


## Release Protective Cover Locks Using Controller Signals or Pushbutton Switches after the Cutting Tool Stops Moving Due to Inertia

- 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.

**Note:** Contact your sales representative for details on models with safety standard certification.



 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**

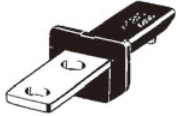

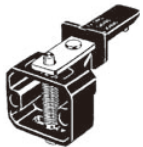
**List of Models**

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 <sub>e</sub> )		3 A	6 A
Rated operating voltage (U <sub>e</sub> )		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)		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 <sup>2</sup> min.
	Malfunction	300 m/s <sup>2</sup> min.
Conditional short-circuit current		100 A (EN60947-5-1)
Conventional enclosed thermal current (I <sub>the</sub> )		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 $\begin{smallmatrix} +10\% \\ -15\% \end{smallmatrix}$ (100% ED)	110 VAC $\pm 10\%$ (50/60 Hz)	24 VDC $\begin{smallmatrix} +10\% \\ -15\% \end{smallmatrix}$ (100% ED)
Current consumption		Approx. 300 mA	Approx. 98 mA	Approx. 300 mA
Insulation class		Class F (130°C or less)		

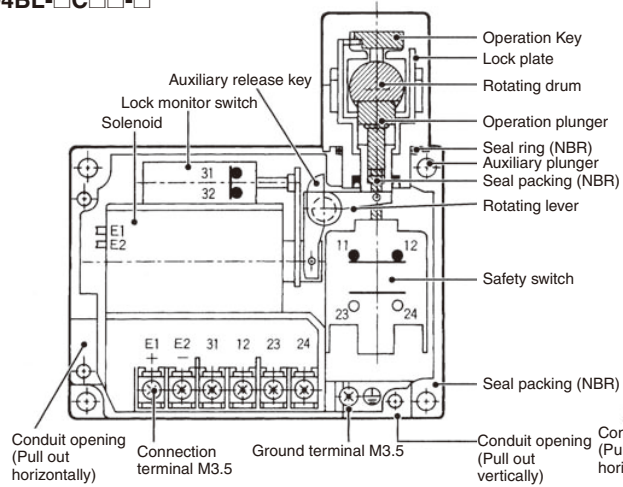
## Indicator Characteristics

Rated voltage	10 to 115 VAC/VDC
Current leakage	Approx. 1 mA
Color (LED)	Orange, green

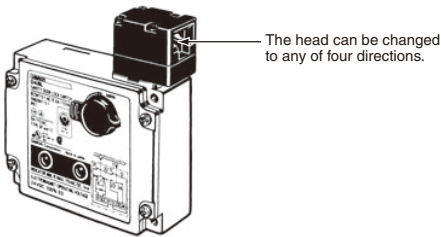
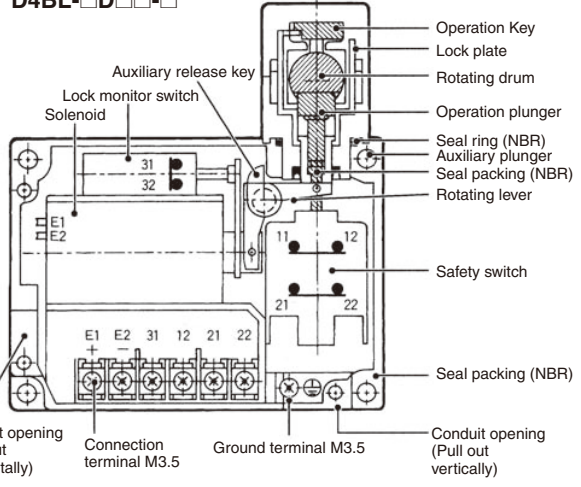
# Structure and Nomenclature

## Structure

D4BL-□C□□-□



D4BL-□D□□-□

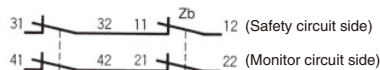


## Contact Form (Diagrams Show State with Key Inserted and Lock Engaged)

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.

