, Item 1.

(2) The F3SN-B complies with the following regulations and standards:

1. EU Regulations
   - Machinery Directive: Directive 98/37/EC
   - EMC Directive: Directive 89/336/EEC
2. European standards: EN61496-1 (TYPE 2 ESPE), prEN61496-2 (TYPE 2 AOPD)
3. International standards: IEC61496-1 (TYPE 2 ESPE), IEC61496-2 (TYPE 2 AOPD)
4. American standards: UL61496-1 (TYPE 2 ESPE), UL61496-2 (TYPE 2 AOPD), UL508, UL1998, CAN/CSA22.2 No. 14, CAN/CSA22.2 No. 0.8
5. JIS standards: JIS B9704-1 (TYPE 2 ESPE), JIS B9704-2 (TYPE 2 AOPD)

(3) The F3SN-B received the following certification from the EU accredited body DEMKO A/S:

- EC Type-Examination in accordance with the EU Machinery Directive (TYPE 2 ESPE)
- Certificate of a competent body for EMC
- DEMKO Type Certification
  Type 2 ESPE (EN61496-1)
  Type 2 AOPD (prEN61496-2)
  Use: EN954-1 Category B, 1, 2

(4) The F3SN-B received the following certification from the Third Party Assessment Body UL:

- Certificate of UL listing for US and Canadian safety standards
  Both of which are: Type 2 ESPE (UL61496-1),
  Type 2 AOPD (UL61496-2)

(5) The F3SN-B received the following certification from BG-PRUFZERT of Germany:

- BG test and certification mark
  License
  Type 2 ESPE (EN61496-1)
  Type 2 AOPD (prEN61496-2)

3. The F3SN-B is designed according to the following standards. To make sure that the F3SN-B complies with the following standards and regulations, you are asked to design and use it as provided by any other related standards, laws, and regulations.
Consult UL or other standardization bodies if you have any questions.

- EN415-4 (European standard)
- OSHA 29 CFR 1910.212 (US Industrial Safety and Health Regulation)
- ANSI/RIA 15.06 (US standard)
- Guideline Concerning Failsafe Methods for Control Mechanisms in Machine Tools, 28 September 1998 (The Announcement No. 464, Ministry of Health, Labour and Welfare)

WARNING

Detection Zone and Intrusion Path

Refer to "*Precautions for All Safety Sensors*" for the installation conditions of Safety Light Curtains.

F3SH-A Multi-beam Safety Sensor

Install protective structures around the machine so that you must pass through the detection zone of the F3SH-A to reach a hazardous part of the machine.
If it is possible for an operator to get between the sensor's detection zone and the hazardous part of the machine, design the system so that machinery cannot start up automatically. Make sure that machinery cannot restart while the operator is in the hazardous area. Position the switch for restarting machinery in a location from which the status of the hazardous area can be seen clearly. The switch position location must be a place where the switch cannot be operated from within the hazardous area.
Failure to do so may result in serious injury.

· Use of the Fixed Blanking Function (F3SN-A only)

After setting the fixed blanking, check that the F3SN-A detects a test rod at any position in the detection zone through which a person can reach the hazardous part of the machine. If any positions are found by check above, install protective structures to prevent intrusion, which the F3SN-A can not detect.
Failure to do so may result in serious injury.

Safety Distance

Always maintain a safe distance (S) between the light curtain and a hazardous part of a machine.
Failure to do so causes the machine to fail to stop before an operator reaches the dangerous area and may result in serious injury.

Use of the floating blanking increases the size of the detection capability. To calculate a safety distance, be sure to use the increased size of the detection capability.
Failure to do so causes the machine to fail to stop before an operator reaches the dangerous area and may result in serious injury.

F3SN-A/F3SN-B Safety Light Curtains

<Reference>

Method for calculating safety distance as provided by International Standard ISO 13855-2002 (European Standard EN 999-1999) (for intrusion perpendicular to the detection zone)

System that has detection capability of 40 mm max.

Substitute K = 2,000 mm/s and C = 8 (d – 14 mm) in equation (1) and calculate as shown below.

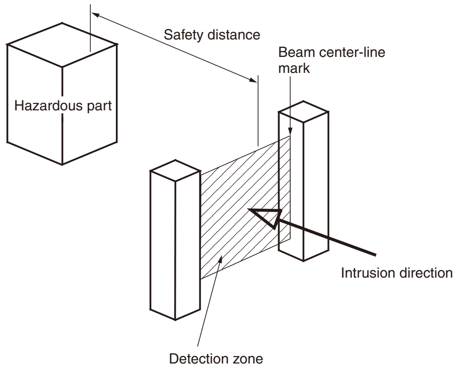
S = 2,000 mm/s × (Tm + Ts) + 8 (d – 14 mm) .... (2)

Where: S = Safety distance (mm)

Tm = Machine response time (s) *1

Ts = Light curtain response time (s) *2

d = Detection capability of the light curtain (mm)



Example:

Tm = 0.05 s, Ts = 0.01 s, d = 14 mm:

S = 2,000 mm/s × (0.05 s + 0.01 s) + 8 (14 mm – 14 mm) = 120 mm

Use S = 100 mm if the result of equation (2) is less than 100 mm. Recalculate using the following equation with K = 1,600 mm/s if the result is over 500 mm.

S = 1,600 mm/s × (Tm + Ts) + 8 (d – 14 mm) .... (3)

Use S = 500 mm if the result from equation (3) is less than 500 mm.

Systems with a Smallest Detectable Object Size (Diameter) Greater than 40 mm

Substitute K = 1,600 mm/s and C = 850 mm in equation (1) and calculate as shown below.

S = 1,600 mm/s × (Tm + Ts) + 850

Where: S = Safety distance (mm)

Tm = Machine response time (s) *1

Ts = Light curtain response time (s) *2

Example:

Tm = 0.05 s, Ts = 0.01 s:

S = 1,600 mm/s × (0.05 s + 0.01 s) + 850 mm = 946 mm

*1. The machine response time refers to the maximum time from the moment the machine receives a stop signal to the moment the hazardous part of the machine stops. The machine response time should be measured on actual machines. The machine response time should be measured and confirmed periodically.

*2. The light curtain response time refers to the time required for output to change from ON to OFF.

Response Time Table

Model	Protective height (mm)	Number of beams	Response time	
			ON to OFF	OFF to ON
F3SNA□□□□ P14(-01)	180 to 450	20 to 50	10.0	40
	459 to 765	51 to 85	12.5	50
	774 to 1,080	86 to 120	15.0	60
	1,089 to 1,125	121 to 125	15.5	62

Model	Protective height (mm)	Number of beams	Response time	
			ON to OFF	OFF to ON
F3SN-A□□□□ P25(-01) F3SN-B□□□□ P25	217 to 772	13 to 50	10.0	40
	787 to 1,297	51 to 85	12.5	50
	1,312 to 1,822	86 to 120	15.0	60

Model	Protective height (mm)	Number of beams	Response time	
			ON to OFF	OFF to ON
F3SN-A□□□□ P40(-01) F3SN-B□□□□ P40	217 to 757	7 to 25	10.0	40
	787 to 1,297	26 to 43	12.5	50
	1,327 to 1,807	44 to 60	15.0	60

Model	Protective height (mm)	Number of beams	Response time	
			ON to OFF	OFF to ON
F3SN-A□□□□ P70(-01) F3SN-B□□□□ P70	277 to 757	5 to 13	10.0	40
	817 to 1,297	14 to 22	12.5	50
	1,357 to 1,777	23 to 30	15.0	60

- Response time for series connected types is calculated as follows: (F3SN-A)
  For 2 sets:
  Response time (ON to OFF): Response time of Light curtain 1 + Response time of Light curtain 2 + 3 ms
  Response time (OFF to ON): Response time of Light curtain 1 + Response time of Light curtain 2 + 12 ms
  For 3 sets:
  Response time (ON to OFF): Response time of Light curtain 1 + Response time of Light curtain 2 + Response time of Light curtain 3 + 4 ms
  Response time (OFF to ON): Response time of Light curtain 1 + Response time of Light curtain 2 + Response time of Light curtain 3 + 16 ms
- Response time of F3SP-B1P is 10 ms, operation time is 100 ms.

Note: When using the F3SP-B1P, determine the safety distance by adding the response time of the F3SP-B1P to that of the F3SN given in the table above.

<Reference>

Method for calculating the safety distance as provided by ANSI B11. 19 (US)

Safety distance (S) = Intrusion speed into the detection zone (K) Response time (Ts + Tc + Tr + Tbm) + Additional distance (Dpf)

Where:

K = Intrusion speed (Recommended value in OSHA standards is 1,600 mm/s)
ANSI B11. 19. does not define Intrusion speed (K). When determining K, consider possible factors including physical ability of operators.

Ts = Time required for machine to stop (s)

Tr = Light curtain response time (s) *

Tc = Maximum response time required for machine control circuit to apply brake (s)

Tbm = Additional time (s)
If the machine is provided with a brake monitor, Tbm = brake monitor setting time – (Ts + Tc). If not provided with a brake monitor, it is recommended to determine a value more than 20% of (Ts + Tc) as the additional time.

Dpf = Additional distance. Dpf is calculated as follows based on ANSI standards.
Dpf = 3.4 × (d – 7.0)
: d is the detection capability of the light curtain (mm).

Example:
Assume that: K = 1,600 mm/s, Ts + Tc = 0.06 s,
Brake monitor setting time = 0.1s, Tr = 0.01s, d = 14 mm.
Then:
Tbm = 0.1 – 0.06 = 0.04 s
Dpf = 3.4 – (14 – 7.0) = 23.8 mm
S = 1,600 × (0.06 + 0.01 – 0.04) + 23.8 = 199.8 mm

* The light curtain response time refers to the time required for output to change from ON to OFF.

<Reference>

Method for calculating the safety distance as provided by ANSI/RIA R15.06 (US) (for intrusion perpendicular to the detection zone)

Safety distance (Ds) = K × (Ts + Tc + Tr) + Dpf

Where:
K = Intrusion speed: 1,600 mm/s min.
Ts = Maximum stop time of machine/equipment (s)
Tc = Maximum stop time of control system (s)
Tr = Light curtain response time (s) *
Os = Diameter of the smallest detectable object (mm)
Dpf = Additional distance (mm)

Assume that the sensor is installed with the lowest beam height above the floor at 300 mm and the highest beam height above the floor at 1,200 mm, with the diameter of the smallest detectable object being 64 mm or less. Then, Dpf is determined from:
Dpf = 3.4 × (Os – 6.875 mm).
If the diameter of the smallest detectable object is more than 64 mm, Dpf is calculated to be 900 mm.

Example:
- F3SN-B□□□□P40 Safety Light Curtain

Assume that K = 1,600 mm/s, Ts + Tc = 0.06 s, Tr = 0.01 s, and Os = 40 mm.
Then:
S = 1,600 × (0.06 + 0.01) + Dpf
= 1,600 × (0.06 + 0.01) + 3. 4 (40 – 6.875)
= 225 mm

- F3SN-B□□□□P70 Safety Light Curtain

Assume that K = 1,600 mm/s, Ts + Tc = 0.06 s, Tr = 0.01 s, and Dpf = 900 mm.
Then:
S = 1,600 × (0.06 + 0.01) + 900
= 1,012 mm

* The light curtain response time refers to the time required for output to change from ON to OFF.

F3SH-A Multi-beam Safety Sensors

<Reference>

Method for calculating safety distance as provided by European Norm EN999 (for intrusion perpendicular to the detection zone)

Substitute K = 1,600 mm/s and C = 850 mm in equation (1) and calculate as shown below.
S = 1,600 mm/s × (Tm + Ts) + 850
Where:
S = Safety distance (mm)
Tm = Machine response time (s) *1
Ts = Sensor response time (s) *2

Example:
Tm = 0.05 s, Ts = 0.01 s:
S = 1,600 mm/s × (0.05 s + 0.01 s) + 850 mm = 946 mm

*1. The machine response time refers to the maximum time from the moment the machine receives a stop signal to the moment the hazardous part of the machine stops. The machine response time should be measured on actual machines. The machine response time should be measured and confirmed periodically.

*2. The sensor response time refers to the time required for output to change from ON to OFF.

Precautions for Correct Use

Do not use the product in atmospheres or environments that exceed product ratings.

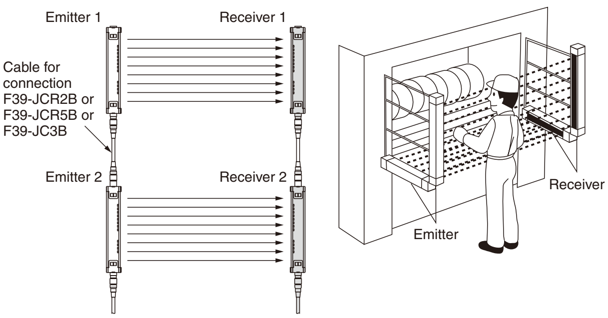
Installation

How to Prevent Mutual Interference

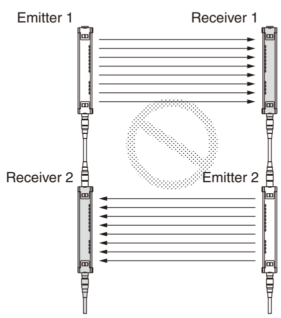
Series connection (Up to 3 sets, 240 beams, sensor models ending in -01, -03, -04, and -05 are required for series connection)

Two or more pairs of the F3SN-A can be connected in series. When connected in series, the F3SN-A sensors generate beams in a time-sharing manner. Thus, they prevent mutual interference and ensure safety.

Correct

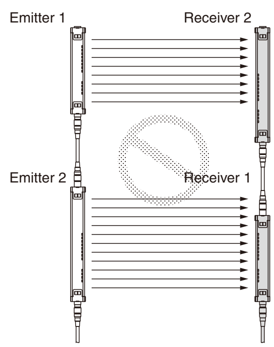


Incorrect



Do not connect the emitter and receiver in series, or a lockout condition will result.

Incorrect



Do not combine an emitter with a receiver of a different pair. This will cause a lockout condition and detection of objects will be disabled.

When not connected

Refer to "*Precautions for All Safety Sensors*" for information on preventing mutual interference of Safety Light Curtains that are not connected in series.

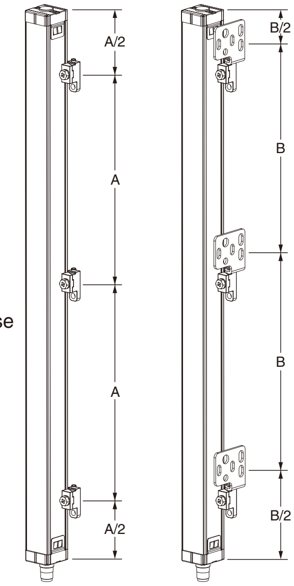
Installation

How to attach Mounting Bracket (F39-L19/L20)

To fully utilize the performance of sensors, locate the F39-L19/L20 mounting brackets in the number satisfying the dimensions "A" and "B" in the sensor longitudinal direction.

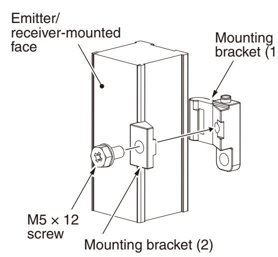
- For the F39-L19
  Spacing "A": 670 mm max.
- For the F39-L20
  Spacing "B": 400 mm max.

Note: When installing sensors at locations susceptible to vibration and shock, increase the number of mounting brackets.



Mounting bracket	Screw × length (mm)	Tightening torque
F39-L19	M5 × 12 screw	2.0 N·m
F39-L20	M4 × 8 screw	1.2 N·m

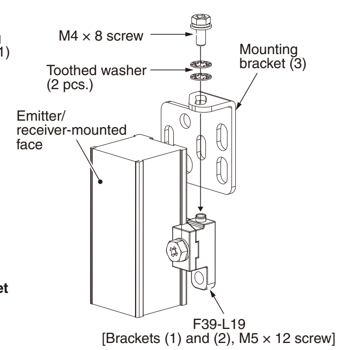
F39-L19



Brackets and screws included in one set

- Mounting bracket (1) 1
- Mounting bracket (2) 1
- M5 × 12 screw 1

F39-L20



Brackets and screws included in one set

- Mounting bracket (1) 1
- Mounting bracket (2) 1
- M5 × 12 screw 1
- Mounting bracket (3) 1
- M4 × 8 screw 1
- Toothed washer 2

Safety-related Functions

Interlock Function

The auto-reset mode and the manual reset mode are wire selectable features of the F3SN-A/F3SN-B/F3SH-A.

Auto-reset Mode

After the power is turned ON and none of the beams are interrupted, the OSSD (Output Signal Switching Device) outputs will go to their ON-state.

Manual Reset Mode

For the factory setting, the start/restart interlock is selected in the manual reset mode. When the light curtain enters the interlock condition, it keeps the OSSD outputs in the OFF-state. Even if all beams become free, the OSSD outputs will not go to the ON-state. When none of the beams are interrupted in the detection zone, applying the reset input resets the interlock condition and the OSSD outputs go to the ON-state.

- Start/restart interlock
  After the power is turned ON, or when at least one beam is interrupted, the light curtain enters the interlock condition.
- Start interlock
  Only after power ON, the light curtain enters the interlock condition.
- Restart interlock
  Only when at least one beam is interrupted, the light curtain enters the interlock condition.

Fixed Blanking Function (F3SN-A only)

This function is set with the F39-MC11 setting console.
This is a function provided to disable a specific area of the light curtain's detection zone. Fixed blanking can be set for any desired number of beams. If an object enters the disabled detection zone, the OSSD outputs status will not change. This function is used when there is a stationary object in the detection zone that needs to be ignored.

Floating Blanking Function (F3SN-A only)

This function is set with the F39-MC11 setting console.
During normal operation when floating blanking is disabled, and at least one beam is interrupted, the light curtain will go to the OFF-state. However, using this function prevents the light curtain from going to the OFF-state until multiple beams (*1, *2, and *3) are interrupted.

*1. The number of the floating blanking beams can be selected in the range of 1 to 3 beams.
*2. This function can be set to be active only if the interrupted beams are adjacent to each other.
*3. This function can be set so that the top and bottom beams cannot be set for the function.

Diagnostic Functions

Self-test

After power ON, the F3SN-A/F3SN-B/F3SH-A performs a complete self-test within 1 second. In addition, it performs a self-test (within response time) periodically during operation.

External Test

This function stops the emission of light from the light curtain using an external signal and checks that the light curtain operates properly.

Lockout Condition

If an error is detected by the self-test, the light curtain enters the lockout condition, keeps the OSSD outputs in their OFF state and displays the error mode. Lockout condition can be cleared either by resetting the power or by changing the setting of the reset switch from closed to open (open to closed for auto-reset). (With some errors, the lockout condition is automatically reset when the light curtain confirms that the cause of the error has been removed.)

EDM (External Device Monitoring)

This function monitors the state of the NC contacts. Connect the NC contact of the MPCEs to the EDM input line of the receiver. If the correct logical relationship between the OSSD outputs and the EDM input is not kept, the light curtain immediately enters the lockout condition and the OSSD outputs will go to their OFF-state.
The light curtain's normal operation is up to 300 ms max. (*), this allows for the delay time caused by the release of the MPCEs.
To ensure the correct usage of this function, the MPCEs must be safety-certified types with forcibly guided contacts.

When the EDM is not used

In the case the EDM input is not used, connect the auxiliary output in the Dark-ON output mode to the EDM input line, or disable the EDM with the F39-MC11 setting console.

* The value can be changed by the F39-MC11.
  (It is impossible to connect the F39-MC11 to the F3SN-B.)

Non-safety Output

Auxiliary Output

The default of this output is the reverse signal of the safety outputs (Dark-ON output). This output can be used for monitoring purposes by connecting it to a device such as a PLC.
The auxiliary output can be selected to give one of the following output operation modes by the F39-MC11. (No selection can be made by the F3SN-B.)

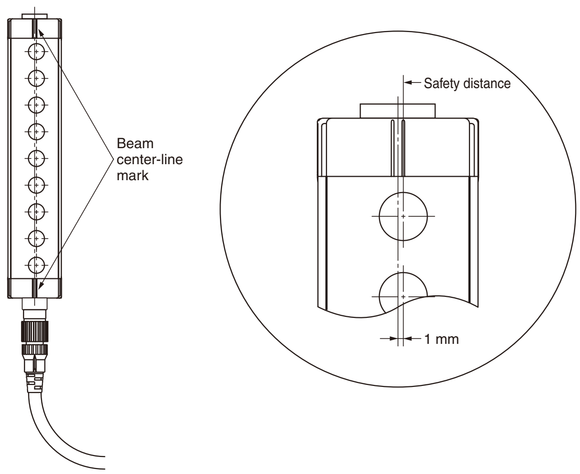
- Dark-ON output mode (fixed for the F3SN-B)
- Light-ON output mode
- Light diagnosis mode
- Lockout mode
- Outermost-beam monitoring mode
- Specified-beam mode
- Blanking monitoring mode (F3SN-A only)

External Indicator Output (Series-connection type only)

This output can be connected to an external indicator to display one of the operation modes as selected by the F39-MC11. The default of this output is Light-ON output. A desired output operation mode can be selected by using the F39-MC11.

Beam Center-line

The beam center-line is the line going through all of the beams. (See diagram below.) This position is a reference line for measuring safety distance. Use the line closer to the hazardous area as a reference line for the safety distance.



Precautions for All Safety Sensors

Note: Refer to the "*Safety Precautions*" section for each Sensor for specific precautions applicable to each Sensor.

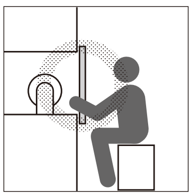
WARNING

Installation Conditions

Detection Zone and Intrusion Path

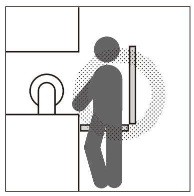
Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas.
If a person is able to step into the hazardous area of a machine and remain behind the Safety Light Curtain's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

Correct Installation



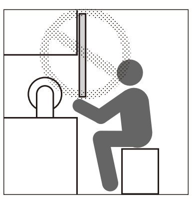
A person can only reach the hazardous part of the machinery by passing through the sensor's detection zone.

Correct Installation



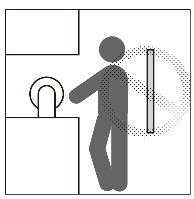
A person enters the detection zone during operation.

Incorrect Installation



A person can reach the hazardous part of the machinery without passing through the sensor's detection zone.

Incorrect Installation



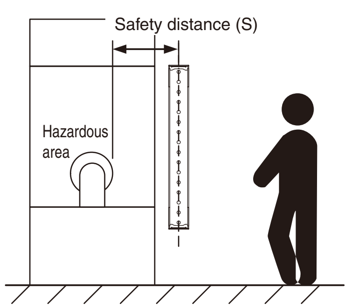
A person is between the sensor's detection zone and the hazardous part of the machinery.

Install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

The Safety Light Curtain cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

Safety Distance

The safety distance is the distance that must be set between the Safety Light Curtain and a machine's hazardous part to stop the hazardous part before a person or object reaches it. The safety distance varies according to the standards of each country and the individual specifications of each machine. In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the Safety Light Curtain. Always refer to relevant standards.



Make sure to secure the safety distance (S) between the Safety Light Curtain and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Note: The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops.
Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

How to calculate the safety distance specified by International standard ISO13855-2002 (European standard EN999-1999) (Reference)

If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.

S = K x T + C . . . Eq. (1)

- S: Safety distance
- K: Approach speed to the detection zone
- T: Total response time of the machine and Safety Light Curtain
- C: Additional distance calculated by the detection capability of the Safety Light Curtain

<System that has detection capability of 40 mm max.>
Use K = 2,000 mm/s and C = 8 x (d - 14 mm) in equation (1) for the calculation.
S = 2,000 mm/s x (Tm + Ts) + 8 x (d - 14 mm)

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s) *
- d = Size of Safety Light Curtain's detection capability (mm) *

* These values differ depending on the Switch. Refer to the "*Precautions for Correct Use*" for the Switch you are using.

[Calculation example]
When Tm = 0.05 s, Ts = 0.01 s, and d = 14 mm:
S = 2,000 mm/s x (0.05 s + 0.01 s) + 8 x (14 mm - 14 mm)
= 120 mm . . . Eq. (2)
If the result is less than 100 mm, use S = 100 mm.
If the result exceeds 500 mm, use the following equation where K = 1,600 mm/s.
S = 1,600 mm/s x (Tm + Ts) + 8 x (d - 14 mm) . . . Eq. (3)
If the result of this Eq. (3) is less than 500 mm, use S = 500 mm.

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 40 mm or Systems Using Multi-beam Safety Sensors>

Assuming K = 1,600 mm/s and C = 850 mm, the following calculation is made using Eq. (1).
S = 1,600 mm/s x (Tm + Ts) + 850 … Eq. 4,

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s)

Calculation example:
When Tm = 0.05 s and Ts = 0.01 s,
S = 1,600 mm/s x (0.05 s + 0.01 s) + 850 mm = 946 mm

How to calculate the safety distance specified by American standard ANSI B11.19
(Reference)
<Systems with a Smallest Detectable Object Size (Diameter) Less than 64 mm>
If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.
S = K x (Ts + Tc + Tr + Tbm) + Dpf

- S: Safety distance
- K: Approach speed to the detection zone (the value recommended by OSHA standard is 1,600 mm/s)

Approach speed K is not specified in the ANSI B.11.19 standard. To determine the value of K to apply, consider all factors, including the operator's physical ability.

- Ts = Machine's stop time (s)
- Tr = Response time of the Safety Light Curtain from ON to OFF (s)
- Tc = Machine control circuit's maximum response time required to activate its brake (s)
- Tbm = Additional time (s)

If a machine has a brake monitor, "Tbm = Brake monitor setting time - (Ts + Tc)". If it has no brake monitor, we recommend using 20% or more of (Ts + Tc) as additional time.

- Dpf = Additional distance

According to ANSI's formula, Dpf is calculated as shown below:
Dpf = 3.4 x (d - 7.0): Where d is the detection capability of the Safety Light Curtain (unit: mm)

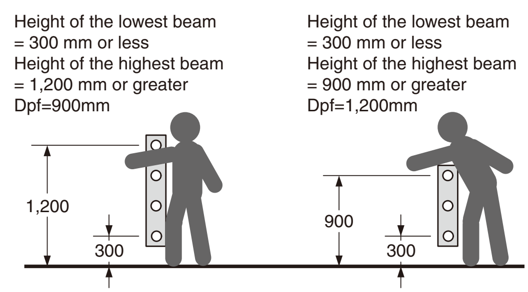
[Calculation example]
When K = 1,600 mm/s, Ts + Tc = 0.06 s, brake monitor setting time = 0.1 s, Tr = 0.01 s, d = 14 mm:
Tbm = 0.1 - 0.06 = 0.04 s
Dpf = 3.4 x (14 - 7.0) = 23.8 mm
S = 1,600 x (0.06 + 0.01 + 0.04) + 23.8 = 199.8 mm

Method for Calculating the Safety Distance as Provided by ANSI/RIA R15.06 (USA)
(Reference)
<Systems with a Smallest Detectable Object Size (Diameter) Greater than 64 mm and Less than 600mm>
The safety distance is calculated based on the following concepts when the human body intrudes perpendicular to the detection zone of the Safety Light Curtain.
S = K x (Ts + Tc + Tr) + Dpf

- S: Safety distance
- K = Intrusion speed into detection zone (1,600 mm/s min. recommended by OSHA)
- Ts = Stop time of machine/equipment (s)
- Tr = Light curtain ON-to-OFF response time (s)
- Tc = Maximum response time of the machine/equipment braking circuit required to operate the brake (s)
- Dpf = Additional distance (mm)

If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 1,200 mm or higher, the Dpf will be 900 mm.
If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 900 mm or higher, the Dpf will be 1,200 mm.

[Calculation example]
K = 1,600 mm/s, Ts + Tc = 0.06s,
If Tr = 0.01 s and Dpf = 900 mm:
S = 1,600 x (0.06 + 0.01) + 900 = 1,012 mm

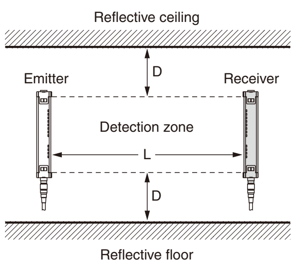


Distance from Glossy Surface

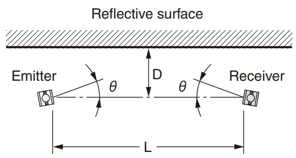
Install the sensor system so that it is not affected by reflection from a glossy surface. Failure to do so may hinder detection, resulting in serious injury.

Install the sensor system at distance D or further from highly reflective surfaces such as metallic walls, floors, ceilings, or workpieces, as shown below.

<Side View>



<Top View>



θ =5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ =10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.13 m	0.26 m
For 3 m or more	L/2 x tan5° = L x 0.044 (m)	L/2 x tan10° = L x 0.088 (m)

Others

To use the Safety Light Curtain in PSDI mode (restart of cycle operation by the sensor), you must configure an appropriate circuit between the Safety Light Curtain and the machine. For details about PSDI, refer to OSHA1910.217, IEC61496-1, and other relevant standards and regulations.

Do not try to disassemble, repair, or modify this product. Doing so may cause the safety functions to stop working properly.

Do not use the Safety Light Curtain in environments where flammable or explosive gases are present. Doing so may result in explosion.

Perform daily and 6-month inspections for the Safety Light Curtain. Otherwise, the system may fail to work properly, resulting in serious injury.

Installation

Prevention of Mutual Interference

The emitter and the receiver to be set facing each other should be a pair of the same set. Erroneous combination may create a zone where objects cannot be detected.

Do not use a sensor system in a reflective configuration. Doing so may hinder detection.
Mirrors can be used change the optical route.

When using more than 1 set of Safety Light Curtain, install them so that mutual interference does not occur, such as by configuring series connections or using physical barriers between adjacent sets.

Precautions for Safe Use

Do not used the product in atmospheres or environments that exceed product ratings

Installation

Prevention of Mutual Interference

For series connection

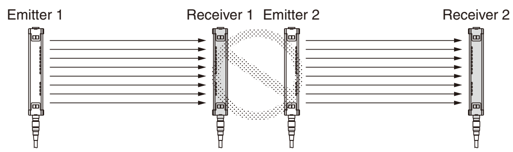
Refer to the "*Precautions for Correct Use*" for individual models for information on preventing mutual interference of linkable Safety Light Curtains.

For no series connection

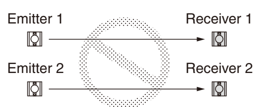
When installing two or more pairs of light curtains independently from each other due to inconvenience of wiring or other reason, take proper measures to prevent mutual interference. If mutual interference occurs, a lockout condition will result for the Safety Light Curtain.

- Installation which may cause mutual interference

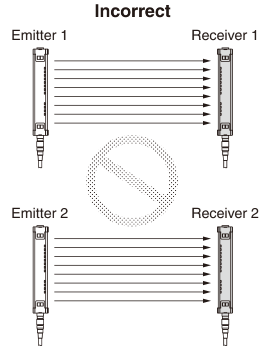
Incorrect



Incorrect



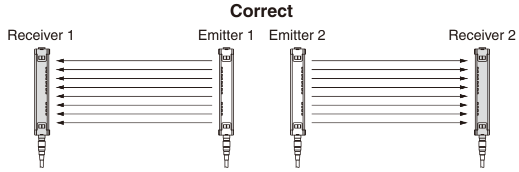
Incorrect



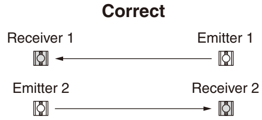
- Installation to prevent mutual interference

(1)Install so that the two light curtains emit in the opposite directions (staggered).

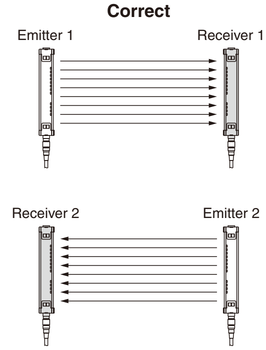
Correct



Correct

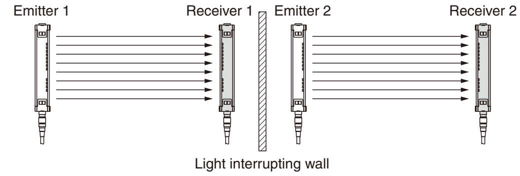


Correct



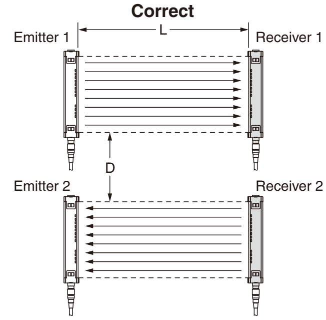
(2)Install a light interrupting wall in between sensors.

Correct

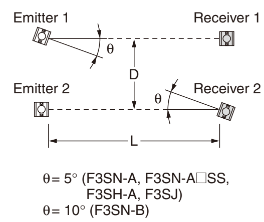


(3)Install the light curtains facing away from the one another to eliminate mutual interference.

Correct



Correct



θ= 5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ= 10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.26 m	0.52 m
For 3 m or more	L x tan5° = L x 0.088 (m)	L x tan10° = L x 0.18 (m)

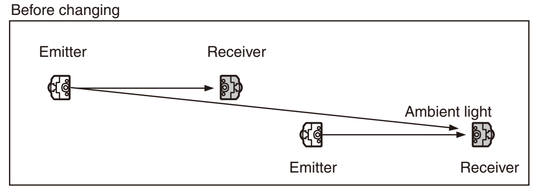
Operating range

Chattering may occur in the output when the distance between the emitter and the receiver is less than 0.2 m. Use only in the rated operating range.

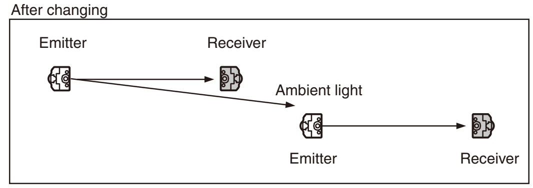
(4)Use a spatter protection slit cover. (F3SN and F3SH)

(5)Shorten the detection distance by setting with a setting tool. (F3SJ)

Before changing



After changing



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
ISO 12100 Basic Concepts, General Principles for Design
IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Short-range Safety Light Curtain (Type 4)
F3SN-A☐SS

Greater resistance to external light interference. Significantly less interference with other sensors.

- Interference reduced both between Sensors of the same type and Sensors of different types.
- Setting Console Optimizes Light Sensitivity for Specific Ranges
- Ideal Where Installation Space Is Limited
- Conforms to International Safety Standards
- Korean standard "S-mark" models are also available.

⚠ Be sure to read the *"Safety Precautions"* on page 21 and the *"Precautions for All Safety Sensors"* .

Features

New Emitter Mechanism Eliminates Excessive Light

Removing excessive light is the key to eliminating mutual interference, external light interference, and other similar causes of unwanted line stoppages.

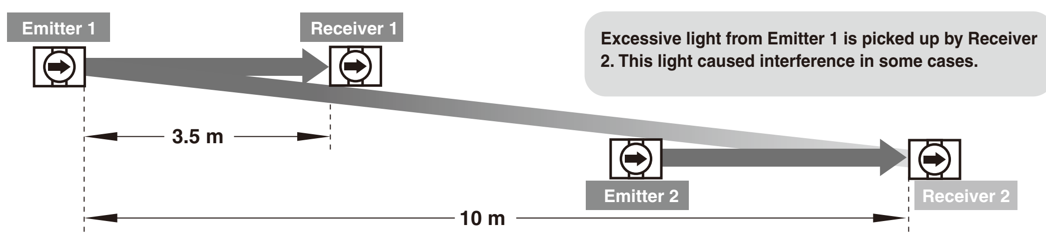
Conventional Models

Conventional models had an operating range that was too long. This meant that they picked up light from sensors in unexpected locations and they interfered with other sensors.

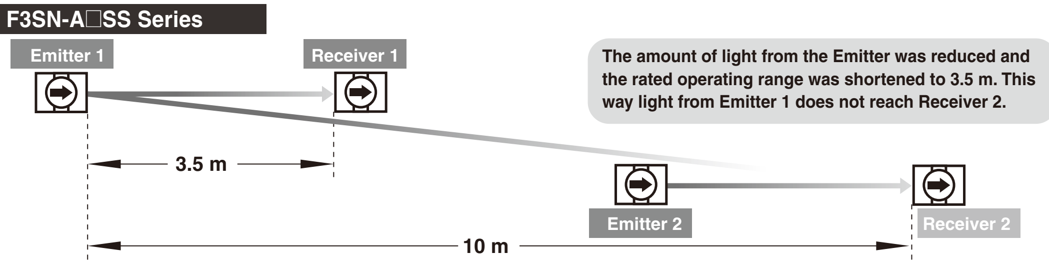
F3SN-A☐SS Series

The operating range for the F3SN-A☐SS Series is limited to 3.5 m as opposed to 10 m for conventional models. This dramatically reduces the negative impact on adjacent light curtains and surrounding photoelectric sensors even in applications where parallel light curtains are installed for multiple devices. It also eliminates additional work such as installing special wiring to prevent interference.

