

FQM1 Series

FQM1-CM002

FQM1-MMP22

FQM1-MMA22

Flexible Motion Controller

OPERATION MANUAL

OMRON

FQM1 Series

FQM1-CM002

FQM1-MMP22

FQM1-MMA22

Flexible Motion Controller




Operation Manual

Produced December 2005

Notice:

OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual.

The following conventions are used to indicate and classify precautions in this manual. Always heed the information provided with them. Failure to heed precautions can result in injury to people or damage to property.

-  **DANGER** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Additionally, there may be severe property damage.
-  **WARNING** Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.
-  **Caution** Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

OMRON Product References

All OMRON products are capitalized in this manual. The word “Unit” is also capitalized when it refers to an OMRON product, regardless of whether or not it appears in the proper name of the product.

The abbreviation “Ch,” which appears in some displays and on some OMRON products, often means “word” and is abbreviated “Wd” in documentation in this sense.

The abbreviation “CM” means Coordinator Module and the abbreviation “MM” means Motion Control Module.

Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

Note Indicates information of particular interest for efficient and convenient operation of the product.

1,2,3... 1. Indicates lists of one sort or another, such as procedures, checklists, etc.

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No patent liability is assumed with respect to the use of the information contained herein. Moreover, because OMRON is constantly striving to improve its high-quality products, the information contained in this manual is subject to change without notice. Every precaution has been taken in the preparation of this manual. Nevertheless, OMRON assumes no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained in this publication.

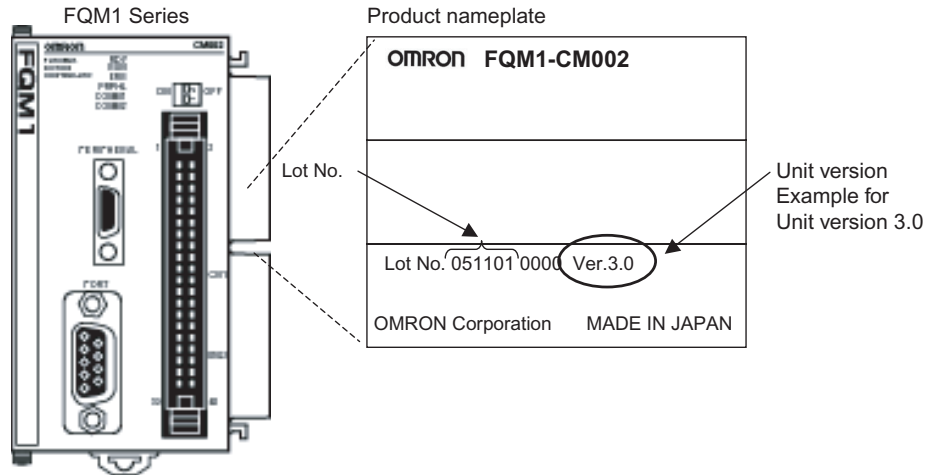
Unit Versions of FQM1 Series Flexible Motion Controller

Unit Versions

The FQM1 Series Controllers have “unit versions”, which are used to manage the differences in functionality associated with upgrades to the Coordinator Modules and Motion Control Modules.

Notation of Unit Versions on Products

The unit version is listed just to the right of the lot number on the nameplate of the Module, as shown below.



Unit Versions and Model Numbers

Name	Unit Ver. 2.0	Unit Ver. 3.0
Coordinator Module	FQM1-CM001	FQM1-CM002
Motion Control Module	FQM1-MMA21 FQM1-MMP21	FQM1-MMA22 FQM1-MMP22

Note The Ver. 2.0 Modules (FQM1-CM001, FQM1-MMA21, and FQM1-MMP21) can be used together with the Ver. 3.0 Modules (FQM1-CM002, FQM1-MMA22, and FQM1-MMP22).

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About this Manual:

This manual describes the operation of the Coordinator Module and Motion Control Modules of the FQM1-series Flexible Motion Controller.

Please read this manual and all related manuals listed in the table below and be sure you understand information provided before attempting to program or use FQM1-series Flexible Motion Controllers in a control system.

Name	Cat. No.	Contents
FQM1 Series FQM1-CM002, FQM1-MMP22, FQM1-MMA22 Flexible Motion Controller Operation Manual (this manual)	O012	This manual provides an overview of and describes the following information for the FQM1-series Flexible Motion Controller: features, system configuration, system design, installation, wiring, maintenance, I/O memory allocation, troubleshooting, etc.
FQM1 Series FQM1-CM002, FQM1-MMP22, FQM1-MMA22 Flexible Motion Controller Instructions Reference Manual	O013	Describes the ladder diagram programming instructions supported by FQM1-series Flexible Motion Controller. Use this manual together with the <i>Operation Manual</i> (Cat. No. O012).
SYSMAC WS02-CXPC1-E-V61 CX-Programmer Operation Manual Version 6.1	W446	Provides information on how to use the CX-Programmer, a Windows-based programming and monitoring package for OMRON PLCs.
SYSMAC WS02-CXPC1-E-V61 CX-Programmer Ver. 6.1 Operation Manual Function Blocks	W447	Describes the CX-Programmer functionality related to function blocks, including function block specifications and procedures. Check for differences in specifications between the CS/CJ Series PLCs and FQM1 Controllers when referring to this manual.

Section 1 describes the features of the FQM1 and its system configuration.

Section 2 provides the specifications of the FQM1 and describes the parts and their functions on the Coordinator Module and Motion Control Modules.

Section 3 describes how to install and wire the FQM1

Section 4 describes the operation of the FQM1.

Section 5 describes the functions common to both the Coordinator Module and Motion Control Modules and the methods to transfer data between the Coordinator Module and Motion Control Modules.

Section 6 describes the serial communications functions, which are supported only by the Coordinator Module.

Section 7 describes the various functions supported by the Motion Control Modules.

Section 8 explains how to connect a personal computer running the CX-Programmer to the FQM1.

Section 9 provides information on identifying and correcting errors that occur during FQM1 operation.

Section 10 provides inspection and maintenance information.

The **Appendices** provide information on programming, I/O Memory, System Setup, and built-in I/O allocations, and Auxiliary Area allocations.



WARNING Failure to read and understand the information provided in this manual may result in personal injury or death, damage to the product, or product failure. Please read each section in its entirety and be sure you understand the information provided in the section and related sections before attempting any of the procedures or operations given.

Read and Understand this Manual

Please read and understand this manual before using the product. 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 the 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 products.

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 manual.
- 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 PRODUCTS ARE PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

PROGRAMMABLE PRODUCTS

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

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 products 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 products.

DIMENSIONS AND WEIGHTS

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

PERFORMANCE DATA

Performance data given in this manual 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.

ERRORS AND OMISSIONS

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

PRECAUTIONS

This section provides general precautions for using the FQM1-series Flexible Motion Controller and related devices.

The information contained in this section is important for the safe and reliable application of the FQM1-series Flexible Motion Controller. You must read this section and understand the information contained before attempting to set up or operate a control system using the FQM1-series Flexible Motion Controller.

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1 Intended Audience

This manual is intended for the following personnel, who must also have knowledge of electrical systems (an electrical engineer or the equivalent).


- Personnel in charge of installing FA systems.
- Personnel in charge of designing FA systems.
- Personnel in charge of managing FA systems and facilities.

2 General Precautions


The user must operate the product according to the performance specifications described in the operation manuals.


Before using the product under conditions which are not described in the manual or applying the product to nuclear control systems, railroad systems, aviation systems, vehicles, combustion systems, medical equipment, amusement machines, safety equipment, petrochemical plants, and other systems, machines, and equipment that may have a serious influence on lives and property if used improperly, consult your OMRON representative.


Make sure that the ratings and performance characteristics of the product are sufficient for the systems, machines, and equipment, and be sure to provide the systems, machines, and equipment with double safety mechanisms.


 **WARNING** It is extremely important that the FQM1 be used for the specified purpose and under the specified conditions, especially in applications that can directly or indirectly affect human life. You must consult with your OMRON representative before applying an FQM1 System to the above-mentioned applications.

3 Safety Precautions

 **WARNING** Do not attempt to take any Modules apart while the power is being supplied. Doing so may result in electric shock.

 **WARNING** Do not touch any of the terminals or terminal blocks while the power is being supplied. Doing so may result in electric shock.