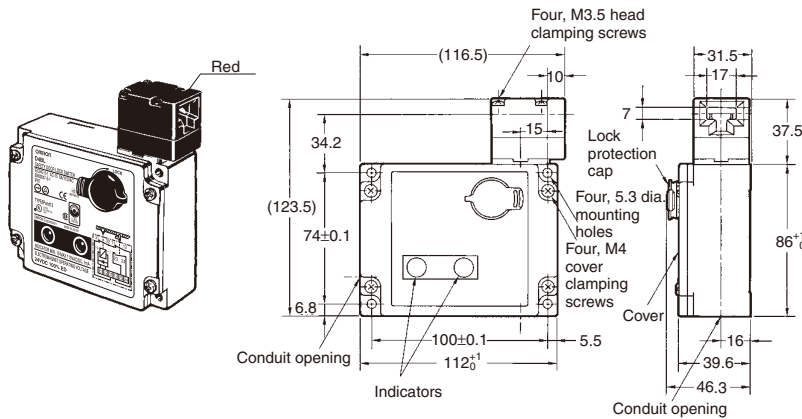
## Contact Form 2NC + 2NC



# Dimensions and Operating Characteristics

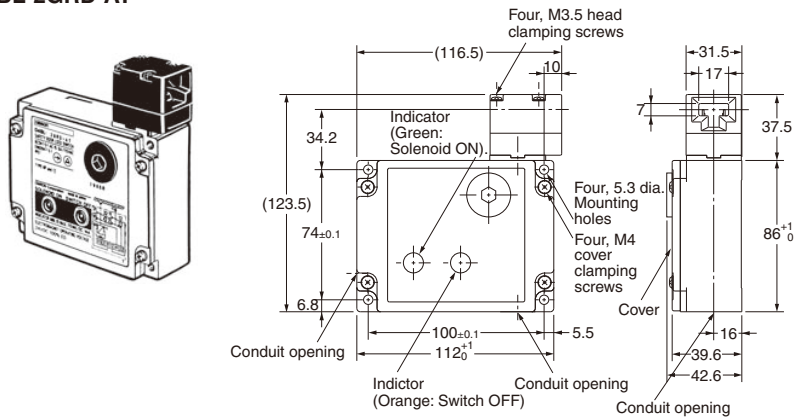
## Switches

D4BL-□□□□-□



Operating Characteristics	Model	D4BL-□□□□
Key insertion force		19.61 N max.
Key extraction force		19.61 N max.
Movement before being locked		15 mm max.
Total travel		23 mm min.

D4BL-2GRD-AT

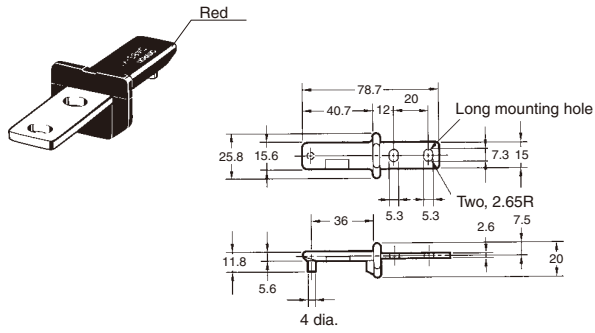


Operating Characteristics	Model	D4BL-2GRD-AT
Key insertion force		19.61 N max.
Key extraction force		19.61 N max.
Movement before being locked		15 mm max.
Total travel		23 mm min.

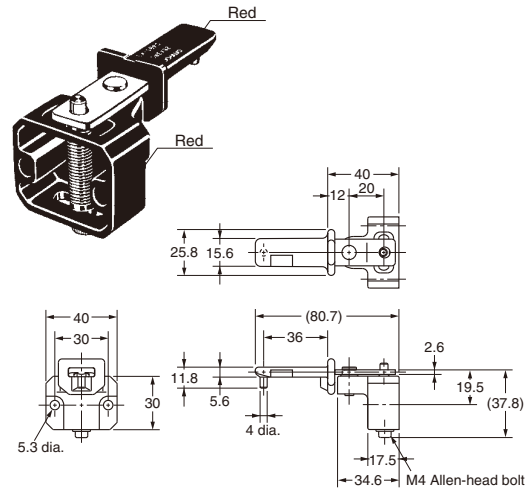
**Note:** 1. Unless otherwise specified, a tolerance of  $\pm 0.4$  mm applies to all dimensions.  
 2. There are fluctuations in the contact ON/OFF timing for 2NC contacts. Confirm performance before application.