Conventional F3SN-A Series

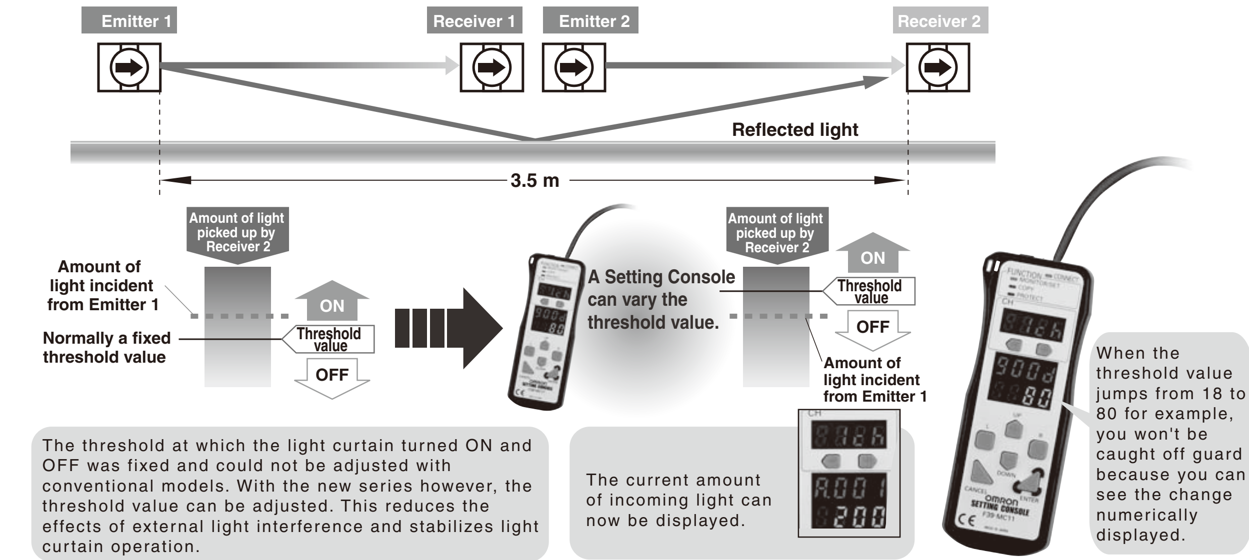


F3SN-A☐SS Series



Setting Console Optimizes Light Sensitivity for Specific Ranges

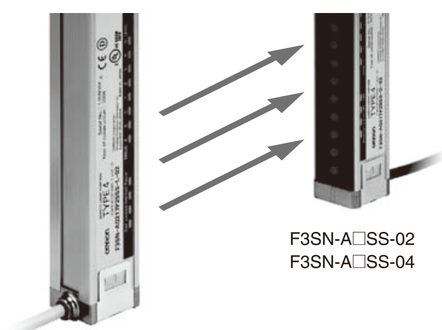
Even Light Reflected from Walls

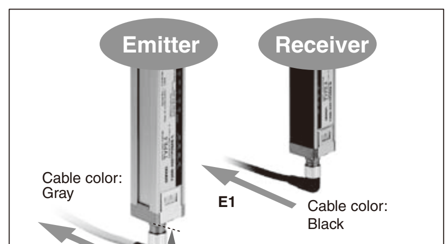


Ideal Where Installation Space Is Limited

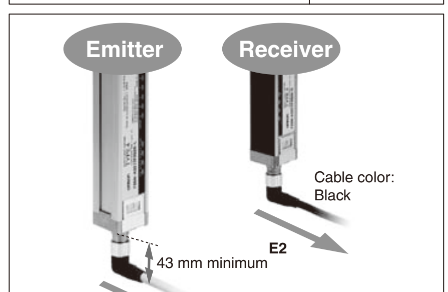
Back-mounted Connector Cable Models and Optional Right-angle Cables

Models with connector cables attached at the back (F3SN-A□SS-02/04) can be used for installation where space is limited and there is no extra room at the bottom of the Light Curtains. The F3SN-A□SS-04 also equipped with a connector cable at the top for series connection. When there is no space at the back, traditional Straight Connector Cables or an optional L-shaped Connector Cable (F39-JC□E□) that extends from the side of the lens surface are also available.





F39-JC□E1



F39-JC□E2

Note: The direction of the cable is fixed.

More Compact Machines
The F3SN-A□P14 finger protection model is ideal for the more compact machines available today. It has a safe distance that can be as short as 88 mm. Refer to F3SN-A/ F3SN-B, F3SH-A for details.

Conforms to International Safety Standards

The F3SN-A□SS is a Type 4 sensor with a category 4 rating. This means that it conforms to the highest standards of safety for a Safety Light Curtain. The F3SN-A□SS conforms to all the following standards.

International standard	IEC61496-1, IEC61496-2
EU regulations, EN standard	Machinery Directive, EMC Directive, EN61496-1, EN61496-2
JIS standards	JIS B9704-1, B9704-2
North American Standards	UL61496-1, UL61496-2, UL508, UL1998, CAN/CSA22.2 No.14, CAN/CSA22.2 No.0.8
Korean Standard	S-mark certification (only -S Models)

Application is also possible in devices covered by the OSHA standards (29 CFR 1910.212) of the USA. The requirements of the USA Industrial Robot Standard ANSI/RIA R15.06-1999 have also been satisfied.

Ordering Information

Main Unit

F3SN-A□SS Safety Light Curtains (Type 4)

A Connector Cable is not supplied with the Main Unit, and must be purchased separately.

Connection method			Min. detectable object	Beam gap	Appearance	Operating range	Protective height (mm)	Number of beams	Model
Sensor bottom	Sensor top	Application							
M12 straight connector	No connector	• Standalone • Last set in a series connection (second of 2 sets connected in series or third of 3 sets connected in series)	25 dia.	15 mm		0.2 to 3.5 m	217	13	**F3SN-A0217P25SS**
							262	16	**F3SN-A0262P25SS**
							352	22	**F3SN-A0352P25SS**
							427	27	**F3SN-A0427P25SS**
							502	32	**F3SN-A0502P25SS**
							592	38	**F3SN-A0592P25SS**
							667	43	**F3SN-A0667P25SS**
							742	48	**F3SN-A0742P25SS**
							832	54	**F3SN-A0832P25SS**
							907	59	**F3SN-A0907P25SS**
							982	64	**F3SN-A0982P25SS**
							1072	70	**F3SN-A1072P25SS**
							1147	75	**F3SN-A1147P25SS**
							1222	80	**F3SN-A1222P25SS**
							1312	86	**F3SN-A1312P25SS**
							1462	96	**F3SN-A1462P25SS**
							1627	107	**F3SN-A1627P25SS**
							1792	118	**F3SN-A1792P25SS**
M12 straight connector	M12 Connector	• Not the last set in a series connection (first of 2 sets connected in series, or first or second of 3 sets connected in series) • For external indicator installations					217	13	**F3SN-A0217P25SS-01**
							262	16	**F3SN-A0262P25SS-01**
							352	22	**F3SN-A0352P25SS-01**
							427	27	**F3SN-A0427P25SS-01**
							502	32	**F3SN-A0502P25SS-01**
							592	38	**F3SN-A0592P25SS-01**
							667	43	**F3SN-A0667P25SS-01**
							742	48	**F3SN-A0742P25SS-01**
							832	54	**F3SN-A0832P25SS-01**
							907	59	**F3SN-A0907P25SS-01**
							982	64	**F3SN-A0982P25SS-01**
							1072	70	**F3SN-A1072P25SS-01**
							1147	75	**F3SN-A1147P25SS-01**
							1222	80	**F3SN-A1222P25SS-01**
							1312	86	**F3SN-A1312P25SS-01**
							1462	96	**F3SN-A1462P25SS-01**
							1627	107	**F3SN-A1627P25SS-01**
							1792	118	**F3SN-A1792P25SS-01**
Connector with 0.4-m cable	No connector	• Standalone • When dimensions at the bottom of the Sensor are restricted • Last set in a series connection (second of 2 sets connected in series or third of 3 sets connected in series)					217	13	**F3SN-A0217P25SS-02**
							262	16	**F3SN-A0262P25SS-02**
							352	22	**F3SN-A0352P25SS-02**
							427	27	**F3SN-A0427P25SS-02**
							502	32	**F3SN-A0502P25SS-02**
							592	38	**F3SN-A0592P25SS-02**
							667	43	**F3SN-A0667P25SS-02**
							742	48	**F3SN-A0742P25SS-02**
							832	54	**F3SN-A0832P25SS-02**
							907	59	**F3SN-A0907P25SS-02**
							982	64	**F3SN-A0982P25SS-02**
							1072	70	**F3SN-A1072P25SS-02**
							1147	75	**F3SN-A1147P25SS-02**
							1222	80	**F3SN-A1222P25SS-02**
							1312	86	**F3SN-A1312P25SS-02**
							1462	96	**F3SN-A1462P25SS-02**
							1627	107	**F3SN-A1627P25SS-02**
							1792	118	**F3SN-A1792P25SS-02**

Connection method			Min. detectable object	Beam gap	Appearance	Operating range	Protective height (mm)	Number of beams	Model
Sensor bottom	Sensor top	Application							
Connector with 0.4-m cable	Connector with 0.2-m cable	• Not the last set in a series connection (first of 2 sets connected in series, or first or second of 3 sets connected in series)	25 dia.	15 mm		0.2 to 3.5 m	217	13	**F3SN-A0217P25SS-04**
							262	16	**F3SN-A0262P25SS-04**
							352	22	**F3SN-A0352P25SS-04**
							427	27	**F3SN-A0427P25SS-04**
							502	32	**F3SN-A0502P25SS-04**
							592	38	**F3SN-A0592P25SS-04**
							667	43	**F3SN-A0667P25SS-04**
							742	48	**F3SN-A0742P25SS-04**
							832	54	**F3SN-A0832P25SS-04**
							907	59	**F3SN-A0907P25SS-04**
							982	64	**F3SN-A0982P25SS-04**
							1072	70	**F3SN-A1072P25SS-04**
							1147	75	**F3SN-A1147P25SS-04**
							1222	80	**F3SN-A1222P25SS-04**
							1312	86	**F3SN-A1312P25SS-04**
							1462	96	**F3SN-A1462P25SS-04**
							1627	107	**F3SN-A1627P25SS-04**
							1792	118	**F3SN-A1792P25SS-04**

F3SN-A□SS-S S-Mark Type 4 Safety Light Curtain

A Connector Cable is not supplied with the Main Unit, and must be purchased separately.

Connection method			Min. detectable object	Beam gap	Appearance	Operating range	Protective height (mm)	Number of beams	Model
Sensor bottom	Sensor top	Application							
M12 straight connector	No connector	• Standalone	25 dia.	15 mm		0.2 to 3.5 m	217	13	**F3SN-A0217P25SS-S**
							262	16	**F3SN-A0262P25SS-S**
							352	22	**F3SN-A0352P25SS-S**
							427	27	**F3SN-A0427P25SS-S**
							502	32	**F3SN-A0502P25SS-S**
							592	38	**F3SN-A0592P25SS-S**
							667	43	**F3SN-A0667P25SS-S**
							742	48	**F3SN-A0742P25SS-S**
							832	54	**F3SN-A0832P25SS-S**
							907	59	**F3SN-A0907P25SS-S**
							982	64	**F3SN-A0982P25SS-S**
							1072	70	**F3SN-A1072P25SS-S**
							1147	75	**F3SN-A1147P25SS-S**
							1222	80	**F3SN-A1222P25SS-S**
							1312	86	**F3SN-A1312P25SS-S**
							1462	96	**F3SN-A1462P25SS-S**
							1627	107	**F3SN-A1627P25SS-S**
							1792	118	**F3SN-A1792P25SS-S**

Note: 1. A Connector Cable is not supplied with the Main Unit, and must be purchased separately. The overall length of the cable connecting a Safety Light Curtain to the DC power supply must not exceed 10 m.

2. Two ferrite cores are provided with Safety Light Curtains that are S-Mark compliant. Attach one ferrite core to the emitter cable and the other to the receiver cable when connecting the Light Curtain with the optional Connector Cable.

3. Japanese-, English-, and Korean-language operation manuals are available on the CD-ROM provided with the S-Mark Safety Light Curtain.

Accessories (Sold Separately)

Cable with Connector on One End (For Emitter and Receiver, 1 Set of 2 Cables)

For Connection with Safety Devices such as Relays with Forcibly Guided Contacts, Safety Relay Units, and Safety Controllers

Type	Appearance	Cable length	Specification	Model
Straight Connectors		3 m	M12 straight connectors (8-pin)	**F39-JC3A**
		7 m		**F39-JC7A**
		10 m		**F39-JC10A**
		15 m		**F39-JC15A**
Right-angle Connectors, Emitter Cable to Right and Receiver Cable to Left		3 m	M12 right-angle connectors (8-pin) Cables go to the back when the Emitter is mounted on the left side and the Receiver is mounted on the right side.	**F39-JC3E1**
		7 m		**F39-JC7E1**
		10 m		**F39-JC10E1**
		15 m		**F39-JC15E1**
Right-angle Connectors, Emitter Cable to Left and Receiver Cable to Right		3 m	M12 right-angle connectors (8-pin) Cables go to the front when the Emitter is mounted on the left side and the Receiver is mounted on the right side.	**F39-JC3E2**
		7 m		**F39-JC7E2**
		10 m		**F39-JC10E2**
		15 m		**F39-JC15E2**

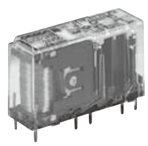
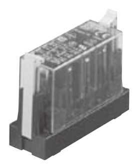
Cable with Connectors on Both Ends (For Emitter and Receiver, 1 Set of 2 Cables)

For Series Connection or Connection with the F3SP-B1P Safety Relay Unit

Appearance	Cable length	Specification	Application	Model
	0.2 m	M12 Straight Connectors (8-pin)	Series connection or connection with the F3SP-B1P Safety Relay Unit *1	**F39-JCR2B**
	0.5 m			**F39-JCR5B**
	3 m			**F39-JC3B**
	5 m		Connection with the F3SP-B1P Safety Relay Unit *2	**F39-JC5B**
	7 m			**F39-JC7B**
	10 m			**F39-JC10B**
	15 m			**F39-JC15B**

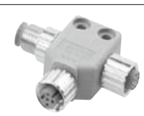
*1. The F3SN-A□SS-04 Series is equipped with a 0.2-m series connection cable and does not require a Cable with Connectors on Both Ends for series connections. Purchase additional cables to extend cables that are too short.
*2. The maximum length of series connection cables is 3 m. Longer cables cannot be used for series connections.

Relays with Forcibly Guided Contacts and Safety Controllers

Type	Appearance	Specification	Model	Remarks
G7SA Relays with Forcibly Guided Contacts		• No. of contacts: 4 • Contact output: 2NO + 2NC • Rated switch load: 6 A at 250 VAC, 6 A at 30 VDC	**G7SA-2A2B**	Refer to G7SA for other models, socket models, and other information.
		• No. of contacts: 4 • Contact output: 3NO + 1NC • Rated switch load: 6 A at 250 VAC, 6 A at 30 VDC	**G7SA-3A1B**	
G7S-□-E Relays with Forcibly Guided Contacts		• No. of contacts: 6 • Contact output: 4NO + 2 NC • Rated switch load: 10 A at 250 VAC, 10 A at 30 VDC	**G7S-4A2B-E**	Refer to G7S-□-E for other models, socket models, and other information.
		• No. of contacts: 6 • Contact output: 3NO + 3NC • Rated switch load: 10 A at 250 VAC, 10 A at 30 VDC	**G7S-3A3B-E**	
Dedicated Control Unit		• Quick connection/disconnection to the F3SN-A□SS with a Cable with Connectors on Both Ends. • Contact output: 3NO + 1NC	**F3SP-B1P**	Use an F39-JC□B Cable with Connectors on Both Ends to connect to the F3SN-A□SS.
Muting Controller		• Connects up to two F3SN-A□SS sets and provides muting capability.	**F3SP-U2P**	Use an F39-JC□A or F39-JC□E□ Cable with Connector on One End to connect to the F3SN-A□SS. Refer to F3SP-U2P for functions and other details.

OMRON offers many Safety Application Controllers to help you build safety circuits.
Refer to Safety Application Controller Product Selection and specifications (Cat. No. Y106).

Setting Console

Type	Appearance	Model	Remarks
Setting Console		**F39-MC11 *1, *2**	Accessories: Branching Connector (1), Connector Cap (1), Special Cable (2 m), Instruction Manual
Extra Branching Connector		**F39-CN1**	One Connector is supplied with the Setting Console. Order extras if needed.

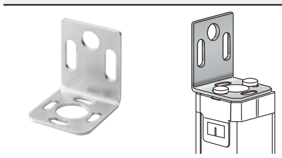
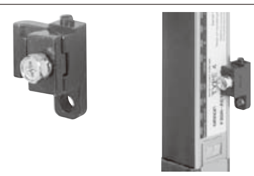
*1. The functions described in this catalog are supported by firmware version 3 or later. They are not supported by products shipped prior to August 2003.
*2. Functions not described in this catalog, such as blanking and output selection, are equivalent to those of the F3SN-A Safety Light Curtain. Refer to F3SN-A/F3SN-B, F3SH-A for details.

Maintenance Tool *

Appearance	Model	Accessories
	**F39-MT11**	Branching Connector (1), Connector Cap (1), Special Cable (2 m), Special Cable with Plug (0.3 m), Instruction Manual

* For detail, see the product datasheet (Cat. No. E355).

Mounting Brackets (Optional)

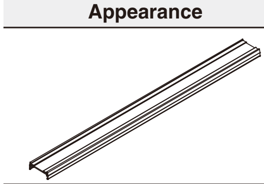
Appearance	Specification	Model	Remarks
	Wall mounting bracket Material: Iron (zinc plating) *	**F39-L18**	For Emitter: 2 pcs. For Receiver: 2 pcs. Total: 4 pcs./set
	Free-location bracket Materials: Zinc die-cast (zinc plating) **Note:** Not provided with an angle deflection mechanism for beam control.	**F39-L19**	Minimum order quantity: 1 pc. Mounting: Back-mounting only Distance from the mounting surface: 7 mm Recommended pitch: 670 mm max. Beam adjustment: Not available (rotating direction)
	Free-location bracket Materials: Sensor fixing element: Zinc die-cast (zinc plating) Mounting bracket: Iron (zinc plating) **Note:** Provided with an angle deflection mechanism for beam control.	**F39-L20**	Minimum order quantity: 1 pc. Mounting: Both front and back mounting Distance from the mounting surface: About 15 mm Recommended pitch: 400 mm max. Beam adjustment: Available

* Use these brackets for Sensors having a protective height where no intermediate bracket is required (with a protective height of less than 640 mm).

External Indicator (Separate Models for Emitters and Receivers)

Appearance	Specification	Indicator	Type	Model
	M12 connector for PNP output	Red	Emitter	**F39-A01PR-L**
			Receiver	**F39-A01PR-D**
		Green	Emitter	**F39-A01PG-L**
			Receiver	**F39-A01PG-D**

Spatter Protection Cover (Includes Two Pieces for Emitter and Receiver) (Each Unit Reduces the Operating Range by 10%)

Appearance	Model
	**F39-HN□□□□-25 ***

* The same 4-digit numbers as protective heights (□□□□ in Light Curtain model numbers) are substituted by □□□□ in the model numbers.

Specifications Refer to the instruction manual for details.

Main Unit Refer to page 5 for details on accessories.

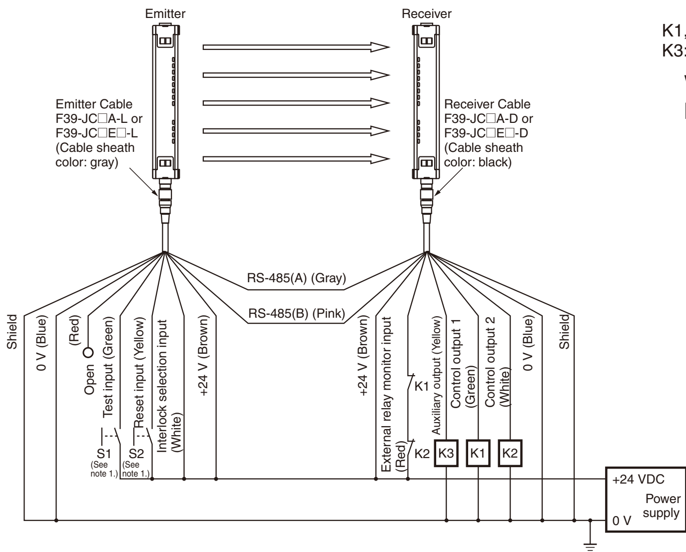
Item	Model	F3SN-A□□□□P25SS (-□□)
Sensor type		Type 4 Safety Light Curtain
Applicable safety category		Category 4, 3, 2, 1, or B
Operating range		0.2 to 3.5 m
Beam gap (P)/Detection capability		P = 15 mm/Opaque objects: 25 mm in diameter
Number of beams (n)		13 to 118 (Refer to *"Ordering Information"* on page 3.)
Protective height (PH)		217 to 1792 mm, PH = (n-1) x P + 37 mm
Effective aperture angle (EAA)		Within ±2.5° for the Emitter and Receiver at a detection distance of at least 3 m according to IEC61496-2.
Light source (emitted wavelength)		Infrared LED (870 nm)
Power supply voltage (Vs)		24 VDC±10% (ripple p-p: 10% max.)
Current consumption (no load)	Emitter	Up to 50 beams: 140 mA max., 51 to 85 beams: 155 mA max., 86 beams or more: 170 mA max.
	Receiver	Up to 50 beams: 100 mA max., 51 to 85 beams: 110 mA max., 86 beams or more: 120 mA max.
Control output (OSSD)		Two PNP transistor outputs, load current: 300 mA max., residual voltage: 2 V max. (except for voltage drop due to cable extension)
Auxiliary output (non-safety output)		One PNP transistor output, load current: 50 mA max., residual voltage: 2 V max. (except for voltage drop due to cable extension)
External indicator output (non-safety output) *1		One PNP transistor output, load current: 40 mA max., residual voltage: 2 V max. (except for voltage drop due to cable extension)
Output operation mode		Control output: Light-ON Auxiliary output: Dark-ON (can be changed by the F39-MC11) External indicator output: Light-ON (can be changed by the F39-MC11) *1
Input voltage		Test input, interlock selection input, reset input, and external relay monitor input voltages: ON voltage: 9 to 24 V (sink current: 3 mA max.), OFF voltage: 0 to 1.5 V or open
Test functions *2		• Self test (when power is turned ON and while power is supplied, one cycle during response time) • External test (light emission stop function by test input)
Mutual interference prevention function		Time-shared beam projection system by series connection • Number of series connected Light Curtains: Up to 3 sets, • Number of beams: Up to 240 beams • Length of the series connection cable: 3 m max., Sensitivity Automatic sensitivity adjustment capability supported by the F39-MC11.
Safety functions *2		• Auto-reset/manual reset (interlock) *3, • External relay monitor, • Fixed blanking *4, • Floating blanking *4
Indicators *5	Emitter	Power indicator (green), interlock indicator (yellow), lockout indicator (red), test indicator (orange), error mode indicator (3 red), light intensity level indicator (green: 5 levels)
	Receiver	OFF-state indicator (red), ON-state indicator (green), lockout indicator (red), blanking indicator (green), error mode indicator (3 red), light intensity level indicator (green: 5 levels)
Protective circuits		Output short-circuit protection, reverse polarity protection
Response time (See *6 for series connections.)	ON→OFF	Protective height: 217 to 742 mm: 10.0 ms, 832 to 1222 mm: 12.5 ms, 1312 to 1792 mm: 15.0 ms
	OFF→ON	Protective height: 217 to 742 mm: 40 ms, 832 to 1222 mm: 50 ms, 1312 to 1792 mm: 60 ms
Startup waiting time		1 s max.
Ambient operating light intensity		Incandescent lamp: 3,000 lx max. (light intensity on the receiver surface) Sunlight: 10,000 lx max. (light intensity on the receiver surface)
Ambient temperature		Operating: –10 to 55°C, storage: –30 to 70°C (with no icing or condensation)
Ambient humidity		Operating/storage: 35% to 95% (with no condensation)
Insulation resistance		20 MΩ min.(at 500 VDC)
Dielectric strength		1000 VAC 50/60 Hz 1 min
Vibration resistance (malfunction)		10 to 55 Hz, 0.7-mm double amplitude, 20 sweeps in X, Y, and Z directions
Shock resistance (malfunction)		100 m/s^2, 1000 times in X, Y, and Z directions
Degree of protection		IP65 (IEC60529)
Connection method		M12 Connector (8 pins)
Weight (packed state)		Weight (g) = (Protective height) x 2.4 +α+β, α = 700 when the protective height is 217 to 592 mm, α = 800 when the protective height is 667 to 1222 mm, α = 900 when the protective height is 1312 to 1792 mm, β = 0 for models with no suffix or ending with -01, β = 100 for models ending with -02, β = 200 for models ending with -04
Materials		Case: Aluminum, end cap: Zinc die-cast, optical cover: PMMA resin (acrylic resin)
Accessories		Test rod, instruction manual, error mode label, mounting brackets (top and bottom), mounting brackets (intermediate) *7
Applicable standards		IEC61496-1, EN61496-1 Type 4 ESPE (Electro-Sensitive Protective Equipment) IEC61496-2 Type 4 AOPD (Active Opto-electronic Protective Devices)

*1. Models ending in -01 and -04 only.
*2. The glossary and functions are the same as those for the F3SN-A Series. Refer to F3SN-A/F3SN-B, F3SH-A.
*3. The default setting of the manual reset mode is for both "Start" and "Restart" interlocks. Use the F39-MC11 to select start interlock only or restart interlock only.
*4. The function is not factory set. It can be set with the F39-MC11.
*5. The test indicator (orange) on the Emitter and the blanking indicator (green) on the Receiver will flash to indicate the need for preventive maintenance when the total ON time exceeds 30,000 hours. (Models without this flashing function are also available as options. An "-NT" to the model number. Ask your OMRON representative for details.)
*6. Use the following equations to determine series connection response time.
Series connection with two sets
Response time (ON→OFF): Sensor 1 response time + Sensor 2 response time + 3 ms
Response time (OFF→ON): Sensor 1 response time + Sensor 2 response time + 12 ms
Series connection with three sets
Response time (ON→OFF): Sensor 1 response time + Sensor 2 response time + Sensor 3 response time + 4 ms
Response time (OFF→ON): Sensor 1 response time + Sensor 2 response time + Sensor 3 response time + 16 ms
*7. Intermediate mounting brackets are supplied with the following models:
When the overall Light Curtain length is 640 to 1280 mm or less: 1 set included
When the overall Light Curtain length is over 1280 mm: 2 sets included

Connections

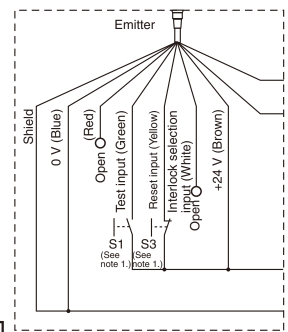
Basic Connection

Wiring for the manual reset mode and the EDM function



S1: External test switch
S2: Interlock/lockout reset switch
S3: Lockout reset switch
(If the switch is not necessary, connect between the reset input and +24 VDC.)
K1, K2: Relay that controls the dangerous parts of machines, etc.
K3: Load, PLC, etc. (used for monitoring)

Wiring for the Auto-reset Mode



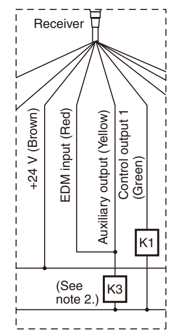
Note: 1. Use a switch suitable for micro loads.
2. If K3 is not necessary, short-circuit the auxiliary output with the EDM input.

When the EDM is Not Used

When the EDM is not necessary
1. Use the F39-MC11 to disable the EDM.

or

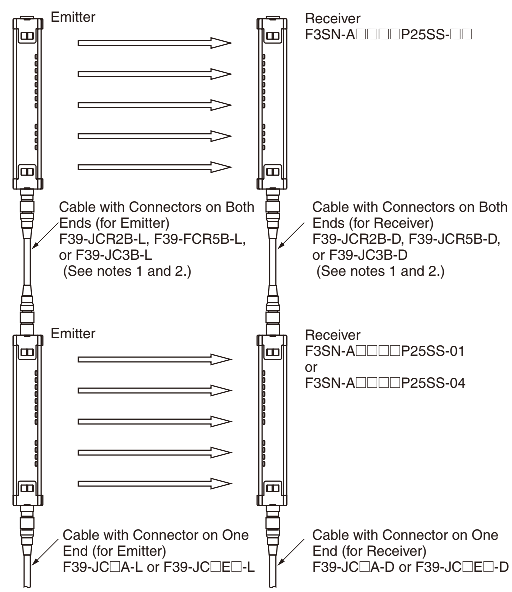
2. Disable the EDM by changing the wiring as shown in the figure below when the auxiliary output is set to the Dark-ON mode.



Series Connection (Up to 3 Sets)

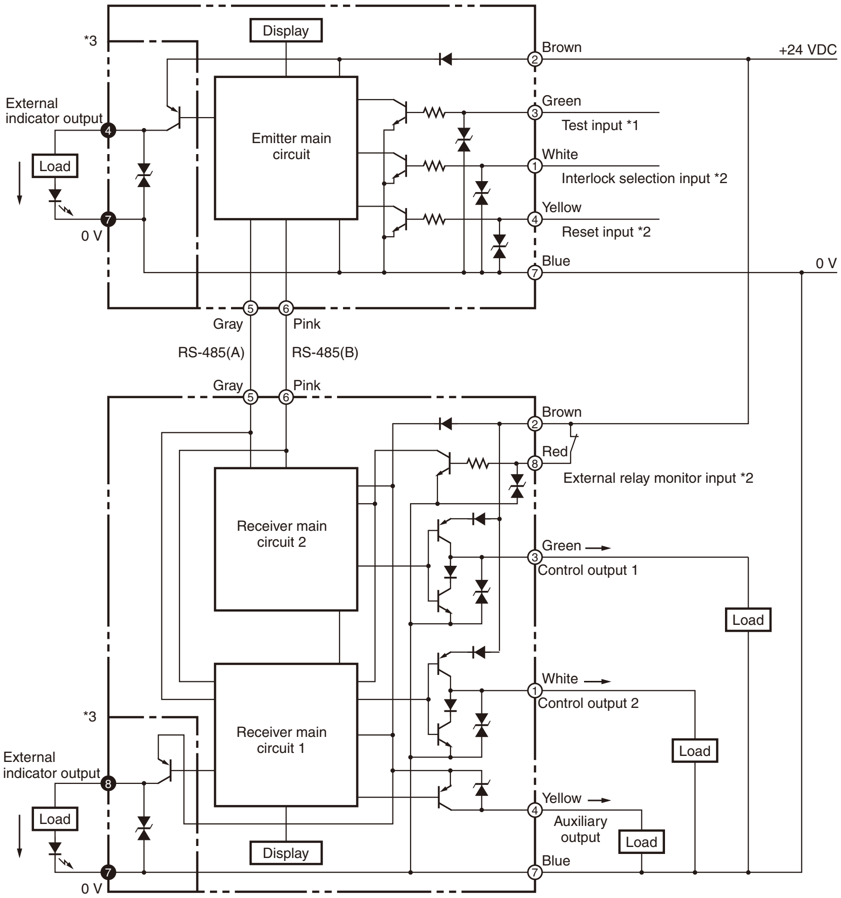
The use of series connection types (models ending in -01 or -04) enables series connection as shown in the figure at the right. Any type of Sensor can be used at the top end.

Note: 1. In order to maintain performance characteristics, use the F39-JCR2B, F39-JCR5B, or F39-JC3B to connect Light Curtains in series.
The F39-JC7B, F39-JC10B, or F39-JC15B cannot be connected in series.
2. Models ending in -04 can be connected in series without an optional Cable with Connectors on Both Ends because they have a Connector with a 0.2-m cable on top.



I/O Circuit Diagrams

Circuit



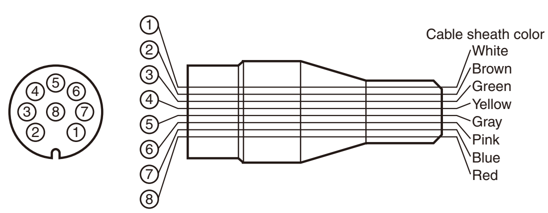
Note: The numbers in ❍ indicate pin numbers of the Connector.
The numbers in ● indicate pin numbers of the series connection Connectors.

*1. Open: normal light emission, short: stops light emission

*2. Refer to "*Connections: Basic Connection*" on page 9.

*3. The section encircled with the dashed line applies to models ending in -01 and -04 only.

Cable with Connector on One End

Model	Internal wiring	Pin No.	Cable sheath color	Signal name	
				Receiver	Emitter
F39-JC3A (3 m) F39-JC7A (7 m) F39-JC10A (10 m) F39-JC15A (15 m) F39-JC3E□ (3 m) F39-JC7E□ (7 m) F39-JC10E□ (10 m) F39-JC15E□ (15 m)		1	White	Control output 2	Interlock selection input
		2	Brown	+24 V	+24 V
		3	Green	Control output 1	Test input
		4	Yellow	Auxiliary output	Reset input
		5	Gray	RS-485 (A)	RS-485 (A)
		6	Pink	RS-485 (B)	RS-485 (B)
		7	Blue	0 V	0 V
		8	Red	EDM input	N.C.

Dimensions

(Unit: mm)

Main Unit

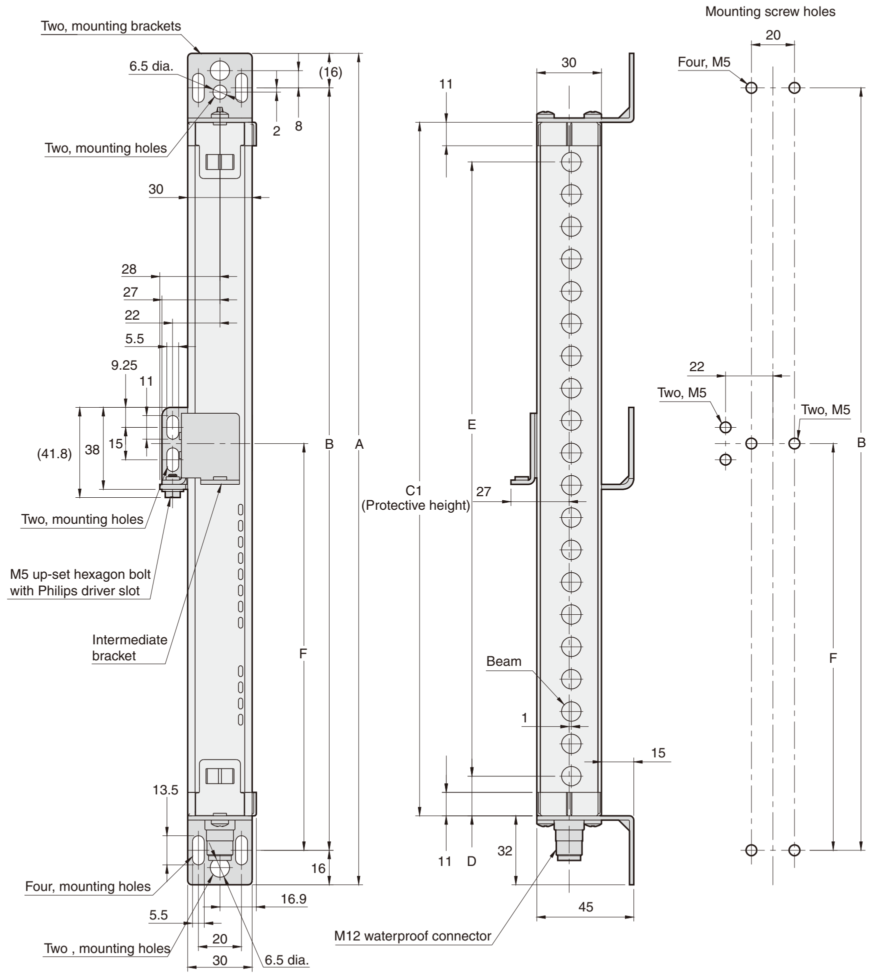
F3SN-A□□□P25SS-□□

Dimensions can be calculated for each model by using the following equations.

Dimension C1 (protective height): 4 digits in the model name
Dimension A = C1 + 64
Dimension B = C1 + 32
Dimension D = 18.5
Dimension E = C1 - 37
Dimension F = Refer to the table right.

Protective height (C1)	Number of intermediate mounting brackets	Dimension F (See note.)
to 0640	0	---
0641 to 1280	1	F = B/2
1281 to 1822	2	F = B/3

Note: If value F obtained from the above equation is not used, set F to 670 mm or less.



Mounting Precautions

Note: 1. The mounting bracket (3) (see Mounting Brackets (Intermediate)) is shown on the left-hand side of the Sensor as an example. If the mounting bracket (3) is on the right-hand side of the Sensor, then the mounting holes must also be on the right-hand side.

2. When using the cable bent, use a minimum bending radius of R = 36 mm. Fig. A shows an example when using a Cable with a Straight Connector. Fig. B shows the dimensions when using a Cable with a Right-angle Connector.