 **WARNING** Do not attempt to disassemble, repair, or modify any Modules. Any attempt to do so may result in malfunction, fire, or electric shock.

 **WARNING** Provide safety measures in external circuits, i.e., not in the Flexible Motion Controller (referred to as the "FQM1"), to ensure safety in the system if an abnormality occurs due to malfunction of the FQM1 or another external factor affecting the FQM1 operation. Not doing so may result in serious accidents.

- Emergency stop circuits, interlock circuits, limit circuits, and similar safety measures must be provided in external control circuits.
- The FQM1 will turn OFF all outputs when its self-diagnosis function detects any error or when a severe failure alarm (FALS) instruction is executed. As a countermeasure for such errors, external safety measures must be provided to ensure safety in the system.
- The FQM1 outputs may remain ON or OFF due to destruction of the output transistors. As a countermeasure for such problems, external safety measures must be provided to ensure safety in the system.

- When the 24-VDC output (service power supply to the FQM1) is overloaded or short-circuited, the voltage may drop and result in the outputs being turned OFF. As a countermeasure for such problems, external safety measures must be provided to ensure safety in the system.

⚠ WARNING Fail-safe measures must be taken by the customer to ensure safety in the event of incorrect, missing, or abnormal signals caused by broken signal lines, momentary power interruptions, or other causes. Not doing so may result in serious accidents.

⚠ Caution Execute online edit only after confirming that no adverse effects will be caused by extending the cycle time. Otherwise, the input signals may not be readable.

⚠ Caution User programs and parameters written to the Coordinator Module or Motion Control Module will be automatically backed up in the FQM1 flash memory (flash memory function). The contents of I/O memory (including the DM Area), however, are not written to flash memory. Part of the DM Area used as a holding area when recovering from a power interruption is backed up using a super capacitor, but correct values will not be maintained if an error occurs that prevents memory backup. As a countermeasure for such problems, take appropriate measures in the program using the Memory Not Held Flag (A404.14) when externally outputting the contents of the DM Area.

⚠ Caution Confirm safety at the destination Module before transferring a program to another Module or editing the I/O area. Doing either of these without confirming safety may result in injury.

⚠ Caution Tighten the screws on the terminal block of the AC Power Supply Unit to the torque specified in the operation manual. The loose screws may result in burning or malfunction.

⚠ Caution Do not touch the Power Supply Unit while the power is ON, and immediately after turning OFF the power. Touching hot surfaces may result in burning.

⚠ Caution Pay careful attention to the polarities (+/-) when wiring the DC power supply. A wrong connection may cause malfunction of the system.


3-1 Operating Environment Precautions

⚠ Caution Do not operate the control system in the following places:


- Locations subject to direct sunlight
- Locations subject to temperatures or humidity outside the range specified in the specifications
- Locations subject to condensation as the result of severe changes in temperature
- Locations subject to corrosive or flammable gases
- Locations subject to dust (especially iron dust) or salts
- Locations subject to exposure to water, oil, or chemicals
- Locations subject to shock or vibration

⚠ Caution Take appropriate and sufficient countermeasures when installing systems in the following locations:


- Locations subject to static electricity or other forms of noise
- Locations subject to strong electromagnetic fields
- Locations subject to possible exposure to radioactivity
- Locations close to power supplies

 **Caution** The operating environment of the FQM1 System can have a large effect on the longevity and reliability of the system. Improper operating environments can lead to malfunction, failure, and other unforeseeable problems with the FQM1 System. Make sure that the operating environment is within the specified conditions at installation and remains within the specified conditions during the life of the system.

3-2 Application Precautions

 **WARNING** Always heed these precautions. Failure to abide by the following precautions could lead to serious or possibly fatal injury.

- Always connect to a ground of 100 Ω or less when installing the FQM1. Not doing so may result in electric shock.
- Always connect to a ground of 100 Ω or less when short-circuiting the functional ground and line ground terminals of the Power Supply Unit, in particular.
- Always turn OFF the power supply to the FQM1 before attempting any of the following. Not turning OFF the power supply may result in malfunction or electric shock.
 - Mounting or dismounting Power Supply Units, Coordinator Modules, Motion Control Modules, I/O Units, Special I/O Units, CPU Bus Units, and End Modules
 - Assembling the Modules
 - Setting DIP switches
 - Connecting or wiring the cables
 - Connecting or disconnecting the connectors

 **Caution** Failure to abide by the following precautions could lead to faulty operation of the FQM1 or the system, or could damage the FQM1. Always heed these precautions.

- Always use the CX-Programmer (Programming Device for Windows) to create new cyclic tasks and interrupt tasks.
- The user program, parameter area data, and part of the DM Area in the Coordinator Module and Motion Control Modules is backed up in the built-in flash memory. Do not turn OFF the power supply to the FQM1 while the user program or parameter area data is being transferred. The data will not be backed up if the power is turned OFF.
- The FQM1 will start operating in RUN mode when the power is turned ON with the default settings (i.e., if the operating mode at power ON (startup mode) setting in the System Setup is disabled).
- Configure the external circuits so that the control power supply turns ON after the power supply to the FQM1 turns ON. If the power is turned ON in the opposite order, the built-in outputs and other outputs may momentarily malfunction and the control outputs may temporarily not operate correctly.

- Outputs may remain ON due to a malfunction in the built-in transistor outputs or other internal circuits. As a countermeasure for such problems, external safety measures must be provided to ensure the safety of the system.
- Part of the DM Area (data memory) in the Motion Control Module is held using the super capacitor. Corrupted memory may prevent the correct values from being saved, however. Take appropriate measures in the ladder program whenever the Memory Not Held Flag (A316.14) turns ON, such as resetting the data in the DM Area.
- Part of the DM Area in the Coordinator Module is backed up in the built-in flash memory when transferring data from the CX-Programmer. Do not turn OFF the power to the FQM1 while data is being transferred. The data will not be backed up if the power is turned OFF.
- Confirm that no adverse effect will occur in the system before attempting any of the following. Not doing so may result in an unexpected operation.
 - Changing the operating mode of the FQM1 (including setting the operating mode at startup)
 - Force-setting/force-resetting any bit in memory
 - Changing the present value of any word or any set value in memory
- Install external breakers and take other safety measures against short-circuiting in external wiring. Insufficient safety measures against short-circuiting may result in burning.
- Be sure that all the terminal screws and cable connector screws are tightened to the torque specified in the relevant manuals. Incorrect tightening torque may result in malfunction.
- Mount the Modules only after checking the connectors and terminal blocks completely.
- Before touching the Module, be sure to first touch a grounded metallic object in order to discharge any static built-up. Not doing so may result in malfunction or damage.
- Be sure that the terminal blocks, connectors, and other items with locking devices are properly locked into place. Improper locking may result in malfunction.
- Wire correctly according to the specified procedures.
- Always use the power supply voltage specified in the operation manuals. An incorrect voltage may result in malfunction or burning.
- Take appropriate measures to ensure that the specified power with the rated voltage and frequency is supplied. Be particularly careful in places where the power supply is unstable. An incorrect power supply may result in malfunction.
- Leave the dust protective label attached to the Module when wiring. Removing the label may result in malfunction.
- Remove the dust protective label after the completion of wiring to ensure proper heat dissipation. Leaving the label attached may result in malfunction.
- Use crimp terminals for wiring. Do not connect bare stranded wires directly to terminals. Connection of bare stranded wires may result in burning.
- Do not apply voltages to the built-in inputs in excess of the rated input voltage. Excess voltages may result in burning.