Operation Keys

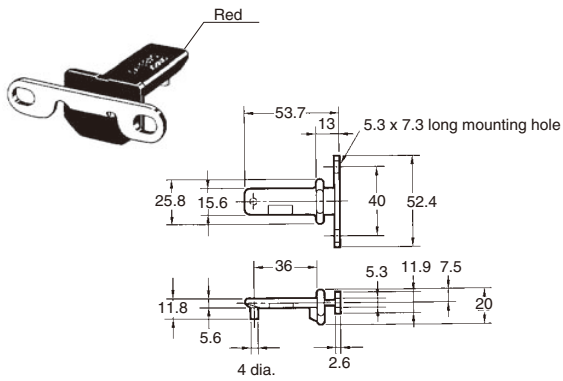
D4BL-K1



D4BL-K3

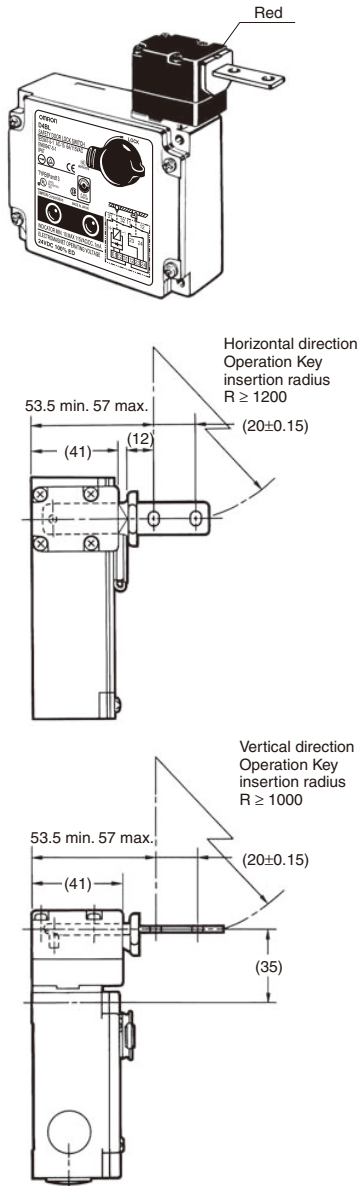


D4BL-K2

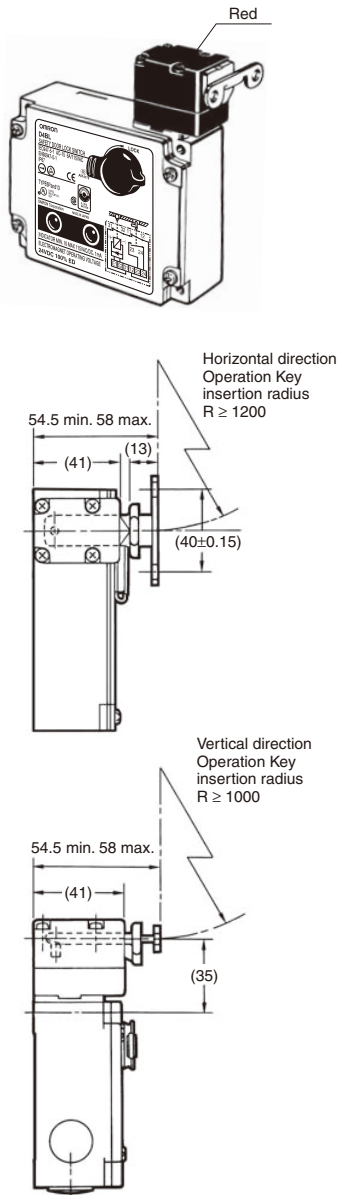


With Operation Key Inserted

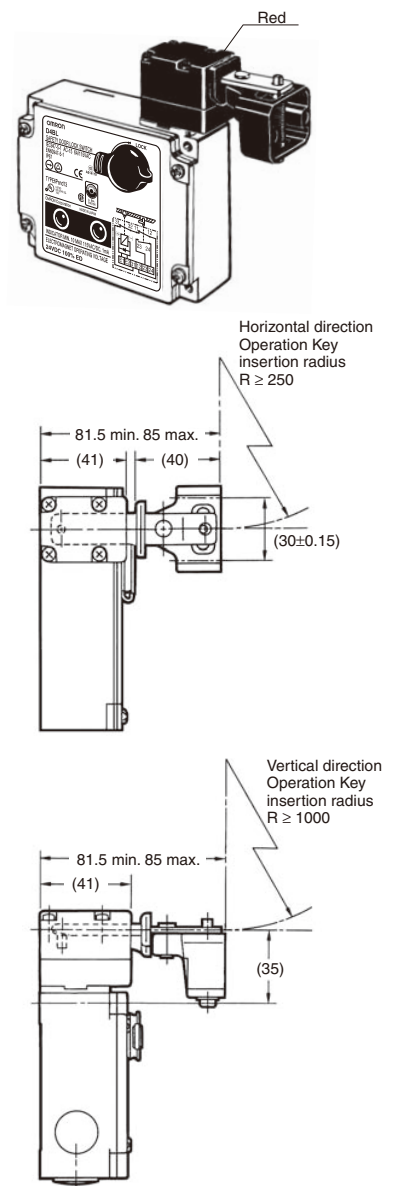
D4BL + D4BL-K1



D4BL + D4BL-K2



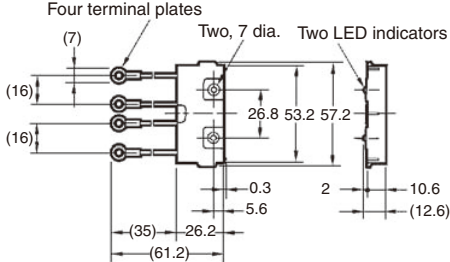
D4BL + D4BL-K3



**Note:** 1. Unless otherwise specified, a tolerance of  $\pm 0.4$  mm applies to all dimensions.  
2. In the above diagrams, the Operation Key is inserted from the front.



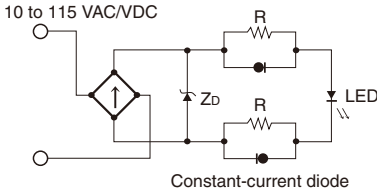
### Indicator Unit



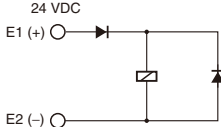
### Connections

#### Internal Circuit Diagram

##### Indicator



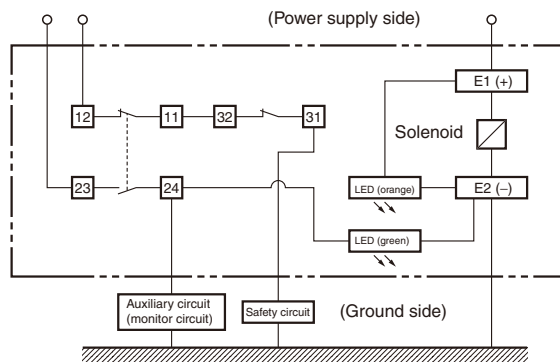
##### Solenoid



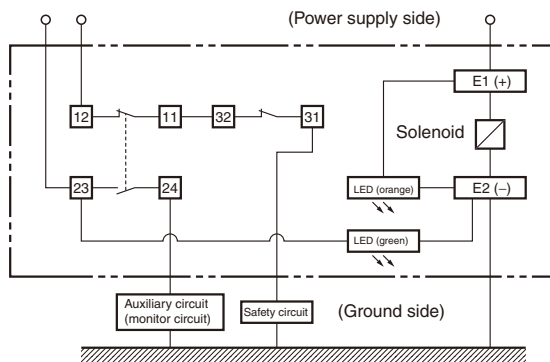
## Circuit Connection Example

- 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.

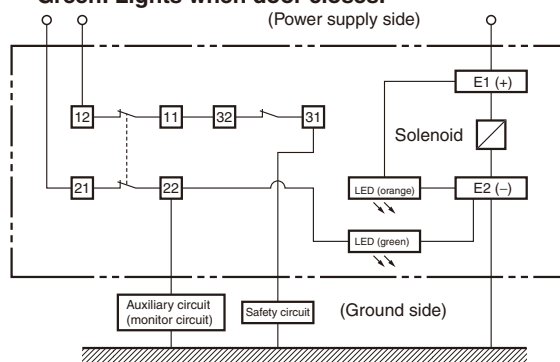
### 1. Orange: Lights when the solenoid turns ON. Green: Lights when the door opens.