Fig. A

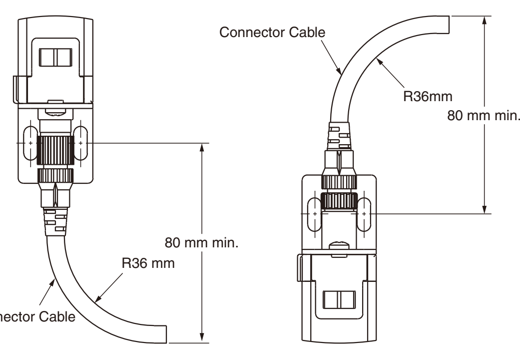
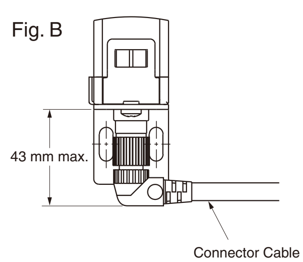
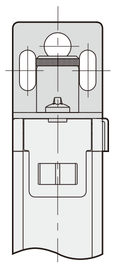
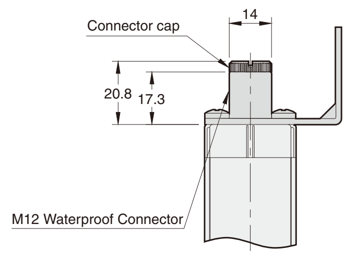


Fig. B

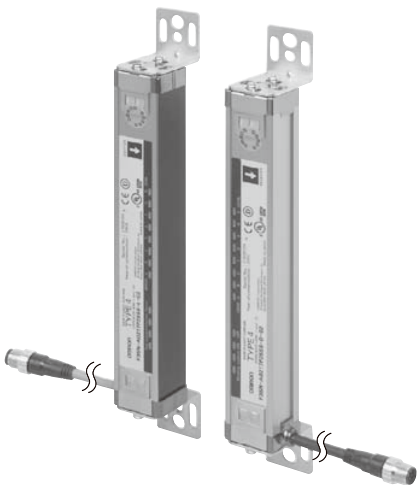


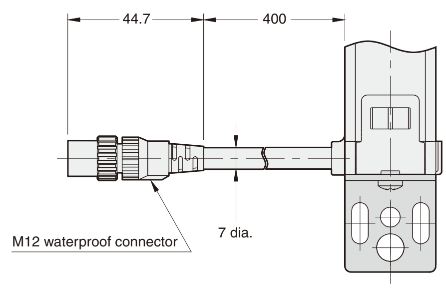
F3SN-A□□□□P25SS-01

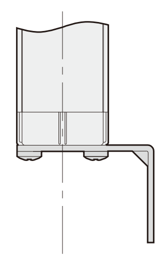




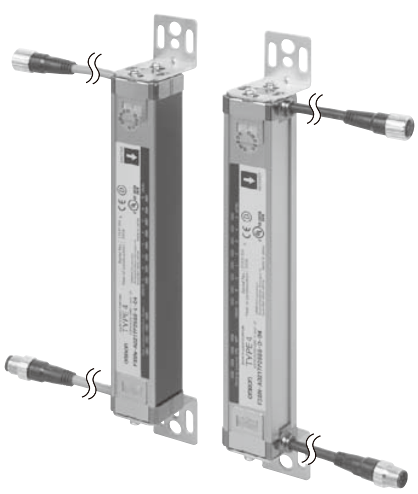
F3SN-A□□□□P25SS-02

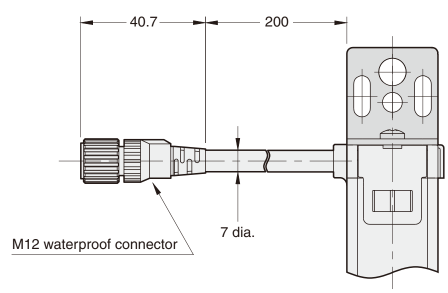


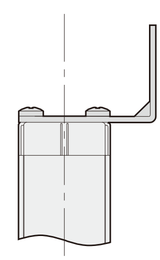


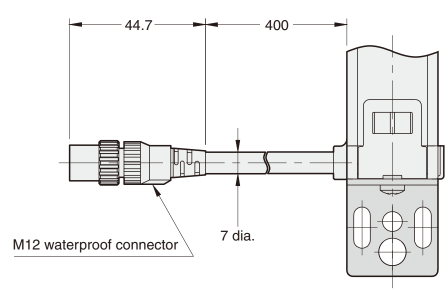


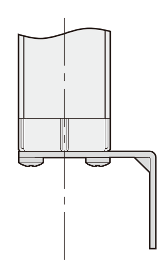
F3SN-A□□□□P25SS-04





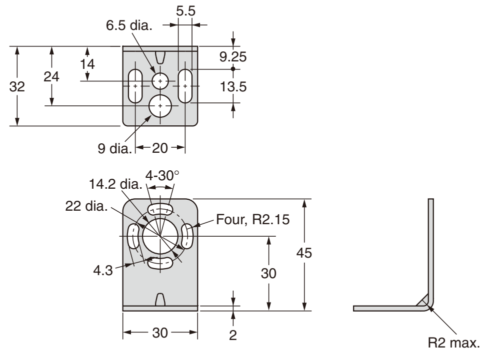






Accessories

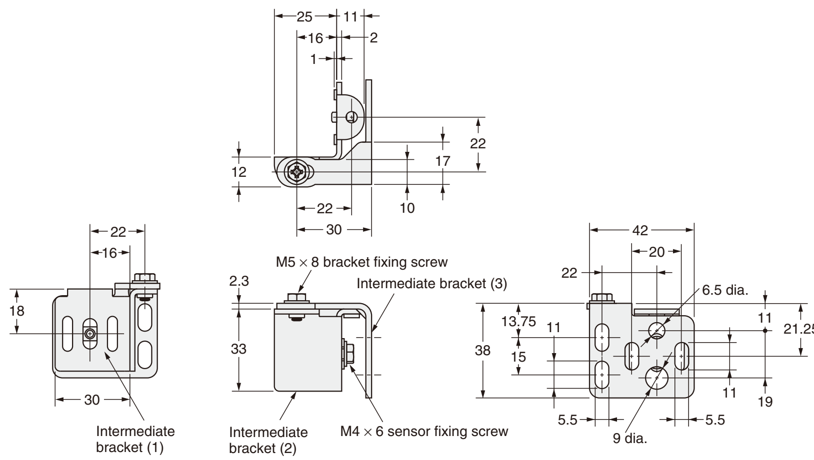
Mounting Brackets (Top and Bottom)



Material: Iron (zinc plating)

Note: Provided with the main unit.

Mounting Brackets (Intermediate)

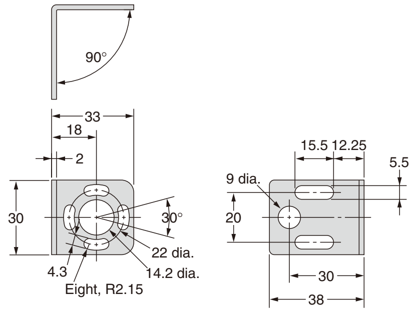


Material: Iron (zinc plating)

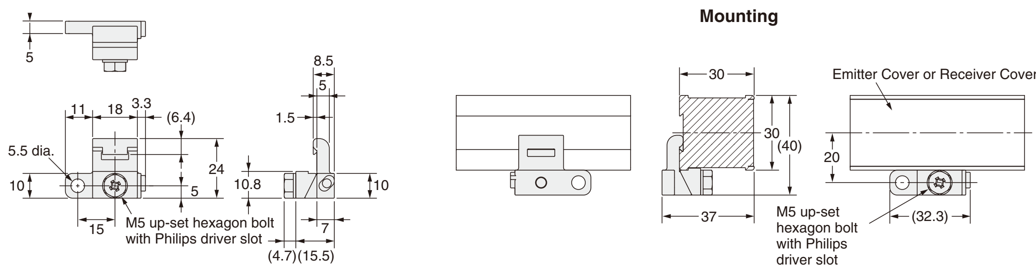
Note: Provided with the main unit. The number of brackets required depends on the total length of the Sensor.

Accessories (Order Separately)

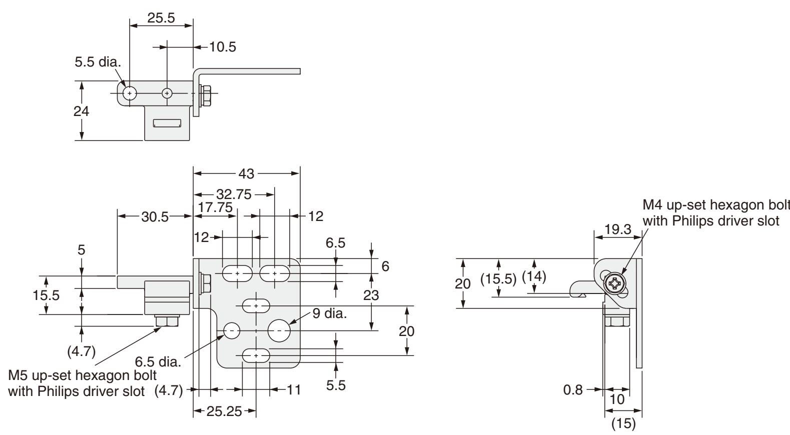
Wall Mounting Bracket
F39-L18



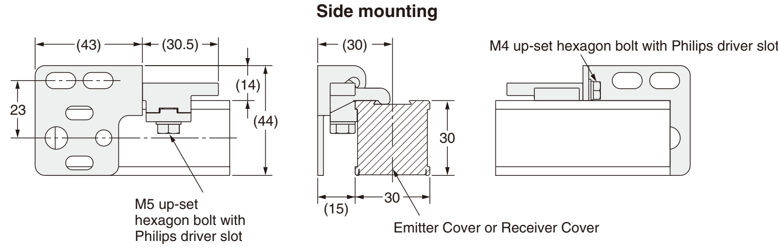
Free-location Bracket
F39-L19



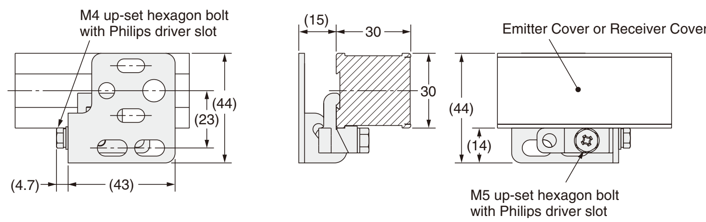
Free-location Bracket
F39-L20



Side mounting

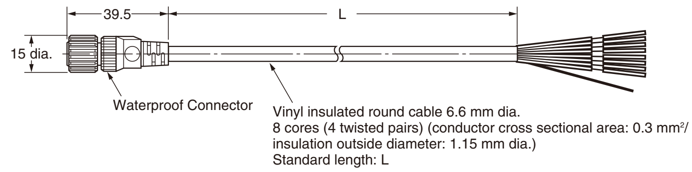


Back mounting



Cable with Connector on One End with Straight Connectors

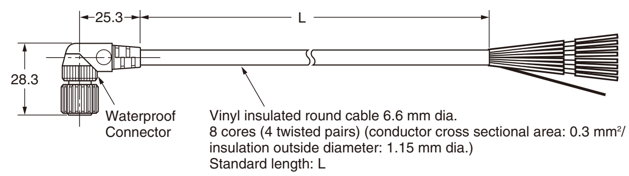
F39-JC3A (L = 3 m) **F39-JC10A (L = 10 m)**
F39-JC7A (L = 7 m) **F39-JC15A (L = 15 m)**



Color: Emitter (gray)
Receiver (black)

Cable with Connector on One End with Right-angle Connectors

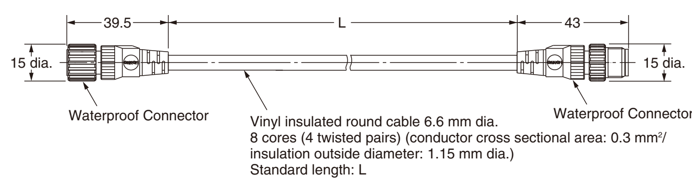
F39-JC1E1 (L = 1 m) **F39-JC1E2 (L = 1 m)**
F39-JC3E1 (L = 3 m) **F39-JC3E2 (L = 3 m)**
F39-JC7E1 (L = 7 m) **F39-JC7E2 (L = 7 m)**
F39-JC10E1 (L = 10 m) **F39-JC10E2 (L = 10 m)**
F39-JC15E1 (L = 15 m) **F39-JC15E2 (L = 15 m)**



Color: Emitter (gray)
Receiver (black)

Cable with Connectors on Both Ends with Straight Connectors

F39-JCR2B (L = 0.2 m) **F39-JC7B (L = 7 m)**
F39-JCR5B (L = 0.5 m) **F39-JC10B (L = 10 m)**
F39-JC3B (L = 3 m) **F39-JC15B (L = 15 m)**
F39-JC5B (L = 5 m) **F39-JC20B (L = 20 m)**



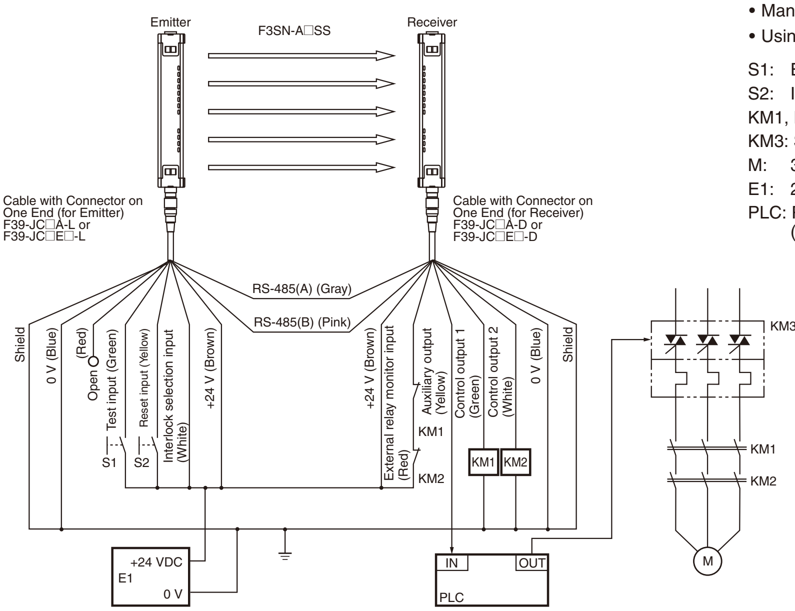
Color: Emitter (gray)
Receiver (black)

Refer to F3SN-A/F3SN-B/F3SH-A for information not provided in the model number.

Connection Circuit Examples

An Example of Safety Circuits Where No Controller is Used

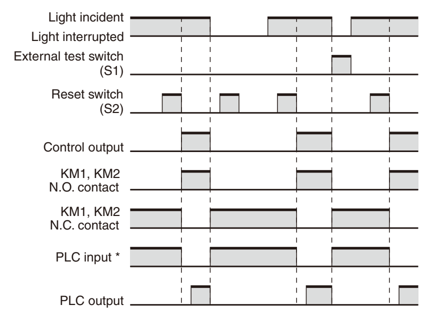
For category 4 rating



Applicable operation mode
- Manual reset mode
- Using the external relay monitor function

S1: External test switch
S2: Interlock/lockout reset switch
KM1, KM2: Relay with forcibly guided contacts (G7SA)
KM3: Solid-state contactor (G3J)
M: 3-phase motor
E1: 24 VDC power supply (S82K)
PLC: Programmable Controller
(Used for monitoring. This is not a part of a safety system.)

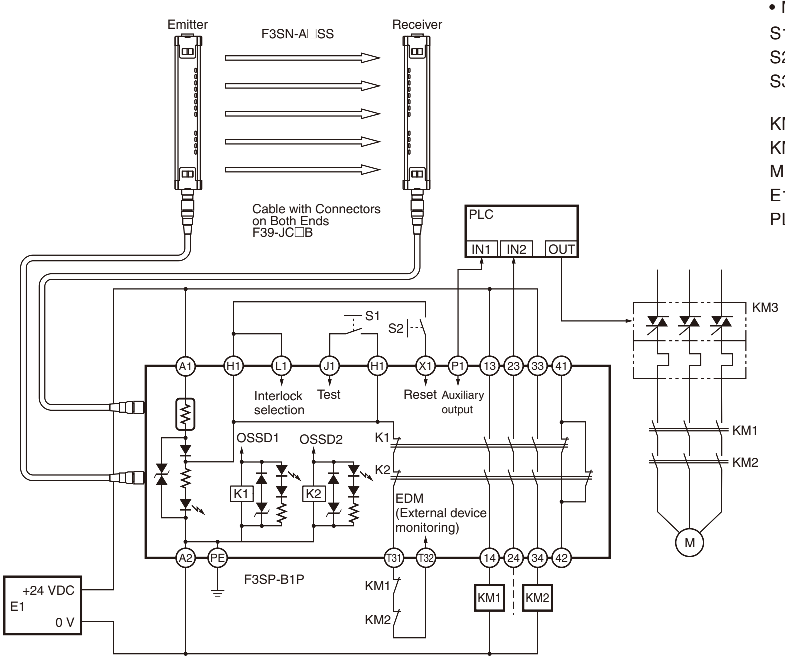
Timing Chart



* The output operation mode of the auxiliary output is the Dark-ON output mode.

An Example of Safety Circuits Where the F3SP-B1P Controller is Used

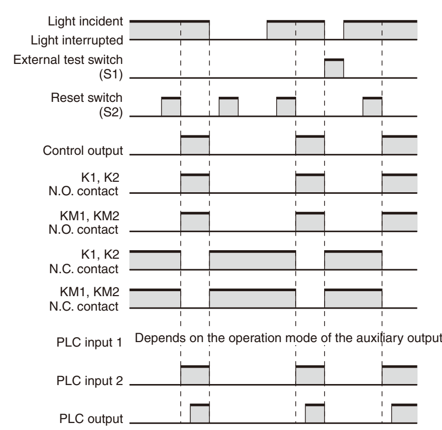
For category 4 rating



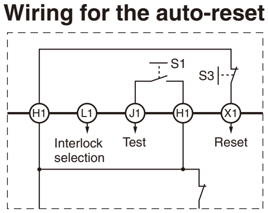
Applicable operation mode
- Manual reset mode

S1: External test switch
S2: Interlock/lockout reset switch
S3: Lockout reset switch (If the switch is not necessary, connect between X1 and H1.)
KM1, KM2: Relay with forcibly guided contacts (G7SA)
KM3: Solid-state contactor (G3J)
M: 3-phase motor
E1: 24 VDC power supply (S82K)
PLC: Programmable Controller
(Used for monitoring. This is not a part of a safety system.)

Timing Chart



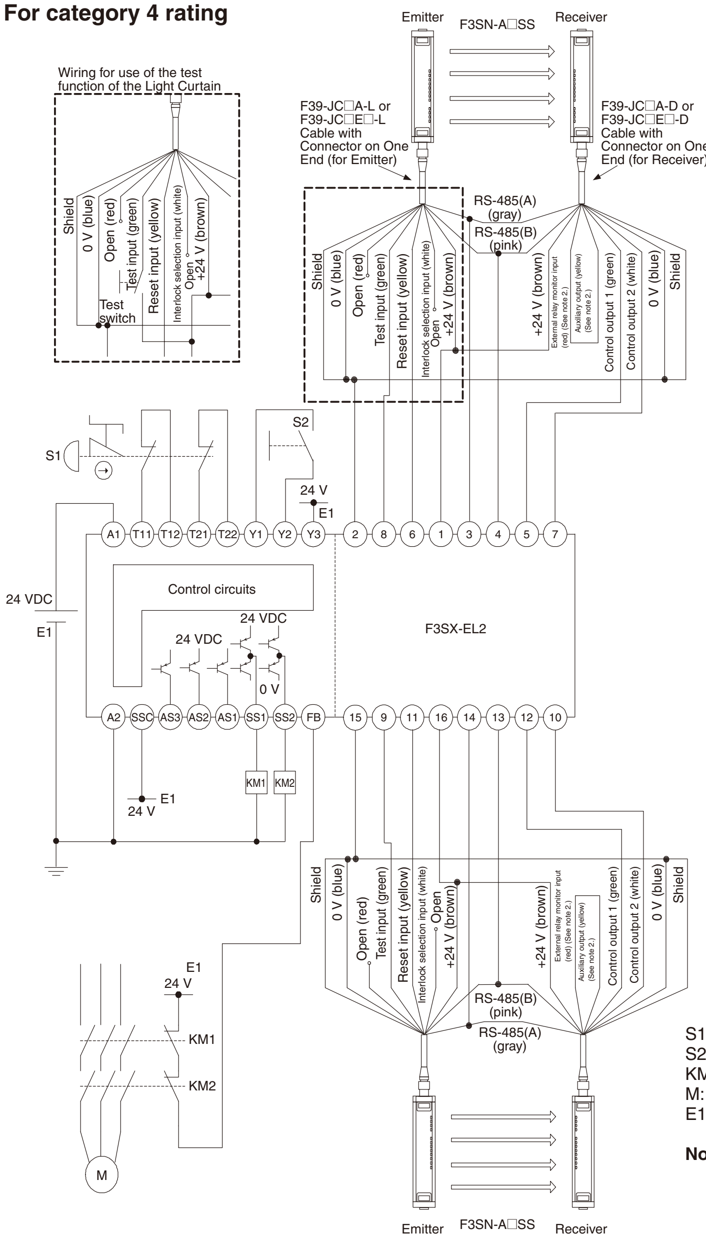
Wiring for the auto-reset mode



Note: 1. If the EDM is not necessary, short-circuit T31 and T32.
2. For the number and arrangement of all terminals on the F3SP-B1P, see the instruction manual packaged together with the F3SP-B1P.

An Example of Safety Circuits Where the F3SX Safety Controller is Used (with Two F3SN-A□SS Sets Connected)

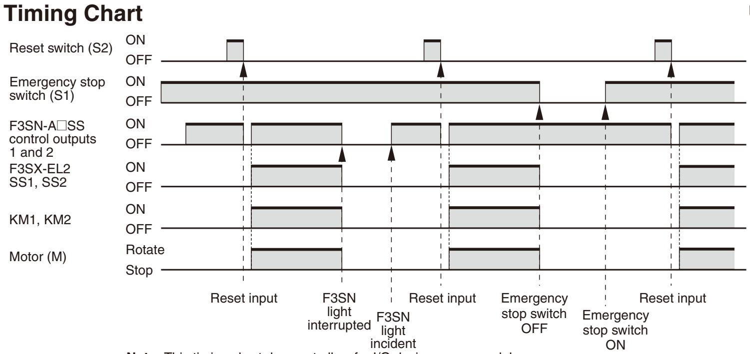
F3SX-EL2 (Manual Reset)
For category 4 rating



S1: Emergency stop switch (A165E, A22E)
S2: Reset switch
KM1, KM2: Relay with forcibly guided contacts
M: Three-phase motor
E1: 24-VDC power supply (S82K)

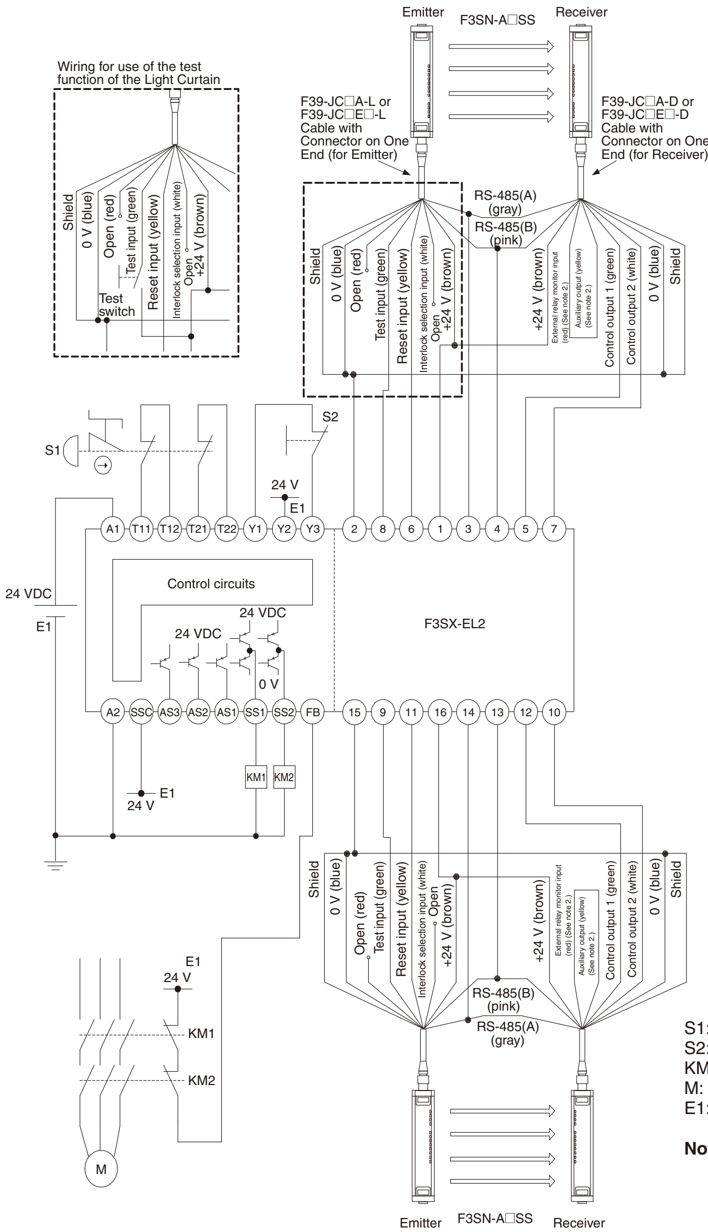
Note: 1. The above circuit diagram conforms to Category 4.
2. In this connection example, the auxiliary output is set to the standard setting (Dark-ON operation).
To operate using non-standard settings, refer to the catalog or *Instruction Manual* for the F3SN-A□SS.
Use the optional F39-MC11 Setting Console to disable the EDM.

Timing Chart



Note: This timing chart does not allow for I/O device response delays.

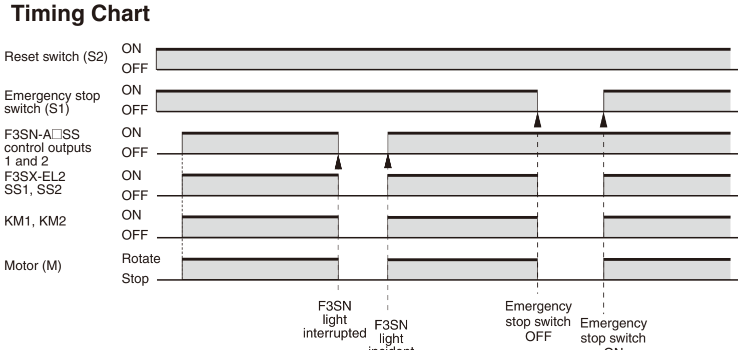
F3SX-EL2 (Auto-reset)
For category 4 rating



S1: Emergency stop switch (A165E, A22E)
S2: Reset switch
KM1, KM2: Relay with forcibly guided contacts
M: Three-phase motor
E1: 24-VDC power supply (S82K)

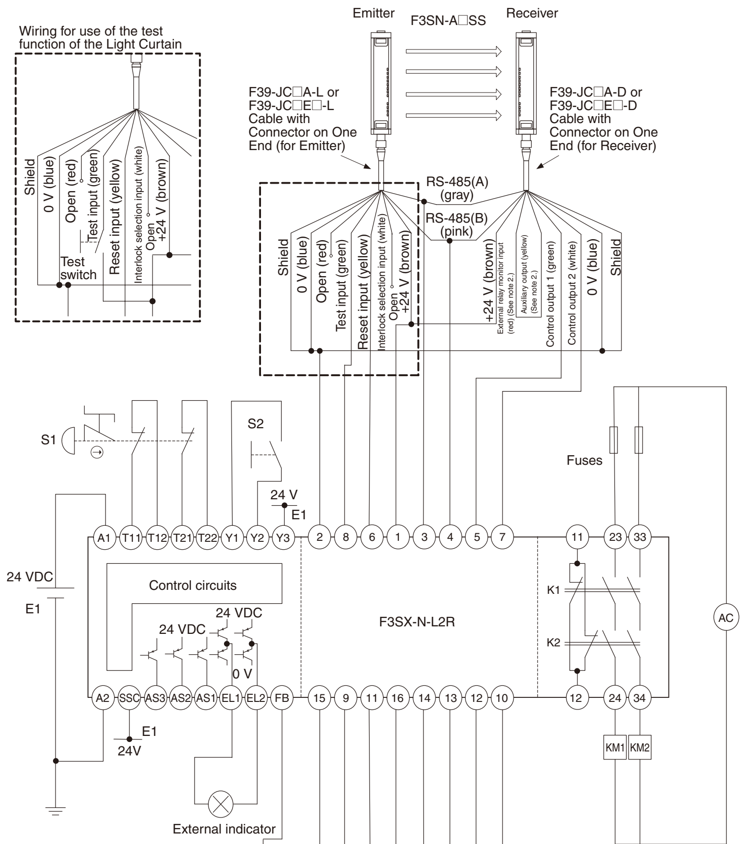
Note: 1. The above circuit diagram conforms to Category 4.
2. In this connection example, the auxiliary output is set to the standard setting (Dark-ON operation).
To operate using non-standard settings, refer to the catalog or *Instruction Manual* for the F3SN-A□SS.
Use the optional F39-MC11 Setting Console to disable the EDM.

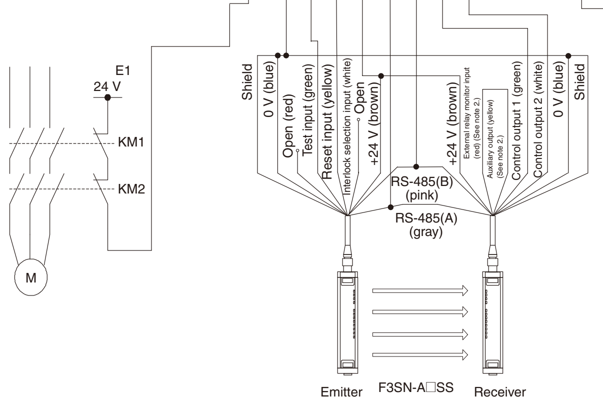
Timing Chart



Note: This timing chart does not allow for I/O device response delays.

F3SX-N-L2R (Manual Reset)
For category 4 rating

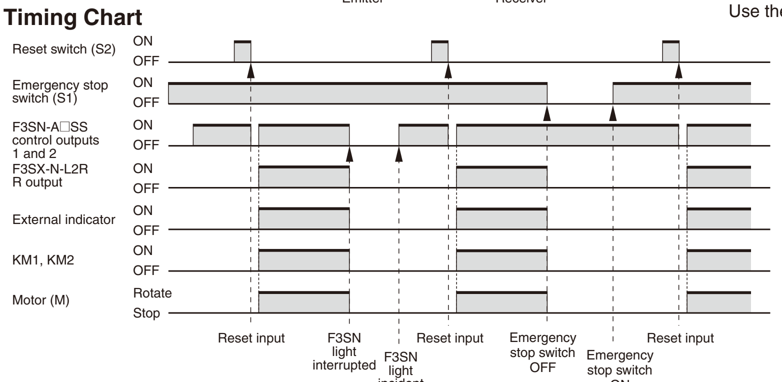




S1: Emergency stop switch (A165E, A22E)
S2: Reset switch
KM1, KM2: Relay with forcibly guided contacts or magnetic contactor
M: Three-phase motor
E1: 24-VDC power supply (S82K)
External indicator: Filament-type indicator
(When an external indicator is not necessary, connect resistance of 1/4 W, 4.7 kΩ.)

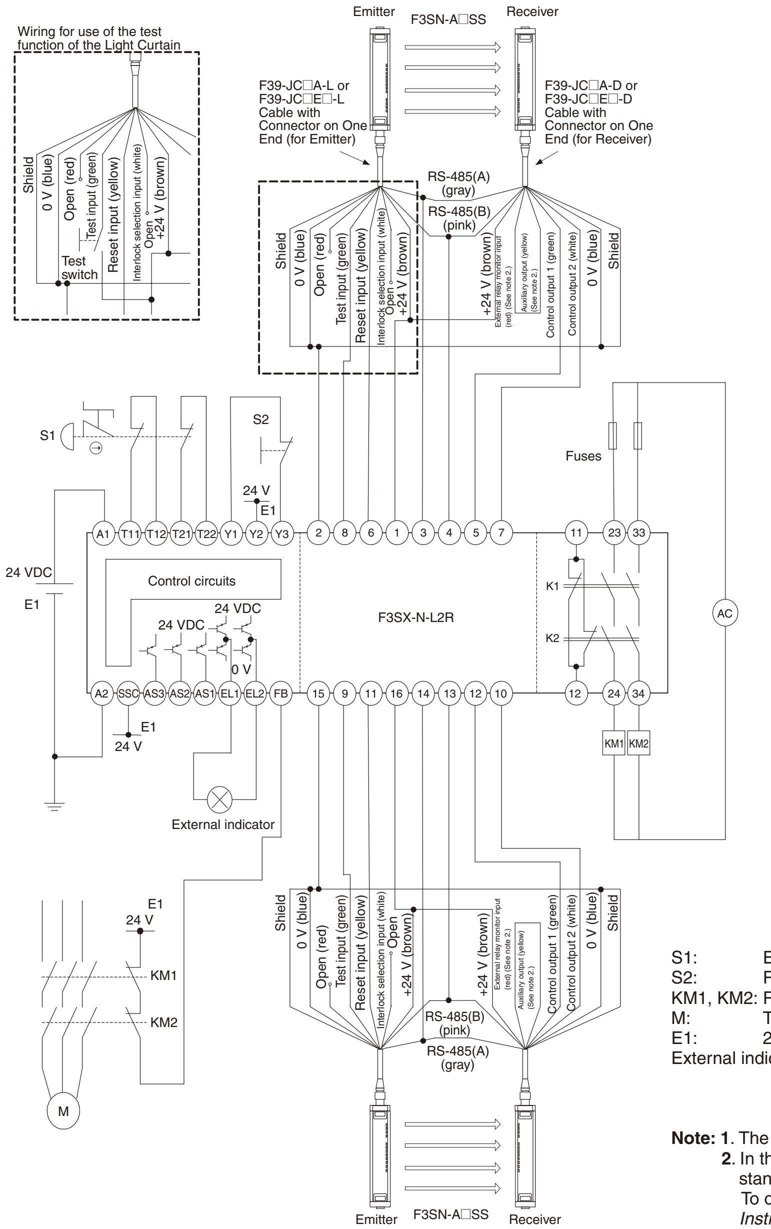
Note: 1. The above circuit diagram conforms to Category 4.
2. In this connection example, the auxiliary output is set to the standard setting (Dark-ON operation).
To operate using non-standard settings, refer to the catalog or *Instruction Manual* for the F3SN-A□SS.
Use the optional F39-MC11 Setting Console to disable the EDM.

Timing Chart



Note: This timing chart does not allow for I/O device response delays.

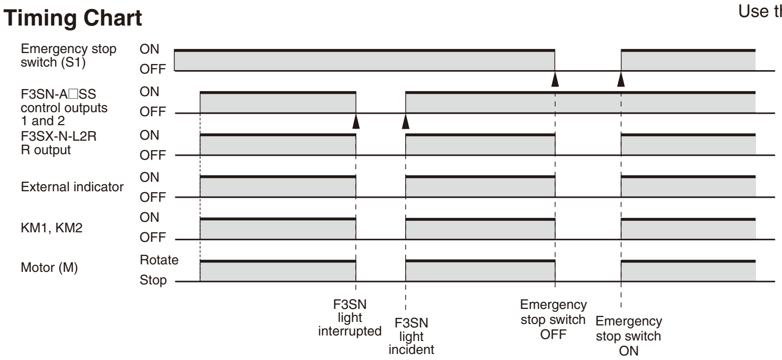
F3SX-N-L2R (Auto-reset)
For category 4 rating



S1: Emergency stop switch (A165E, A22E)
S2: Reset switch
KM1, KM2: Relay with forcibly guided contacts or magnetic contactor
M: Three-phase motor
E1: 24-VDC power supply (S82K)
External indicator: Filament-type indicator
(When an external indicator is not necessary, connect resistance of 1/4 W, 4.7 kΩ.)

Note: 1. The above circuit diagram conforms to Category 4.
2. In this connection example, the auxiliary output is set to the standard setting (Dark-ON operation).
To operate using non-standard settings, refer to the catalog or *Instruction Manual* for the F3SN-A□SS.
Use the optional F39-MC11 Setting Console to disable the EDM.

Timing Chart



Note: This timing chart does not allow for I/O device response delay.

Safety Precautions

Refer to “*Regulations and Standards*” and “*Safety Precautions*” for F3SN-A/F3SN-B/F3SH-A.
“Type Certification” specified in the Chapter 44. 2 of the Industrial Safety and Health Law in Japan does not apply to independent F3SS Sensors. This law applies to systems incorporating the Sensor. When using the F3SL Sensor in Japan as a “safety device for presses or shearing machines,” as specified in the Chapter 42 of the same law, apply for certification for the overall system.

⚠ WARNING

Detection Zone and Intrusion Path

Refer to “*Precautions for All Safety Sensors*” for the installation conditions of Safety Light Curtains.

· Use of the Fixed Blanking Function

Install protective structures in all parts of the detection zone where detection is disabled by the fixed blanking function so no one can pass through the detection zone to reach the hazardous part of the machine. Failure to do so may result in serious injury.

Safety Distance

Always maintain a safety distance (S) between the Light Curtain and a hazardous part of a machine.
Failure to do so may prevent the machine from stopping before an operator reaches the dangerous area and may result in serious injury.