- Do not apply voltages or connect loads to the built-in outputs in excess of the maximum switching capacity. Excess voltage or loads may result in burning.
- Disconnect the functional ground terminal when performing withstand voltage tests. Not disconnecting the functional ground terminal may result in burning.
- Wire correctly and double-check all the wiring or the setting switches before turning ON the power supply. Incorrect wiring may result in burning.
- Check that the DIP switches and data memory (DM) are properly set before starting operation.
- Check the user program for proper execution before actually running it on the Module. Not checking the program may result in an unexpected operation.
- Resume operation only after transferring to the new Module the contents of the DM Areas, programs, parameters, and data required for resuming operation. Not doing so may result in an unexpected operation.
- Do not pull on the cables or bend the cables beyond their natural limit. Doing either of these may break the cables.
- Do not place objects on top of the cables. Doing so may break the cables.
- Use the dedicated connecting cables specified in operation manuals to connect the Modules. Using commercially available RS-232C computer cables may cause failures in external devices or the Coordinator Module.
- Do not connect pin 6 (+5V) on the RS-232C port on the Coordinator Module to any external device other than the NT-AL001 or CJ1W-CIF11 Conversion Adapter. Doing so may result in damage to the external device and the Coordinator Module.
- When replacing parts, be sure to confirm that the rating of a new part is correct. Not doing so may result in malfunction or burning.
- When transporting or storing the product, cover the PCBs with electrically conductive materials to prevent LSIs and ICs from being damaged by static electricity, and also keep the product within the specified storage temperature range.
- Do not touch the mounted parts or the rear surface of PCBs because PCBs have sharp edges such as electrical leads.
- When connecting the Power Supply Module, Coordinator Module, Motion Control Module, End Module, I/O Unit, Special I/O Unit, or CPU Bus Unit, slide the upper and lower latches until a click sound is heard to lock them securely. Desired functionality may not be achieved unless Modules are securely locked in place.
- Be sure to mount the End Module supplied with the Coordinator Module to the rightmost Module. Unless the End Module is properly mounted, the FQM1 will not function properly.
- Make sure that parameters are set correctly. Incorrect parameter settings may result in unexpected operations. Make sure that equipment will not be adversely affected by the parameter settings before starting or stopping the FQM1.

4 Conformance to EC Directives

4-1 Applicable Directives

- EMC Directives
- Low Voltage Directive

4-2 Concepts

EMC Directives

OMRON devices that comply with EC Directives also conform to the related EMC standards so that they can be more easily built into other devices or the overall machine. The actual products have been checked for conformity to EMC standards (see the following note). Whether the products conform to the standards in the system used by the customer, however, must be checked by the customer.

EMC-related performance of the OMRON devices that comply with EC Directives will vary depending on the configuration, wiring, and other conditions of the equipment or control panel on which the OMRON devices are installed. The customer must, therefore, perform the final check to confirm that devices and the overall machine conform to EMC standards.

Note Applicable EMC (Electromagnetic Compatibility) standards are as follows:

EMS (Electromagnetic Susceptibility): EN61000-6-2
EMI (Electromagnetic Interference): EN61000-6-4
(Radiated emission: 10-m regulations)

Low Voltage Directive

Always ensure that devices operating at voltages of 50 to 1,000 V AC and 75 to 1,500 V DC meet the required safety standards for the Motion Controller (EN61131-2).

4-3 Conformance to EC Directives

The FQM1-series Flexible Motion Controllers comply with EC Directives. To ensure that the machine or device in which the Motion Controller is used complies with EC Directives, the Motion Controller must be installed as follows:

- 1,2,3...
1. The Motion Controller must be installed within a control panel.
 2. You must use reinforced insulation or double insulation for the DC power supplies used for the communications power supply and I/O power supplies.
 3. Motion Controllers complying with EC Directives also conform to the Common Emission Standard (EN61000-6-4). Radiated emission characteristics (10-m regulations) may vary depending on the configuration of the control panel used, other devices connected to the control panel, wiring, and other conditions. You must therefore confirm that the overall machine or equipment complies with EC Directives.

4-4 EMC Directive Conformance Conditions

The immunity testing condition of the Motion Control Modules is as follows:

Overall accuracy of FQM1-MMA22 analog I/O: +4%/-2%

4-5 Relay Output Noise Reduction Methods

The FQM1-series Flexible Motion Controller conforms to the Common Emission Standards (EN61000-6-4) of the EMC Directives. However, noise generated by relay output switching may not satisfy these Standards. In such a case, a noise filter must be connected to the load side or other appropriate countermeasures must be provided external to the Motion Controller.

Countermeasures taken to satisfy the standards vary depending on the devices on the load side, wiring, configuration of machines, etc. Following are examples of countermeasures for reducing the generated noise.

Countermeasures

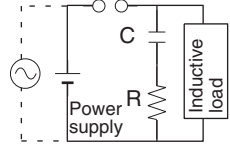
(Refer to EN61000-6-4 for more details.)

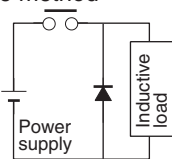
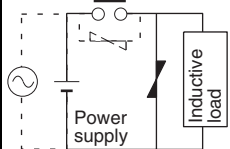
Countermeasures are not required if the frequency of load switching for the whole system with the Motion Controller included is less than 5 times per minute.

Countermeasures are required if the frequency of load switching for the whole system with the Motion Controller included is more than 5 times per minute.

Countermeasure Examples

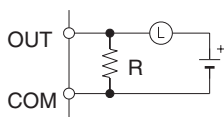
When switching an inductive load, connect a surge protector, diodes, etc., in parallel with the load or contact as shown below.

Circuit	Current		Characteristic	Required element
	AC	DC		
<p>CR method</p> 	Yes	Yes	<p>If the load is a relay or solenoid, there is a time lag between the moment the circuit is opened and the moment the load is reset.</p> <p>If the supply voltage is 24 or 48 V, insert the surge protector in parallel with the load. If the supply voltage is 100 to 200 V, insert the surge protector between the contacts.</p>	<p>The capacitance of the capacitor must be 1 to 0.5 μF per contact current of 1 A and resistance of the resistor must be 0.5 to 1 Ω per contact voltage of 1 V. These values, however, vary with the load and the characteristics of the relay. Decide these values from experiments, and take into consideration that the capacitance suppresses spark discharge when the contacts are separated and the resistance limits the current that flows into the load when the circuit is closed again.</p> <p>The dielectric strength of the capacitor must be 200 to 300 V. If the circuit is an AC circuit, use a capacitor with no polarity.</p>

Circuit	Current		Characteristic	Required element
	AC	DC		
<p>Diode method</p> 	No	Yes	<p>The diode connected in parallel with the load changes energy accumulated by the coil into a current, which then flows into the coil so that the current will be converted into Joule heat by the resistance of the inductive load.</p> <p>This time lag, between the moment the circuit is opened and the moment the load is reset, caused by this method is longer than that caused by the CR method.</p>	<p>The reversed dielectric strength value of the diode must be at least 10 times as large as the circuit voltage value.</p> <p>The forward current of the diode must be the same as or larger than the load current.</p> <p>The reversed dielectric strength value of the diode may be two to three times larger than the supply voltage if the surge protector is applied to electronic circuits with low circuit voltages.</p>
<p>Varistor method</p> 	Yes	Yes	<p>The varistor method prevents the imposition of high voltage between the contacts by using the constant voltage characteristic of the varistor. There is time lag between the moment the circuit is opened and the moment the load is reset.</p> <p>If the supply voltage is 24 or 48 V, insert the varistor in parallel with the load. If the supply voltage is 100 to 200 V, insert the varistor between the contacts.</p>	---

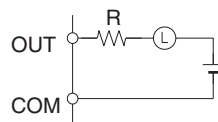
When switching a load with a high inrush current such as an incandescent lamp, suppress the inrush current as shown below.

Countermeasure 1



Providing a dark current of approx. one-third of the rated value through an incandescent lamp

Countermeasure 2



Providing a limiting resistor

The following Unit and Cables can be used with the FQM1-series Flexible Motion Controller.