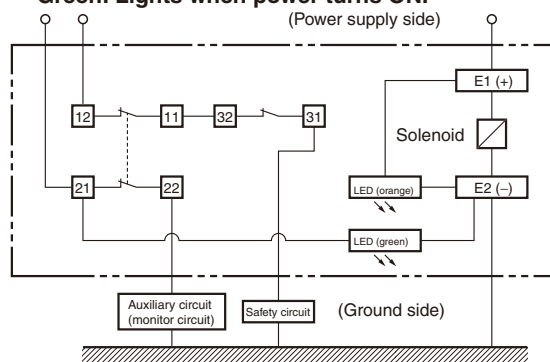
### 2. Orange: Lights when the solenoid turns ON. Green: Lights when power turns ON.



### 3. Orange: Lights when the solenoid turns ON. Green: Lights when door closes.

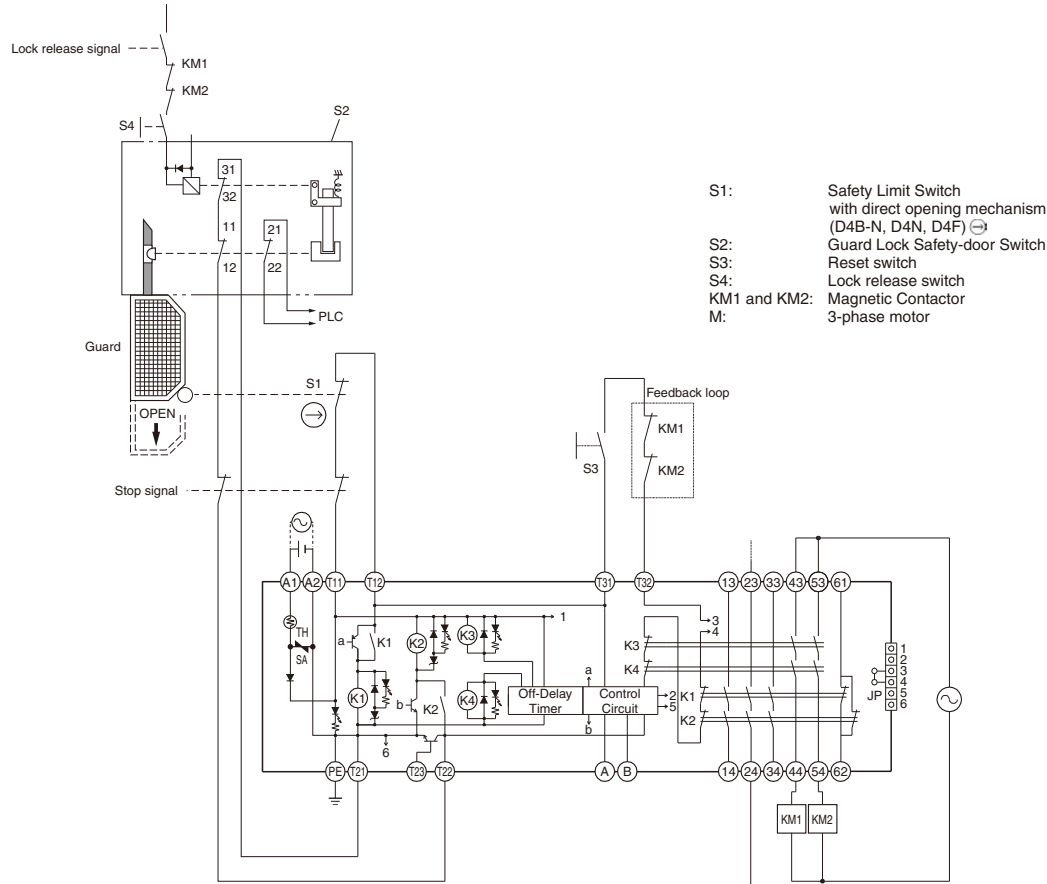


### 4. Orange: Lights when the solenoid turns ON. Green: Lights when power turns ON.



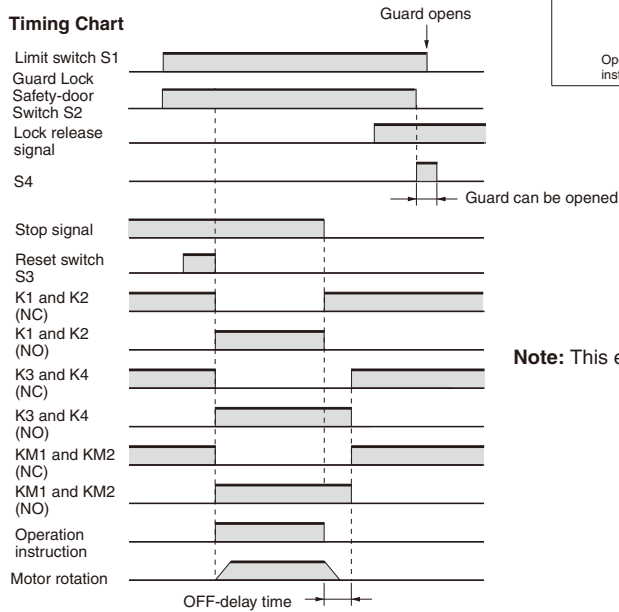
# Connection Example with OMRON's G9SA Safety Relay Unit