Floating blanking is used to increase the minimum detectable object size. Be sure to use the minimum detectable object size for floating blanking when calculating safety distance. Failure to do so may prevent the machine from stopping before an operator reaches the dangerous area and may result in serious injury.

Refer to F3SN-A/F3SN-B/F3SH-A for examples of calculating the safety distance.

Precautions for Correct Use

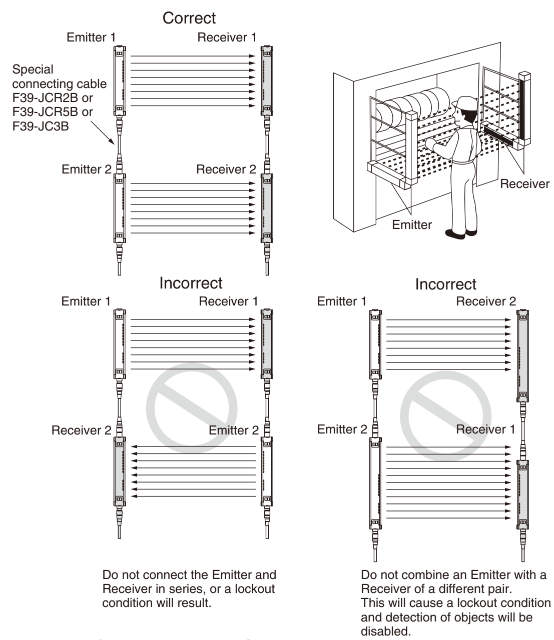
Do not used the product in atmospheres or environments that exceed product ratings.

Installation

How to Prevent Mutual Interference

Series Connections (Up to 3 sets, 240 beams, Sensor models ending in -01 and -04 are required for series connection)

Two or more pairs of the F3SN-A□SS can be connected in series. When connected in series, the F3SN-A□SS Sensors generate beams in a time-sharing manner to prevent mutual interference and ensure safety.



When Not Connected in Series

Refer to “*Precautions for All Safety Sensors*” for information on preventing mutual interference of Safety Light Curtains that are not connected in series.

Precautions for All Safety Sensors

Note: Refer to the "*Safety Precautions*" section for each Sensor for specific precautions applicable to each Sensor.

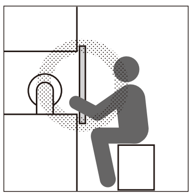
WARNING

Installation Conditions

Detection Zone and Intrusion Path

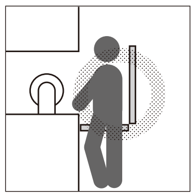
Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas.
If a person is able to step into the hazardous area of a machine and remain behind the Safety Light Curtain's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

Correct Installation



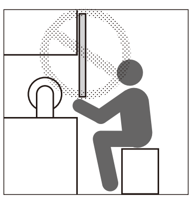
A person can only reach the hazardous part of the machinery by passing through the sensor's detection zone.

Correct Installation



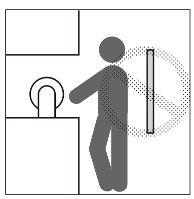
A person enters the detection zone during operation.

Incorrect Installation



A person can reach the hazardous part of the machinery without passing through the sensor's detection zone.

Incorrect Installation



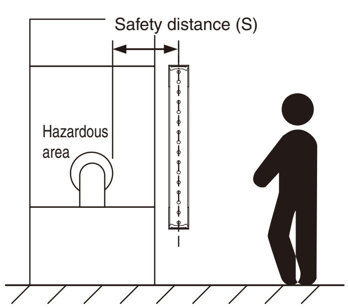
A person is between the sensor's detection zone and the hazardous part of the machinery.

Install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

The Safety Light Curtain cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

Safety Distance

The safety distance is the distance that must be set between the Safety Light Curtain and a machine's hazardous part to stop the hazardous part before a person or object reaches it. The safety distance varies according to the standards of each country and the individual specifications of each machine. In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the Safety Light Curtain. Always refer to relevant standards.



Make sure to secure the safety distance (S) between the Safety Light Curtain and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Note: The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops.
Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

How to calculate the safety distance specified by International standard ISO13855-2002 (European standard EN999-1999) (Reference)

If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.

$S = K \times T + C$ . . . Eq. (1)

- S: Safety distance
- K: Approach speed to the detection zone
- T: Total response time of the machine and Safety Light Curtain
- C: Additional distance calculated by the detection capability of the Safety Light Curtain

<System that has detection capability of 40 mm max.>
Use K = 2,000 mm/s and C = 8 x (d - 14 mm) in equation (1) for the calculation.

S = 2,000 mm/s x (Tm + Ts) + 8 x (d - 14 mm)

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s) *
- d = Size of Safety Light Curtain's detection capability (mm) *

*These values differ depending on the Switch. Refer to the "*Precautions for Correct Use*" for the Switch you are using.

[Calculation example]
When Tm = 0.05 s, Ts = 0.01 s, and d = 14 mm:
S = 2,000 mm/s x (0.05 s + 0.01 s) + 8 x (14 mm - 14 mm)
= 120 mm . . . Eq. (2)
If the result is less than 100 mm, use S = 100 mm.
If the result exceeds 500 mm, use the following equation where K = 1,600 mm/s.
S = 1,600 mm/s x (Tm + Ts) + 8 x (d - 14 mm) . . . Eq. (3)
If the result of this Eq. (3) is less than 500 mm, use S = 500 mm.

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 40 mm or Systems Using Multi-beam Safety Sensors>

Assuming K = 1,600 mm/s and C = 850 mm, the following calculation is made using Eq. (1).
S = 1,600 mm/s x (Tm + Ts) + 850 … Eq. 4,

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s)

Calculation example:
When Tm = 0.05 s and Ts = 0.01 s,
S = 1,600 mm/s x (0.05 s + 0.01 s) + 850 mm = 946 mm

How to calculate the safety distance specified by American standard ANSI B11.19
(Reference)

<Systems with a Smallest Detectable Object Size (Diameter) Less than 64 mm>
If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.
S = K x (Ts + Tc + Tr + Tbm) + Dpf

- S: Safety distance
- K: Approach speed to the detection zone (the value recommended by OSHA standard is 1,600 mm/s)

Approach speed K is not specified in the ANSI B.11.19 standard. To determine the value of K to apply, consider all factors, including the operator's physical ability.

- Ts = Machine's stop time (s)
- Tr = Response time of the Safety Light Curtain from ON to OFF (s)
- Tc = Machine control circuit's maximum response time required to activate its brake (s)
- Tbm = Additional time (s)

If a machine has a brake monitor, "Tbm = Brake monitor setting time - (Ts + Tc)". If it has no brake monitor, we recommend using 20% or more of (Ts + Tc) as additional time.

- Dpf = Additional distance

According to ANSI's formula, Dpf is calculated as shown below:
Dpf = 3.4 x (d - 7.0): Where d is the detection capability of the Safety Light Curtain (unit: mm)

[Calculation example]
When K = 1,600 mm/s, Ts + Tc = 0.06 s, brake monitor setting time = 0.1 s, Tr = 0.01 s, d = 14 mm:
Tbm = 0.1 - 0.06 = 0.04 s
Dpf = 3.4 x (14 - 7.0) = 23.8 mm
S = 1,600 x (0.06 + 0.01 + 0.04) + 23.8 = 199.8 mm

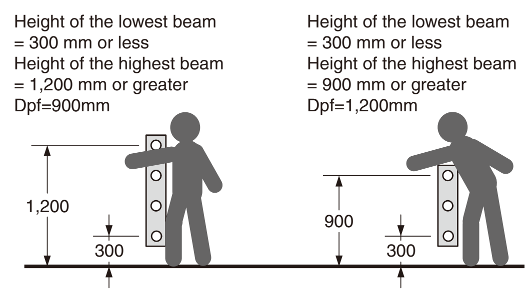
Method for Calculating the Safety Distance as Provided by ANSI/RIA R15.06 (USA)
(Reference)

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 64 mm and Less than 600mm>
The safety distance is calculated based on the following concepts when the human body intrudes perpendicular to the detection zone of the Safety Light Curtain.
S = K x (Ts + Tc + Tr) + Dpf

- S: Safety distance
- K = Intrusion speed into detection zone (1,600 mm/s min. recommended by OSHA)
- Ts = Stop time of machine/equipment (s)
- Tr = Light curtain ON-to-OFF response time (s)
- Tc = Maximum response time of the machine/equipment braking circuit required to operate the brake (s)
- Dpf = Additional distance (mm)

If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 1,200 mm or higher, the Dpf will be 900 mm.
If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 900 mm or higher, the Dpf will be 1,200 mm.

[Calculation example]
K = 1,600 mm/s, Ts + Tc = 0.06s,
If Tr = 0.01 s and Dpf = 900 mm:
S = 1,600 x (0.06 + 0.01) + 900 = 1,012 mm

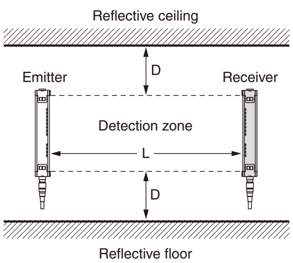


Distance from Glossy Surface

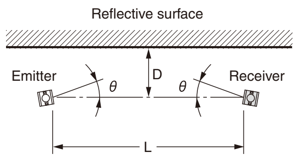
Install the sensor system so that it is not affected by reflection from a glossy surface. Failure to do so may hinder detection, resulting in serious injury.

Install the sensor system at distance D or further from highly reflective surfaces such as metallic walls, floors, ceilings, or workpieces, as shown below.

<Side View>



<Top View>



θ =5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ =10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.13 m	0.26 m
For 3 m or more	L/2 x tan5° = L x 0.044 (m)	L/2 x tan10° = L x 0.088 (m)

Others

To use the Safety Light Curtain in PSDI mode (restart of cycle operation by the sensor), you must configure an appropriate circuit between the Safety Light Curtain and the machine. For details about PSDI, refer to OSHA1910.217, IEC61496-1, and other relevant standards and regulations.

Do not try to disassemble, repair, or modify this product. Doing so may cause the safety functions to stop working properly.

Do not use the Safety Light Curtain in environments where flammable or explosive gases are present. Doing so may result in explosion.

Perform daily and 6-month inspections for the Safety Light Curtain. Otherwise, the system may fail to work properly, resulting in serious injury.

Installation

Prevention of Mutual Interference

The emitter and the receiver to be set facing each other should be a pair of the same set. Erroneous combination may create a zone where objects cannot be detected.

Do not use a sensor system in a reflective configuration. Doing so may hinder detection.
Mirrors can be used change the optical route.

When using more than 1 set of Safety Light Curtain, install them so that mutual interference does not occur, such as by configuring series connections or using physical barriers between adjacent sets.

Precautions for Safe Use

Do not used the product in atmospheres or environments that exceed product ratings

Installation

Prevention of Mutual Interference

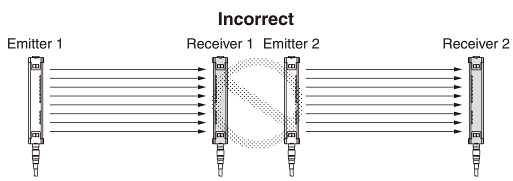
For series connection

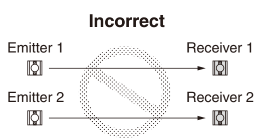
Refer to the "*Precautions for Correct Use*" for individual models for information on preventing mutual interference of linkable Safety Light Curtains.

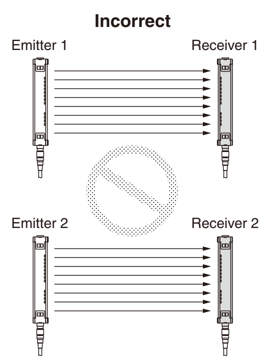
For no series connection

When installing two or more pairs of light curtains independently from each other due to inconvenience of wiring or other reason, take proper measures to prevent mutual interference. If mutual interference occurs, a lockout condition will result for the Safety Light Curtain.

- Installation which may cause mutual interference

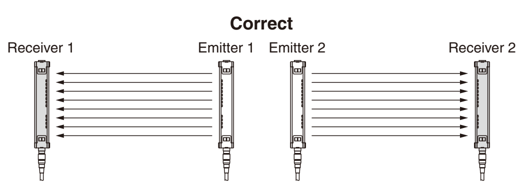


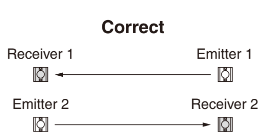


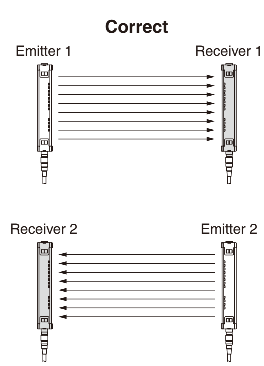


- Installation to prevent mutual interference

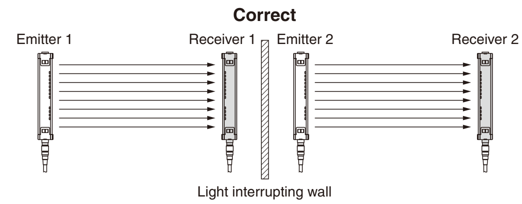
(1)Install so that the two light curtains emit in the opposite directions (staggered).



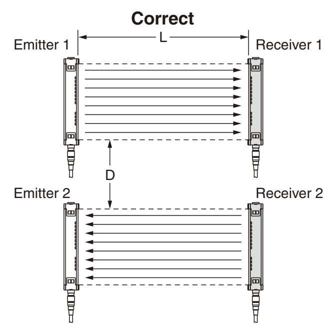


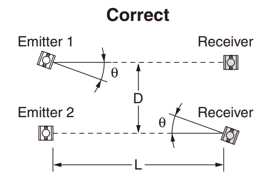


(2)Install a light interrupting wall in between sensors.



(3)Install the light curtains facing away from the one another to eliminate mutual interference.





θ= 5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ= 10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.26 m	0.52 m
For 3 m or more	L x tan5° = L x 0.088 (m)	L x tan10° = L x 0.18 (m)

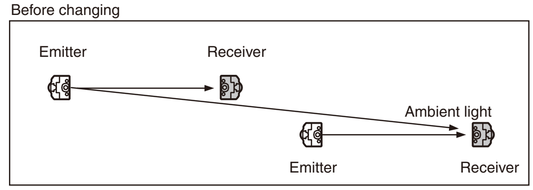
Operating range

Chattering may occur in the output when the distance between the emitter and the receiver is less than 0.2 m. Use only in the rated operating range.

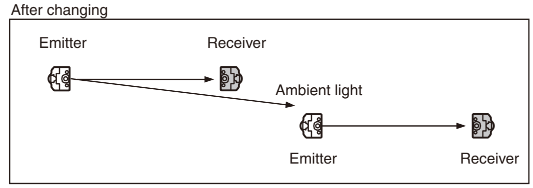
(4)Use a spatter protection slit cover. (F3SN and F3SH)

(5)Shorten the detection distance by setting with a setting tool. (F3SJ)

Before changing



After changing



⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

In the interest of product improvement, specifications are subject to change without notice.

Single-beam Safety Sensor for Long Distance Detection
F3SS

60-m long-distance detection.
This transmissive-type photoelectric sensor for human body detection (Type 4) is ideal for integrated protection of an entire line or multi-sided detection of intrusion into large machines.

- Mutual interference protection function for up to four sets.
- Complies with IEC standards and North American standards (received IEC61496-1, -2, and UL/CSA certification). Can be used as a safety guard for satisfaction of OSHA requirements for on-site labor safety in North America.
- Special controller not needed. Detection of human body intrusion is possible using just the sensor unit.
- Includes “Start/restart interlock function” to prevent automatic reset of output.
- The projector lens and receiver lens are equipped with heaters for worry-free operation even in environments where condensation easily forms.
- Optional glass and stainless steel mirrors are available.

Be sure to read the *“Safety Precautions”* on page 8 and the *“Precautions for All Safety Sensors”* .

Ordering Information

Sensors

Infrared

Sensor type	Appearance	Case material	Connection method	Sensing distance	Output	Model
Through-beam		Aluminum	Connected to the terminal block on the internal board.	0.3 to 60 m	PNP output	**F3SS-AT60P**

Note: F3SS-AT60P-L Emitter and F3SS-AT60P-D Receiver can also be ordered individually.

Accessories (Order Separately)

Item	Model
Laser Alignment Kit (for beam alignment)	**F39-LLK**
Glass Mirror	**F39-MSG**
Stainless Steel Mirror	**F39-MSS**
45° Mirror Clamp	**F39-LM45**
Mirror Clamp for Wall Mounting	**F39-LA**
Sensor Clamp for 42-mm-diameter Pipe Stand	**F39-LSP**

Note: Wiring is based on a built-in terminal block. Please purchase a 4-mm to 7-mm (dia.) cable separately.

Specifications

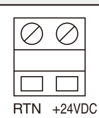
Item / Model	F3SS-AT60P
Sensing method	Through-beam models
Case material	Aluminum (case and cap)
Connection method	Connected to the terminal block on the internal board.
Power supply voltage	24 VDC ±10% (ripple p-p: 5% max.)
Effective aperture angle	±2.5° at 3 m
Current consumption	Emitter: 170 mA max. Receiver: 800 mA max.
Sensing distance	0.3 to 60 m
Detection capability	Opaque objects, 31 mm in diameter or greater
Response time	35 ms max.
Control outputs	Two PNP transistor outputs, load current 250 mA or less (residual voltage 1 V or less) (excluding voltage drop due to cable extension), Dark ON
Operating mode	Auto start mode, start interlock mode, and start/restart interlock mode can all be selected using a switch in the receiver.
Startup waiting time	4 s or less
Ambient temperature	Operating/Storage: 0 to 55°C (with no icing or condensation)
Ambient humidity	Operating/Storage: 35% to 95% (with no condensation)
Vibration resistance	Malfunction/destruction: 10 to 50 Hz, amplitude 0.7 mm, 20 sweeps each in X, Y, and Z directions
Shock resistance	Malfunction/destruction: 100 m/s^2, 1,000 times each in X, Y, and Z directions
Degree of protection	IEC60529 Standard IP65
Light source (emitted wavelength)	Infrared LED (880 nm)
Indicators	Emitter: Power indicator (orange), error mode indicator (red) Receiver: Light intensity level indicator (orange), OFF-state indicator (red), ON-state indicator (green), interlock indicator (yellow)
Protective circuits	Output load short and power supply reverse connection protection
Weight (packed state)	Approx. 2.5 kg (1 set)
Applicable standards	IEC (EN) 61496-1 TYPE4 ESPE *1, IEC(prEN)61496-2 TYPE4 AOPD *2
Accessories	Set of mounting clamps, operation manual, caps for conduits

*1. ESPE (Electro-Sensitive Protective Equipment)
*2. AOPD (Active Opto-electronic Protective Devices)

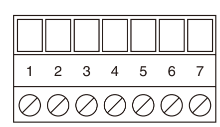
Connections

Wire the F3SS only after all power has been turned off.

Emitter

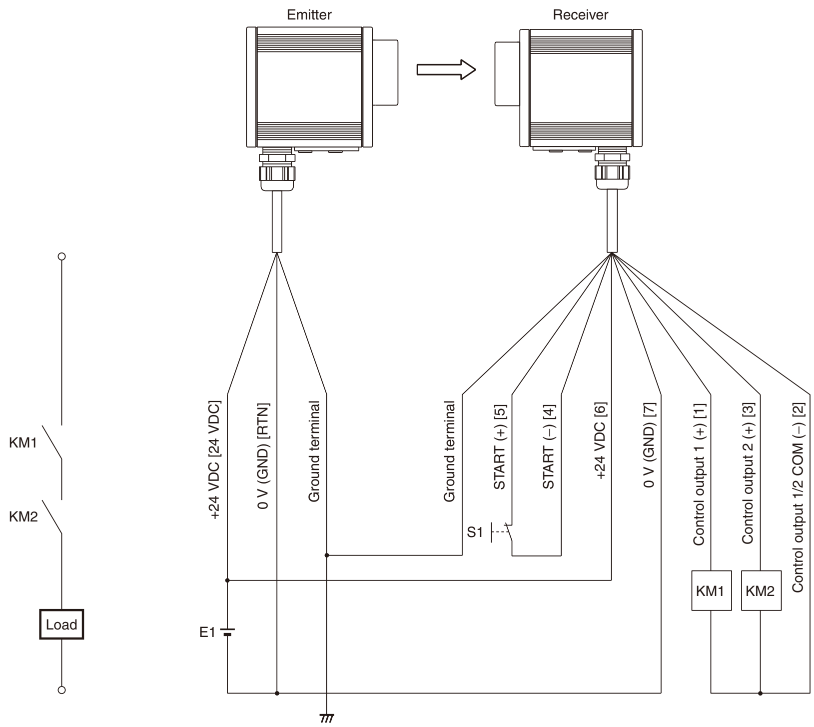
Terminal block number	Terminal name	Functions	Terminal block assignments
J3	+24 VDC	+24 VDC	
	RTN	0V (GND)	

Receiver

Terminal block number	Terminal name	Functions	Terminal block assignments
J5	1	Control output 1 (+)	
	2	For control output 1/2 COM (-)	
	3	Control output 2 (+)	
	4	START(-)	
	5	START(+)	
	6	+24 VDC	
	7	0V (GND)	

Note: Ground the projector and receiver to the ground terminal inside the case.

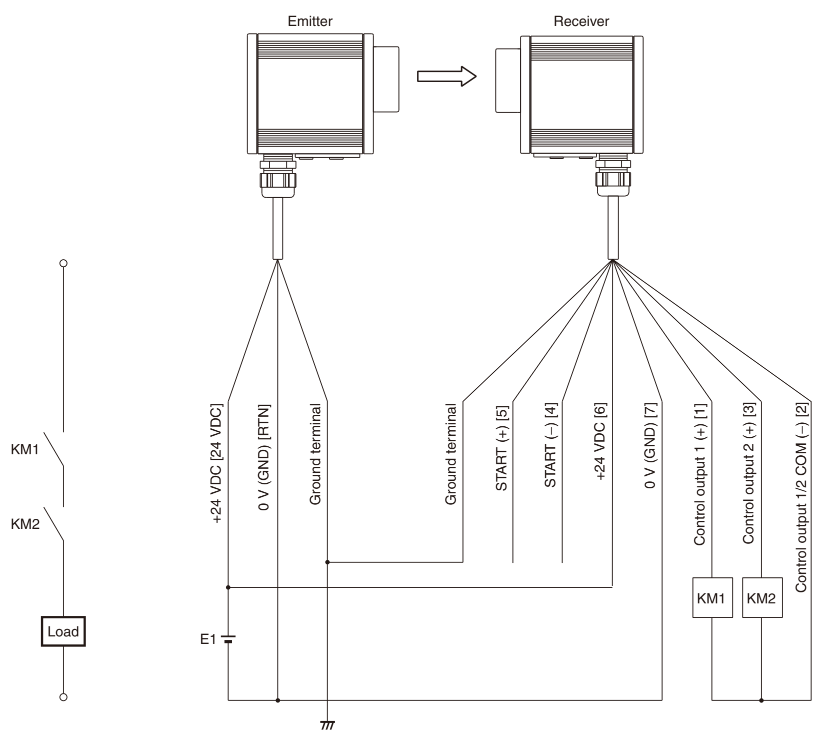
Start Interlock or Start/Reset Interlock Mode



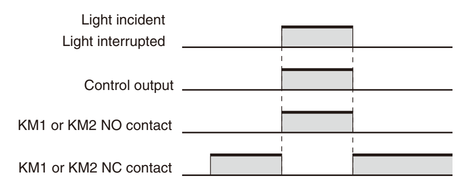
Timing Chart

Terminal names or numbers are given in brackets [ ].
E1: 24-VDC power supply (recommended: S82K)
S1: Start switch (to release interlock): NC contact
KM1, KM2: DC-driven high-sensitivity contactors (e.g., J7AN)

Auto-start Mode

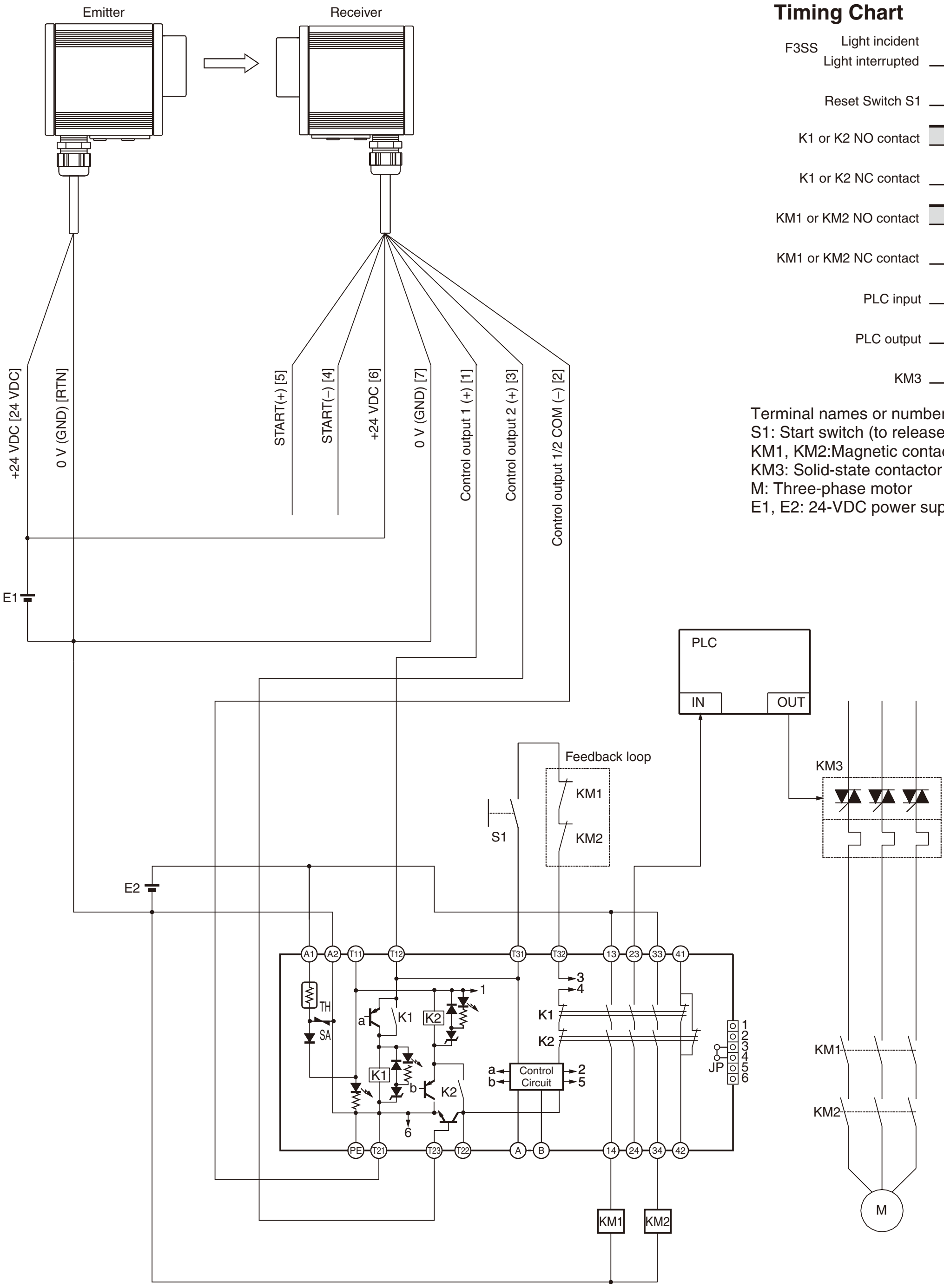


Timing Chart

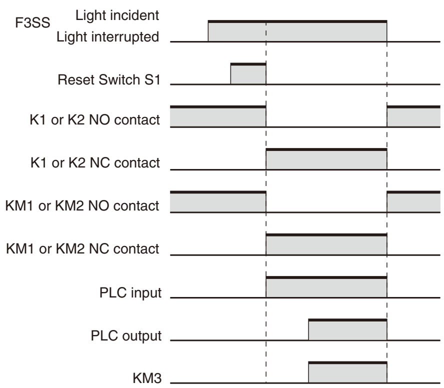


Terminal names or numbers are given in brackets [ ].
E1: 24-VDC power supply (recommended: S82K)
KM1, KM2: DC-driven high-sensitivity contactors (e.g., J7AN)

Connection with OMRON G9SA-301 Safety Relay Unit (Category 4)



Timing Chart



Terminal names or numbers are given in brackets [ ].
S1: Start switch (to release interlock): NC contact
KM1, KM2:Magnetic contactors
KM3: Solid-state contactor (e.g., G3J)
M: Three-phase motor
E1, E2: 24-VDC power supply (recommended: S82K)

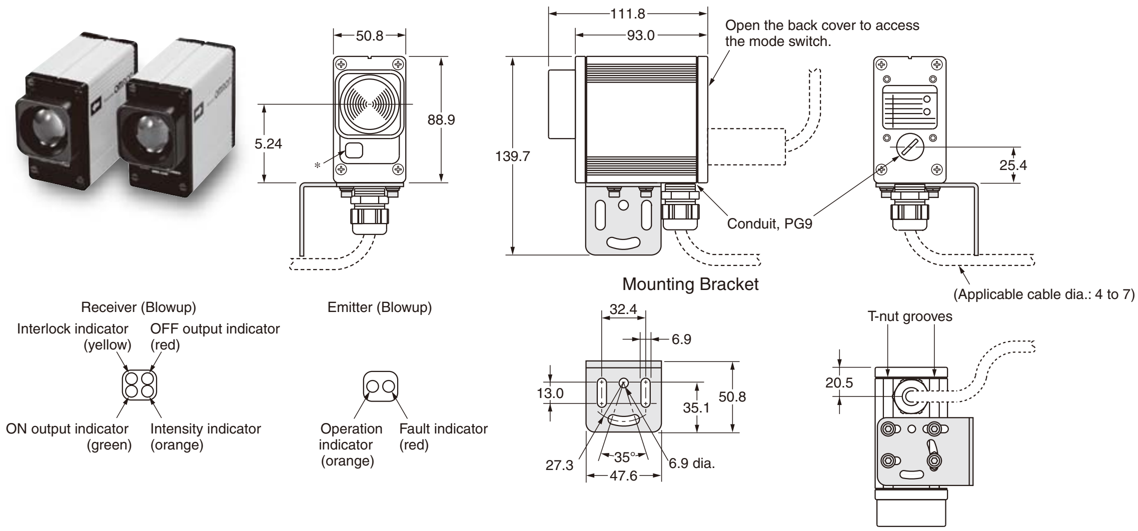
Note: When connecting the F3SS to the G9SA-301, disable the F3SS's start/restart interlock function and use the interlock function in the G9SA-301 instead.

Refer to the *Instruction Manual* included with the product for details.

Dimensions

(Unit: mm)

F3SS-AT60P



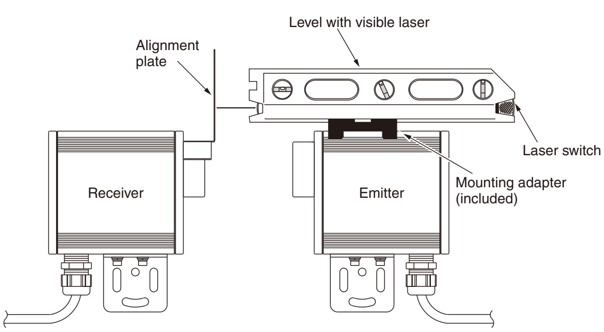
Accessories (Order Separately)

Laser Alignment Kit (for Beam Alignment)

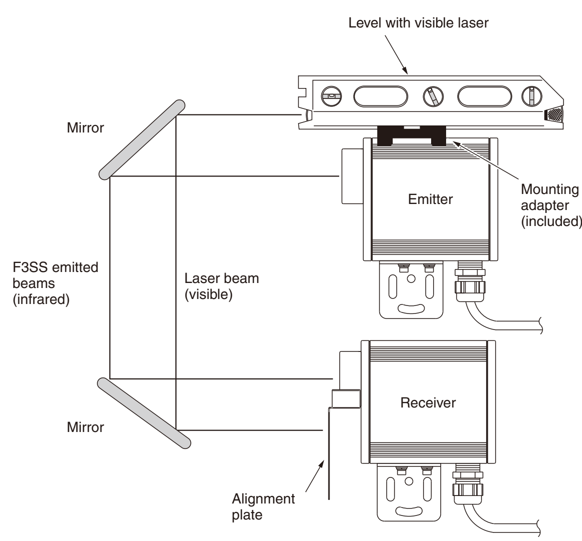
F39-LLK

The Laser Alignment Kit is used to align beams for long detection distances or when using Mirrors in the installation. A Level with a Visible Laser Beam is mounted on top of the Emitter and an Alignment Plate is mounted on the Receiver. First, the built-in levels are used to level the Emitter and Receiver and then the visible laser is turned ON. The heights and angles of the Emitter and Receiver are then adjusted so that the visible laser beam strikes the cross marks on the alignment plate. (Power supply: Three AA batteries, included in the Kit.)

Not Using Mirrors or Using Mirror To Bend Beam Horizontally



Using Two Mirrors to Bend Beam at a Right Angle



Note: The Laser Alignment Kit includes the alignment plate, level with visible laster, mounting attachment, and three AA batteries.

Glass Mirror

F39-MSG

Stainless Steel Mirror

F39-MSS

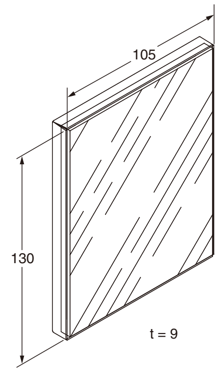
These Mirrors are used to bend the beams at 90° angles. Multiple Mirrors can be used to provide protection in two directions or to build a detection system with a 2-beam configuration.

There are two types of Mirror: Glass and Stainless Steel. The reflection rate of the Stainless Steel Mirror is lower, but there is no change of breakage.

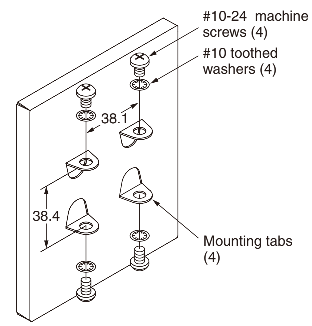
The rate of attenuation in the detection distance is 12% for each F39-MSG Glass Mirror and 18% for each F39-MSS Stainless Steel Mirror. The detection distances according to the number of Mirrors used is given in the following table.

Mirror material	Model	Detection distance (m) vs. No.of mirrors			
		1 Mirror	2 Mirrors	3 Mirrors	4 Mirrors
Glass	F39-MSG	52	46	40	35
Stainless steel	F39-MSS	49	40	33	27

Mirrored Surface



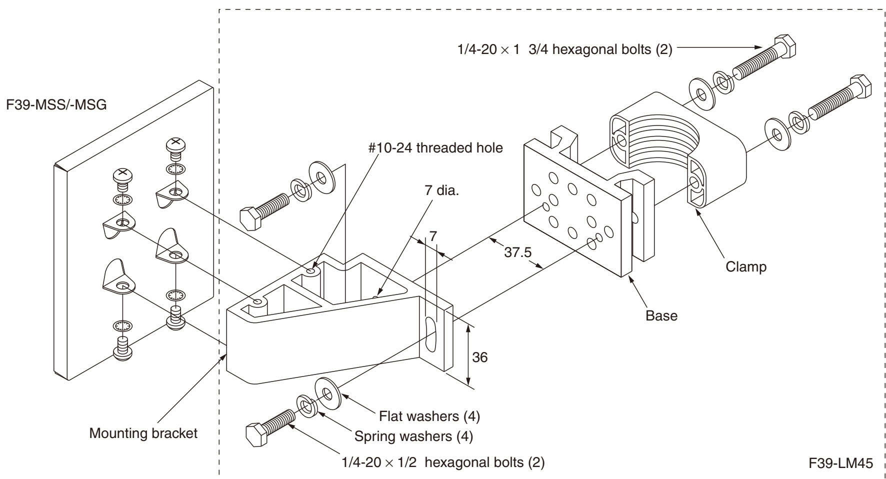
Mounting Surface

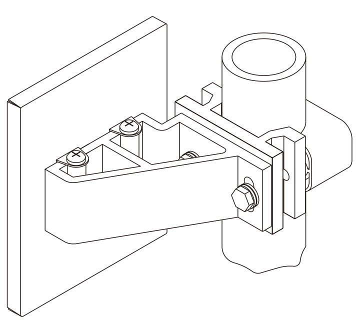


45° Mirror Clamp (for F39-MSG/-MSS)

F39-LM45

Use the F39-LM45 Mirror Clamp when mounting the F39-MSG/-MSS Mirror to a wall or pipe (dia.: 42 ±1). This Clamp enables mounting the Mirror at a 45° angle and bending the beam at a 90° angle.