Name	Model	Cable length
Relay Unit	XW2B-80J7-1A	---
Controller Connecting Cables	XW2Z-050J-A28	0.5 m
	XW2Z-100J-A28	1 m
	XW2Z-050J-A30	0.5 m
	XW2Z-100J-A30	1 m
	XW2Z-050J-A31	0.5 m
	XW2Z-100J-A31	1 m

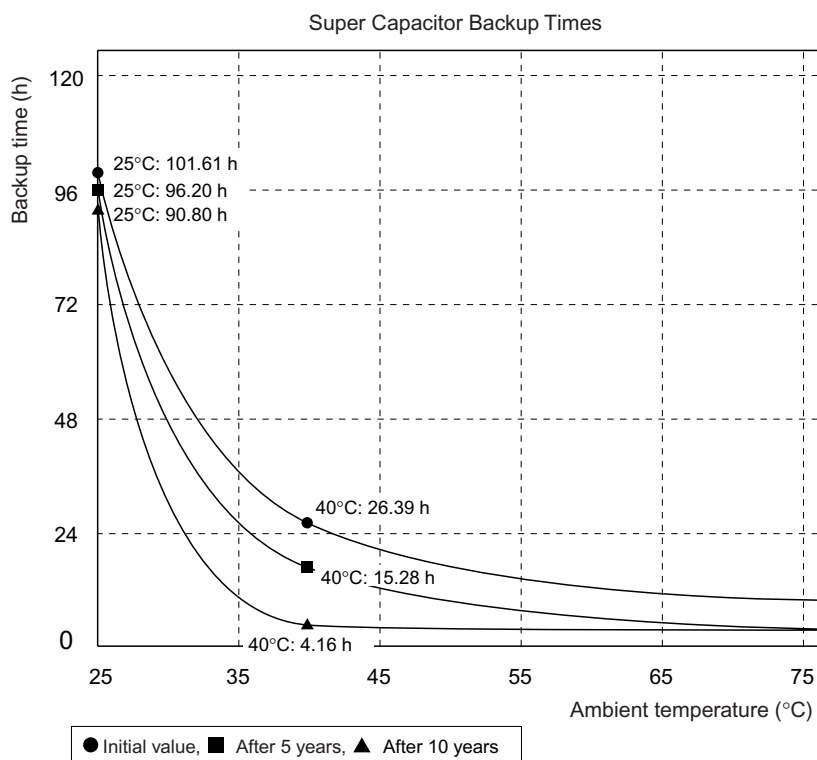
5 Data Backup by Capacitor

The user programs, I/O memory, and other data in the Coordinator Module and Motion Control Modules is backed up either by a super capacitor or flash memory, as listed in the following table.

Module	Data	Data backup
Coordinator Module	Error log	RAM with super capacitor
Motion Control Module	DM Area words D30000 to D32767 Error log	
Coordinator Module	User program System Setup DM Area words D30000 to D32767	Flash memory
Motion Control Module	User program System Setup DM Area words D00000 to D29999 (An Auxiliary Area control bit must be turned ON to save the data.)	

The data backup time of the super capacitor is given in the following table and shown in the following graph.

Temperature	Initial	After 5 years	After 10 years
Ta = 25°C	101.61 hours (4.23 days)	96.2 hours (4.01 days)	90.8 hours (3.78 days)
Ta = 40°C	26.39 hours (1.09 days)	15.28 hours	4.16 hours



- Note 1. The times give above assume that the capacitor is completely charged. Power must be supply to the FQM1 for at least 20 minutes to completely charge the capacitor.

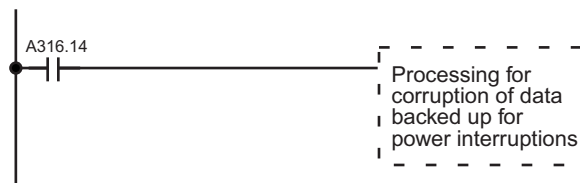
2. The backup time of the super capacitor is reduced as the capacitor ages. It is also affected by the ambient temperature. Use portion of the DM Area backed up by the super capacitor only for data that is to be held during momentary power interruptions. For operating parameters and other long-term data, use the portion of DM Area stored in flash memory in the Coordinator Module and transfer it to the Motion Control Modules before starting operation.

The data in the DM Area and error log will become unstable or corrupted if the power to the system is OFF for longer than the backup time.

If the power supply is to be turned OFF for an extended period of time, use D20000 to D32767 in the Coordinator Module, which is backed up in flash memory, to store data.

Otherwise, the Memory Not Held Flag (A316.14) can be used as the input condition for programming using data in areas stored for power interruptions to perform suitable processing.

A316.14: Turns ON when power is turned ON if data stored for power interruptions in the DM Area or error log is corrupted.



DM Area words D20000 to D32767 in the Coordinator Module can be backed up in flash memory as described in the next section. DM Area words D00000 to D29999 in the Motion Control Module can also be backed up to flash memory, but a password must be set in A752 and control bit A751.15 must be turned ON to save this data.

Backing Up DM Area Data in Flash Memory

DM Area words D20000 to D32767 in the Coordinator Module are read from flash memory when the power supply is turned ON. In addition, DM Area words D00000 to D29999 in the Motion Control Module are read from flash memory when the power supply is turned ON if the System Setup is set to read DM data at startup. We recommend using DM Area words D20000 to D32767 in the Coordinator Module to store operating parameters and other data required for system operation and then using the DM transfer function to transfer the data from the Coordinator Module to the Motion Control Modules at the start of operation.

SECTION 1

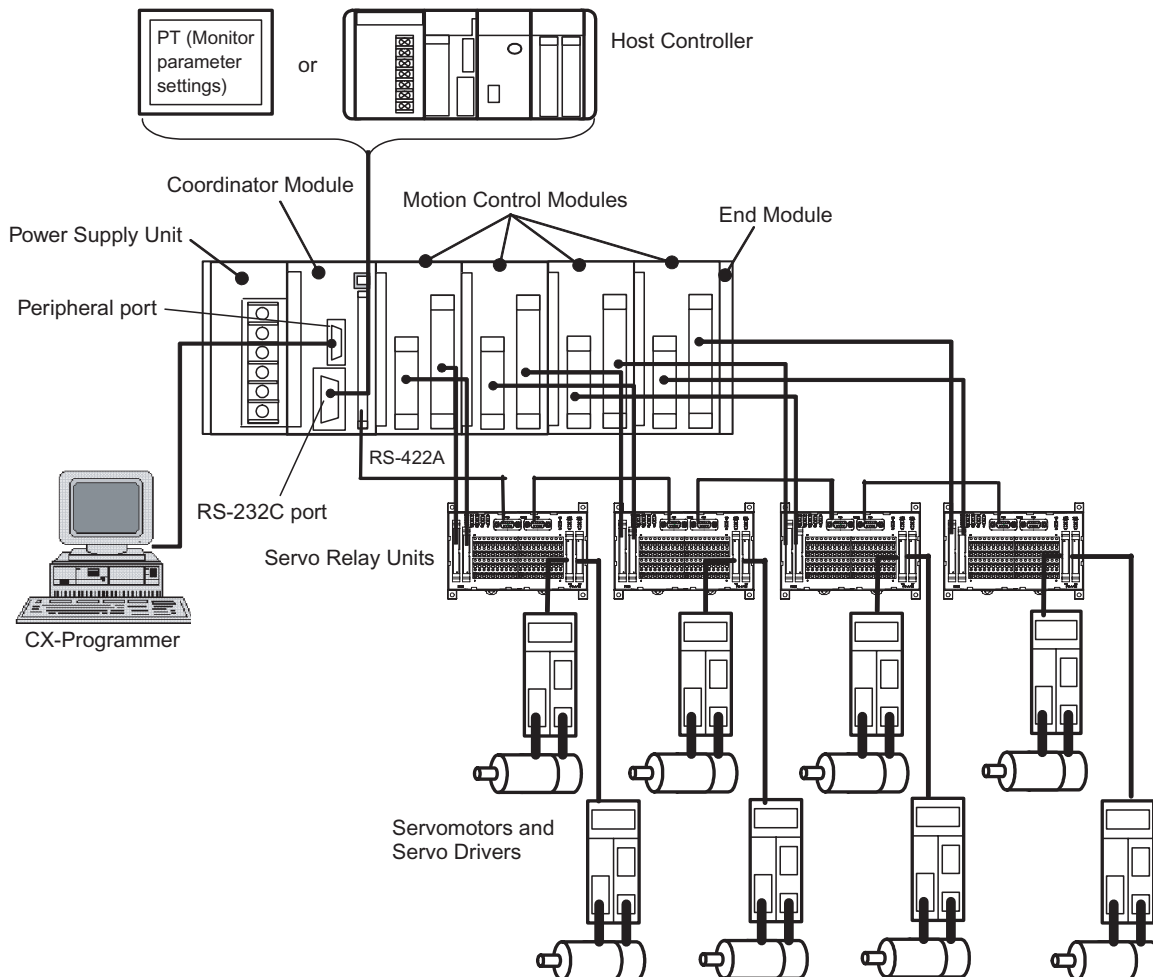
Features and System Configuration

This section describes the features of the FQM1 and its system configuration.

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1-1 Outline of FQM1 Flexible Motion Controller

The FQM1 (Flexible Quick Motion) is a stand-alone Flexible Motion Controller that can be used to create flexible high-speed, high-precision motion control systems for 2 to 8 axes.