## G9SA-321-T□ (24 VAC/VDC) + D4BL-□D□A-□, -□D□B-□ (Mechanical Lock Type) Circuit Diagram (Manual Reset)



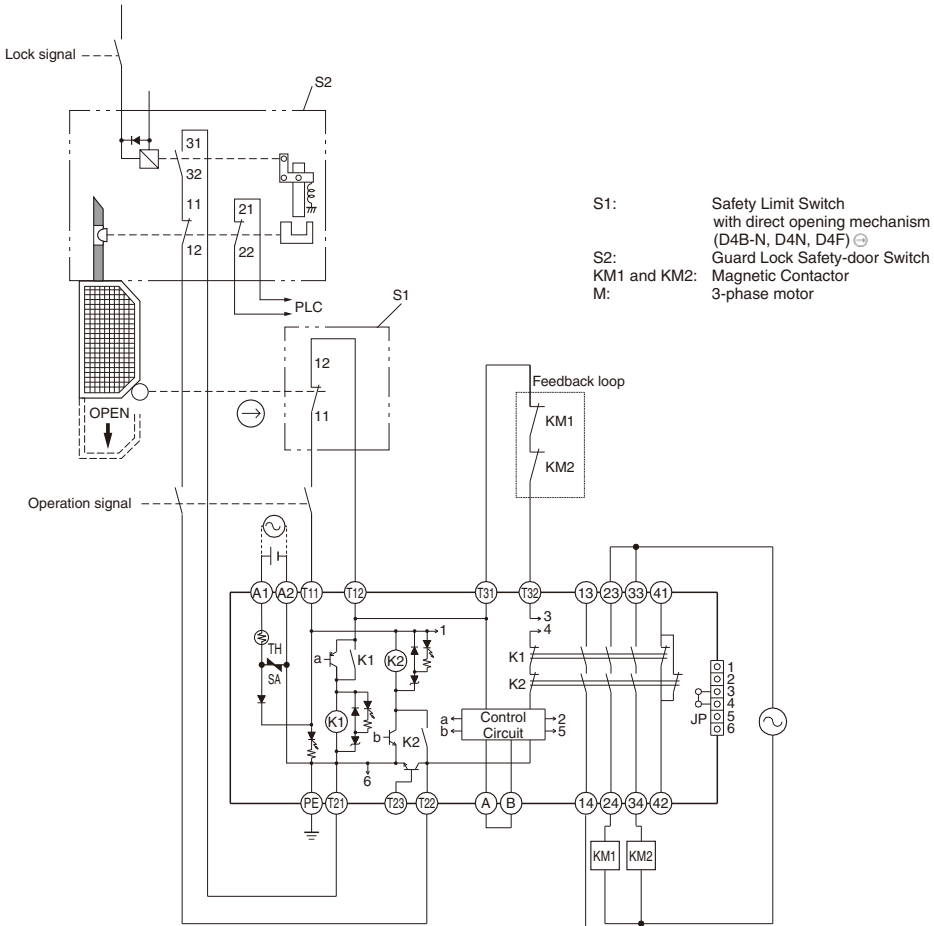
- S1: Safety Limit Switch with direct opening mechanism (D4B-N, D4N, D4F) ⇨
- S2: Guard Lock Safety-door Switch
- S3: Reset switch
- S4: Lock release switch
- KM1 and KM2: Magnetic Contactor
- M: 3-phase motor

### Timing Chart

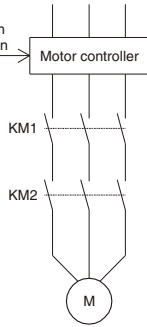
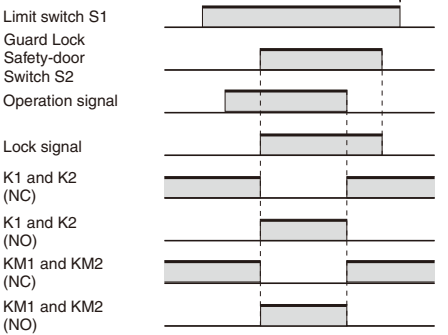


**Note:** This example circuit is for Category 3.

G9SA-301 (24 VAC/VDC) + D4BL-□D□G-□ (Solenoid Lock Type) Circuit Diagram (Auto-reset)



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.

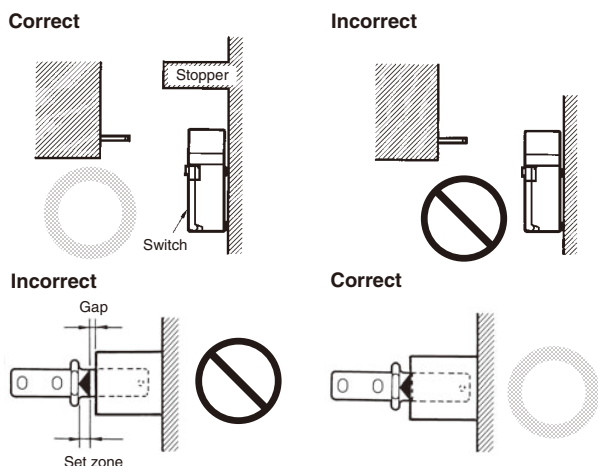


### **Precautions for Safe Use**

- 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<sup>2</sup>.