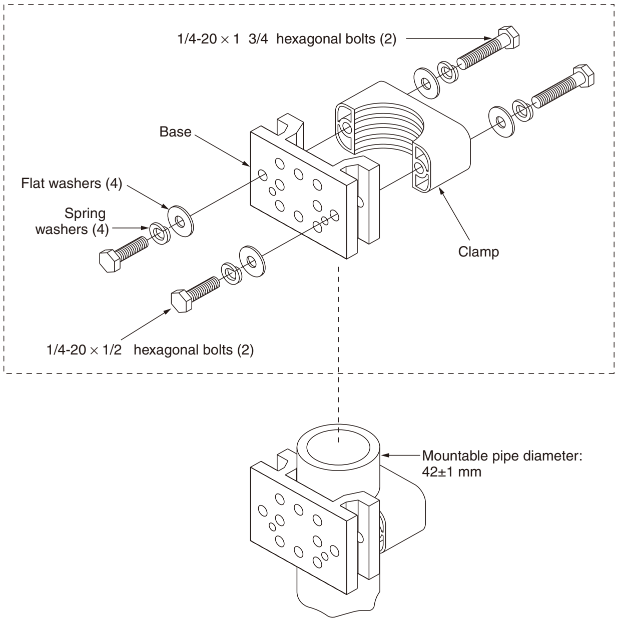
Assembled State

Sensor Clamp for 42-mm-dia. Pipe Stand

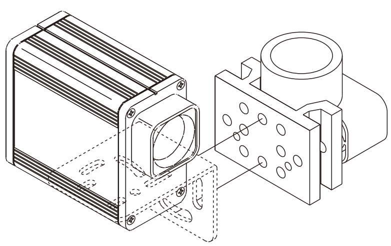
F39-LSP

This Clamp is used to mount the F3SS Sensor to a pipe with a diameter of 42 ±1 mm.

F39-LSP (Two Sets of Following Parts)



Mounting Method Using Bracket Included with F3SS

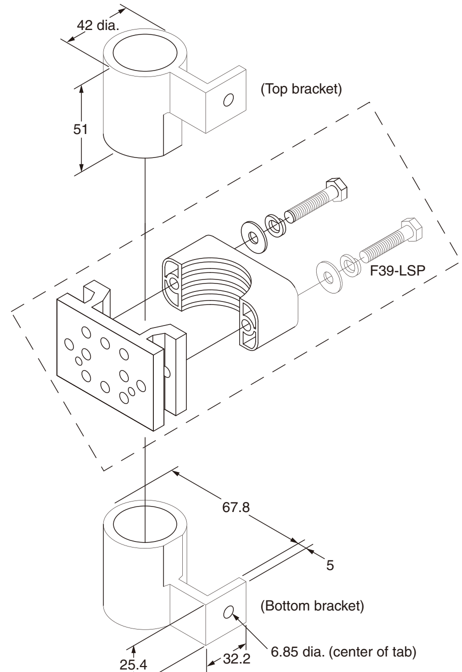


Mirror Clamp for Wall Mounting

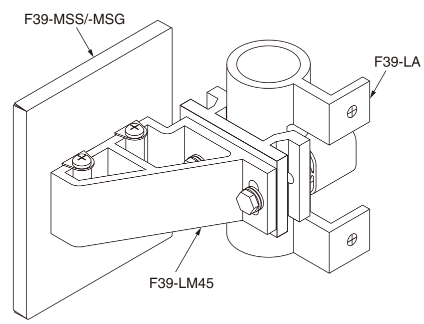
F39-LA

This Clamp is used to mount the F39-LSP or F39-LM45 to a wall without using a pipe.

F39-LA (Top and Bottom Brackets)



Using the F39-LM45 and F39-LA to Mount the F39-MSS/-MSG Mirror to a Wall



Safety Precautions

Observe the following precautions when using the F3SS.

Regulations and Standards

The F3SS has not received the type certification provided by Article 44-2 of the Industrial Safety and Health Law of Japan.
Therefore, it cannot be used in Japan as a safety device for pressing or shearing machines provided by Article 42 of that law.

⚠ WARNING

Safety Distance

Always maintain a safety distance (S) between the F3SS and a hazardous part of a machine.
Failure to do so causes the machine to fail to stop before an operator reaches the dangerous area and may result in serious injury.

The "safety distance" is the minimum distance that must be maintained between the F3SS and a hazardous part of a machine in order to stop the machine before someone or something reaches it.

If the safety distance is not specified in an individual machine standard of the EU Standard, the safety distance is calculated as provided by European Norm EN999 (Machine Safety: Positioning of Protective Devices Related to the Worker Approach Speed).

Install the Sensor so that the beams are parallel to the floor and so that the beams will be interrupted only by an erect person. The safety distance can be calculated as follows assuming that risk assessment has shown that an independent Single-beams Safety Sensor can be used.

Safety distance (S) = Intrusion speed into the detection zone (K) × Total response time for the machine and F3SS (T)+ Additional distance (C) ....(1)

The intrusion speed (K) and additional distance (C) depend on the national standards and individual machine standards. Be sure to refer to related standards.

<Reference>
Method for calculating safety distance as provided by European Norm EN999 (for intrusion perpendicular to the detection zone)

Substitute K = 1,600 mm/s and C = 1,200 mm in equation (1) and calculate as shown below.

S = 1,600 mm/s × (Tm + Ts) + 1,200 mm.................................(2)

Where: S = Safety distance (mm)
Tm = Machine response time (s) *1
Ts = F3SS response time (s) = 0.035 *2

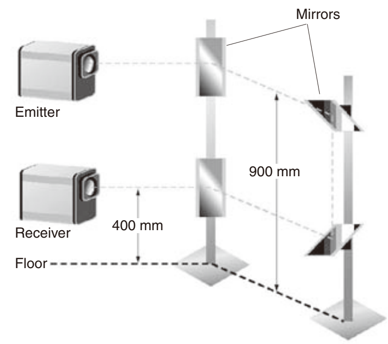
Example:
Tm = 0.1 s, Ts = 0.035 s:
S = 1,600 mm/s × (0.1 s + 0.035 s) + 1,200 mm = 1,416 mm

*1. The machine response time is the maximum time from the moment the machine receives a stop signal to the moment the hazardous part of the machine stops.
*2. The F3SS response time is the time required for output to change from ON to OFF.

Recommended Beam Installation Heights

- When using the F3SS as a Single-beam Safety Sensor, we recommend that the beam height be adjusted to a height of 750 mm from the floor or reference surface to prevent accidents from occurring as the result of persons crossing over or under the beam.
- The following beam heights from the floor or reference surface are recommended when using multiple F3SS beams aligned vertically or using Mirrors to bend a single beams and thus use the F3SS as a Multi-beam Safety Sensor.

No. of beams	Recommended beam heights from floor (mm)
2	400 and 900
3	300, 700, and 1,100
4	300, 600, 900, and 1,200



Precautions for Safe Use

Do not used the product in atmospheres or environments that exceed product ratings.
Refer to the *Instruction Manual* for details on installation, connections, and operating methods.

Precautions for All Safety Sensors

Note: Refer to the "*Safety Precautions*" section for each Sensor for specific precautions applicable to each Sensor.

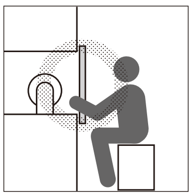
⚠ WARNING

Installation Conditions

Detection Zone and Intrusion Path

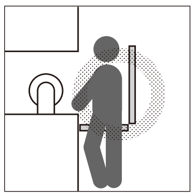
Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas.
If a person is able to step into the hazardous area of a machine and remain behind the Safety Light Curtain's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

Correct Installation



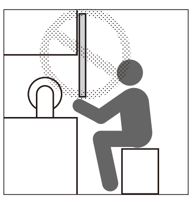
A person can only reach the hazardous part of the machinery by passing through the sensor's detection zone.

Correct Installation



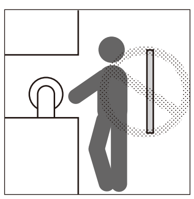
A person enters the detection zone during operation.

Incorrect Installation



A person can reach the hazardous part of the machinery without passing through the sensor's detection zone.

Incorrect Installation



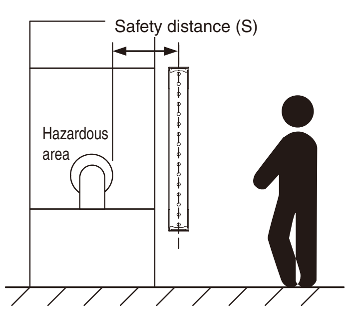
A person is between the sensor's detection zone and the hazardous part of the machinery.

Install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

The Safety Light Curtain cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

Safety Distance

The safety distance is the distance that must be set between the Safety Light Curtain and a machine's hazardous part to stop the hazardous part before a person or object reaches it. The safety distance varies according to the standards of each country and the individual specifications of each machine. In addition, the calculation of the safety distance differs if the direction of approach is not perpendicular to the detection zone of the Safety Light Curtain. Always refer to relevant standards.



Make sure to secure the safety distance (S) between the Safety Light Curtain and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Note: The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops.
Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

How to calculate the safety distance specified by International standard ISO13855-2002 (European standard EN999-1999) (Reference)

If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.

S = K x T + C . . . Eq. (1)

- S: Safety distance
- K: Approach speed to the detection zone
- T: Total response time of the machine and Safety Light Curtain
- C: Additional distance calculated by the detection capability of the Safety Light Curtain

<System that has detection capability of 40 mm max.>

Use K = 2,000 mm/s and C = 8 x (d - 14 mm) in equation (1) for the calculation.

S = 2,000 mm/s x (Tm + Ts) + 8 x (d - 14 mm)

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s) *
- d = Size of Safety Light Curtain's detection capability (mm) *

* These values differ depending on the Switch. Refer to the "*Precautions for Correct Use*" for the Switch you are using.

[Calculation example]
When Tm = 0.05 s, Ts = 0.01 s, and d = 14 mm:
S = 2,000 mm/s x (0.05 s + 0.01 s) + 8 x (14 mm - 14 mm)
= 120 mm . . . Eq. (2)
If the result is less than 100 mm, use S = 100 mm.
If the result exceeds 500 mm, use the following equation where K = 1,600 mm/s.
S = 1,600 mm/s x (Tm + Ts) + 8 x (d - 14 mm) . . . Eq. (3)
If the result of this Eq. (3) is less than 500 mm, use S = 500 mm.

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 40 mm or Systems Using Multi-beam Safety Sensors>

Assuming K = 1,600 mm/s and C = 850 mm, the following calculation is made using Eq. (1).
S = 1,600 mm/s x (Tm + Ts) + 850 … Eq. 4,

- S = Safety distance (mm)
- Tm = Machine's response time (s)
- Ts = Response time of the Safety Light Curtain from ON to OFF (s)

Calculation example:
When Tm = 0.05 s and Ts = 0.01 s,
S = 1,600 mm/s x (0.05 s + 0.01 s) + 850 mm = 946 mm

How to calculate the safety distance specified by American standard ANSI B11.19
(Reference)

<Systems with a Smallest Detectable Object Size (Diameter) Less than 64 mm>
If a person approaches the detection zone of the Safety Light Curtain perpendicularly, calculate the safety distance as shown below.
S = K x (Ts + Tc + Tr + Tbm) + Dpf

- S: Safety distance
- K: Approach speed to the detection zone (the value recommended by OSHA standard is 1,600 mm/s)

Approach speed K is not specified in the ANSI B.11.19 standard. To determine the value of K to apply, consider all factors, including the operator's physical ability.

- Ts = Machine's stop time (s)
- Tr = Response time of the Safety Light Curtain from ON to OFF (s)
- Tc = Machine control circuit's maximum response time required to activate its brake (s)
- Tbm = Additional time (s)

If a machine has a brake monitor, "Tbm = Brake monitor setting time - (Ts + Tc)". If it has no brake monitor, we recommend using 20% or more of (Ts + Tc) as additional time.

- Dpf = Additional distance

According to ANSI's formula, Dpf is calculated as shown below:
Dpf = 3.4 x (d - 7.0): Where d is the detection capability of the Safety Light Curtain (unit: mm)

[Calculation example]
When K = 1,600 mm/s, Ts + Tc = 0.06 s, brake monitor setting time = 0.1 s, Tr = 0.01 s, d = 14 mm:
Tbm = 0.1 - 0.06 = 0.04 s
Dpf = 3.4 x (14 - 7.0) = 23.8 mm
S = 1,600 x (0.06 + 0.01 + 0.04) + 23.8 = 199.8 mm

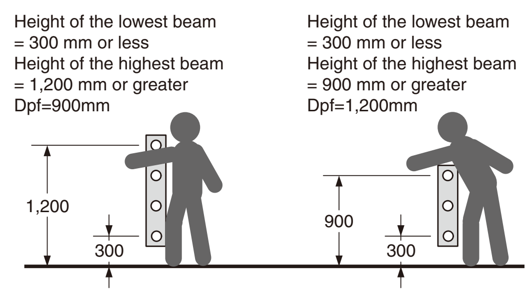
Method for Calculating the Safety Distance as Provided by ANSI/RIA R15.06 (USA)
(Reference)

<Systems with a Smallest Detectable Object Size (Diameter) Greater than 64 mm and Less than 600mm>
The safety distance is calculated based on the following concepts when the human body intrudes perpendicular to the detection zone of the Safety Light Curtain.
S = K x (Ts + Tc + Tr) + Dpf

- S: Safety distance
- K = Intrusion speed into detection zone (1,600 mm/s min. recommended by OSHA)
- Ts = Stop time of machine/equipment (s)
- Tr = Light curtain ON-to-OFF response time (s)
- Tc = Maximum response time of the machine/equipment braking circuit required to operate the brake (s)
- Dpf = Additional distance (mm)

If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 1,200 mm or higher, the Dpf will be 900 mm.
If the Sensor is installed with the lowest beam height above the floor at 300 mm or lower and the highest beam height above the floor at 900 mm or higher, the Dpf will be 1,200 mm.

[Calculation example]
K = 1,600 mm/s, Ts + Tc = 0.06s,
If Tr = 0.01 s and Dpf = 900 mm:
S = 1,600 x (0.06 + 0.01) + 900 = 1,012 mm

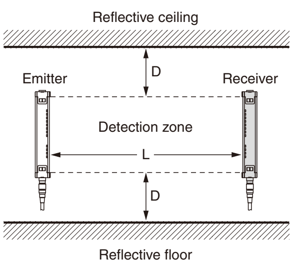


Distance from Glossy Surface

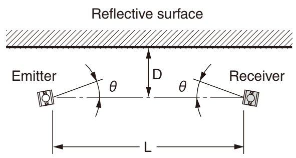
Install the sensor system so that it is not affected by reflection from a glossy surface. Failure to do so may hinder detection, resulting in serious injury.

Install the sensor system at distance D or further from highly reflective surfaces such as metallic walls, floors, ceilings, or workpieces, as shown below.

<Side View>



<Top View>



θ =5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ =10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.13 m	0.26 m
For 3 m or more	L/2 x tan5° = L x 0.044 (m)	L/2 x tan10° = L x 0.088 (m)

Others

To use the Safety Light Curtain in PSDI mode (restart of cycle operation by the sensor), you must configure an appropriate circuit between the Safety Light Curtain and the machine. For details about PSDI, refer to OSHA1910.217, IEC61496-1, and other relevant standards and regulations.

Do not try to disassemble, repair, or modify this product. Doing so may cause the safety functions to stop working properly.

Do not use the Safety Light Curtain in environments where flammable or explosive gases are present. Doing so may result in explosion.

Perform daily and 6-month inspections for the Safety Light Curtain. Otherwise, the system may fail to work properly, resulting in serious injury.

Installation

Prevention of Mutual Interference

The emitter and the receiver to be set facing each other should be a pair of the same set. Erroneous combination may create a zone where objects cannot be detected.

Do not use a sensor system in a reflective configuration. Doing so may hinder detection.
Mirrors can be used change the optical route.

When using more than 1 set of Safety Light Curtain, install them so that mutual interference does not occur, such as by configuring series connections or using physical barriers between adjacent sets.

Precautions for Safe Use

Do not used the product in atmospheres or environments that exceed product ratings

Installation

Prevention of Mutual Interference

For series connection

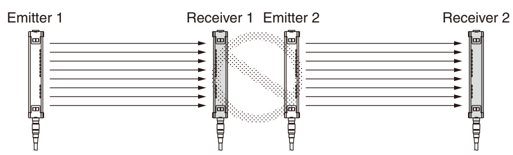
Refer to the "*Precautions for Correct Use*" for individual models for information on preventing mutual interference of linkable Safety Light Curtains.

For no series connection

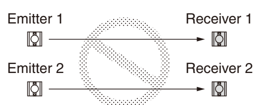
When installing two or more pairs of light curtains independently from each other due to inconvenience of wiring or other reason, take proper measures to prevent mutual interference. If mutual interference occurs, a lockout condition will result for the Safety Light Curtain.

- Installation which may cause mutual interference

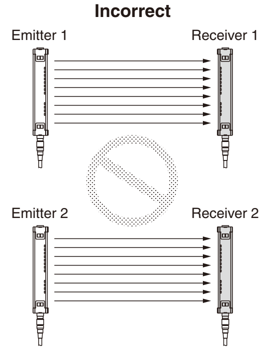
Incorrect



Incorrect



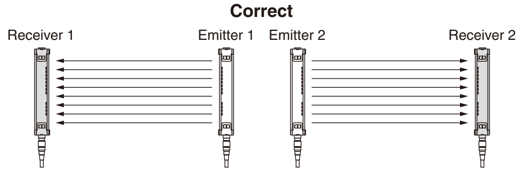
Incorrect



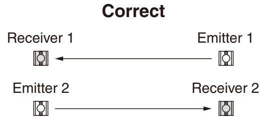
- Installation to prevent mutual interference

(1)Install so that the two light curtains emit in the opposite directions (staggered).

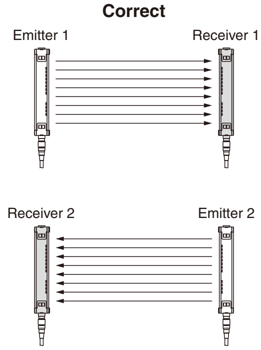
Correct



Correct

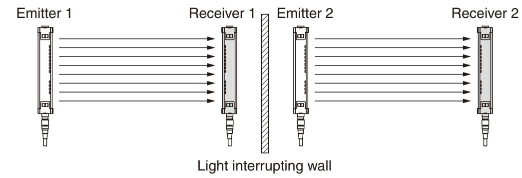


Correct



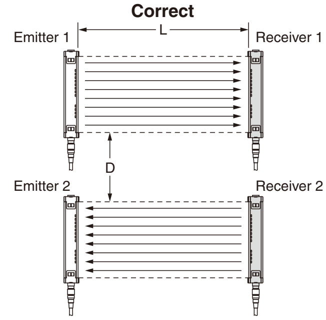
(2)Install a light interrupting wall in between sensors.

Correct

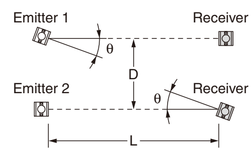


(3)Install the light curtains facing away from the one another to eliminate mutual interference.

Correct



Correct



θ= 5° (F3SN-A, F3SN-A□SS, F3SH-A, F3SJ)
θ= 10° (F3SN-B)

Distance between emitter and receiver (Detection Distance)	Allowable installation distance D	
	Type 4	Type 2
For 0.2 to 3 m	0.26 m	0.52 m
For 3 m or more	L x tan5° = L x 0.088 (m)	L x tan10° = L x 0.18 (m)

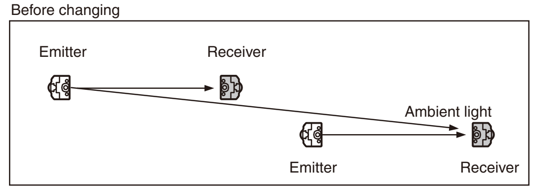
Operating range

Chattering may occur in the output when the distance between the emitter and the receiver is less than 0.2 m. Use only in the rated operating range.

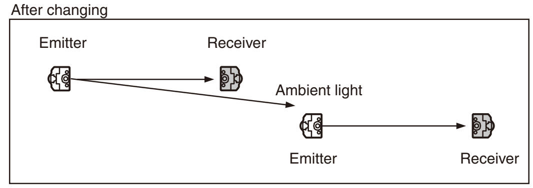
(4)Use a spatter protection slit cover. (F3SN and F3SH)

(5)Shorten the detection distance by setting with a setting tool. (F3SJ)

Before changing



After changing



WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2007.11

In the interest of product improvement, specifications are subject to change without notice.

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/

Safety Light Curtain

MS4800 Series

Safety Light Curtains with Durable, Impact-resistant Body and Long, 20-m Sensing Distance

MS/MSF4800A Advanced Series

- Programming and Diagnostics Module (PDM) makes it easy to set functions.
- Series connection is possible only with the MSF4800A.
- Blanking can be set.
- Muting is possible only with the MSF4800A by using the MS4800-RM6 Resource Module.

MS/MSF4800B Basic Series

- Features all necessary basic Safety Light Curtain functions.
- Series connection is possible only with the MSF4800B.
- Programming and Diagnostics Module (PDM) makes it easy to set functions.

⚠ Be sure to read the *Precautions for Safe Use* on page 26.

Features

Durable Housing Withstands Vibration and Impacts

MS4800 Safety Light Curtains have a thick aluminum case (3 mm at its thinnest parts). This makes them ideal for applications with considerable vibration or impacts.

Long-distance Sensing

The maximum sensing distance is 20 meters. This makes the MS4800 Safety Light Curtain well suited to peripheral guard applications using mirrors.

Select the Minimum Detectable Object Size and Protective Height to Match the Application

The minimum detectable object size can be selected as either 30 mm or 40 mm in diameter.
When the 30-mm size is selected, the protective height can be from 280 mm to 2,120 mm.
When the 40-mm size is selected, the protective height can be from 360 mm to 2,040 mm.

Individual Beam Indicators (IBI)

When the infrared beams are interrupted or when the beams are not correctly aligned, Individual Beam Indicators on the Receiver light. This makes it easy to align beams even from a distance.

Series Connection Function (MSF4800 Only)

Up to four MSF4800 Safety Light Curtains can be "daisy-chained" in series. When using this configuration, the total number of beams must not exceed 256. Each MSF4800 in the configuration is called a segment. The segment connected to the control system and power supply is called the master segment, and the other segments are called slave segments. There must be one master segment. When connecting two segments, use one master segment and one slave segment. For three segments, use one master segment and two slave segments; and for four segments, use one master segment and three slave segments.
Note: A slave segment cannot be used alone.

No Special Controller

A Category 4 safety circuit can be configured using only Receivers and Transmitters.

Test Input (MTS)

This function lets you use an external signal to halt the light emission of the Safety Light Curtain to check the operation of the safety system when the Safety Light Curtain is interrupted.

External Device Monitoring (EDM, MPCE Monitoring)

This function detects operating faults such as contact welding of the external device (relay) that is used to control a machine.

Scan Code for Mutual Interference Reduction

Switching the two types of scan codes helps to reduce mutual interference between adjacent Safety Light Curtains.

Complies with the Newest Global Safety Standards

Ordering Information

Safety Light Curtains

MS/MSF4800-series Safety Light Curtains

▭ Infrared light

Series	Minimum detectable object	Beam gap	Appearance	Sensing distance	Number of beams	Protective height (mm)	Model: Individual use	Model: Series connection (for muting ✻1)	
Advanced Series	30-mm-dia.	20 mm		0.3 to 20 m	14 to 106	280 to 2120	**MS4800A-30-□**	Master	**MSF4800A-30-□**
								Slave ✻2	**MSF4800-30-□ -XR2**
	40-mm-dia.	30 mm			12 to 68	360 to 2040	**MS4800A-40-□**	Master	**MSF4800A-40-□**
								Slave ✻2	**MSF4800-40-□ -XR2**
Basic Series	30-mm-dia.	20 mm			14 to 106	280 to 2120	**MS4800B-30-□**	Master	**MSF4800B-30-□**
								Slave ✻2	**MSF4800-30-□ -XR2**
	40-mm-dia.	30 mm			12 to 68	360 to 2040	**MS4800B-40-□**	Master	**MSF4800B-40-□**
								Slave ✻2	**MSF4800-40-□ -XR2**

Note: A 4-digit number indicating the protective height of the Light Curtain must be included in place of the box (□) in the model number.
✻1. There is no muting function in Basic-series Safety Light Curtains.
✻2. The same Slave Light Curtains are used for both the Advanced Series and Basic Series. These Slaves cannot be used individually.

Functional Comparison of Advanced Series and Basic Series

Function / Series, Model	Advanced Series MS/MSF4800A	Basic Series MS/MSF4800B
Scan code for mutual interference reduction	Supported. ✻1	Supported. ✻1
External device monitoring (EDM)	Supported. ✻2	Supported. ✻2
Operation mode	Supported. ✻1	Supported. ✻1
Machine test signal (MTS)	Supported. ✻1	Supported. ✻1
Auxiliary output (PNP transistor × 1, or NPN transistor × 1)	Supported. ✻1	Supported. (PNP/control output synchronizing only)
Muting via the MS4800-RM6 Resource Module	Supported. ✻1	
Floating blanking	Supported. ✻1	
Fixed blanking	Supported. ✻1	
Monitored blanking	Supported. ✻1	
Reduced resolution blanking	Supported. ✻1	
Sensing distance setting	Supported. ✻1	Supported. ✻1
Start input method	Supported. ✻1	
Response time adjustment	Supported. ✻1	

✻1. This function can be set by using the Programming and Diagnostics Module (PDM).
✻2. This function can be set by using the PDM or a wiring connection.

Safety Light Curtain Model List

Advanced-series Curtains Used Individually (Minimum detectable object: 30-mm dia., Beam gap: 20 mm)

Model	Number of beams	Protective height (mm)
MS4800A-30-0280	14	280
MS4800A-30-0320	16	320
MS4800A-30-0360	18	360
MS4800A-30-0400	20	400
MS4800A-30-0440	22	440
MS4800A-30-0480	24	480
MS4800A-30-0520	26	520
MS4800A-30-0560	28	560
MS4800A-30-0600	30	600
MS4800A-30-0640	32	640
MS4800A-30-0680	34	680
MS4800A-30-0720	36	720
MS4800A-30-0760	38	760
MS4800A-30-0800	40	800
MS4800A-30-0840	42	840
MS4800A-30-0880	44	880
MS4800A-30-0920	46	920
MS4800A-30-0960	48	960
MS4800A-30-1000	50	1000
MS4800A-30-1040	52	1040
MS4800A-30-1080	54	1080
MS4800A-30-1120	56	1120
MS4800A-30-1160	58	1160
MS4800A-30-1200	60	1200
MS4800A-30-1240	62	1240
MS4800A-30-1280	64	1280
MS4800A-30-1320	66	1320
MS4800A-30-1360	68	1360
MS4800A-30-1400	70	1400
MS4800A-30-1440	72	1440
MS4800A-30-1480	74	1480
MS4800A-30-1520	76	1520
MS4800A-30-1560	78	1560
MS4800A-30-1600	80	1600
MS4800A-30-1640	82	1640
MS4800A-30-1680	84	1680
MS4800A-30-1720	86	1720
MS4800A-30-1760	88	1760
MS4800A-30-1800	90	1800
MS4800A-30-1840	92	1840
MS4800A-30-1880	94	1880
MS4800A-30-1920	96	1920
MS4800A-30-1960	98	1960
MS4800A-30-2000	100	2000
MS4800A-30-2040	102	2040
MS4800A-30-2080	104	2080
MS4800A-30-2120	106	2120

Basic-series Curtains Used Individually (Minimum detectable object: 30-mm dia., Beam gap: 20 mm)

Model	Number of beams	Protective height (mm)
MS4800B-30-0280	14	280
MS4800B-30-0320	16	320
MS4800B-30-0360	18	360
MS4800B-30-0400	20	400
MS4800B-30-0440	22	440
MS4800B-30-0480	24	480
MS4800B-30-0520	26	520
MS4800B-30-0560	28	560
MS4800B-30-0600	30	600
MS4800B-30-0640	32	640
MS4800B-30-0680	34	680
MS4800B-30-0720	36	720
MS4800B-30-0760	38	760
MS4800B-30-0800	40	800
MS4800B-30-0840	42	840
MS4800B-30-0880	44	880
MS4800B-30-0920	46	920
MS4800B-30-0960	48	960
MS4800B-30-1000	50	1000
MS4800B-30-1040	52	1040
MS4800B-30-1080	54	1080
MS4800B-30-1120	56	1120
MS4800B-30-1160	58	1160
MS4800B-30-1200	60	1200
MS4800B-30-1240	62	1240
MS4800B-30-1280	64	1280
MS4800B-30-1320	66	1320
MS4800B-30-1360	68	1360
MS4800B-30-1400	70	1400
MS4800B-30-1440	72	1440
MS4800B-30-1480	74	1480
MS4800B-30-1520	76	1520
MS4800B-30-1560	78	1560
MS4800B-30-1600	80	1600
MS4800B-30-1640	82	1640
MS4800B-30-1680	84	1680
MS4800B-30-1720	86	1720
MS4800B-30-1760	88	1760
MS4800B-30-1800	90	1800
MS4800B-30-1840	92	1840
MS4800B-30-1880	94	1880
MS4800B-30-1920	96	1920
MS4800B-30-1960	98	1960
MS4800B-30-2000	100	2000
MS4800B-30-2040	102	2040
MS4800B-30-2080	104	2080
MS4800B-30-2120	106	2120

Advanced-series Curtains Used Individually (Minimum detectable object: 40-mm dia., Beam gap: 30 mm)

Model	Number of beams	Protective height (mm)
MS4800A-40-0360	12	360
MS4800A-40-0480	16	480
MS4800A-40-0600	20	600
MS4800A-40-0720	24	720
MS4800A-40-0840	28	840
MS4800A-40-0960	32	960
MS4800A-40-1080	36	1080
MS4800A-40-1200	40	1200
MS4800A-40-1320	44	1320
MS4800A-40-1440	48	1440
MS4800A-40-1560	52	1560
MS4800A-40-1680	56	1680
MS4800A-40-1800	60	1800
MS4800A-40-1920	64	1920
MS4800A-40-2040	68	2040

Basic-series Curtains Used Individually (Minimum detectable object: 40-mm dia., Beam gap: 30 mm)

Model	Number of beams	Protective height (mm)
MS4800B-40-0360	12	360
MS4800B-40-0480	16	480
MS4800B-40-0600	20	600
MS4800B-40-0720	24	720
MS4800B-40-0840	28	840
MS4800B-40-0960	32	960
MS4800B-40-1080	36	1080
MS4800B-40-1200	40	1200
MS4800B-40-1320	44	1320
MS4800B-40-1440	48	1440
MS4800B-40-1560	52	1560
MS4800B-40-1680	56	1680
MS4800B-40-1800	60	1800
MS4800B-40-1920	64	1920
MS4800B-40-2040	68	2040

Advanced-series Curtains Connected in Series (Minimum detectable object: 30-mm dia., Beam gap: 20 mm)
Masters

Model	Number of beams	Protective height (mm)
MSF4800A-30-0280	14	280
MSF4800A-30-0320	16	320
MSF4800A-30-0360	18	360
MSF4800A-30-0400	20	400
MSF4800A-30-0440	22	440
MSF4800A-30-0480	24	480
MSF4800A-30-0520	26	520
MSF4800A-30-0560	28	560
MSF4800A-30-0600	30	600
MSF4800A-30-0640	32	640
MSF4800A-30-0680	34	680
MSF4800A-30-0720	36	720
MSF4800A-30-0760	38	760
MSF4800A-30-0800	40	800
MSF4800A-30-0840	42	840
MSF4800A-30-0880	44	880
MSF4800A-30-0920	46	920
MSF4800A-30-0960	48	960
MSF4800A-30-1000	50	1000
MSF4800A-30-1040	52	1040
MSF4800A-30-1080	54	1080
MSF4800A-30-1120	56	1120
MSF4800A-30-1160	58	1160
MSF4800A-30-1200	60	1200
MSF4800A-30-1240	62	1240
MSF4800A-30-1280	64	1280
MSF4800A-30-1320	66	1320
MSF4800A-30-1360	68	1360
MSF4800A-30-1400	70	1400
MSF4800A-30-1440	72	1440
MSF4800A-30-1480	74	1480
MSF4800A-30-1520	76	1520
MSF4800A-30-1560	78	1560
MSF4800A-30-1600	80	1600
MSF4800A-30-1640	82	1640
MSF4800A-30-1680	84	1680
MSF4800A-30-1720	86	1720
MSF4800A-30-1760	88	1760
MSF4800A-30-1800	90	1800
MSF4800A-30-1840	92	1840
MSF4800A-30-1880	94	1880
MSF4800A-30-1920	96	1920
MSF4800A-30-1960	98	1960
MSF4800A-30-2000	100	2000
MSF4800A-30-2040	102	2040
MSF4800A-30-2080	104	2080
MSF4800A-30-2120	106	2120

Basic-series Curtains Connected in Series (Minimum detectable object: 30-mm dia., Beam gap: 20 mm)
Masters

Model	Number of beams	Protective height (mm)
MSF4800B-30-0280	14	280
MSF4800B-30-0320	16	320
MSF4800B-30-0360	18	360
MSF4800B-30-0400	20	400
MSF4800B-30-0440	22	440
MSF4800B-30-0480	24	480
MSF4800B-30-0520	26	520
MSF4800B-30-0560	28	560
MSF4800B-30-0600	30	600
MSF4800B-30-0640	32	640
MSF4800B-30-0680	34	680
MSF4800B-30-0720	36	720
MSF4800B-30-0760	38	760
MSF4800B-30-0800	40	800
MSF4800B-30-0840	42	840
MSF4800B-30-0880	44	880
MSF4800B-30-0920	46	920
MSF4800B-30-0960	48	960
MSF4800B-30-1000	50	1000
MSF4800B-30-1040	52	1040
MSF4800B-30-1080	54	1080
MSF4800B-30-1120	56	1120
MSF4800B-30-1160	58	1160
MSF4800B-30-1200	60	1200
MSF4800B-30-1240	62	1240
MSF4800B-30-1280	64	1280
MSF4800B-30-1320	66	1320
MSF4800B-30-1360	68	1360
MSF4800B-30-1400	70	1400
MSF4800B-30-1440	72	1440
MSF4800B-30-1480	74	1480
MSF4800B-30-1520	76	1520
MSF4800B-30-1560	78	1560
MSF4800B-30-1600	80	1600
MSF4800B-30-1640	82	1640
MSF4800B-30-1680	84	1680
MSF4800B-30-1720	86	1720
MSF4800B-30-1760	88	1760
MSF4800B-30-1800	90	1800
MSF4800B-30-1840	92	1840
MSF4800B-30-1880	94	1880
MSF4800B-30-1920	96	1920
MSF4800B-30-1960	98	1960
MSF4800B-30-2000	100	2000
MSF4800B-30-2040	102	2040
MSF4800B-30-2080	104	2080
MSF4800B-30-2120	106	2120

Advanced-series Curtains Connected in Series (Minimum detectable object: 40-mm dia., Beam gap: 30 mm)
Masters

Model	Number of beams	Protective height (mm)
MSF4800A-40-0360	12	360
MSF4800A-40-0480	16	480
MSF4800A-40-0600	20	600
MSF4800A-40-0720	24	720
MSF4800A-40-0840	28	840
MSF4800A-40-0960	32	960
MSF4800A-40-1080	36	1080
MSF4800A-40-1200	40	1200
MSF4800A-40-1320	44	1320
MSF4800A-40-1440	48	1440
MSF4800A-40-1560	52	1560
MSF4800A-40-1680	56	1680
MSF4800A-40-1800	60	1800
MSF4800A-40-1920	64	1920
MSF4800A-40-2040	68	2040

Basic-series Curtains Connected in Series (Minimum detectable object: 40-mm dia., Beam gap: 30 mm)
Masters

Model	Number of beams	Protective height (mm)
MSF4800B-40-0360	12	360
MSF4800B-40-0480	16	480
MSF4800B-40-0600	20	600
MSF4800B-40-0720	24	720
MSF4800B-40-0840	28	840
MSF4800B-40-0960	32	960
MSF4800B-40-1080	36	1080
MSF4800B-40-1200	40	1200
MSF4800B-40-1320	44	1320
MSF4800B-40-1440	48	1440
MSF4800B-40-1560	52	1560
MSF4800B-40-1680	56	1680
MSF4800B-40-1800	60	1800
MSF4800B-40-1920	64	1920
MSF4800B-40-2040	68	2040

Advanced Series/Basic-series Curtains Connected in Series (Minimum detectable object: 30-mm dia., Beam gap: 20 mm)

Slaves

Model	Number of beams	Protective height (mm)
MSF4800-30-0280-XR2	14	280
MSF4800-30-0320-XR2	16	320
MSF4800-30-0360-XR2	18	360
MSF4800-30-0400-XR2	20	400
MSF4800-30-0440-XR2	22	440
MSF4800-30-0480-XR2	24	480
MSF4800-30-0520-XR2	26	520
MSF4800-30-0560-XR2	28	560
MSF4800-30-0600-XR2	30	600
MSF4800-30-0640-XR2	32	640
MSF4800-30-0680-XR2	34	680
MSF4800-30-0720-XR2	36	720
MSF4800-30-0760-XR2	38	760
MSF4800-30-0800-XR2	40	800
MSF4800-30-0840-XR2	42	840
MSF4800-30-0880-XR2	44	880
MSF4800-30-0920-XR2	46	920
MSF4800-30-0960-XR2	48	960
MSF4800-30-1000-XR2	50	1000
MSF4800-30-1040-XR2	52	1040
MSF4800-30-1080-XR2	54	1080
MSF4800-30-1120-XR2	56	1120
MSF4800-30-1160-XR2	58	1160
MSF4800-30-1200-XR2	60	1200
MSF4800-30-1240-XR2	62	1240
MSF4800-30-1280-XR2	64	1280
MSF4800-30-1320-XR2	66	1320
MSF4800-30-1360-XR2	68	1360
MSF4800-30-1400-XR2	70	1400
MSF4800-30-1440-XR2	72	1440
MSF4800-30-1480-XR2	74	1480
MSF4800-30-1520-XR2	76	1520
MSF4800-30-1560-XR2	78	1560
MSF4800-30-1600-XR2	80	1600
MSF4800-30-1640-XR2	82	1640
MSF4800-30-1680-XR2	84	1680
MSF4800-30-1720-XR2	86	1720
MSF4800-30-1760-XR2	88	1760
MSF4800-30-1800-XR2	90	1800
MSF4800-30-1840-XR2	92	1840
MSF4800-30-1880-XR2	94	1880
MSF4800-30-1920-XR2	96	1920
MSF4800-30-1960-XR2	98	1960
MSF4800-30-2000-XR2	100	2000
MSF4800-30-2040-XR2	102	2040
MSF4800-30-2080-XR2	104	2080
MSF4800-30-2120-XR2	106	2120

Advanced Series/Basic-series Curtains Connected in Series (Minimum detectable object: 40-mm dia., Beam gap: 30 mm)

Slaves

Model	Number of beams	Protective height (mm)
MSF4800-40-0360-XR2	12	360
MSF4800-40-0480-XR2	16	480
MSF4800-40-0600-XR2	20	600
MSF4800-40-0720-XR2	24	720
MSF4800-40-0840-XR2	28	840
MSF4800-40-0960-XR2	32	960
MSF4800-40-1080-XR2	36	1080
MSF4800-40-1200-XR2	40	1200
MSF4800-40-1320-XR2	44	1320
MSF4800-40-1440-XR2	48	1440
MSF4800-40-1560-XR2	52	1560
MSF4800-40-1680-XR2	56	1680
MSF4800-40-1800-XR2	60	1800
MSF4800-40-1920-XR2	64	1920
MSF4800-40-2040-XR2	68	2040

Accessories (Sold Separately)

Connector Cables with a Connector on One End

Type	Appearance	Specifications	Cable length	Model	Application
Transmitter Cables		M12 connector (5-pin)	10 m	**MS4800-CBLTX-10M**	For wiring safety circuits containing individual relays with forcibly guided contacts, safety relay units, safety controllers, etc.
			15 m	**MS4800-CBLTX-15M**	
			30 m	**MS4800-CBLTX-30M**	
Receiver Cables		M12 connector (8-pin)	10 m	**MS4800-CBLRX-10M**	
			15 m	**MS4800-CBLRX-15M**	
			30 m	**MS4800-CBLRX-30M**	

Connector Cables with Connectors on Both Ends

Type	Appearance	Specifications	Cable length	Model	Application
Transmitter Cables		M12 connector (5-pin)	5 m	**MS4800-CBLTXT-05M**	Extension cables for connector cables with a connector on one end.
			10 m	**MS4800-CBLTXT-10M**	
			15 m	**MS4800-CBLTXT-15M**	
			25 m	**MS4800-CBLTXT-25M**	
Receiver Cables		M12 connector (8-pin)	5 m	**MS4800-CBLRXT-05M**	
			10 m	**MS4800-CBLRXT-10M**	
			15 m	**MS4800-CBLRXT-15M**	
			25 m	**MS4800-CBLRXT-25M**	

Series Connection Cables

Type	Appearance	Specifications	Cable length	Model	Application
Transmitter Cables		M12 connector (4-pin)	0.3 m	**MS4800-CBLTXIC-003M**	For series connection.
			0.5 m	**MS4800-CBLTXIC-005M**	
			1 m	**MS4800-CBLTXIC-01M**	
			2 m	**MS4800-CBLTXIC-02M**	
			3 m	**MS4800-CBLTXIC-03M**	
			5 m	**MS4800-CBLTXIC-05M**	
			10 m	**MS4800-CBLTXIC-10M**	
Receiver Cables		M12 connector (4-pin)	0.3 m	**MS4800-CBLRXIC-003M**	
			0.5 m	**MS4800-CBLRXIC-005M**	
			1 m	**MS4800-CBLRXIC-01M**	
			2 m	**MS4800-CBLRXIC-02M**	
			3 m	**MS4800-CBLRXIC-03M**	
			5 m	**MS4800-CBLRXIC-05M**	
			10 m	**MS4800-CBLRXIC-10M**	

Adaptor Cables for Replacement Use

Type	Appearance	Specifications	Cable length	Model	Application
Transmitter Cables		M12 connector (8-pin)	0.22 m	**MS4800-ADPT-TXM**	For replacing an MS4600 (with test input) with an MS4800.
		M12 connector (5-pin)	0.22 m	**MS4800-ADPT-TXS**	For replacing an F3SL or MS4600 (without test input) with an MS4800.
Receiver Cables		M12 connector (8-pin)	0.22 m	**MS4800-ADPT-RX**	For replacing an F3SL or MS4600 with an MS4800.