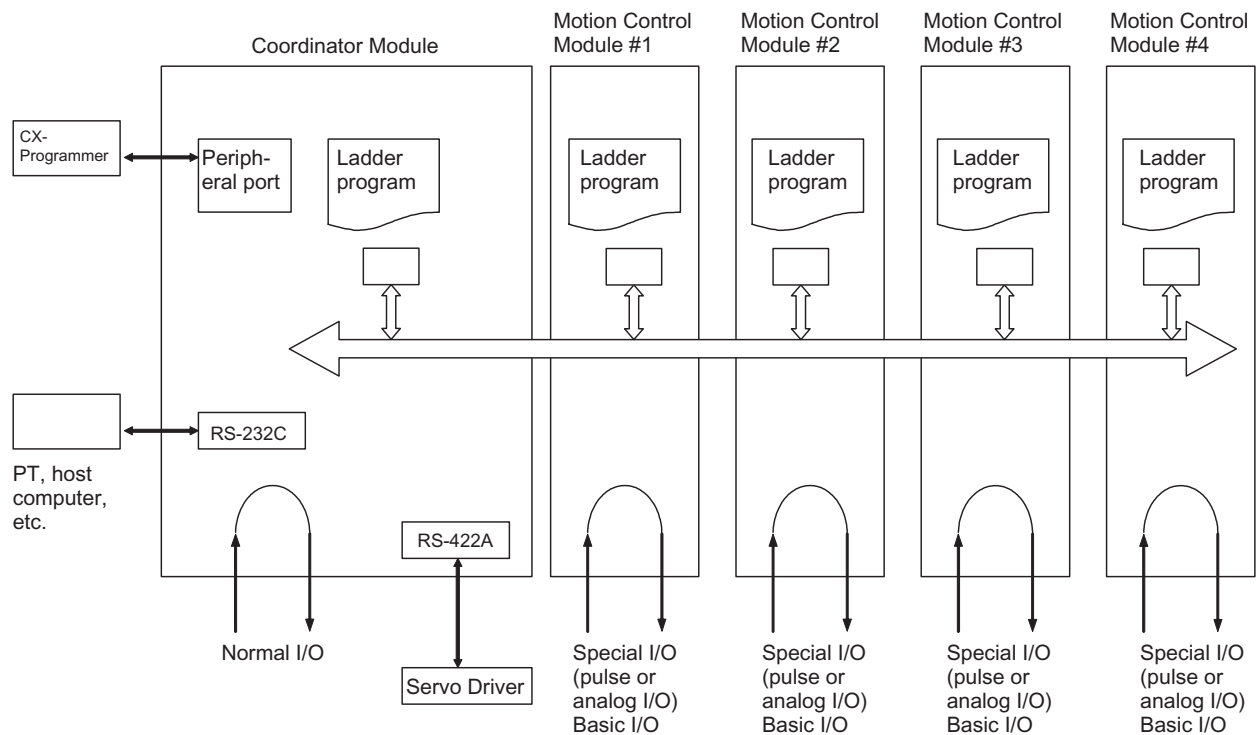
Flexible Configurations of Up To 8 Axes

An FQM1 Flexible Motion Controller System is made up of a Power Supply Unit, a Coordinator Module, one or more Motion Control Modules, and an End Module.

Motion Control Modules are available with either pulse I/O or analog I/O, and a mixture of up to four Motion Control Modules can be included in one system (up to three if only analog I/O Motion Control Modules are used.) A flexible system ideal for the application can be created because each Motion Control Module controls two axes, giving total motion control of eight axes when four Motion Control Modules are connected.

High-speed Processing

Each Motion Control Module and Coordinator Module has independent ladder programming, allowing high-speed independent control of pulse and analog I/O. Data can be shared between all Modules. The Coordinator Module performs general-purpose I/O control and manages overall system operation.



Built-in RS-232C Port in Coordinator Module

A Programmable Terminal (PT) can be connected to the Coordinator Module to monitor present values on the PT or make parameter settings for Servomotors from the PT.

The RS-232C port is useful for a variety of applications. It can be used, for example, to connect to a host computer or for a Serial PLC Link connection to a SYSMAC CJ1M Programmable Controller.

Built-in RS-422A Port in Coordinator Module

A PT can be connected to the Coordinator Module so that Servo parameters can be read from and written to each Servo Driver using a Serial Gateway Function.

Commands can also be sent from the Coordinator Module ladder program to each Servo Driver.

Motion Control with Familiar Ladder Programming

The Coordinator Module and Motion Control Modules each have their own ladder program, which perform basic I/O and special I/O (pulse I/O and analog I/O).

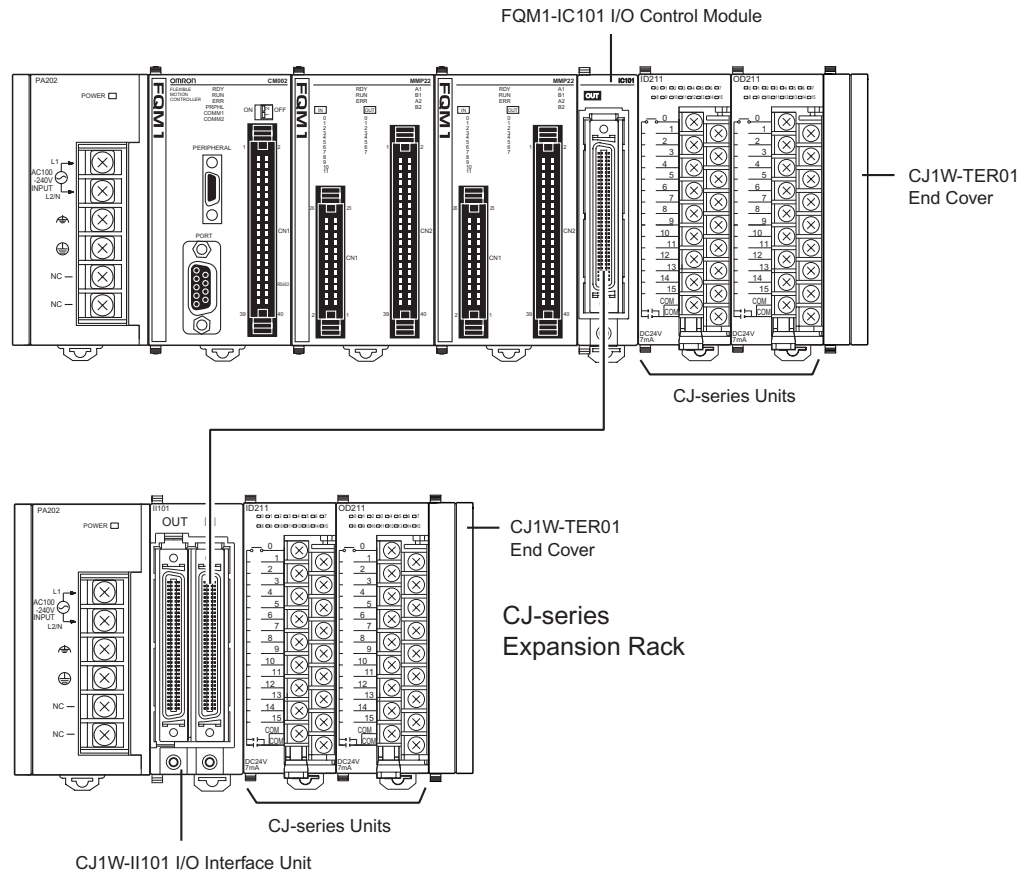
Programming with Function Blocks and ST Language

Function blocks and structured text (ST) programming are supported, so the CX-Programmer's function block and ST programming can be used.

CJ-series Units Supported

When an FQM1-IC101 I/O Control Module is mounted to the FQM1 Controller, some CJ-series Units (Basic I/O Units, CPU Bus Units, Special I/O Units, and Communications Units) are supported. Up to 10 Motion Control Units and CJ-series Units can be mounted.

If mounting space or power supply capacity is limited, a CJ1W-II101 I/O Interface Unit can be used to expand the Controller. (Just one Expansion Rack can be used.)



Note When using CJ-series Units with an I/O Control Module, always mount a CJ1W-TER01 End Cover on the last CJ-series Unit. If an FQM1-TER01 End Module is used, an I/O bus error will occur and the Coordinator Module will stop operating. Likewise, an I/O bus error will occur if only Motion Control Modules are being used (without CJ-series Units) but a CJ-series End Cover is mounted.