### **Precautions for Correct Use**

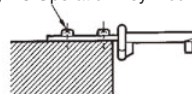
#### **Appropriate Tightening Torque**

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

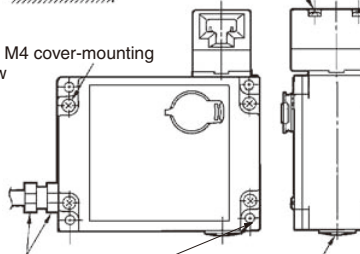
\* Use M5 screws. Apply a torque of 4.90 to 5.88 N·m for an Allen-head bolt. For a pan head screw, apply a torque of 2.35 to 2.75 N·m

5. Two, M5 Operation Key mounting screw



3. Four, M3.5 head-mounting screw

2. Four, M4 cover-mounting screw

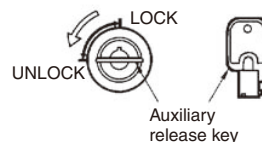


6. Conduit 4. Four, M5 switch-mounting screw

7. Conduit cap

### **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.

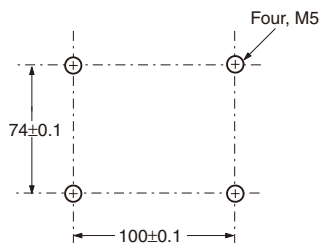
### Switch and Operation Key Mounting

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.

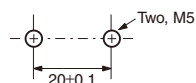
### Mounting Dimensions

#### Switch Mounting Dimensions

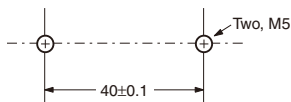


#### Operation Key Mounting Holes

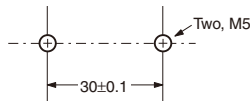
##### D4BL-K1



##### D4BL-K2

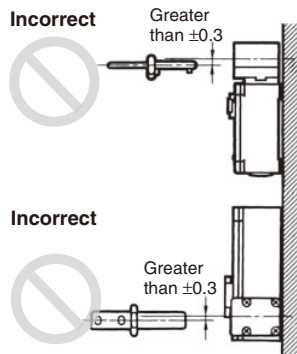


##### D4BL-K3



### 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  $\pm 0.3$  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.



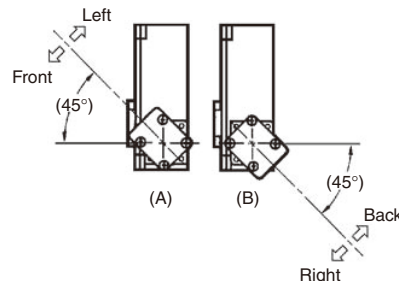
- The Operation Key for the D4BL is different from the one for the D4BS.

### Head Direction

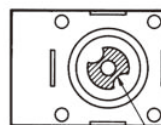
- The head can be mounted in four directions by loosening the four screws holding the head. To remove the head, turn the head at the surface mating with the Switch body by  $45^\circ$  as shown in figures (A) and (B) below.

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  $45^\circ$ , 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

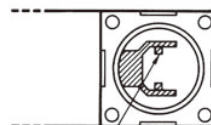


#### Head Bottom View



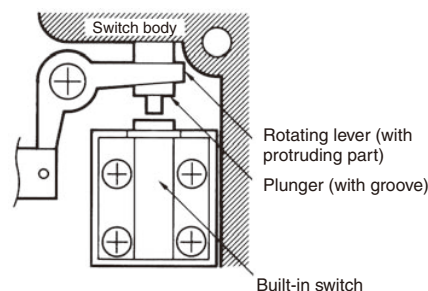
Operation plunger and groove mechanism

#### Switch Top View



Rotation lever and protruding part

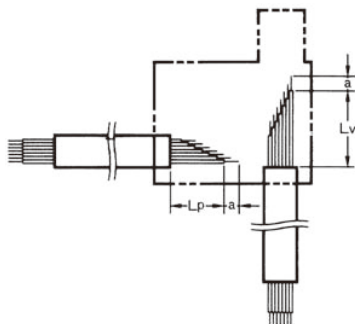
### Normal Positions of Rotating Lever and Plunger



- 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 of 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<sup>2</sup>) 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.

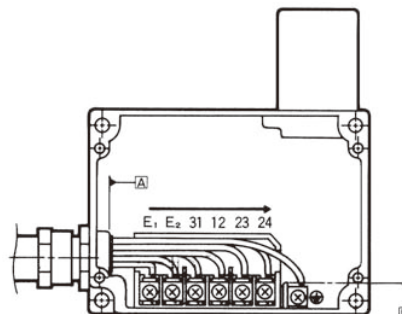


Terminal no.	Lp (mm)	Lv (mm)	a (mm)
E <sub>1</sub>	30±2	80±2	8±1
E <sub>2</sub>	35±2	75±2	
31	45±2	60±2	
12	55±2	50±2	
23 (21)	65±2	45±2	
24 (22)	70±2	35±2	
⊕	90±2	50±2	

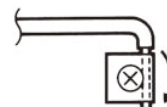
- Properly attach and securely tighten the provided conduit cap to the unused conduit opening to the suitable tightening torque when wiring the D4BL.

### Cable Connection Example

1. Connect the wires to the terminals in the order shown below for wiring efficiency.

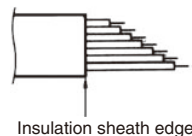


Tighten each wired terminal clockwise to a torque of 0.59 to 0.78 N·m.



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.