Loose-wire Connectors for Relays

Type	Appearance	Specifications	Cable length	Model	Application
Transmitter Cables		M12 connector (5-pin)	1 m	**MS4800-PMCTX-01M**	Loose-wire connectors for mounting in relay boxes.
			5 m	**MS4800-PMCTX-05M**	
Receiver Cables		M12 connector (8-pin)	1 m	**MS4800-PMCRX-01M**	
			5 m	**MS4800-PMCRX-05M**	

Programming and Diagnostics Module (PDM)

Appearance	Model	Remarks
	**MS4800-PDM**	Cable length: 2 m

Mirrors (12% Sensing Distance Attenuation)

Appearance	Mirror material	Width (mm)	Thickness (mm)	Length (mm)	Model
	Glass mirror	145	32	406	**F39-MLG0406**
				610	**F39-MLG0610**
				711	**F39-MLG0711**
				914	**F39-MLG0914**
				1,067	**F39-MLG1067**
				1,219	**F39-MLG1219**
				1,422	**F39-MLG1422**
				1,626	**F39-MLG1626**
				1,830	**F39-MLG1830**
				2,134	**F39-MLG2134**

MS4800-RM6 Connection Cables

Appearance	Cable length	Model	Application
	10 m	**MS4800-CBLMT-10M**	For connecting an MSF4800A Receiver and an MS4800-RM6 Resource Module.
	15 m	**MS4800-CBLMT-15M**	
	30 m	**MS4800-CBLMT-30M**	

Resource Module

Appearance	Model	Application
	**MS4800-RM6**	A special terminal module for using muting.

Water-resistant IP67 Cases (for Both Transmitters and Receivers, 2 Cases Per Set) (10% Maximum Sensing Distance Attenuation Per Case)

Type	Appearance	Model	Remarks
For individual use		**MS4800-IP67-□ ✻**	Accessories: Two mounting brackets (one top, one bottom) Material: Acryl
For series-connection use		**MSF4800-IP67-□ ✻**	

✻ A 4-digit number indicating the protective height of the Light Curtain must be included in place of the box (□) in the model number.

Spatter Protection Covers (for Both Transmitters and Receivers, 2 Covers Per Set) (10% Maximum Sensing Distance Attenuation Per Cover)

Type	Appearance	Model	Remarks
MS4800 Cover		**MS4800WS-□ ✻**	Material: Acryl

✻ A 4-digit number indicating the protective height of the Light Curtain must be included in place of the box (□) in the model number.

Specifications (For details, refer to the *Instruction Manual* or *User's Manual*.)

Safety Light Curtains

MS/MSF4800-series Safety Light Curtains

Item	Series / Model	Advanced Series		Basic Series	
Model	Individual use	MS4800A-30-□	MS4800A-40-□	MS4800B-30-□	MS4800B-40-□
	Series connection	MSF4800A-30-□	MSF4800A-40-□	MSF4800B-30-□	MSF4800B-40-□
Sensor type		Type 4 Safety Light Curtain			
Applicable safety category		Category 4, 3, 2, 1, or B			
Minimum detectable object		Opaque object: 30-mm dia.	Opaque object: 40-mm dia.	Opaque object: 30-mm dia.	Opaque object: 40-mm dia.
Beam gap		20 mm	30 mm	20 mm	30 mm
Number of beams		14 to 106	12 to 68	14 to 106	12 to 68
Protective height		280 to 2120 mm	360 to 2040 mm	280 to 2120 mm	360 to 2040 mm
Sensing distance ✻1		0.3 to 20 m (selectable from 0.3 to 8 m with the Programming and Diagnostics Module)			
Response time (Refer to page 10 for details.)	**ON to OFF**	Individual: 14 to 32 ms	Individual: 14 to 23 ms	Individual: 14 to 32 ms	Individual: 14 to 23 ms
	OFF to ON	320 ms max.			
Startup waiting time		3.5 s max. for individual use, 4.5 s max. for series connection			
Power supply voltage (Vs)		24 VDC ±20% (ripple p-p: 5% max.)			
Current consumption ✻2 (no load)	**Transmitter**	285 mA max.			
	Receiver	450 mA max.			
Light source (emitted wavelength)		Infrared LEDs (wavelength: 880 nm)			
Effective aperture angle (EAA)		Within ±2.5° for the Transmitter and Receiver at a sensing distance of at least 3 m according to IEC 61496-2.			
Control output (OSSD) ✻3		Output transistor: PNP × 2, Load current: 625 mA max. (at 24 VDC), short-circuit protection			
Auxiliary output ✻3 (non-safety output)		Output transistor: PNP × 1 or NPN × 1, selectable with the Programming and Diagnostics Module, Load current: 100 mA max. (at 24 VDC) Output mode: Control output synchronizing or alarm is selectable with the Programming and Diagnostics Module		Output transistor: PNP × 1, Load current: 100 mA max. (at 24 VDC) Output mode: Control output synchronizing	
Output operation mode (Receiver)		Control output 1, 2: Light-ON Auxiliary output: Control Output Synchronizing Mode: Auxiliary output goes ON when control output goes ON Alarm Mode: Auxiliary output goes ON when the MS4800 enters alarm (lockout) condition			
Input voltage		External device monitoring input ON voltage: 11 to 28.8 V, OFF voltage: 0 to 2.6 V Start input ON voltage: 11 to 28.8 V, OFF voltage: 0 to 1.2 V For the MS4800B, use NC contacts for the start input switch. For the MS4800A, refer to *Start Input Methods (MS/MSF4800A Only)* on page 19.			
Mutual interference reduction function		The scan code (A/B) can be switched with the Programming and Diagnostics Module			
Series connection		MSF4800 only • Connectable segments: 4 max. • Total number of beams: 256 max. • Maximum cable length between segments: 10 m • Response time when connected: Refer to page 10.			
Test functions		• Self test (when power is turned ON and while power is supplied) • External test (light emission stop function by test input)			
Safety functions		• Selection of auto start mode and interlock mode • External device monitoring • Muting (MSF4800A only) (MS4800-RM6 (sold separately) is required.) • Fixed blanking • Floating blanking • Monitored blanking • Reduced resolution blanking		• Selection of auto start mode and interlock mode • External device monitoring	

✻1. Use of the Spatter Protection Cover causes a 10% maximum sensing distance attenuation.
✻2. The consumption current must not exceed 1.35 A for both the control outputs and auxiliary output. The rated current is the sum of the Transmitter (285 mA), Receiver (450 mA), control output 1 (625 mA), control output 2 (625 mA), and auxiliary output (100 mA).
✻3. The 24-VDC value is a nominal value. The actual voltage depends on the supply voltage. Actual voltage = Supply voltage − 1 V.

Item	Series	Advanced Series		Basic Series	
Model	Individual use	MS4800A-30-□	MS4800A-40-□	MS4800B-30-□	MS4800B-40-□
	Series connection	MSF4800A-30-□	MSF4800A-40-□	MSF4800B-30-□	MSF4800B-40-□
Connection method		Power supply connectors (M12, Transmitter: 5-pin, Receiver: 8-pin) Series-connection connectors: (M12, Transmitter: 4-pin, Receiver: 4-pin)			
Protective circuit		Output short-circuit protection, reverse polarity protection			
Ambient temperature		Operating: –10 to 55°C (with no icing), storage: –25 to 70°C			
Ambient humidity		95% max. (with no condensation)			
Insulation resistance		20 MΩ min. (at 500 VDC)			
Degree of protection		IP65 (IEC 60529)			
Vibration resistance		Malfunction: 10 to 55 Hz, 0.35-mm double amplitude, 20 sweeps in X, Y, and Z directions			
Shock resistance		Malfunction: 10G, 1,000 times in X, Y, and Z directions			
Materials		Case: Aluminum with polyurethane powder coating Cap: Polycarbonate			
Accessories		Test rod, Instruction Manual, mounting set (2 top, 2 bottom mounting brackets), surge absorber			
Applicable standards		IEC 61496-1, EN 61496-1, UL 61496-1 Type 4 ESPE (Electro-Sensitive Protective Equipment), IEC 61496-2, prEN 61496-2, UL 61496-2 Type 4 AOPD (Active Opto-electronic Protective Devices), IEC 61508 SIL3			

Response Time

Curtains Used Individually (1-segment System)

Minimum number of beams	Maximum number of beams	Response time (ms)	
		Normal	Delayed ✻
0	16	14	23
17	71	23	38
72	126	32	53
127	180	41	68
181	235	50	83
236	256	59	99

Curtains Used in Series Connection (2-segment System)

Minimum number of beams	Maximum number of beams	Response time (ms)	
		Normal	Delayed ✻
0	65	23	38
66	120	32	53
121	174	41	68
175	229	50	83
230	256	59	99

Curtains Used in Series Connection (3-segment System)

Minimum number of beams	Maximum number of beams	Response time (ms)	
		Normal	Delayed ✻
0	59	23	38
60	114	32	53
115	168	41	68
169	223	50	83
224	256	59	99

Curtains Used in Series Connection (4-segment System)

Minimum number of beams	Maximum number of beams	Response time (ms)	
		Normal	Delayed ✻
0	53	23	38
54	108	32	53
109	162	41	68
163	217	50	83
218	256	59	99

✻ Refer to *Response Time Adjustment (MS/MSF4800A Only)* on page 19.

Cable Extension Length

The maximum length and wire gauge for input and output signals are given in the following table.

Type	Signal name	Wire gauge	Rated maximum length
Receiver	Control outputs 1 and 2	22 AWG (0.32 mm)	300-mA load: 45 m, 625-mA load: 22 m
	Auxiliary output	22 AWG (0.32 mm)	50 m
	Start input	24 AWG (0.20 mm)	50 m
	External device monitoring (EDM) input	24 AWG (0.20 mm)	50 m
	+24 V, 0 V	20 AWG (0.52 mm)	1.8-A load: 12.5 m, 1-A load: 22 m
Transmitter	+24 V, 0 V	22 AWG (0.32 mm)	0.3-A load: 47 m
	Machine test signal (MTS)	22 AWG (0.32 mm)	50 m

Note: Keep the cable length within the rated length. Failure to do so is dangerous because it may prevent safety functions from operating normally.

Accessories

Resource Module

Item Model	MS4800-RM6
Input power supply	24 VDC ±20%, 30 mA max.
Ambient temperature	0 to 55°C
Ambient humidity	95% max. (with no condensation)
Storage temperature	–25 to 75°C
Vibration resistance	Malfunction: 10 to 55 Hz, 0.35-mm double amplitude, 20 sweeps in X, Y, and Z directions
Shock resistance	Malfunction: 10G, 1,000 times in X, Y, and Z directions
Degree of protection	IP20 (IEC 60529)
Muting sensor ✻1	PNP 24-VDC (power consumption: 20 mA) Dark-ON/Light-ON or NO/NC combination
Muting indicator output ✻2	10 to 100 mA (NPN), 30 VDC max.
Applicable safety category	IEC 61496-1 Type 4

✻1. For details, refer to *Mini Safe 4800 Series Ligtht Curtains Installation and Operating Manual*.
✻2. The muting indicator output contains a current monitoring circuit to confirm normal operation. Connect an external indicator load that supplies 10 to 100 mA of current.

Programming and Diagnostics Module

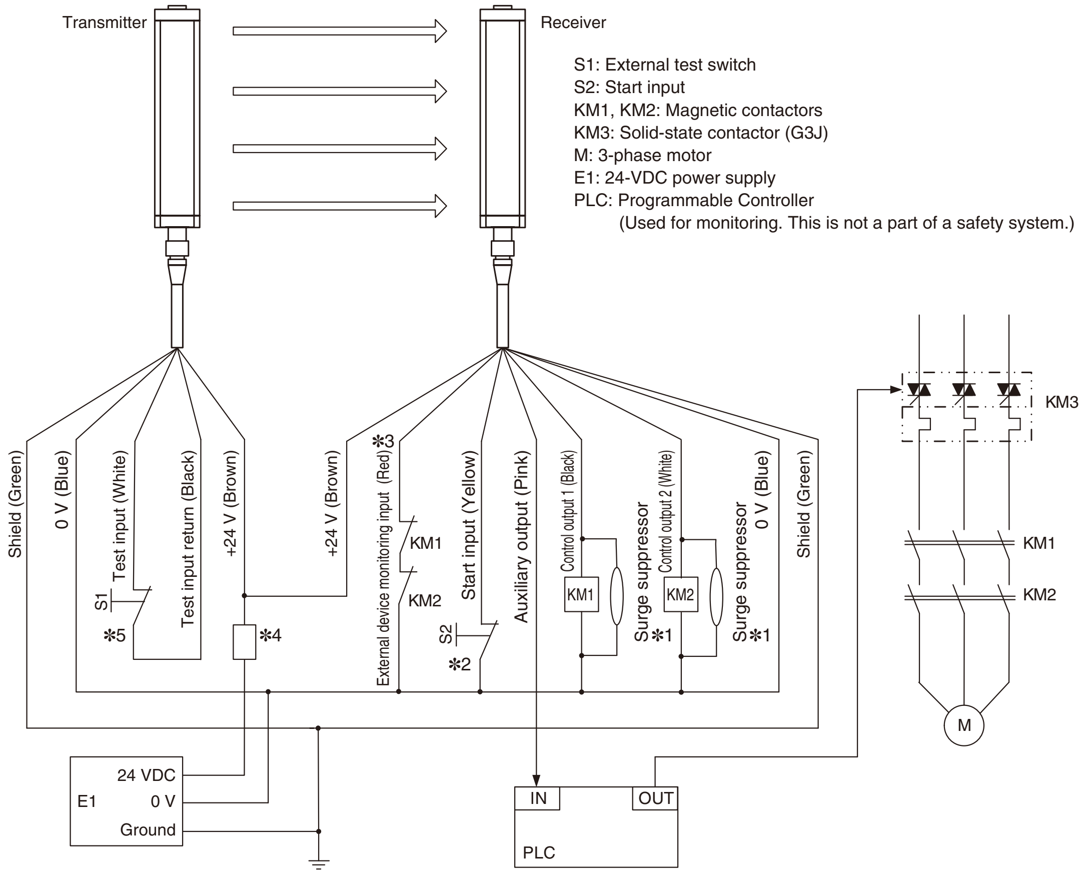
Item Model	MS4800-PDM
Display	LCD multi-line display
Language capability	English, Japanese
Degree of protection	Conforms to IP 65

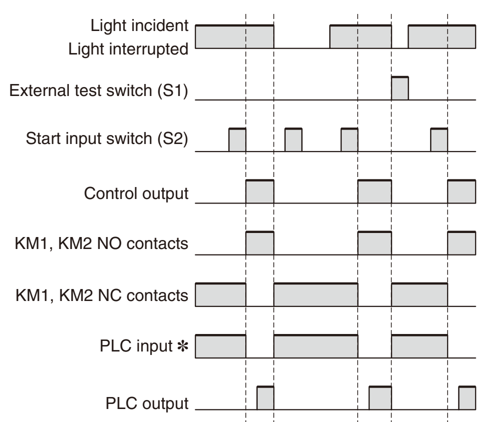
Connection Circuit Examples

Examples of Safety Circuits

Example When Using the MS/MSF4800 Individually (Category 4)

MS/MSF4800 Settings
- Use Start/Restart Interlock Mode. (Use the PDM to set the operation mode to Start/Restart Interlock Mode.)
- Use the external relay monitor function. (Use the PDM to turn ON the EDM function.)
- Use the test input. (Use the PDM to enable the test input.)





✻ The output operation mode of the auxiliary output is the Dark-ON output mode.

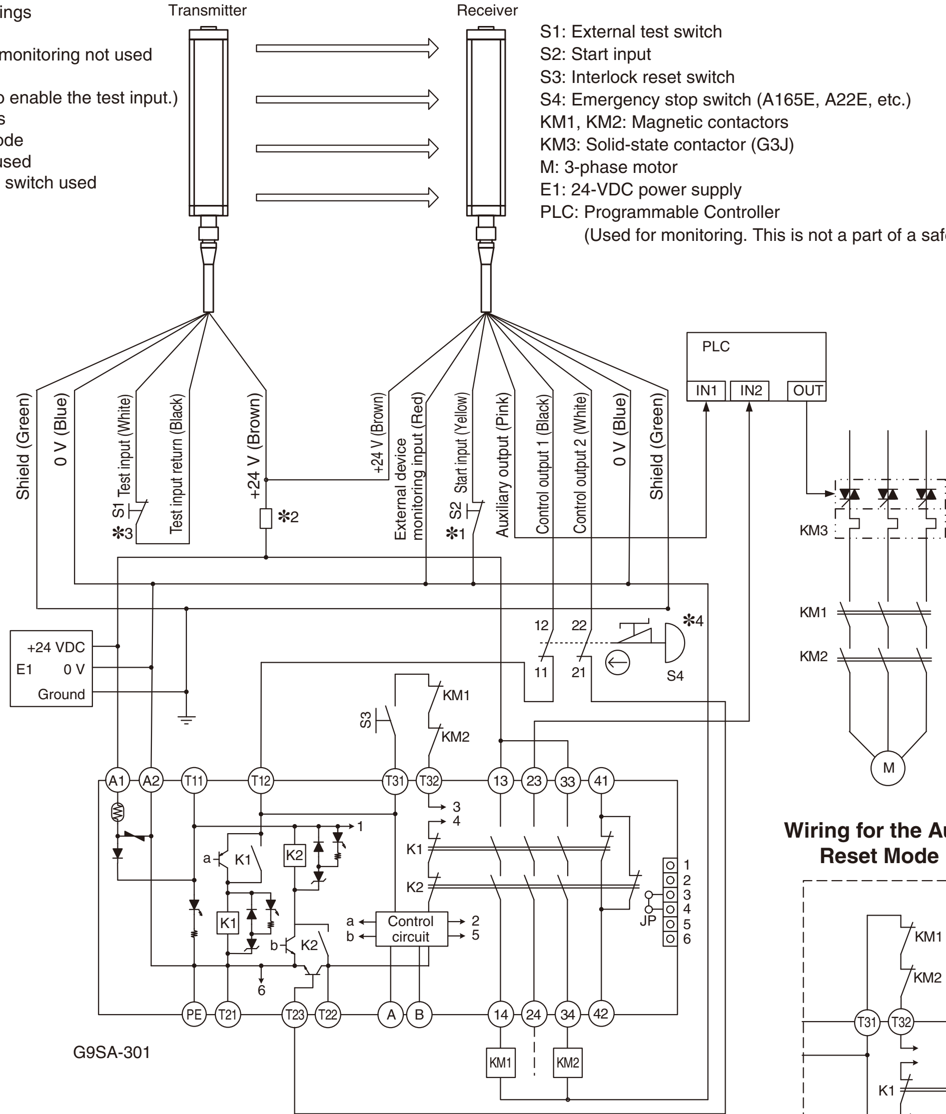
✻1. Make sure that both external devices have been suitably suppressed.
✻2. For the MS/MS4800B, use an NC contacts for the start input switch. For the MS/MS4800A, refer to *Start Input Methods (MS/MSF4800A Only)* on page 19. When using Auto Start Mode, use the PDM to check that the operation mode is set to Auto Start Mode (default), and connect the start input to 0 V.
✻3. With the default setting, the external relay monitor input (EDM) is set so that the EDM is enabled and disabled with the start input. This will prevent accessing the normal functionality of the start input.
To use both the start input and the EDM as shown in the example safety circuits on this page, connect the PDM to the Receiver and use the PDM to enable the EDM. If the EDM is not necessary, use the PDM to disable the EDM, and then connect the EDM (red wire) to 0 V. For details, refer to *Mini Safe 4800 Series Light Curtains Installation and Operating Manual*.
✻4. Fuse (provided by the customer).
✻5. The test input is disabled with the default setting. To use the test input, connect the PDM to the Receiver and enable the test input, and use NC contacts for the test input.

Example When Connected to the G9SA-301 Controller (Category 4)

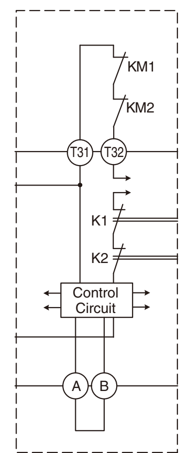
MS/MSF4800 Settings
- Auto start mode
- External device monitoring not used
- Test input used.
  (Use the PDM to enable the test input.)

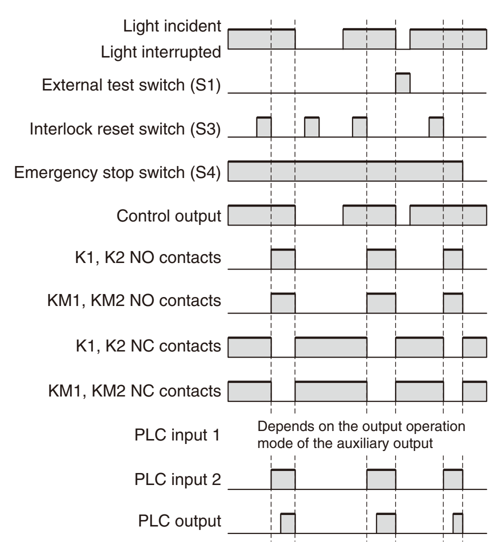
G9SA-301 Settings
- Manual reset mode
- Feedback loop used
- Emergency stop switch used

S1: External test switch
S2: Start input
S3: Interlock reset switch
S4: Emergency stop switch (A165E, A22E, etc.)
KM1, KM2: Magnetic contactors
KM3: Solid-state contactor (G3J)
M: 3-phase motor
E1: 24-VDC power supply
PLC: Programmable Controller
(Used for monitoring. This is not a part of a safety system.)



Wiring for the Auto Reset Mode



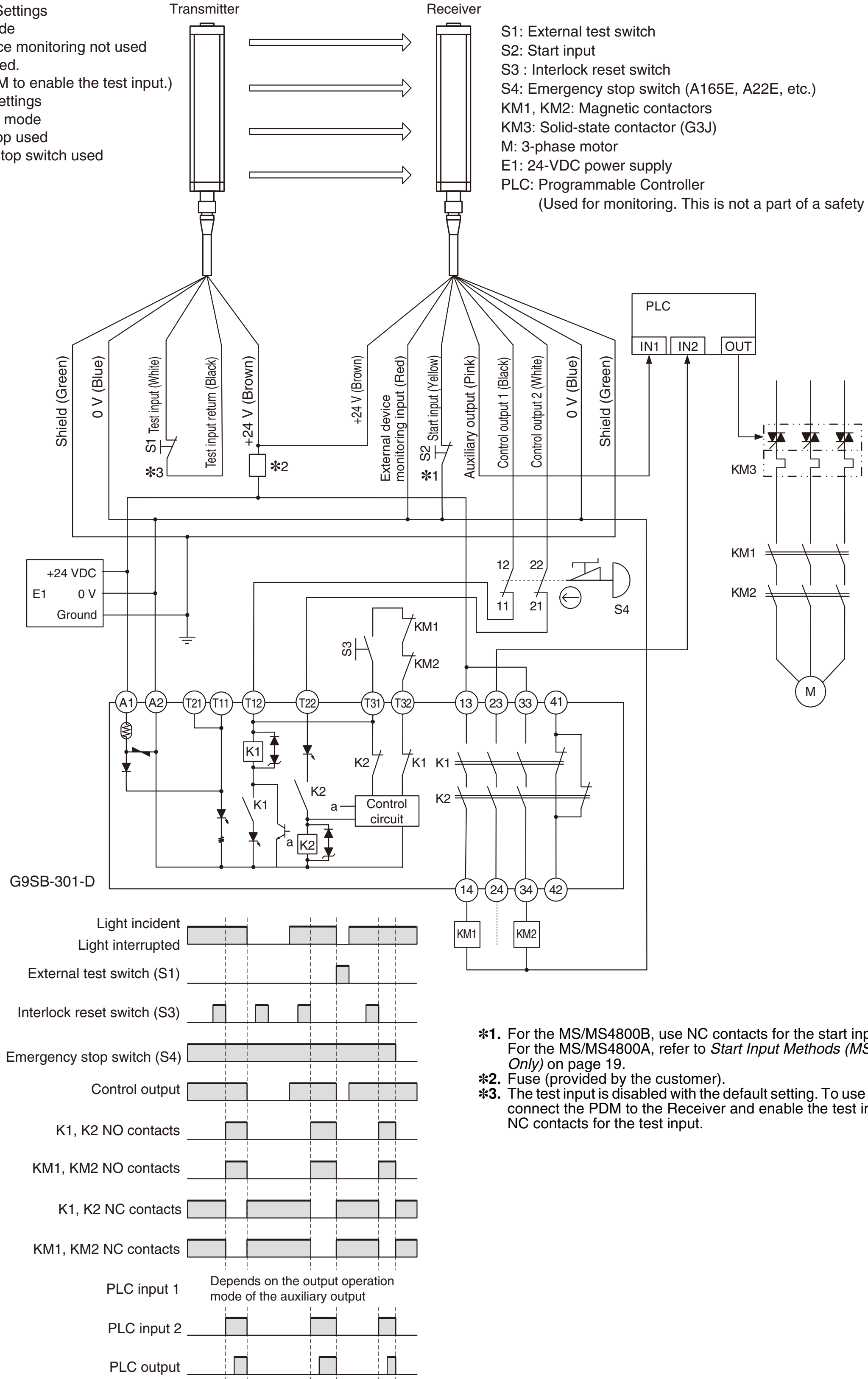


✻1. For the MS/MS4800B, use NC contacts for the start input switch.
For the MS/MS4800A, refer to *Start Input Methods (MS/MSF4800A Only)* on page 19.
✻2. Fuse (provided by the customer).
✻3. The test input is disabled with the default setting. To use the test input, connect the PDM to the Receiver and enable the test input, and use NC contacts for the test input.
✻4. If an emergency stop switch is not used, connect control output 1 to T12 terminal and control output 2 to T23 terminal directly.

Example When Connected to the G9SB-301-D Controller (Category 4)

MS/MSF4800 Settings
• Auto start mode
• External device monitoring not used
• Test input used.
(Use the PDM to enable the test input.)
G9SB-301-D Settings
• Manual reset mode
• Feedback loop used
• Emergency stop switch used

S1: External test switch
S2: Start input
S3 : Interlock reset switch
S4: Emergency stop switch (A165E, A22E, etc.)
KM1, KM2: Magnetic contactors
KM3: Solid-state contactor (G3J)
M: 3-phase motor
E1: 24-VDC power supply
PLC: Programmable Controller
(Used for monitoring. This is not a part of a safety system.)



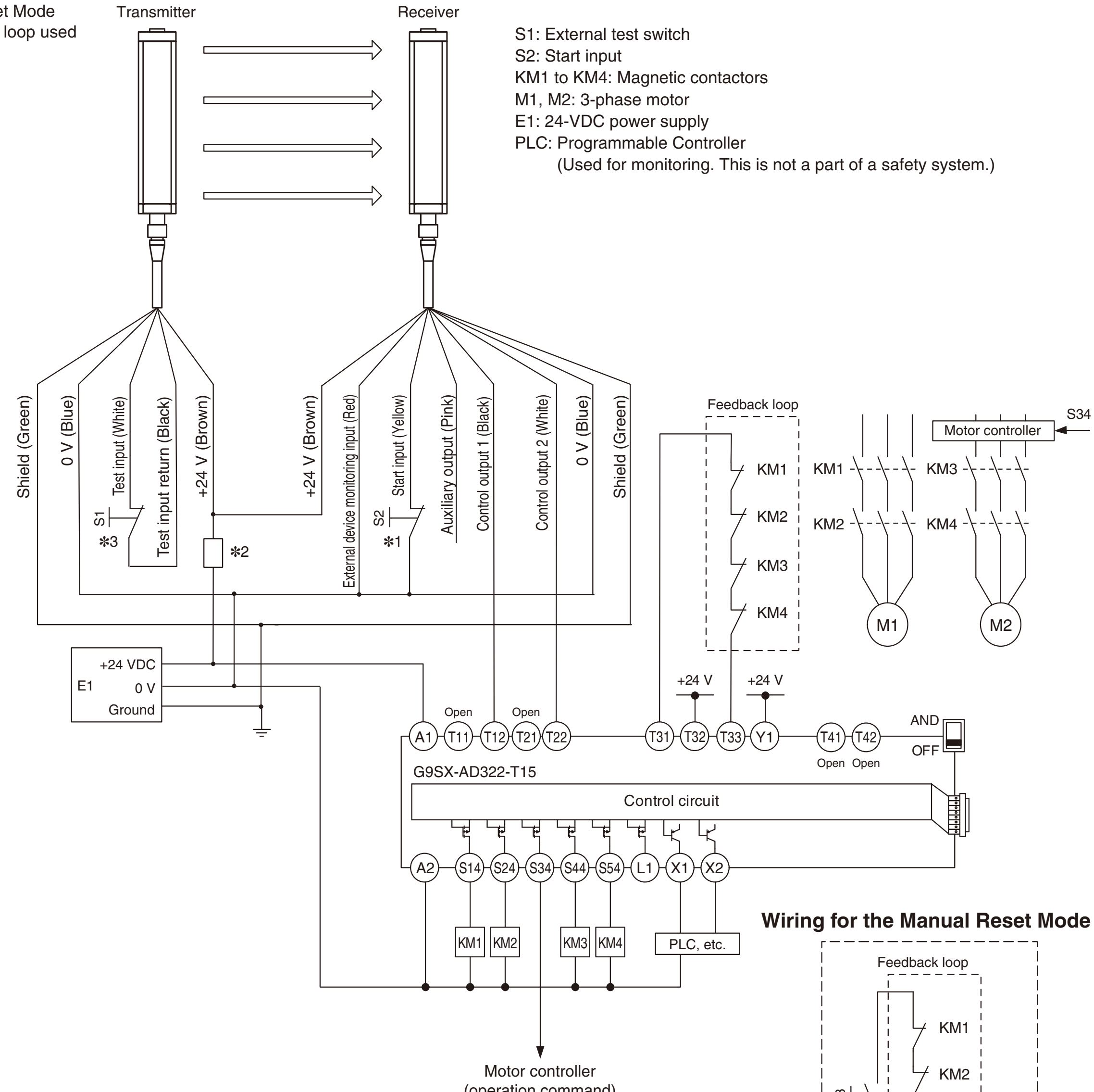
✻1. For the MS/MS4800B, use NC contacts for the start input switch. For the MS/MS4800A, refer to *Start Input Methods (MS/MSF4800A Only)* on page 19.
✻2. Fuse (provided by the customer).
✻3. The test input is disabled with the default setting. To use the test input, connect the PDM to the Receiver and enable the test input, and use NC contacts for the test input.

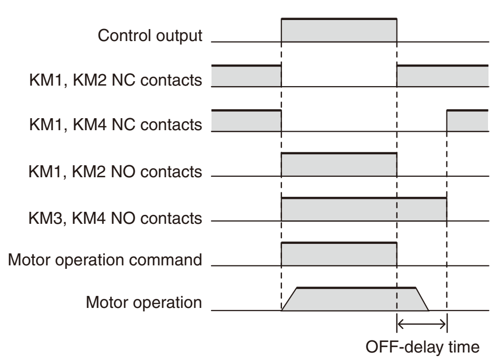
Example When Connected to the G9SX-AD322-T15 Controller (Category 4)

MS/MSF4800 Settings
- Auto start mode
- External device monitoring not used
- Test input used. (Use the PDM to enable the test input.)

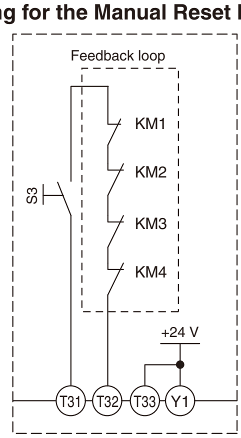
G9SX-AD322-T15 Settings
- Auto Reset Mode
- Feedback loop used

S1: External test switch
S2: Start input
KM1 to KM4: Magnetic contactors
M1, M2: 3-phase motor
E1: 24-VDC power supply
PLC: Programmable Controller
(Used for monitoring. This is not a part of a safety system.)