Built-in General-purpose I/O in Coordinator Module

The Coordinator Module has 24 built-in I/O (16 inputs and 8 outputs) for communications with host controllers and 12 inputs and 8 outputs for Motion Control Modules.

Built-in General-purpose I/O in Motion Control Modules

Motion Control Modules have 12 contact inputs and 8 contact outputs for I/O with peripheral devices.

Connections for Absolute Servomotors

Motion Control Modules can read absolute position data from W-series Absolute Servomotors/Servo Drivers.

High-speed Counter Latch Function

The high-speed counter latch function latches the high-speed counter's PV using 2 external signals. Ladder programs can then be used to read the latched values.

Pulse Input Sampling Function

The number of pulse inputs within a specified time can be measured.

Pulse Input Frequency Measurement Function

The speed of pulse inputs can be measured at the same time as the number of pulse inputs is counted.

Wide Variety of Interrupt Functions

The FQM1 can provide high-speed I/O responses because it has a wide variety of functions for starting interrupt tasks, in addition to input interrupts, interval timer interrupts, high-speed counter interrupts, and pulse output interrupts.

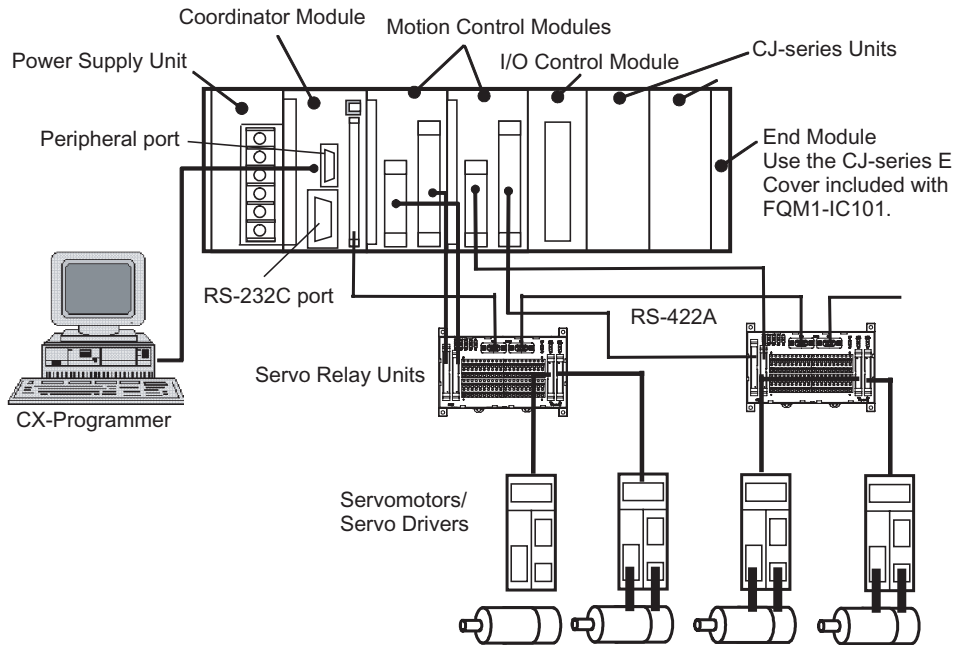
High-speed Analog I/O Supported

Motion Control Modules with analog I/O support linear (displacement/length measurement) sensor input, inverter control, and control of Servomotors with analog-input Servo Drivers. This gives flexibility for a great variety of motion applications.

Writing and Monitoring Ladder Programs

The ladder program for each Module is written using the CX-Programmer and then written to each Module via the peripheral port on the Coordinator Module. The ladder program is saved in each Module and operation of the program can be monitored from the CX-Programmer.

1-2 FQMI Configuration



The FQMI consists of a Power Supply Unit, a Coordinator Module, one or more Motion Control Modules, and an End Module. Motion Control Modules are available with either pulse I/O or analog I/O and up to four Motion Control Modules can be connected in one system. (See note.)

Note The number of Motion Control Modules with Analog I/O that can be connected is limited by the output capacity of the Power Supply Unit.

FQMI-CM002 Coordinator Module

One Coordinator Module is required in an FQMI. The Coordinator Module provides the following:

- I/O: 16 inputs, 8 outputs
- Program capacity: 10 Ksteps
- DM Area capacity: 32 Kwords (DM)

- The CX-Programmer (Ver. 6.11 or later) is connected to the peripheral port on the Coordinator Module, and a PT (Programmable Terminal) or other device is connected to the RS-232C port.
- The Coordinator Module has its own ladder program, which is used to coordinate Motion Control Module data.
- The Coordinator Module has 24 general-purpose I/O (16 inputs and 8 outputs).

- The Coordinator Module has a Cyclic Refresh Bit Area, in which 10 words are allocated for cyclic refreshing with each Motion Control Module. This area is refreshed each Coordinator Module cycle.
- The Coordinator Module has a Synchronous Data Link Bit Area, in which 4 words are allocated for sharing with the Synchronous Data Link Bit Area of each Motion Control Module.

**FQMI-MMP22/MMA22
Motion Control Modules**

Each Motion Control Module provides the following:

Pulse I/O Motion Control Module	FQMI-MMP22	Program capacity: 10 Ksteps Pulse inputs: 2 Pulse outputs: 2 General-purpose inputs: 12 General-purpose outputs: 8
Analog I/O Motion Control Module	FQMI-MMA22	Program capacity: 10 Ksteps Pulse inputs: 2 Analog inputs: 1 Analog outputs: 2 General-purpose inputs: 12 General-purpose outputs: 8

- Rotary Encoders, Linear Sensors, Servos, Inverters, etc., can be connected to the special I/O.
- Each Motion Control Module has a ladder program for executing motion control and other functions.
- Each Motion Control Module has 20 general-purpose I/O (12 inputs and 8 outputs).
- Each Motion Control Module has 10 words allocated in the Coordinator Module's Cyclic Refresh Bit Area that is refreshed every Coordinator Module cycle.
- Each Module cycle, 4 words of Motion Control Module Synchronous Data Link Bit Area data is shared with the Coordinator Module's Synchronous Data Link Bit Area.

**CJ1W-PA202/PA205R
Power Supply Units**

SYSMAC CJ-series Power Supply Units are used.

CJ1W-PA202	100 to 240 V AC, output capacity: 5 V DC, 2.8 A, 24 V DC, 0.4 A, up to 14 W total.
CJ1W-PA205R	100 to 240 V AC, output capacity: 5 V DC, 5.0 A, 24 V DC, 0.8 A, up to 25 W total.

Select a Power Supply Unit with a capacity greater than the total current consumption of the connected Modules.

FQMI-TER01 End Module

One FQMI-TER01 End Module is supplied with the Coordinator Module. Attach the End Module to the right side of the Motion Control Module. When an I/O Control Module is being used, mount a CJ1W-TER01 End Cover on the last CJ-series Unit. (A CJ1W-TER01 End Cover is included with the I/O Control Module.)

Always mount an End Module because it acts as a terminator for the Rack. A fatal I/O bus error will occur if no End Module is attached.

FQMI-IC101 I/O Control Module

An I/O Control Module is required to connect CJ1-series Units to the FQMI Controller. An I/O Control Module is also required to connect an Expansion Rack.

Connect the I/O Control Module to the right side of the Coordinator Module or Motion Control Module. One CJ1W-TER01 End Cover is included with the I/O Control Module. Mount this End Cover to the right side of the Rack if CJ-series Units are mounted.

CJ-series Units

CJ-series Units can be connected to an I/O Control Module (on the FQM1 Rack) or an I/O Interface Unit (on the Expansion Rack). It is possible to connect CJ-series Basic I/O Units, CPU Bus Units, Special I/O Units, and Communications Units, but there are some limitations on the Units that can be connected.

Unit type	Supported models	Description
Basic I/O Units	All models except the CJ1W-INT01 Interrupt Unit and CJ1W-IDP01 Quick-response Input Unit	Provides 320 additional I/O points.
CPU Bus Units	CJ1W-SPU01 Data Collection Unit	Automatically collects specified data at high speed from the Coordinator Module.
	CJ1W-NCF71 MECHATROLINK II Position Control Unit	Connects multiple axes of Servos with communications capabilities.
Special I/O Units	CJ1W-SRM21 CompoBus/S Master Unit	Provides additional I/O points with reduced wiring.
Communications Units	CJ1W-DRM21 DeviceNet Unit	Can be used in Slave mode only. Provides high capacity data exchange with the host PLC.