### 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

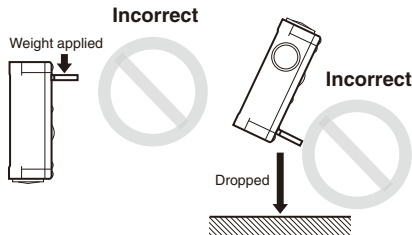
- Do not use the Switch in atmospheres containing explosive or flammable gases.
- Although the switch body is protected from the ingress of dust or water, avoid the ingress of foreign substance through the key hole on the head. Otherwise, accelerated wear, breaking, or malfunction may result.
- The durability 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**

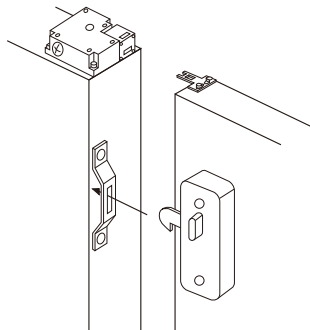
**Operation Key**

- 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<sub>2</sub>S, SO<sub>2</sub>, NH<sub>3</sub>, HNO<sub>3</sub>, and Cl<sub>2</sub>, 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<sub>2</sub>S, SO<sub>2</sub>, NH<sub>3</sub>, HNO<sub>3</sub>, and Cl<sub>2</sub>, may be present, or in locations that are subject to excessive dirt, excessive dust, high temperature, or high humidity.

**Other Precautions**

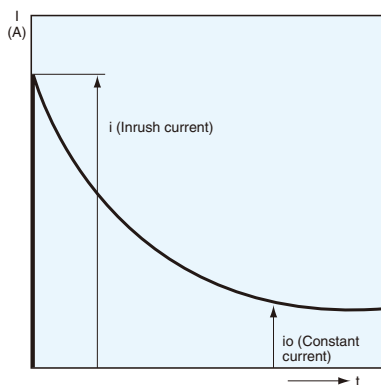
- When attaching a cover, be sure that the seal rubber is in place and that there is no foreign material present. If the cover is attached with the seal rubber out of place or if foreign material is stuck to the rubber, a proper seal will not be obtained.
- Perform maintenance inspections periodically.
- 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.

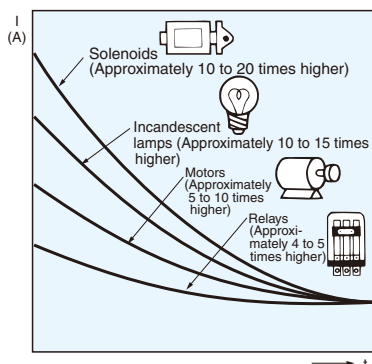
Inductive load: A minimum power factor of 0.4 (AC) or a maximum time constant of 7 ms (DC)

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

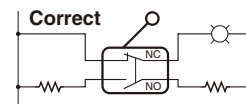
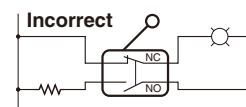
- The switching load capacity of the Switch greatly varies between AC and DC. Always be sure to apply the rated load. The control capacity will drastically drop if it is a DC load. This is because a DC load has no current zero-cross point, unlike an AC load. Therefore, if an arc is generated, it may 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 connect a single Switch to two power supplies that are different in polarity or type.

#### Power Connection Examples (Connection of Different Polarities)



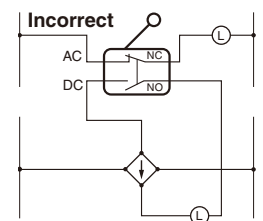
Connect the load to the same polarities.



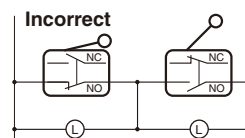
#### Incorrect Power Connection Example

(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.

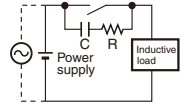
### Contact Protection Circuits

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.

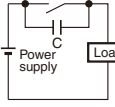
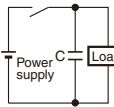
The following tables shows typical examples of contact protection circuits. If the Switch is used in an excessively humid location for

switching a load that easily generates arcs, such as an inductive load, the arcs may generate NO<sub>x</sub>, which will change into HNO<sub>3</sub> 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		
	*	Yes	* Load impedance must be much smaller than the CR circuit impedance when using the Switch for an AC voltage.  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.	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		
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.	---

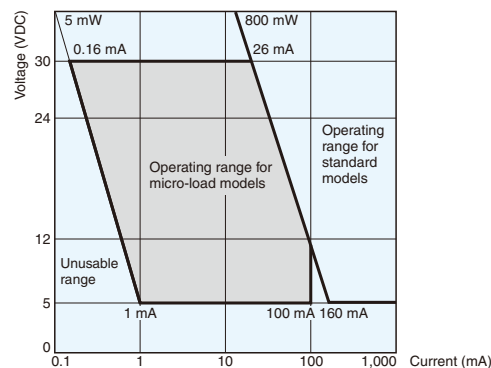
Do not use the following types of contact protection circuit.

 <p>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.</p>	 <p>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.</p>
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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.

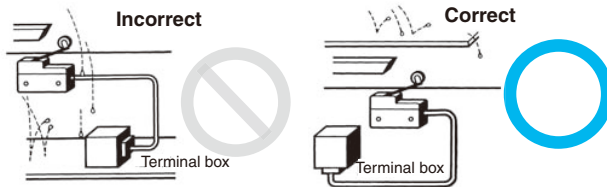
### Using Switches for Microloads

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% ( $\lambda_{60}$ ) (JIS C5003). The equation,  $\lambda_{60} = 0.5 \times 10^{-6} / \text{operations}$  indicates that the estimated malfunction rate is less than 1/2,000,000 operations with a reliability level of 60%.

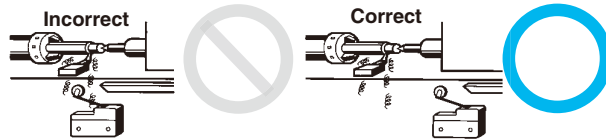


## Operating Environment

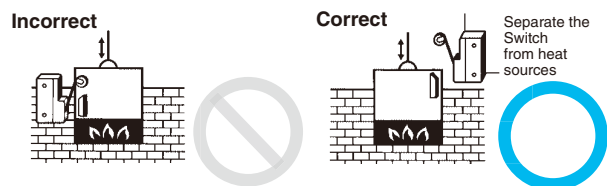
- The Switches are designed for use indoors. Using a Switch outdoors may cause it to malfunction.
- Do not use the Switch submerged in oil or water, or in locations continuously subject to splashes of water. Doing so may result in oil or water entering the Switch interior.
- Confirm suitability (applicability) 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.