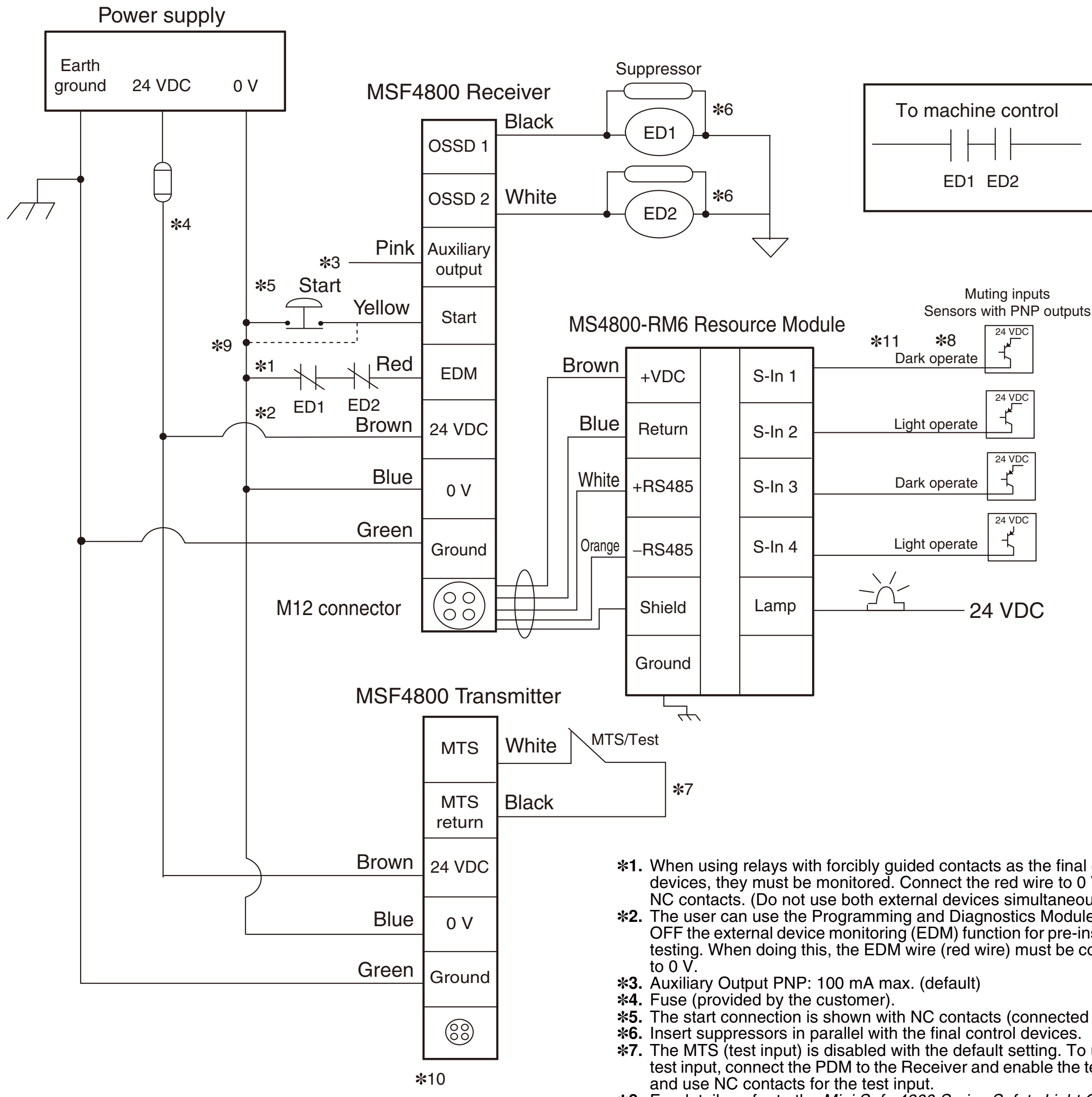
Wiring for the Manual Reset Mode



S3: Reset switch

✻**1.** For the MS/MS4800B, use NC contacts for the start input switch.
For the MS/MS4800A, refer to *Start Input Methods (MS/MSF4800A Only)* on page 19.
✻**2.** Fuse (provided by the customer).
✻**3.** The test input is disabled with the default setting. To use the test input, connect the PDM to the Receiver and enable the test input, and use NC contacts for the test input.

Connection to the MS4800-RM6 Resource Module (MSF4800A Only)



*1. When using relays with forcibly guided contacts as the final control devices, they must be monitored. Connect the red wire to 0 V via the NC contacts. (Do not use both external devices simultaneously.)

*2. The user can use the Programming and Diagnostics Module to turn OFF the external device monitoring (EDM) function for pre-installation testing. When doing this, the EDM wire (red wire) must be connected to 0 V.

*3. Auxiliary Output PNP: 100 mA max. (default)

*4. Fuse (provided by the customer).

*5. The start connection is shown with NC contacts (connected to 0 V).

*6. Insert suppressors in parallel with the final control devices.

*7. The MTS (test input) is disabled with the default setting. To use the test input, connect the PDM to the Receiver and enable the test input, and use NC contacts for the test input.

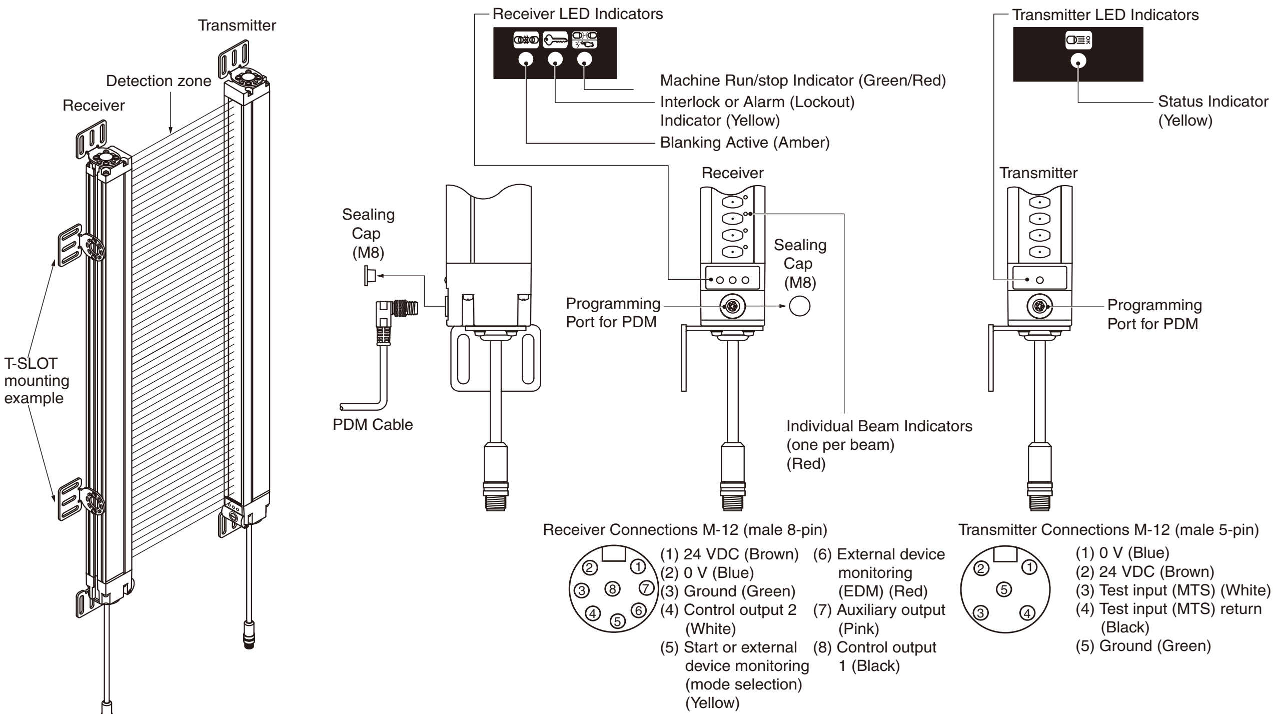
*8. For details, refer to the *Mini Safe 4800 Series Safety Light Curtains Installation and Operating Manual*.

*9. Connect the yellow wire to 24 VDC to enable external device monitoring (EDM), and to 0 V to disable EDM.

*10. Not used.

*11. There is no need to connect sensor inputs that are not used.

Nomenclature



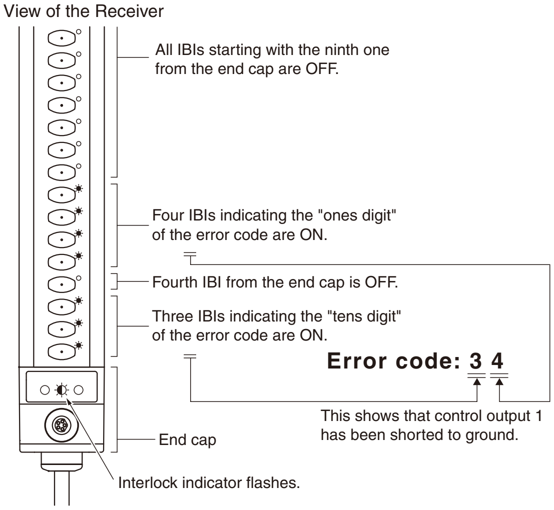
Note: Remove the sealing cap (M8) to connect the PDM cable.

Individual Beam Indicators (IBI)

All MS4800 Safety Light Curtains have an Individual Beam Indicator (IBI) next to each infrared beam on the Receiver. The IBI indicates whether the beam is interrupted or clear. When the beam is interrupted, the IBI goes ON; when it is clear, the IBI goes OFF. If there is less than 10 clear beams, every other IBI will light to indicate that the MS/MSF4800 is not synchronized.

Example of IBI Indication for an Error (Error Code 34)

Front View of the Receiver



Note: For details on error codes, refer to the *Mini Safe 4800 Series Safety Light Curtains Installation and Operating Manual*.

Receiver LED Indicators

OFF / Flashing / ON

Operating condition	Condition indication	Description
Machine Run State	Green	Two Receiver control outputs (safety outputs) are ON, and the green Machine Run indicator is ON.
Machine Stop State	Red	Two Receiver control outputs (safety outputs) are OFF, and the red Machine Stop indicator is ON.
Interlock State	Yellow Red	Two Receiver control outputs (safety outputs) are OFF, and the red Machine Stop indicator and the yellow Interlock indicator are ON.
Alarm (Lock-out) state	Yellow Red	Two Receiver control outputs (safety outputs) are OFF, the red Machine Stop indicator is ON, the yellowInterlock indicator is flash-ing, and the auxiliary output is OFF.
Blanking Ac-tive state	Amber	Operating with blanking enabled.

Transmitter LED Indicators

Flashing / ON

Operating condition	Condition indication	Description
Transmitting state	Yellow	When the Transmitter receives power and enters the Transmitting state, the indicator turns ON. When the Machine Test Signal (MTS) is enabled, the Transmitter enters the Transmitting Stop state, and the indicator turns OFF.
Error state/ PDM Pro-gramming state	Yellow	When an error occurs due to the Transmitter, or when the Program-ming and Diagnostics Module is being used to change a setting, the indicator flashes.

Safety Functions

Operation Modes

Auto Start

If no objects are detected in the sensing area when the power is turned ON in Auto Start Mode, the system enters the Machine Run State. If an object is then detected, the system changes from the Machine Run State to the Machine Stop State, and remains in that state until the object is removed. When the intrusion into the sensing area disappears, the system automatically changes from the Machine Stop State to the Machine Run State.

Start Interlock

If no objects are in the sensing area when the power is turned ON in Start Interlock Mode and an alarm (lockout) condition does not occur, the system enters the Interlock State. To shift to the Machine Run State, an operator must press and release the Start Button on the Safety Light Curtain. If an object intrudes in the sensing area during the Machine Run State, the system will change to the Machine Stop State. When the object is removed from the sensing area, the system will automatically shift to the Machine Run State.

Start/Restart Interlock

If no objects are in the sensing area when the power is turned ON in Start/Restart Interlock Mode and an alarm (lockout) condition does not occur, the system enters the Interlock State. To shift to the Machine Run State, an operator must press and release the Start Button on the Safety Light Curtain. If an object intrudes in the sensing area during the Machine Run State, the system will change to the Machine Stop State. When the object is removed from the sensing area, the system will shift to the Interlock State instead of automatically shifting to the Machine Run State. To shift to the Machine Run State, an operator must press and release the Start Button. When there is an object in the sensing area, the Start Button is disabled.

Blanking Functions (Advanced Series Only)

Fixed Blanking

This function is used when a machine or workpiece constantly interrupts beams in a part of the sensing area. Fixed blanking allows the Safety Light Curtain to remain in the Machine Run State while the obstruction in the sensing area as a non-moving object. The output is turned OFF when a beam other than the set fixed blanking beams is interrupted, or when light is incident on a fixed blanking beam.

Floating Blanking

This function turns OFF the output when the total number of interrupted beams inside the sensing area exceeds the number of set beams (1 or 2).

Monitored Blanking

This function is used when a machine or workpiece constantly interrupts beams in a part of the sensing area and moves within the sensing area. Monitored blanking allows the Safety Light Curtain to remain in the Machine Run State while the obstruction moves within the sensing area. The output is turned OFF when the machine or workpiece disappears from the monitored blanking area that was set by teaching, or when the total number of interrupted beams increases due to a different obstruction.

Reduced Resolution Blanking

When the resolution of the MS/MSF4800A is reduced, the size of the minimum detectable object is increased. The output will not turn OFF regardless of how many continuous interrupted beams there are in the sensing area as long as the beams are fewer than the set number (1, 2, or 3 beams).
When an object whose size exceeds the set number of beams intrudes, the output is turned OFF. For example, in an application where a conveyor cart approaches a robot work area, the Safety Light Curtain can be set so that it does not detect only the wheels of the cart, allowing the MS/MSF4800A to be used as a presence sensing device.

Muting Functions (MSF4800A Only)

Use of the MS4800-RM6 Resource Module (sold separately) makes it possible to temporarily disable the Safety Light Curtain. Select from among four muting modes to match each application with the appropriate number and placement of muting sensors.

Note: For details on blanking and muting, refer to the *Mini Safe 4800 Series Safety Light Curtains Installation and Operating Manual*.

Diagnostic Functions

External Device Monitoring (EDM) (MPCE Monitoring)

This function detects malfunctions, such as welded contacts in external relays (or contactors) that control the hazardous area of a machine. This function constantly monitors that a specified voltage is applied to the Receiver's external device monitoring input line, and enters LOCKOUT state when an error occurs. The relay's operational delay can be up to 300 ms without being evaluated as an error.
To utilize this function properly, use relays and contactors that have a forcibly guided contact structure.

Enabling/Disabling External Device Monitoring

The external device monitoring can be enabled or disabled with the Programming and Diagnostics Module. When using the Auto Start Mode, enabling and disabling can be switched by combining the start input line with the external device monitoring wiring.

Note: For details, refer to the *Mini Safe 4800 Series Safety Light Curtains Installation and Operating Manual*.

Machine Test Signal (MTS)

The Machine Test Signal (MTS) is used to confirm that the safety system stops correctly when an MS/MSF4800 beam is interrupted by purposely halting the emission with an external signal. MTS is provided by placing a normally closed switch across the MTS and MTS Return lines of the Transmitter. A close-to-open transition on this switch will enable the MTS and halt the emission.

Other Functions

Sensing Distance Selection

The Programming and Diagnostics Module can be used to select the sensing distance. The Short Range Mode is 8 m, and the Long Range Mode is 20 m (default). This function is useful when there are many Safety Light Curtains operating within a small space and the possibility of mutual interference is likely.

Response Time Adjustment (MS/MSF4800A Only)

The MS4800 allows the user to slow down the scan rate of the Safety Light Curtain for maximum immunity against environmental interference. This function may be used in harsh environmental conditions where electrical noise, ambient smoke, or dust and flying debris interfere with the Safety Light Curtain. For details, refer to ***Response Time*** on page 10.

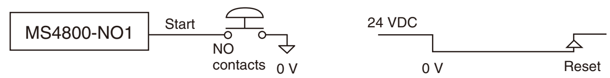
⚠ WARNING

Recalculate the safety distance whenever the response time has been changed.

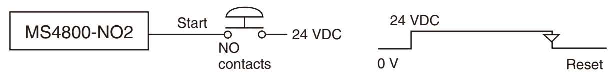
Start Input Methods (MS/MSF4800A Only)

For the MS/MSF4800A, select one of the following four combinations of switch and ON/OFF logic for connection to the Start Input line. (The default is the 0-V connection with NC contacts.) As the following timing chart shows, the switch is reset by pressing it once, then returning it.

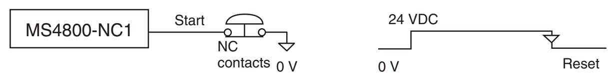
NO1: Normally Open (with 0-VDC Connection)



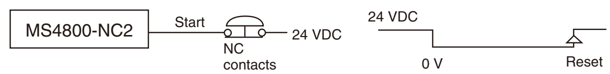
NO2: Normally Open (with 24-VDC Connection)



NC1: Normally Closed (with 0-VDC Connection) (Default)



NC2: Normally Closed (with 24-VDC Connection) (Default)



Optical Synchronization

The synchronization between the MS4800-series Transmitter and Receiver is optical. To establish synchronization, the system needs to have a certain number of consecutive clear beams.

Note: For details, refer to the *Mini Safe 4800 Series Safety Light Curtains Installation and Operating Manual*.

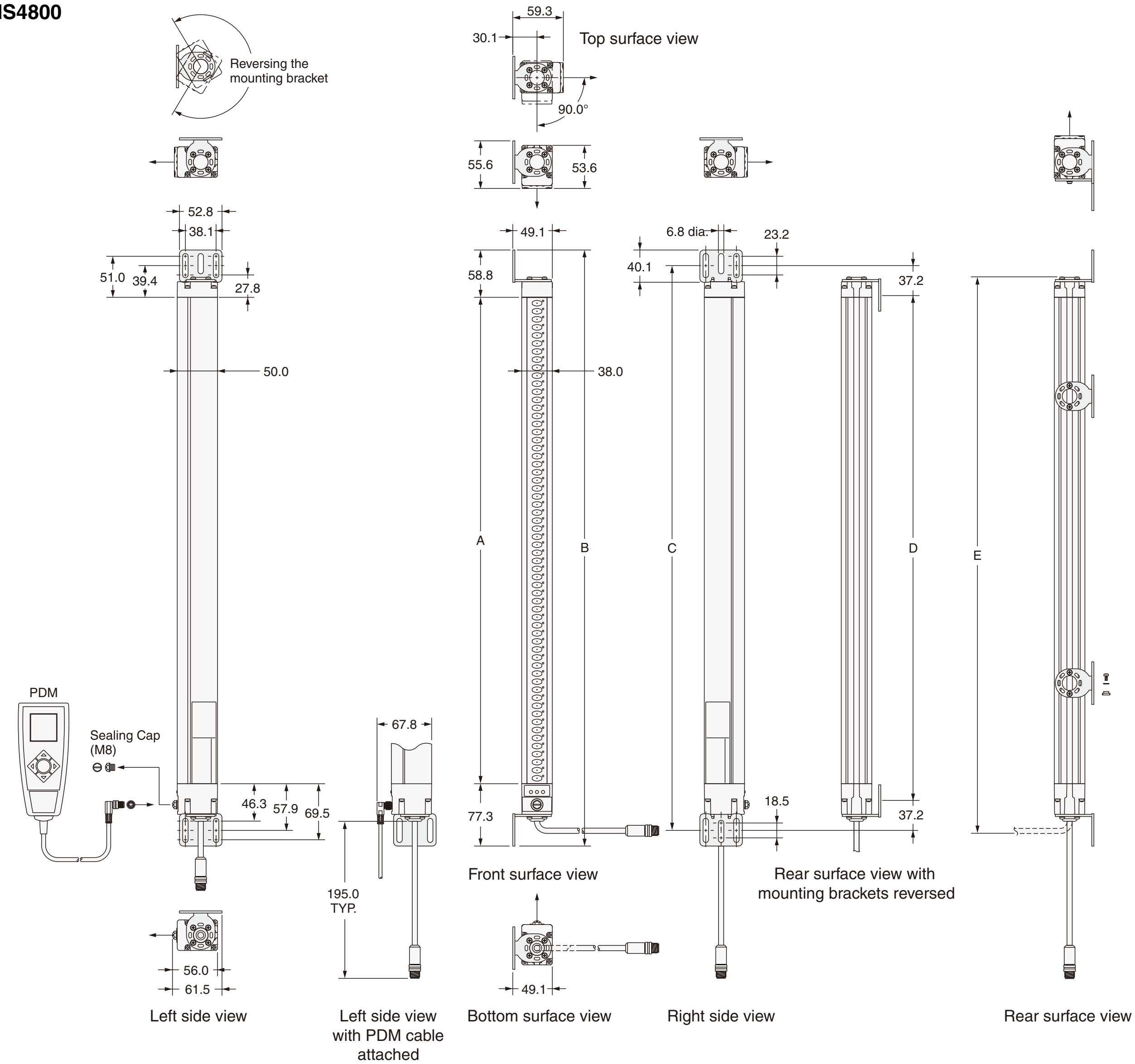
Dimensions

(Unit: mm)

Safety Light Curtains

Safety Light Curtains Used Individually

MS4800



MS4800-30 Transmitter and Receiver Dimensions

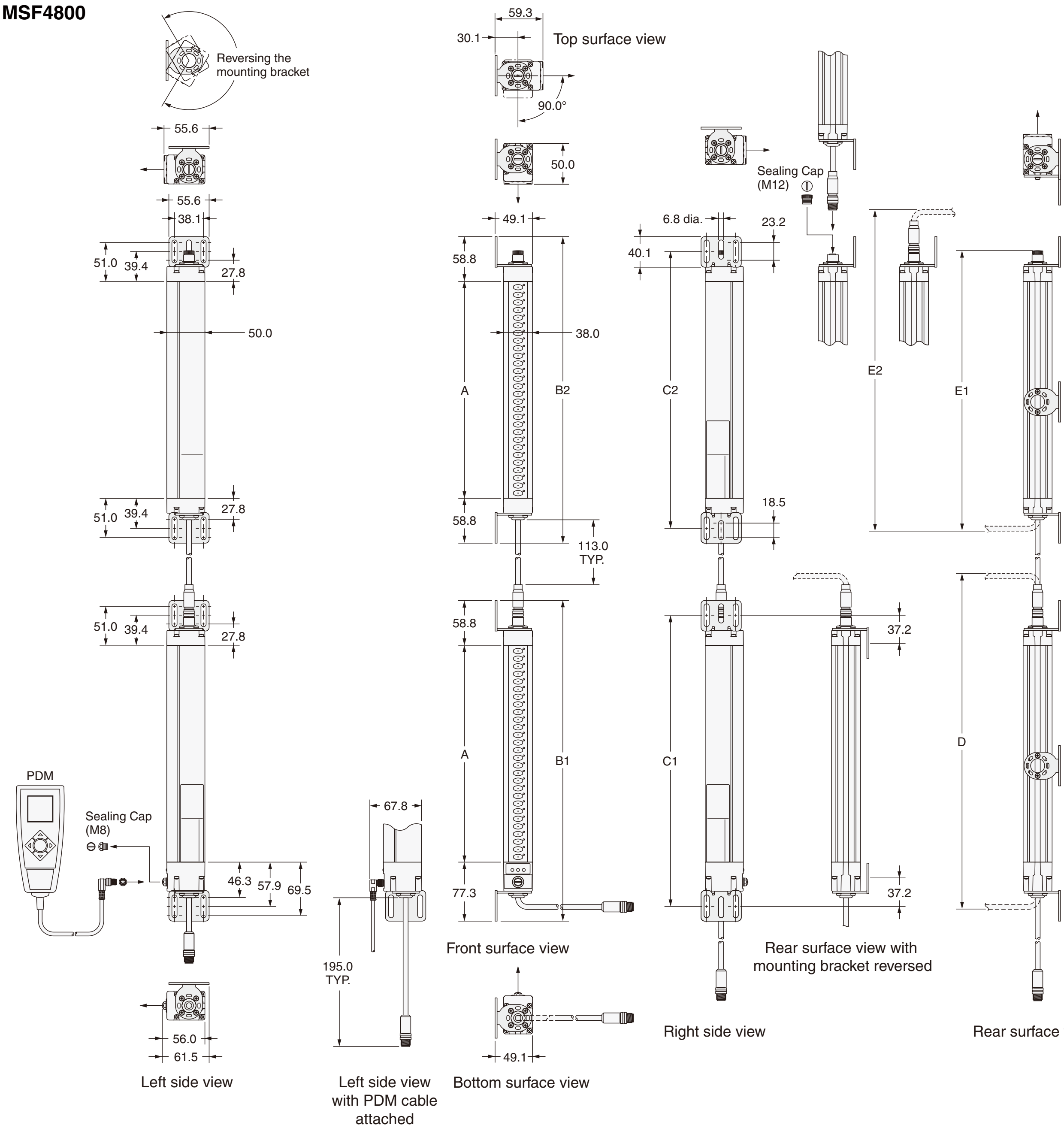
Sensing area \ Dimensions	A	B	C	D	E
280	284.4	420.4	381.7	307.3	371.3
320	324.8	460.8	422.1	347.7	411.7
360	364.5	500.5	461.8	387.4	451.4
400	404.2	540.2	501.5	427.1	491.1
440	443.9	579.9	541.2	466.8	530.8
480	484.3	620.3	581.6	507.2	571.2
520	523.4	659.4	620.7	546.3	610.3
560	563.7	699.7	661.0	586.6	650.6
600	604.1	740.1	701.4	627.0	691.0
640	643.9	779.9	741.2	666.8	730.8
680	683.6	819.6	780.9	706.5	770.5
720	724.0	860.0	821.3	746.9	810.9
760	763.0	899.0	860.3	785.9	849.9
800	803.5	939.5	900.8	826.4	890.4
840	843.8	979.8	941.1	866.7	930.7
880	882.8	1018.8	980.1	905.7	969.7
920	922.5	1058.5	1019.8	945.4	1009.4
960	963.6	1099.6	1060.9	986.5	1050.5
1000	1002.6	1138.6	1099.9	1025.5	1089.5
1040	1042.9	1178.9	1140.2	1065.8	1129.8
1080	1083.9	1219.9	1181.2	1106.8	1170.8
1120	1122.3	1258.3	1219.6	1145.2	1209.2
1160	1162.7	1298.7	1260.0	1185.6	1249.6
1200	1203.8	1339.8	1301.1	1226.7	1290.7
1240	1242.1	1378.1	1339.4	1265.0	1329.0
1280	1281.8	1417.8	1379.1	1304.7	1368.7
1320	1323.6	1459.6	1420.9	1346.5	1410.5
1360	1362.0	1498.0	1459.3	1384.9	1448.9
1400	1401.7	1537.7	1499.0	1424.6	1488.6
1440	1443.4	1579.4	1540.7	1466.3	1530.3
1480	1481.8	1617.8	1579.1	1504.7	1568.7
1520	1521.5	1657.5	1618.8	1544.4	1608.4
1560	1563.3	1699.3	1660.6	1586.2	1650.2
1600	1600.9	1736.9	1698.2	1623.8	1687.8
1640	1641.3	1777.3	1738.6	1664.2	1728.2
1680	1681.3	1817.3	1778.6	1704.2	1768.2
1720	1720.8	1856.8	1818.1	1743.7	1807.7
1760	1760.5	1896.5	1857.8	1783.4	1847.4
1800	1802.9	1938.9	1900.2	1825.8	1889.8
1840	1840.6	1976.6	1937.9	1863.5	1927.5
1880	1880.3	2016.3	1977.6	1903.2	1967.2
1920	1922.8	2058.8	2020.1	1945.7	2009.7
1960	1960.4	2096.4	2057.7	1983.3	2047.3
2000	2000.1	2136.1	2097.4	2023.0	2087.0
2040	2042.6	2178.6	2139.9	2065.5	2129.5
2080	2079.6	2215.6	2176.9	2102.5	2166.5
2120	2120.0	2256.0	2217.3	2142.9	2206.9

MS4800-40 Transmitter and Receiver Dimensions

Sensing area \ Dimensions	A	B	C	D	E
360	364.5	500.5	461.8	387.4	451.4
480	484.3	620.3	581.6	507.2	571.2
600	604.1	740.1	701.4	627.0	691.0
720	724.0	860.0	821.3	746.9	810.9
840	843.4	979.4	940.7	866.3	930.3
960	963.6	1099.6	1060.9	986.5	1050.5
1080	1083.9	1219.9	1181.2	1106.8	1170.8
1200	1203.8	1339.8	1301.1	1226.7	1290.7
1320	1323.6	1459.6	1420.9	1346.5	1410.5
1440	1443.4	1579.4	1540.7	1466.3	1530.3
1560	1563.3	1699.3	1660.6	1586.2	1650.2
1680	1683.1	1819.1	1780.4	1706.0	1770.0
1800	1802.9	1938.9	1900.2	1825.8	1889.8
1920	1922.8	2058.8	2020.1	1945.7	2009.7
2040	2042.6	2178.6	2139.9	2065.5	2129.5

Safety Light Curtains in Series Connection

MSF4800



MSF4800-30 Transmitter and Receiver Dimensions

Dimen-sions Sensing area	A	B1	B2	C1	C2	D	E1	E2
240	244.6	380.6	362.1	341.9	323.3	400.2	327.9	381.6
280	284.4	420.4	401.9	381.7	363.1	440.0	367.7	421.4
320	324.8	460.8	442.3	422.1	403.5	480.4	408.1	461.8
360	364.5	500.5	482.0	461.8	443.2	520.1	447.8	501.5
400	404.2	540.2	521.7	501.5	482.9	559.8	487.5	541.2
440	443.9	579.9	561.4	541.2	522.6	599.5	527.2	580.9
480	484.3	620.3	601.8	581.6	563.0	639.9	567.6	621.3
520	523.4	659.4	640.9	620.7	602.1	679.0	606.7	660.4
560	563.7	699.7	681.2	661.0	642.4	719.3	647.0	700.7
600	604.1	740.1	721.6	701.4	682.8	759.7	687.4	741.1
640	643.9	779.9	761.4	741.2	722.6	799.5	727.2	780.9
680	683.6	819.6	801.1	780.9	762.3	839.2	766.9	820.6
720	724.0	860.0	841.5	821.3	802.7	879.6	807.3	861.0
760	763.0	899.0	880.5	860.3	841.7	918.6	846.3	900.0
800	803.5	939.5	921.0	900.8	882.2	959.1	886.8	940.5
840	843.8	979.8	961.3	941.1	922.5	999.4	927.1	980.8
880	882.8	1018.8	1000.3	980.1	961.5	1038.4	966.1	1019.8
920	922.5	1058.5	1040.0	1019.8	1001.2	1078.1	1005.8	1059.5
960	963.6	1099.6	1081.1	1060.9	1042.3	1119.2	1046.9	1100.6
1000	1002.6	1138.6	1120.1	1099.9	1081.3	1158.2	1085.9	1139.6
1040	1042.9	1178.9	1160.4	1140.2	1121.6	1198.5	1126.2	1179.9
1080	1083.9	1219.9	1201.4	1181.2	1162.6	1239.5	1167.2	1220.9
1120	1122.3	1258.3	1239.8	1219.6	1201.0	1277.9	1205.6	1259.3
1160	1162.7	1298.7	1280.2	1260.0	1241.4	1318.3	1246.0	1299.7
1200	1203.8	1339.8	1321.3	1301.1	1282.5	1359.4	1287.1	1340.8
1240	1242.1	1378.1	1359.6	1339.4	1320.8	1397.7	1325.4	1379.1
1280	1281.8	1417.8	1399.3	1379.1	1360.5	1437.4	1365.1	1418.8
1320	1323.6	1459.6	1441.1	1420.9	1402.3	1479.2	1406.9	1460.6
1360	1362.0	1498.0	1479.5	1459.3	1440.7	1517.6	1445.3	1499.0
1400	1401.7	1537.7	1519.2	1499.0	1480.4	1557.3	1485.0	1538.7
1440	1443.4	1579.4	1560.9	1540.7	1522.1	1599.0	1526.7	1580.4
1480	1481.8	1617.8	1599.3	1579.1	1560.5	1637.4	1565.1	1618.8
1520	1521.5	1657.5	1639.0	1618.8	1600.2	1677.1	1604.8	1658.5
1560	1563.3	1699.3	1680.8	1660.6	1642.0	1718.9	1646.6	1700.3
1600	1600.9	1736.9	1718.4	1698.2	1679.6	1756.5	1684.2	1737.9
1640	1641.3	1777.3	1758.8	1738.6	1720.0	1796.9	1724.6	1778.3
1680	1683.1	1819.1	1800.6	1780.4	1761.8	1838.7	1766.4	1820.1
1720	1720.8	1856.8	1838.3	1818.1	1799.5	1876.4	1804.1	1857.8
1760	1760.5	1896.5	1878.0	1857.8	1839.2	1916.1	1843.8	1897.5
1800	1802.9	1938.9	1920.4	1900.2	1881.6	1958.5	1886.2	1939.9
1840	1840.6	1976.6	1958.1	1937.9	1919.3	1996.2	1923.9	1977.6
1880	1880.3	2016.3	1997.8	1977.6	1959.0	2035.9	1963.6	2017.3
1920	1922.8	2058.8	2040.3	2020.1	2001.5	2078.4	2006.1	2059.8
1960	1960.4	2096.4	2077.9	2057.7	2039.1	2116.0	2043.7	2097.4
2000	2000.1	2136.1	2117.6	2097.4	2078.8	2155.7	2083.4	2137.1
2040	2042.6	2178.6	2160.1	2139.9	2121.3	2198.2	2125.9	2179.6
2080	2079.6	2215.6	2197.1	2176.9	2158.3	2235.2	2162.9	2216.6
2120	2120.0	2256.0	2237.5	2217.3	2198.7	2275.6	2203.3	2257.0

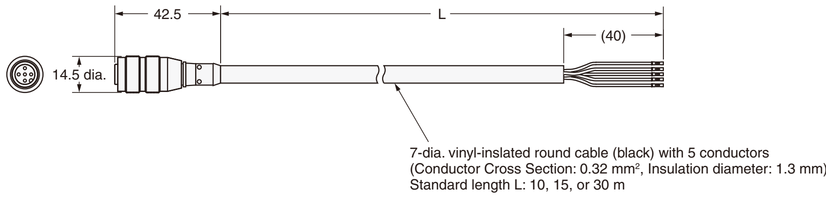
MSF4800-40 Transmitter and Receiver Dimensions

Dimen-sions Sensing area	A	B1	B2	C1	C2	D	E1	E2
360	364.5	500.5	482.0	461.8	443.2	520.1	447.8	501.5
480	484.3	620.3	601.8	581.6	563.0	639.9	567.6	621.3
600	604.1	740.1	721.6	701.4	682.8	759.7	687.4	741.1
720	724.0	860.0	841.5	821.3	802.7	879.6	807.3	861.0
840	843.8	979.8	961.3	941.1	922.5	999.4	927.1	980.8
960	963.6	1099.6	1081.1	1060.9	1042.3	1119.2	1046.9	1100.6
1080	1083.9	1219.9	1201.4	1181.2	1162.6	1239.5	1167.2	1220.9
1200	1203.4	1339.4	1320.9	1300.7	1282.1	1359.0	1286.7	1340.4
1320	1323.6	1459.6	1441.1	1420.9	1402.3	1479.2	1406.9	1460.6
1440	1443.4	1579.4	1560.9	1540.7	1522.1	1599.0	1526.7	1580.4
1560	1563.3	1699.3	1680.8	1660.6	1642.0	1718.9	1646.6	1700.3
1680	1681.3	1817.3	1798.8	1778.6	1760.0	1836.9	1764.6	1818.3
1800	1802.9	1938.9	1920.4	1900.2	1881.6	1958.5	1886.2	1939.9
1920	1922.8	2058.8	2040.3	2020.1	2001.5	2078.4	2006.1	2059.8
2040	2042.6	2178.6	2160.1	2139.9	2121.3	2198.2	2125.9	2179.6

Accessories

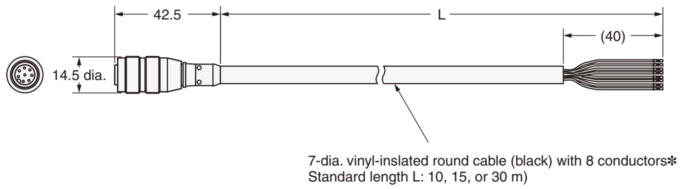
Cables with Connector on One End for Transmitter

MS4800-CBLTX-10M (L = 10 m)
MS4800-CBLTX-15M (L = 15 m)
MS4800-CBLTX-30M (L = 30 m)



Cables with Connector on One End for Receiver

MS4800-CBLRX-10M (L = 10 m)
MS4800-CBLRX-15M (L = 15 m)
MS4800-CBLRX-30M (L = 30 m)



*

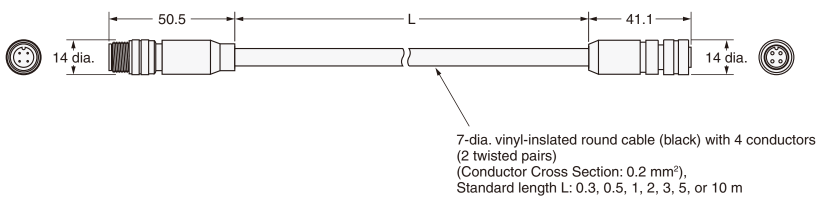
Wire color	Conductor cross sectional area (mm^2)	Insulation outside diameter (mm)
Brown	0.52	1.6 dia.
Blue	0.52	1.6 dia.
Green	0.52	1.6 dia.
White	0.32	1.3 dia.
Yellow	0.2	1.2 dia.
Red	0.2	1.2 dia.
Pink	0.32	1.3 dia.
Black	0.32	1.3 dia.