- Note**
- (1) When a CJ1W-SPU01 Data Collection Unit is mounted, it takes about 20 seconds for the Coordinator Module to recognize the SPU Unit. Consequently, the Controller will be in standby status (CPU waiting) for a longer time when an SPU Unit is mounted.
 - (2) The CJ1W-NCF71 can control up to 16 axes of Servo Drivers, but too many axes may cause an excessive Coordinator Module cycle time because the I/O refreshing time will be longer and a longer program will be required to control the axes. Limit the number of controlled axes to maintain the required Coordinator Module performance.

CJ1W-II101 I/O Interface Unit

An I/O Interface Unit is required to connect an Expansion Rack to the FQM1 Controller. The I/O Interface Unit mounts to the right side of the Expansion Rack's Power Supply Unit.

Other Peripheral Devices

Special Servo Relay Units are available for connecting the FQM1 Flexible Motion Control system to OMRON W-series and SMARTSTEP Servo Drivers. Specific cables suitable for the connected Servomotor/Servo Driver models and the FQM1 Motion Control Module models are also available.

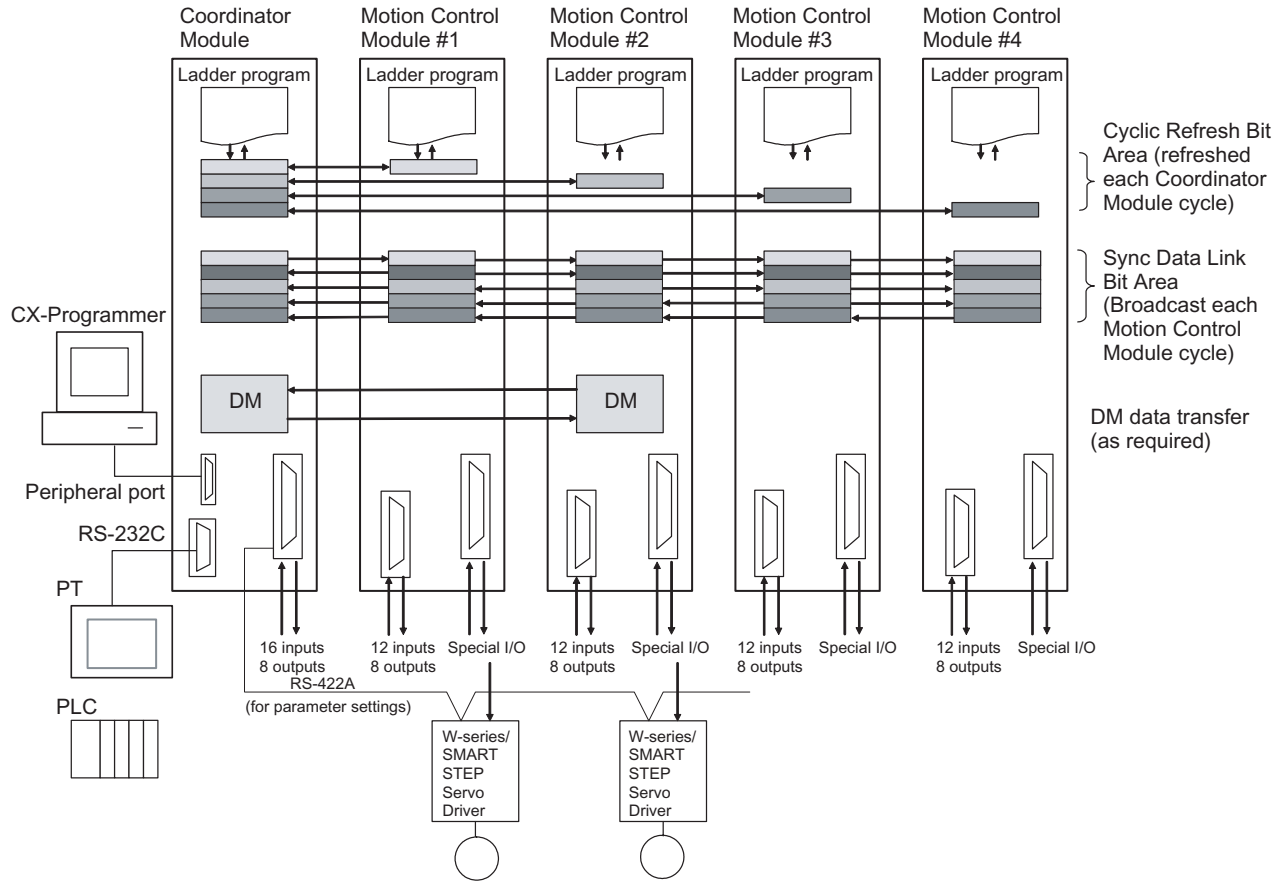
- Note**
- When an I/O Control Module is being used to connect CJ-series Units, always mount a CJ1W-TER01 End Cover on the right side of the Rack. If an FQM1-TER01 End Module is used, an I/O bus error will occur and the Coordinator Module will stop operating. Likewise, an I/O bus error will occur if only Motion Control Modules are being used, but a CJ-series End Cover is mounted.

1-3 Modules

The Coordinator Module acts as the interface between the FQM1 system and peripheral devices, shares data with each Motion Control Module, and synchronizes specific data (e.g., virtual axis data) between Modules. Some CJ-series Units can also be used.

	Item	Details	
Functions	Interfaces for peripheral devices	Connection with the CX-Programmer (peripheral port) Connection with PT for monitoring and parameter settings (RS-232C port) Connections with Servo Drivers (RS-422A port)	
	Sharing data with each Motion Control Module (each Coordinator Module cycle)	There are 10 words allocated for each Motion Control Module in the Cyclic Refresh Bit Area of the Coordinator Module (CIO 4000 to CIO 4039), based on the Motion Control Module slot number. These words correspond to CIO 4000 to CIO 4009 in the Cyclic Refresh Bit Area of each Motion Control Module. <ul style="list-style-type: none"> Coordinator Module to Motion Control Module: 5 words (General-purpose output) Motion Control Module to Coordinator Module: 5 words (General-purpose input: 4 words, program RUN, fatal errors, non-fatal errors) This cyclic refresh data is refreshed every Coordinator Module cycle.	
	Synchronized sharing of special data between Modules (broadcast at specified sync cycle)	User-specified synchronous data (see following list) can be allocated to CIO 1200 to CIO 1219 in the Synchronous Data Link Bit Area of the Coordinator Module and each Motion Control Module, 4 words at a time (2 types of data × 2 words). The allocations are fixed, starting with the Coordinator Module and followed by Motion Control Modules in order of slot number. <ul style="list-style-type: none"> Any ladder program data High-speed counter PV Pulse output PV Analog input PV Analog output PV Built-in I/O input values The synchronous data is broadcast each specified sync cycle and all other Modules receive this data in essentially real-time.	
	DM data transfer with specific Motion Control Modules (as required)	DM data (499 words max.) can be transferred in the specified direction between the specified words in the DM Area in the specified Motion Control Module and the specified DM Area words in the Coordinator Module when the DM Write Request Bit (A530.00) or DM Read Request Bit (A530.01) in the Auxiliary Area of the Coordinator Module turns ON.	
	Exchange data with CJ-series Units	An FQM1-IC101 I/O Control Module can be mounted to the Coordinator Module in order to use some CJ-series Units. Data will be exchanged with the CJ-series Units each Coordinator Module cycle.	
I/O	Serial communications	<ul style="list-style-type: none"> Peripheral port: Peripheral bus (for CX-Programmer) One RS-232C port: NT Link (for OMRON PTs), Host Link (for host computers), or no protocol (for PLCs) One RS-422A port (Same connector as general-purpose I/O): 1:N communications with Servo Drivers (for transferring parameters to Servo Drivers) 	
	General-purpose I/O	General-purpose inputs: 16 General-purpose outputs: 8	40-pin connector (including RS-422A)
Programs	Program capacity	10 Ksteps (for data exchange with host computer, coordination of Motion Control Modules, and other peripheral programming)	