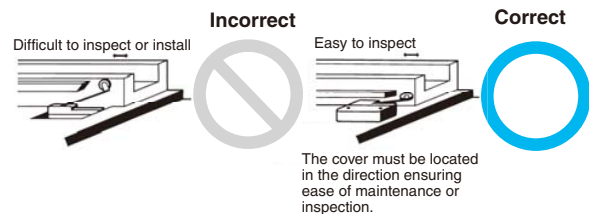
- Be sure to protect the Switch with a cover if the Switch is in a location where the Switch may be actuated by mistake or where the Switch is likely cause an accident.



- 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<sub>2</sub>S or SO<sub>2</sub>), ammonium gas (NH<sub>3</sub>), nitric gas (HNO<sub>3</sub>), or chlorine gas (Cl<sub>2</sub>), 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<sub>2</sub>) 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<sub>2</sub>S, SO<sub>2</sub>, NH<sub>3</sub>, HNO<sub>3</sub>, or Cl<sub>2</sub>, 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.



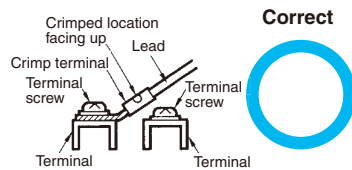
## Typical Problems, Probable Causes, and Remedies

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.	<ul style="list-style-type: none"> <li>Change the design of the dog or cam and smooth the contacting surface of the cam.</li> </ul>
		The contacting surface of the dog or cam is rough.	
		The Actuator in use is not suitable.	<ul style="list-style-type: none"> <li>Scrutinize the suitability of the Actuator. (Make sure that the Actuator does not bounce.)</li> </ul>
		The operating direction of the Actuator is not correct.	<ul style="list-style-type: none"> <li>Attach a decelerating device or change the mounting position of the Switch.</li> </ul>
		The operation speed is excessively high.	
		Excessive stroke.	<ul style="list-style-type: none"> <li>Change the stroke.</li> </ul>
		The rubber or grease hardened due to low temperature.	<ul style="list-style-type: none"> <li>Use a cold-resistive Switch.</li> </ul>
		The accumulation of sludge, dust, or cuttings.	<ul style="list-style-type: none"> <li>Use a drip-proof model or one with high degree of protection.</li> <li>Use a protection cover and change the solvent and materials.</li> </ul>
	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.	<ul style="list-style-type: none"> <li>Regularly inspect the Switch.</li> <li>Use a better quality Switch.</li> <li>Tighten the mounting screws securely. Use a mounting board.</li> </ul>
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.	<ul style="list-style-type: none"> <li>Solder the Switch quickly.</li> <li>Change the lead wire according to the carry current and ratings.</li> </ul>	
	The Switch has been connected to and pulled by thick lead wires with excessive force.		
	High temperature or thermal shock resulted.	<ul style="list-style-type: none"> <li>Use a temperature-resistive Switch or change mounting positions.</li> </ul>	
Failures related to chemical or physical characteristics	Contact chattering.	Vibration or shock is beyond the rated value.	<ul style="list-style-type: none"> <li>Attach an anti-vibration mechanism.</li> <li>Attach a rubber circuit to the solenoid.</li> <li>Increase the operating speed (with an accelerating mechanism).</li> </ul>
		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.	<ul style="list-style-type: none"> <li>Use a drip-proof or waterproof Switch.</li> <li>Use the correct connector and cable.</li> </ul>
		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.	
	Deterioration of the rubber part.	The Switch has been burnt or carbonated due to the penetration of dust or oil.	<ul style="list-style-type: none"> <li>Use an oil-resistant rubber or Teflon bellows.</li> <li>Use a weather-resistant rubber or protective cover.</li> <li>Use a Switch with a metal bellows protective cover.</li> </ul>
		The expansion and dissolution of the rubber caused by solvent or lubricating oil.	
		Cracks due to direct sunlight or ozone.	
	Corrosion (rusting or cracks).	Damage to the rubber caused by scattered or heated cuttings.	<ul style="list-style-type: none"> <li>Change the lubricating oil or change mounting positions.</li> <li>Use a crack-resistant material.</li> </ul>
		The oxidation of metal parts resulted due to corrosive solvent or lubricating oil.	
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.			
Failures related to electric characteristics	No actuation. No current breakage. Contact welding.	The cracking of alloyed copper due to rapid changes in temperature.	<ul style="list-style-type: none"> <li>Add an erasing circuit.</li> <li>Use a Switch with a special alloy contact or use a sealed Switch.</li> <li>Reduce the switching frequency or use a Switch with a large switching capacity.</li> <li>Change the circuit design.</li> <li>Use a protective box.</li> </ul>
		Inductive interference in the DC circuit.	
		Carbon generated on the surface of the contacts due to switching operations.	
		A short-circuit or contact welding due to contact migration.	
		Contact welding due to an incorrectly connected power source.	
Foreign materials or oil penetrated into the contact area.			

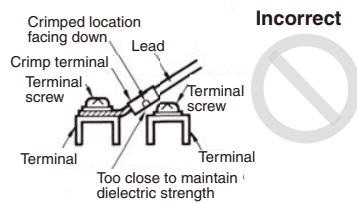
## Other

- 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.

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- 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.

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