Series Connection Cables for Transmitter

MS4800-CBLTXIC-003M (L = 0.3 m)
MS4800-CBLTXIC-005M (L = 0.5 m)
MS4800-CBLTXIC-01M (L = 1 m)
MS4800-CBLTXIC-02M (L = 2 m)
MS4800-CBLTXIC-03M (L = 3 m)
MS4800-CBLTXIC-05M (L = 5 m)
MS4800-CBLTXIC-10M (L = 10 m)

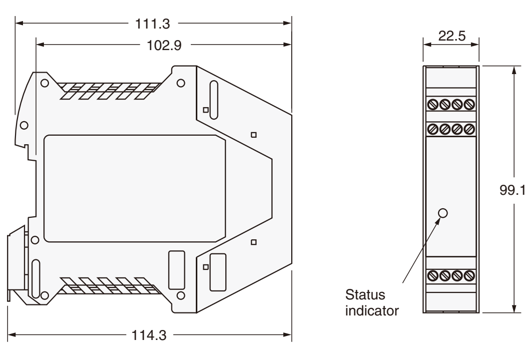
Series Connection Cables for Receiver

MS4800-CBLRXIC-003M (L = 0.3 m)
MS4800-CBLRXIC-005M (L = 0.5 m)
MS4800-CBLRXIC-01M (L = 1 m)
MS4800-CBLRXIC-02M (L = 2 m)
MS4800-CBLRXIC-03M (L = 3 m)
MS4800-CBLRXIC-05M (L = 5 m)
MS4800-CBLRXIC-10M (L = 10 m)



Resource Module

MS4800-RM6



Safety Precautions

This document is intended as a guide for product selection. Be sure to read the *Instruction Manual* provided with the product for actual operation.

Regulations and Standards

1. Application of an MS/MSF4800-series Safety Light Curtain alone cannot receive type certification provided by Article 44-2 of the Industrial Safety and Health Law of Japan. It is necessary to apply the Curtain in a system. Therefore, when using the MS/MSF4800-series Safety Light Curtain in Japan as a “safety device for presses or shearing machines” prescribed in Article 42 of that law, the system must receive type certification.

2. The MS/MSF4800-series Safety Light Curtain is electro-sensitive protective equipment (ESPE) in accordance with European Union (EU) Machinery Directive Index Annex IV, B, Safety Components, Item 1.

3. The MS/MSF4800-series Safety Light Curtain complies with the following legislation and standards:

(1) EU Regulations
Machinery Directive: Directive 98/37/EC
EMC Directive: Directive 89/336/EEC

(2) European standards:
EN 61496-1 (TYPE 4 ESPE)
prEN 61496-2 (TYPE 4 AOPD)
EN 61508-1 to -7 (SIL3)
EN 954-1 (Category B, 1, 2, 3, 4)

(3) International standards:
IEC 61496-1 (TYPE 4 ESPE)
IEC 61496-2 (TYPE 4 AOPD)
EN 61508-1 to -7 (SIL3)

(4) JIS standards:
JIS B9704-1 (TYPE 4 ESPE)
JIS B9704-2 (TYPE 4 AOPD)

(5) North American standards:
UL 61496-1 (Type 4 ESPE)
UL 61496-2 (Type 4 AOPD)
UL 508, UL 1998, CAN/CSA 22.2 No. 14
CAN/CSA 22.2 No. 0.8

4. The MS/MSF4800 received the following certification from TÜV Rheinland, an EU-accredited body:

- EC type test based on Machinery Directive
  Type 4 ESPE (IEC 61496-1)
  Type 4 AOPD (IEC 61496-2)
- TÜV Rheinland type certification
  Type 4 ESPE (IEC 61496-1)
  Type 4 AOPD (IEC 61496-2)
- SIL3 (IEC 61508)

5. The MS/MSF4800 has received certificates for UL listing for US and Canadian safety standards from UL, a third party assessment body.

- Type 4 ESPE (UL 61496-1)
  Type 4 AOPD (UL 61496-2)

6. The MS/MSF4800 is designed according to the standards listed below. To make sure that the final system complies with the following standards and regulations, you are asked to design and use it in accordance with all other related standards, laws, and regulations.
If you have any questions, consult with UL or other specialized organizations.

- European standards: EN 415-4, EN 692, EN 693
- US Occupational Safety and Health Administration: OSHA 29 CFR 1910.212
- US Occupational Safety and Health Administration: OSHA 29 CFR 1910.217
- American National Standard Institute: ANSI B11.1 to B11.19
- American National Standard Institute: ANSI/RIA 15.06
- Canadian Standards Association: CSA Z142, Z432, Z434
- SEMI standard SEMI S2

Precautions for Safe Use

Indications and Meanings for Safe Use

To ensure safe use of the MS/MSF4800, signal words and an alert symbol are used in this document to indicate safety-related instructions. These instructions describe details very important to your safety. It is extremely important that you understand and follow the instructions. The signal words and alert symbol used in this document are shown below.

WARNING	**Indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, or may result in serious injury or death. Additionally, there may by significant property damage.**

Meaning of Symbol

	General Prohibition **Indicates a general prohibition**

Warning Indications

WARNING

The MS/MSF4800 is a safety area sensor that is designed to protect operators who work in hazardous environments, such as those containing operating machinery.

MS/MSF4800 safety levels for specific applications and installation conditions can be attained only by achieving safe usage, installation, maintenance, and operation of the MS/MSF4800. These factors must be thoroughly confirmed by the customer who purchased the MS/MSF4800, as well as installers and employers.

Precautions for Users

WARNING

The MS/MSF4800 must be installed, set, and integrated into the mechanical control system by a qualified technician who has received the appropriate training. Installation by an unqualified person may prevent the MS/MSF4800 from operating correctly, with the result that people may go undetected, and serious injuries may occur.

When changing parameters with the Programming and Diagnostics Module, the change must be made and the contents of the change must be managed by the person in charge of the system. Unintentional or mistaken parameter changes may prevent detection of people and result in serious injury.

The manager of the system is responsible for the selection and training of personnel to properly install, operate, and maintain the machine and its safeguarding systems.

The MS/MSF4800 must be installed, verified, and maintained by a qualified person. A qualified person is defined as someone who holds credentials or certification proving that he or she has received relevant professional training, or someone whose ability to solve problems related to the specific matters or operations at hand has been verified by considerable knowledge, training or considerable experience. (See ANSI/PMMI B155.1-2006 for details.)

Machine Installation

WARNING

Do not use this sensor for machines that cannot possibly be quickly stopped by electrical controls. For example, do not use it for a pressing machine that uses a full-rotation clutch. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Do not use the auxiliary output for safety applications. Failure of the MS/MSF4800 may cause a person to go undetected, resulting in serious injury.

The guarded machine must not present a hazard from flying parts.

The guarded machine must have a consistent stopping time and adequate control mechanisms.

All safety-related machine control elements must be designed so that a failure in the control logic or a failure in the control circuit does not lead to danger.

Additional guarding may be required for access to dangerous areas not covered by the MS/MSF4800 system.

For mounting

WARNING

Be sure to test the operation of the MS/MSF4800 after installation with the machine in a non-operating condition to verify that the MS/MSF4800 operates as intended. Unintended function settings may cause a person to go undetected, resulting in serious injury.

Be sure to secure the safety distance between the MS/MSF4800 and the hazardous parts. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas. If a person is able to step into the hazardous area of a machine and remain behind the MS/MSF4800's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

When using Start/Restart Intelock Mode, install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

The MS/MSF4800 cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

When detection of an area has been disabled by the fixed blanking function, provide a protective structure around the entire area that will prevent a person from passing through it and reaching the hazardous part of the machinery. Failure to do so may prevent detection of people and result in serious injury.

After setting the fixed blanking function, be sure to confirm that a test rod is detected within all areas that require detection. Failure to do so may prevent detection of people and result in serious injury.

When the fixed blanking, floating blanking, monitored blanking, or reduced resolution blanking function is used, the diameter for the minimum detectable object becomes larger. Be sure to use the diameter for the minimum detectable object for the fixed blanking, floating blanking, monitored blanking, or reduced resolution blanking function when calculating the safety distance. Failure to do so may prevent the machinery from stopping before a person reaches the hazardous part of the machinery, and result in serious injury.

The muting and override functions disable the safety functions of the device. Additional safety measures must be taken to ensure safety while these functions are working.

Muting lamps that indicate the state of the muting and override functions must be installed where they are clearly visible to workers from all the operating positions.

Install Muting Sensors so that they can distinguish between the object that is being allowed to be passed through the detection zone and a person. If the muting function is activated by the detection of a person, it may result in serious injury.

Muting times must be precisely set according to the application by qualified personnel who have received appropriate training. In particular, if the muting time limit is to be set to infinity, the person who makes the setting must bear responsibility.

Use two independent input devices for the muting inputs.

Install the MS/MSF4800, Muting Sensors, or a protective wall so that workers cannot enter hazardous areas while muting is in effect, and set muting times.

Position the switch that is used to activate the override function in a location where the entire hazardous area can be seen, and where the switch cannot be operated from inside the hazardous area. Make sure that nobody is in the hazardous area before activating the override function.

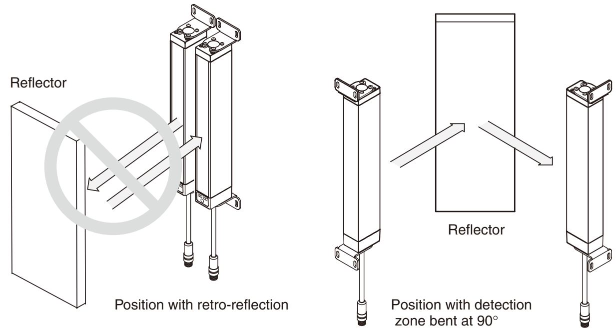
Install the MS/MSF4800 so that it is not affected by reflective surfaces. Failure to do so may hinder detection, resulting in serious injury.

When using more than one set of MS/MSF4800, install them so that mutual interference does not occur, such as by configuring series connections, using physical, light-blocking barriers, or changing scan codes between adjacent sets.

Make sure that the MS/MSF4800 is securely mounted and its cables and connectors are properly connected.

Make sure that no foreign material, such as water, oil or dust, enters the MS/MSF4800 or connectors while caps are removed.

Do not use the sensor system with mirrors in a retro-reflective configuration as shown in the following diagram. Doing so may hinder detection. It is possible to use mirrors to “bend” the detection zone to a 90-degree angle.



Inspect all MS/MSF4800 systems as instructed in the *Mini Safe 4800 Series Ligtht Curtains Installation and Operating Manual*. When using series connections, perform inspection of all connected MS/MSF4800 Curtains as instructed in the Manual.

Recalculate the safety distance whenever the response time has been changed.

Conduct all tests and repairs with the procedures given in the *Mini Safe 4800 Series Ligtht Curtains Installation and Operating Manual*.

Conduct the test procedures given in the *Mini Safe 4800 Series Ligtht Curtains Installation and Operating Manual* according to the periodic inspection system established by the employer. These test procedures must be conducted after performing maintenance, changing tools, setting up the system, making adjustments, or otherwise making changes to the MS/MSF4800 or the guarded machine. When more than one operator uses the guarded machine, or when the guarded machine is used in shifts, it is recommended that these test procedures be conducted after each operation change or shift change. It is necessary to confirm that the MS/MSF4800 and the safety system of the guarded machine function properly and that the machine stops as intended. If the test results in failure, there is a strong possibility that a serious accident could occur involving an operator.

Wiring Precautions

⚠ WARNING

For an PNP output, connect the load between the output and 0 V line. Connecting the load between the output and +24 V line results in a dangerous condition because the operation mode is reversed to "ON when light is interrupted."

Do not interconnect an output line with the +24-V line. Otherwise, the output is always ON, creating a dangerous situation. Also, 0 V of the power supply must be grounded so that output does not turn ON due to grounding of the output line.

Configure the system by using the optimal number of control outputs that satisfy the requirements of the necessary safety category.

Do not connect the lines of the MS/MSF4800 to a DC power supply higher than 24 VDC +20%. Also, do not connect to an AC power supply. Otherwise, it may result in electric shock.

For the MS/MSF4800 to comply with IEC 61496-1 and UL 508, the DC power supply unit must satisfy all of the following conditions:

- **Must be within rated power voltage (24 VDC ±20%).**
- **Must have tolerance against the total rated current of devices if it is connected to multiple devices.**
- **Must comply with EMC directives (industrial environment).**
- **Double or enhanced insulation must be applied between the primary and secondary circuits.**
- **Automatic recovery must be possible for overcurrent protection.**
- **Output holding time must be 20 ms or longer.**
- **Must satisfy output characteristic requirements for class 2 circuit or limited voltage current circuit defined by UL508.**
- **Must comply with the EMC, laws, and regulations of the country or region where the MS/MSF4800 is used. (For example, in the EU, the power supply must comply with the EMC Low Voltage Directive.)**

Double or enhanced insulation from hazardous voltage must be applied to all input and output lines. Failure to do so may result in electric shock.

The cable extension length must be no greater than the specified length. Otherwise, the safety functions may fail to work properly, resulting in danger.

Other Precautions

⚠ WARNING

To use the MS/MSF4800 in PSDI Mode (i.e., restarting cycle operation by the sensor), you must configure an appropriate control circuit between the MS/MSF4800 and the machine. For details about PSDI, refer to ANSI RIA 15.06-1999, OSHA 1910.217 (h), ANSI B11.2-1995 (R2005), and other relevant standards and regulations.

Do not try to disassemble, repair, or modify this product. Doing so may cause the safety functions to stop working properly.

Do not use the MS/MSF4800 in environments where flammable or explosive gases are present. Doing so may result in explosion.

Perform daily and 6-month inspections for the MS/MSF4800. Otherwise, the system may fail to work properly, resulting in serious injury.

Safety Distance

⚠ WARNING

Be sure to secure the safety distance between the MS/MSF4800 and the hazardous part. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Note: The response time of a machine is the time period from when the machine receives a stop signal to when the machine's hazardous part stops. Measure the response time on the actual system. Also, periodically check that the response time of the machine has not changed.

● How to Calculate the Safety Distance Specified by International Standard ISO 13855-2002 (European Standard EN 999-1999) (Reference)

The following explanation is based on standard EN 999. This standard applies to Safety Light Curtains used in an industrial environment.

Systems with a Detection Capability of 40 mm Max.

Use the following calculation for a system that detects objects with a minimum detectable diameter of 40 mm max.

$S = (K \times T) + C$

Where,

S: The shortest distance (in mm) between the hazardous part and the detection point (edge, surface, or area).

$K = 2000$ mm/s

T: The time (in seconds) required to stop the entire system.

$T = t_1 + t_2$

t1: The response time (in seconds) of the Safety Light Curtain. This response time is listed in the ***Response Time*** on page 10.

t_2 = Maximum time (in seconds) required to stop the machine.

$C = 8 (d - 14$ mm), however, this must be 0 or more.

d: Minimum detectable object (in mm) of the MS/MSF4800.

The following calculation is given as an example:

$S = (2000$ mm/s $\times T) + 8 (d - 14$ mm)

This calculation applies to all shortest distance S values to 500 mm max. The S value must be 100 mm min.

If the above-described calculation results in an S value greater than 500 mm, use the following calculation:

For this calculation the S value must be 500 mm min.

$S = (1600$ mm/s $\times T) + 8 (d - 14$ mm)

Systems with a Detection Capability Greater Than 40 mm

Use the following calculation for a system that detects objects with a minimum detectable diameter greater than 40 mm.

$S = (K \times T) + C$

Where,

S: The shortest distance (in mm) between the hazardous part and the detection point (edge, surface, or area).

$K = 1600$ mm/s

T: The time (in seconds) required to stop the entire system.

$T = t_1 + t_2$

t_1: The response time (in seconds) of the Safety Light Curtain. This is given in the ***Response Time*** on page 10.

t_2: Maximum time (in seconds) required to stop the machine.

$C = 850$ mm

The following calculation is given as an example:

$S = (1600 \text{ mm/s} \times T) + 850 \text{ mm}$

● How to Calculate the Safety Distance Specified by American Standard ANSI B11.19 (Reference)

If a person approaches the detection zone of the MS/MSF4800 perpendicularly, calculate the safety distance as shown below.

$Ds = K \times (Ts + Tc + Tr + Tbm) + Dpf$

Where,

Ds: Safety distance (in inches)

K: Approach speed to the detection zone (in inches)

Assuming that the operator is beginning to perform a manual task, the ANSI standard value for K is 63 inches/second. ANSI B11.19-2003 requires that the following factors be considered in determining the K value.

a. Movement of hands or arms
b. Twisting of the body or shoulder, or bending of the waist
c. Walking or running

Use the above-described factors to determine the approach speed for the actual application.

Ts: The time (in seconds) required to stop the machine.

Tc: The maximum response time (in seconds) of the machine's control circuit required to activate the braking device of the machine.

Note: Ts + Tc are normally measured simultaneously by a device for measuring the time required for stopping.

Tr: The response time (in seconds) for the MS/MSF4800. This is given in the ***Response Time*** on page 10.

Tbm: The stopping time (in seconds) added by a brake monitor before determining degradation in the machine stopping time.

If a machine has a brake monitor, "Tbm = Brake monitor setting time − (Ts + Tc)." If it has no brake monitor, it is necessary to increase the value added to the machine's stopping time somewhat to account for brake wear. For details, consult the manufacturer of the machine.

The depth penetration factor (Dpf) is related to the minimum detectable object diameter of the MS/MSF4800. Determine the minimum detectable object diameter (S) and the model number of the MS/MSF4800 that is being used, then obtain the Dpf directly from the following table, *Examples of Minimum Detectable Object (S), Additional Safety Distance (C), and Dpf.*

Examples of Minimum Detectable Object (S), Additional Safety Distance (C), and Dpf

Model	Total number of beams disabled by fixed or floating blanking	Minimum detectable object diameter: S (mm)	Additional safety distance obtained by ISO 13855-2002 (European standard EN 999-1999) calculation: C (mm) $C = 8 (S - 14)$	Depth penetration factor using the ANSI calculation (Dpf) $Dpf = 3.4 (S - 0.276)$ inches
MS/MSF4800-30	None	30	128	3.1 inches (78 mm)
	1	50	850 (for S = 40 mm min.)	5.76 inches (146 mm)
	2 or more	Greater than 64		36 inches (900 mm)
MS/MSF4800-40	None	40	850 (for S = 40 mm min.)	4.4 inches (112 mm)
	1 or more	Greater than 64		36 inches (900 mm)

Installation

Reflective Surface Interference

⚠ WARNING

Install the MS/MSF4800 where it will not be affected by reflective surfaces. Failure to do so may prevent detection and result in serious injury.

There is a possibility that reflective surfaces next to the sensing area may reflect light and prevent the detection of beam interruption due to obstacles within the area (refer to Figs. 1 to 5). Reflective surfaces may exist on parts of machinery, mechanical protective devices, or products. The minimum distance (d) must be set between the reflective object and the beam centerline of the MS/MSF4800 sensing area.

For information on how to test this condition, refer to the *Mini Safe 4800 Series Lighth Curtains Installation and Operating Manual*.

Fig. 1 Example of Correct Installation with Proper Placement

The interruption of the beam due to the obstacle is accurately detected. The reflective object is outside the directional angle.

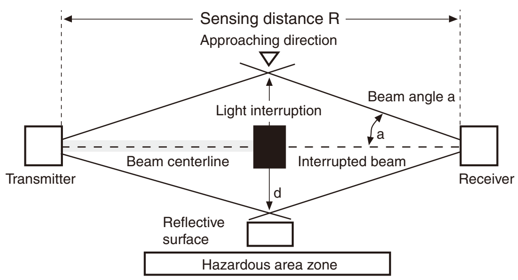


Fig. 2 Example of Unsafe Installation

Reflection prevents the obstacle from being detected. The reflective object is inside the beam angle.

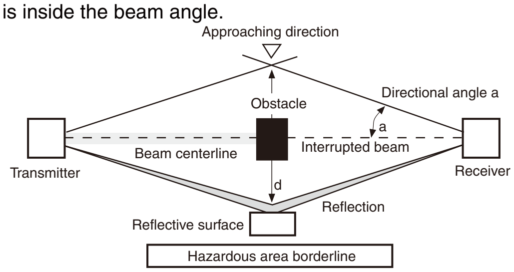


Fig. 3 Example of Unsafe Installation

The interruption of the beam due to the obstacle is not detected because of reflection. Reflective surface interference can occur from either above or below the sensing area.

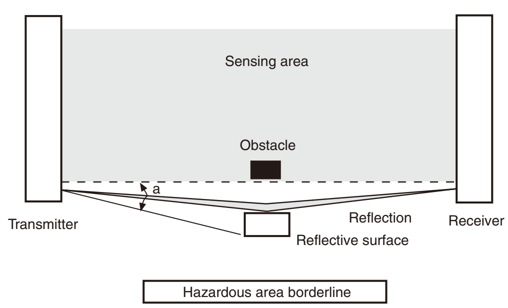


Fig. 4 Worst Placement Example

This example shows the minimum distance d from the reflective surface to one of the beam centerlines.

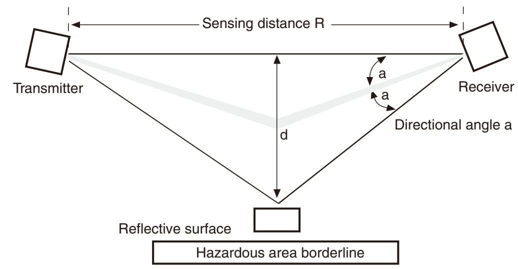
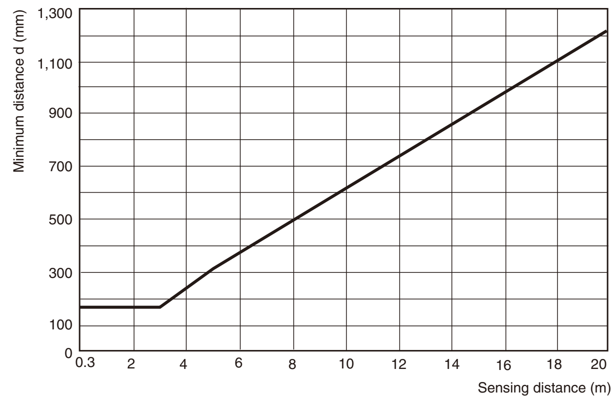


Fig. 5 Sensing Distance vs. Minimum Distance from the Reflective Surface



Prevention of Mutual Interference

⚠ WARNING

Do not use the sensor system with mirrors in a retro-reflective configuration. Doing so may hinder detection. It is possible to use mirrors to change the route of the light.

When using more than 1 set of MS/MS4800, install them so that mutual interference does not occur, such as by configuring a series connection or using physical barriers between adjacent sets.

The MS/ MSF4800 is equipped with two scan codes, A and B, to reduce mutual interference from other Safety Light Curtains. The Transmitter and Receiver must both be set to the same scan code to enable the Receiver to change to Machine Run State.

Basic Installation Precautions

⚠ WARNING

Install a protective structure so that the hazardous part of a machine can only be reached by passing through the sensor's detection zone. Install the sensors so that part of the person is always present in the detection zone when working in a machine's hazardous areas. If a person is able to step into the hazardous area of a machine and remain behind the MS/MSF4800's detection zone, configure the system with an interlock function that prevents the machine from being restarted. Otherwise it may result in heavy injury.

Do not use this sensor for machines that cannot possibly be quickly stopped by electrical controls. For example, do not use it for a pressing machine that uses a full-rotation clutch. Otherwise, the machine may not stop before a person reaches the hazardous part, resulting in serious injury.

Using the MS/MSF4800 in Presence Sensing Device Initiation (PSDI) Mode, which is used to restart machine cycle operation, requires that an appropriate control circuit be configured between the MS/MSF4800 and the guarded machine. For details on PSDI, refer to related standards and regulations, including ANSI RIA 15.06-1999, OSHA 1910.217(h), and ANSI B11.2-1995 (R2005).

When using the Start/Restart Interlock Mode, install the interlock reset switch in a location that provides a clear view of the entire hazardous area and where it cannot be activated from within the hazardous area.

Do not use the MS/MSF4800 in environments where flammable or explosive gases are present. Doing so may result in explosion.

The MS/MSF4800 cannot protect a person from an object flying from a hazardous area. Install protective cover(s) or fence(s).

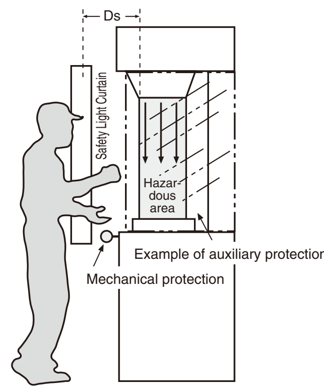
Make sure that the MS/MSF4800 is securely mounted and its cables and connectors are properly connected.

Be sure to test the operation of the MS/MSF4800 after installation with the machine in a non-operating condition to verify that the MS/MSF4800 operates as intended. Unintended function settings may cause a person to go undetected, resulting in serious injury.

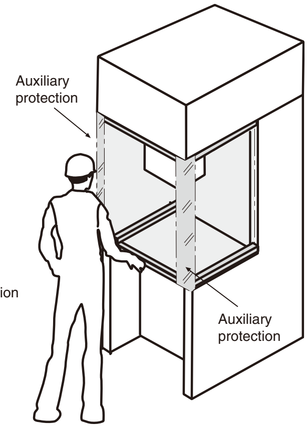
Additional Protection

It is necessary to use an appropriate means, such as a fixed barrier guard, interlock guard, or safety mat, to protect areas that provide access to any hazardous areas of a machine that are not protected by the MS/MSF4800. See the examples in the following diagram.

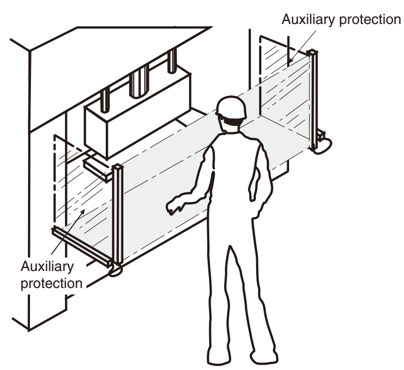
Correct Safety Light Curtain Installation Examples



Adding Mechanical Protection to the MS4800



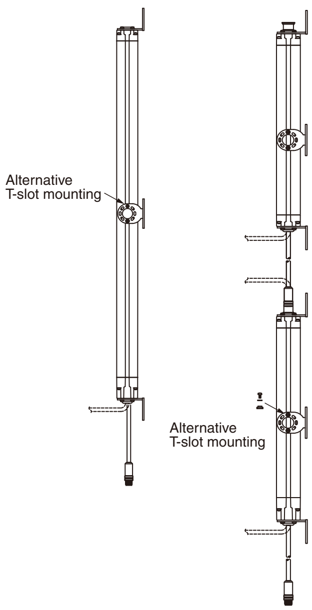
Three-directional MSF4800 Protection



Two-axis MSF4800 Protection

● Strengthening Rigidity during Installation

To increase rigidity, it is recommended that mounting brackets be added when installing an MS/MSF4800 system that has a length of 1,000 mm or more. Use the T-slot groove on the back of the MS/MSF4800 to install the mounting brackets to the rear surfaces of both the Transmitter and Receiver.

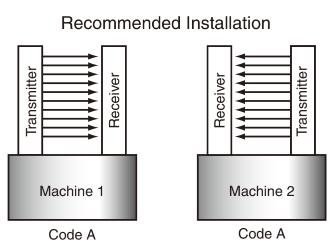


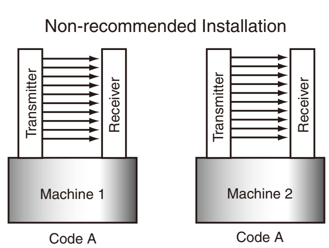
Note: When the alternate T-slot mounting is used to secure the MS/MSF4800, the mounting bracket can no longer be used to adjust the beams.

● Installing Multiple Systems

When installing two or more MS/MSF4800 systems with the same scan code in a line in close proximity, measures must be taken to prevent mutual interference between the systems. This problem can be solved by positioning Transmitters and Receivers back-to-back, or by stacking the systems.

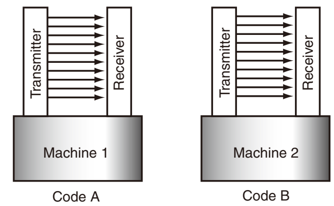
Staggering Positions When Installing Multiple Safety Light Curtains





The MS/MSF4800 scan code function can also be used to install multiple systems in a line in close proximity. Special coding for the light beams allows unique system operation, and can be used with other systems possessing different scan codes. The MS/MSF4800 is equipped with two scan codes.

Setting the Scan Codes When Installing Multiple Safety Light Curtains



● Sensing Area

The sensing area of the MS/MSF4800 can be delineated by drawing lines from the inside edges of the End Caps on the Transmitter and Receiver. The area outside these lines is not sensed. Install the MS/MSF4800 so that it is not possible to enter the hazardous area without passing through the sensing area.

● Installation Adjustment

The installation adjustment for the Transmitter and Receiver is easiest when the system is in Auto Start Mode with the fixed blanking function disabled. Install the Transmitter and Receiver at the same height, on the same flat surface. The individual beam indicators (IBI) will turn ON when the beams are not aligned. For details, refer to ***Individual Beam Indicators (IBI)*** on page 17.

● Input Power Supply Requirements

The MS/MSF4800 operates at 24 VDC ±20%. The power supply for the MS/MSF4800 must satisfy the momentary power interruption and voltage drop requirements of IEC 61496-1 (4.3.2.2, 5.4.3.2) and IEC 60204-1 (4.3.3). Use the OMRON power supply with STI Parts No. 42992 or equivalent.

● Peripheral Protection Requirements

For peripheral protection, install the MS/MSF4800 so that its sensing area is outside the periphery of the guarded machine or robot. This installation method can be used to provide space for the operator to stand between the sensing area and the hazardous area. In this configuration, the guarded machine must be restartable only by using a key switch, and the key switch must be outside the hazardous operation area, in a location where the entire hazardous area is visible. Start/Restart Interlock Mode is well suited to peripheral protection applications.

● Minimum Detectable Object Diameter Indication

The serial number labels on the Transmitter and Receiver have marks for four minimum detectable object diameters. When installing the MS/MSF4800, use an oil-based marking pen to cross out the minimum detectable object diameters that were not set. The minimum detectable object diameter differs when floating blanking is not used and when floating blanking is set for one or two beams. For details, refer to the *Mini Safe 4800 Series Ligtht Curtains Installation and Operating Manual*.

● Sensor Restart of Machine Cycle Operation (PSDI)

Using the Safety Light Curtain to initiate a machine cycle after an object is removed from the sensing area is called Presence Sensing Device Initiation (PSDI). Use of PSDI places additional requirements on the guarding and safety controls. It can restrict advanced Safety Light Curtain features such as floating blanking and fixed blanking. Details on PSDI can be found in ANSI RIA 15.06-1999, OSHA 1910.217(h), and ANSI B11.2-1995 (R2005).

For wiring

⚠ WARNING

For PNP output, connect the load between the output and 0 V line. Connecting the load between the output and +24 V line results in a dangerous condition because the operation mode is reversed to "ON when light is interrupted."

Do not interconnect an output line with a +24-V line. Otherwise, the output is always ON, creating a dangerous situation. Also, 0 V of the power supply must be grounded so that output does not turn ON due to grounding of the output line.

Configure the system by using the optimal number of control outputs that satisfy the requirements of the necessary safety category.

Do not connect the lines of the MS/MSF4800 to a DC power supply higher than 24 V +20%. Also, do not connect to an AC power supply. Otherwise, it may result in electric shock.

For the MS/MSF4800 to comply with IEC 61496-1 and UL 508, the DC power supply unit must satisfy all of the following conditions:

- **Must be within rated power voltage (24 VDC ±20%).**
- **Must have tolerance against the total rated current of devices if it is connected to multiple devices.**
- **Must comply with EMC directives (industrial environment).**
- **Double or enhanced insulation must be applied between the primary and secondary circuits.**
- **Automatic recovery must be possible for overcurrent protection.**
- **Output holding time must be 20 ms or longer.**
- **Must satisfy output characteristic requirements for class 2 circuit or limited voltage current circuit defined by UL508.**
- **Must comply with the EMC, laws, and regulations of the country or region where the MS/MSF4800 is used. (For example, in the EU, the power supply must comply with the EMC Low Voltage Directive.)**

Double or enhanced insulation from hazardous voltage must be applied to all input and output lines. Failure to do so may result in electric shock.

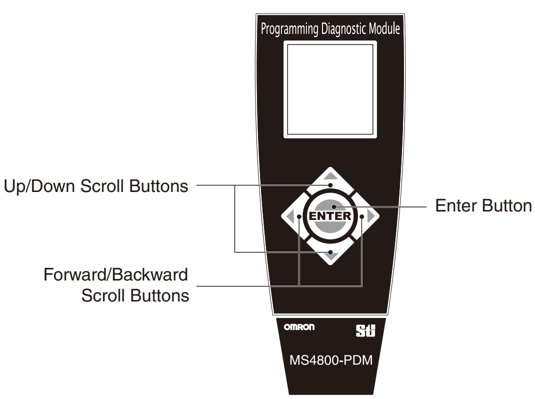
The cable extension length must be no greater than the specified length. Otherwise, the safety functions may fail to work properly, resulting in danger.

Programming and Diagnostics Module

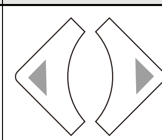
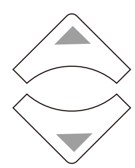
The MS/MSF4800-series Safety Light Curtains require the use of a Programming and Diagnostics Module (PDM) to program the operating parameters of the Light Curtain. In addition to Safety Light Curtain configuration, this Module also serves as a diagnostics device, allowing the user to retrieve fault information.

- Displays programming and diagnostics information on a multi-line LCD display.
- Supports English and Japanese languages. To switch between English and Japanese, continue to press the right Forward/Backward Scroll Button more than ten times at the log-in screen that appears after the PDM is connected to the MS/MSF4800.
- The housing is rated IP65, allowing permanent mounting near the Safety Light Curtain.

Note: The light curtain does not require the PDM to operate. The factory default settings allow for basic guarding operation.



PDM Navigation Buttons

Name	Shape	Description
Forward/ Backward Scroll But- tons		Scroll forward and backward to review the previous and next menu, or to move within the same screen.
Up/Down Scroll But- tons		Scroll up and down to review the selection of the current menu.
Enter But- ton		When pressed the selected func- tion will be accessed.

Note: For information on the operating method, refer to the *Mini Safe 4800 Series Safety Light Curtains Installation and Operating Manual.*

In the interest of product improvement, specifications are subject to change without notice.

⚠ WARNING

This catalog is a guide to help customers select the proper safety products. Observe the following items when choosing products, select the right products for your devices or equipment, and develop a safety-related system to fully utilize product functions.

Setting Up a Risk Assessment System

The items listed in this catalog must be used properly in terms of product location as well as product performance and functionality. Part of the process of selecting and using these products should include the introduction and development of a risk assessment system early in the design development stage to help identify potential dangers in your equipment that will optimize safety product selection. A badly designed risk assessment system often results in poor choices when it comes to safety products.

• Related International Standards:
  ISO 14121 Principles of Risk Assessment

Safety Policy

When developing a safety system for the devices and equipment that use safety products, make every effort to understand and conform to the entire series of international and industrial standards available, such as the examples given below.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Role of Safety Products

Safety products have functions and mechanisms that ensure safety as defined by standards. These functions and mechanisms are designed to attain their full potential within safety-related systems. Make sure you fully understand all functions and mechanisms, and use that understanding to develop systems that will ensure optimal usage.

• Related International Standards:
  ISO 14119 Interlocking Devices Associated with Guards-Principles for Design and Selection

Installing Safety Products

Make sure that properly educated and trained engineers are selected to develop your safety-related system and to install safety products in devices and equipment.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Observing Laws and Regulations

Safety products should conform to pertinent laws, regulations, and standards, but make sure that they are used in accordance with the laws, regulations, and standards of the country where the devices and equipment incorporating these products are distributed.

• Related International Standards:
  IEC 60204 Electrical Equipment of Machines

Observing Usage Precautions

Carefully read the specifications and precautions listed in this catalog for your product as well as all items in the Operating Manual packed with the product to learn usage procedures that will optimize your choice. Any deviation from precautions will lead to unexpected device or equipment failure not anticipated by safety-related systems or fire originating from equipment failure.

Transferring Devices and Equipment

When transferring devices and equipment, be sure to keep one copy of the Operating Manual and pack another copy with the device or equipment so the person receiving it will have no problem operating it.

• Related International Standards:
  ISO 12100 Basic Concepts, General Principles for Design
  IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

Read and Understand This Catalog

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS, OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the product.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this catalog.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the product may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased product.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

ERRORS AND OMISSIONS

The information in this catalog has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

PERFORMANCE DATA

Performance data given in this catalog is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

COPYRIGHT AND COPY PERMISSION

This catalog shall not be copied for sales or promotions without permission.

This catalog is protected by copyright and is intended solely for use in conjunction with the product. Please notify us before copying or reproducing this catalog in any manner, for any other purpose. If copying or transmitting this catalog to another, please copy or transmit it in its entirety.

2008.4

In the interest of product improvement, specifications are subject to change without notice.

OMRON Corporation
Industrial Automation Company

http://www.ia.omron.com/