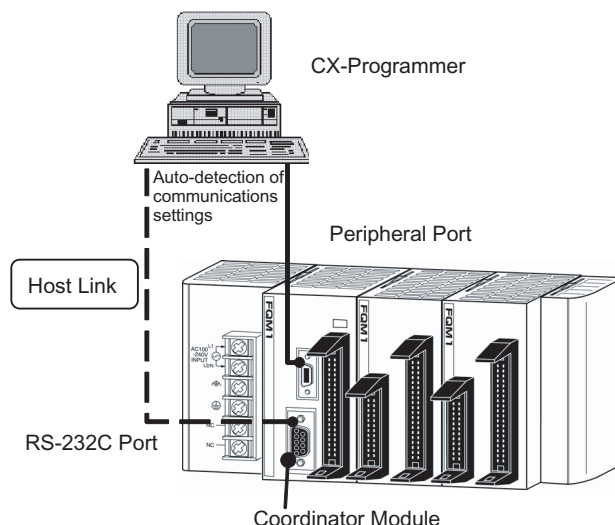
Outline of Internal Data Exchange and I/O



<p>Coordinator Module</p>	<ul style="list-style-type: none"> • Peripheral port for connecting CX-Programmer and RS-232C port for connecting PTs and other devices • Ladder program for coordinating Motion Control Module data and other functions • 24 general-purpose I/O • 10 words of cyclic refresh data for each Motion Control Module allocated in Cyclic Refresh Bit Area, which is refreshed each Coordinator Module cycle • 4 synchronous data link words allocated for each Motion Control Module in Coordinator Module's Synchronous Data Link Bit Area, which is shared each Module cycle • Memory is allocated to each CJ-series Basic I/O Unit, Special I/O Unit, and CPU Bus Unit and the prescribed amount of data is exchanged with the Units each Module cycle.
<p>Motion Control Modules</p>	<ul style="list-style-type: none"> • Linear Sensors, Servo Drivers, Inverters, etc., connected to special I/O • Ladder program for executing motion control and other functions • 20 general-purpose I/O • 10 words of cyclic refresh data for each Motion Control Module allocated in its Cyclic Refresh Bit Area, which is refreshed each Coordinator Module cycle • 4 synchronous data link words allocated for each Motion Control Module in Coordinator Module's Synchronous Data Link Bit Area, which is shared each Module cycle

1-4 CX-Programmer

The CX-Programmer provides programming and debugging functions. Use CX-Programmer Ver. 6.11 or later for the FQM1-CM002, FQM1-MMP22, or FQM1-MMA22. Refer to 8-1 CX-Programmer.



CX-Programmer

Item	Details		
Applicable Motion Controllers	FQM1 Series Note CX-Programmer can also be used for SYSMAC CS/CJ-series PLCs.		
OS	Microsoft Windows 95, 98, or NT4.0 Service Pack 6	Microsoft Windows 2000 or Me	Microsoft Windows XP
Personal computers	IBM PC/AT or compatible	IBM PC/AT or compatible	IBM PC/AT or compatible
Connection method	Peripheral port or built-in RS-232C port on the Coordinator Module		
Communications protocol with FQM1	Peripheral Bus or Host Link		
Offline functions	Programming, editing of I/O memory, System Setup, printing		
Online functions	Transferring comparing data, monitoring, System Setup		
Main functions	<ol style="list-style-type: none"> 1. Programming functions: Creating and editing of applicable FQM1 ladder or mnemonic programs. 2. Changing operating modes for each Module. 3. Transfer functions: Transferring programs, I/O memory data, and System Setup between computer and Modules. 4. Monitoring program execution status: Monitoring I/O bit status and PV using ladder display, monitoring I/O bit status and PV using mnemonic display, and monitoring PV using I/O memory display. 		

Note The CX-Programmer can be connected online to FQM1 Coordinator Modules and Motion Control Modules at the same time. If the default baud rate is changed when Coordinator and Motion Control Modules are connected at the same time, set the baud rate to 38.4 kpps max.

The following table lists the Programming Devices other than the CX-Programmer that can be used with CJ-series Units.

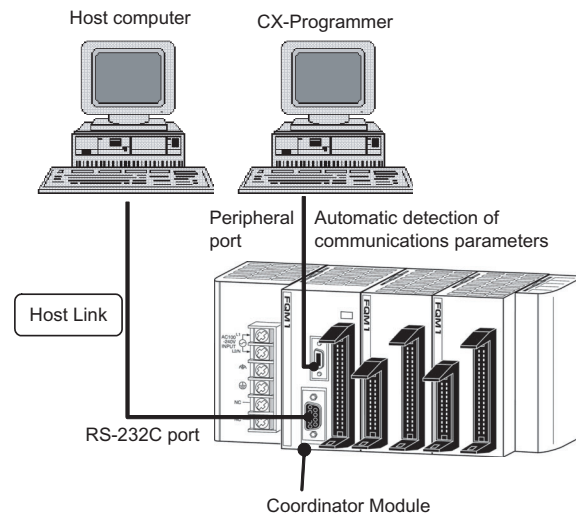
Programming Device	Description	Connection
CX-Designer NS-Designer	These are Programming Devices for HMI devices. Can be connected through the Coordinator Module's communications port or directly connected to PT.	Supported
CX-Motion-NCF	The CX-Motion-NCF can be used to set CJ1W-NCF71 Position Control Units and connected Servo Drivers. Connect through the Coordinator Module's communications port.	Supported
CX-Integrator	The CX-Integrator is network configuration support software, which cannot be used through the Coordinator Module's communications port. DeviceNet settings for DeviceNet Slave Units in the FQM1 can be made through the DeviceNet Master Unit mounted to the host PLC. The Configurator can be connected to the Coordinator Module's communications port.	Not supported
CX-Drive	Use the CX-Motion-NCF to change parameters in Servo Drivers connected to a CJ1W-NCF71 Position Control Unit.	Not supported
SPU-Console	The SPU-Console can be used to set and operate SYSMAC SPU Units. Connect this Programming Device directly to the SPU Unit.	Supported

1-5 Expanded System Configuration

1-5-1 Serial Communications

The FQM1 system can be expanded using the two serial ports built into the Coordinator Module: Peripheral port and RS-232C port.

System Configuration



1-5-2 Systems

The serial communications port mode (protocol) can be switched in the Coordinator Module's System Setup. Depending on the protocol selected, the following systems can be configured.

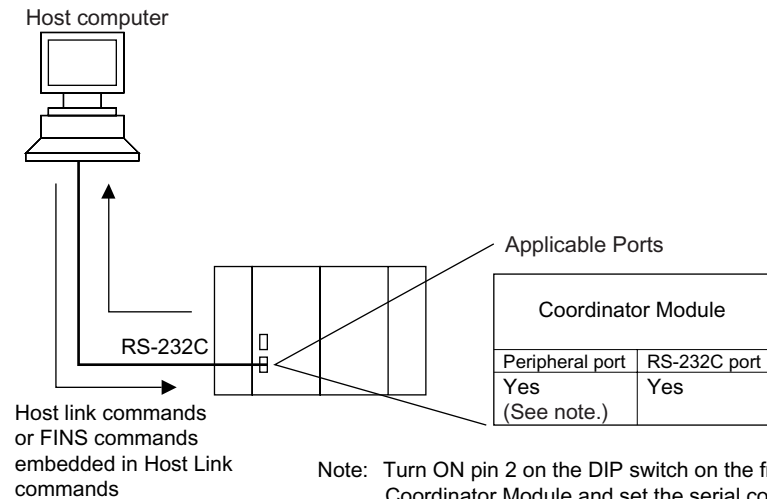
Protocols

The following protocols support serial communications.

Protocol (Serial communications mode)	Main connection	Use	Applicable commands and communications instructions
Host Link (SYS-MAC WAY)	Personal computer OMRON Programmable Terminals (PTs)	Communications between the host computer and the Module	Host Link commands/ FINS commands
No-protocol (custom) communications	General-purpose external devices Servo Drivers Host controllers	No-protocol communications with general-purpose devices, host controllers, and Servo Drivers	TXD(236) instruction and RXD(235) instruction
NT Links (1: N)	OMRON Programmable Terminals (PTs)	High-speed communications with Programmable Terminals via direct access	None
Peripheral Bus (Toolbus)	CX-Programmer	Communications between the CX-Programmer running on a computer and the FQM1	None
Serial PLC Link Slave	OMRON PLC	Communications between OMRON PLC and the FQM1	None
Serial Gateway	OMRON Programmable Terminals (PTs) Servo Drivers	Communications between a PT and W-series or SMARTSTEP Servo Drivers via the FQM1	FINS commands

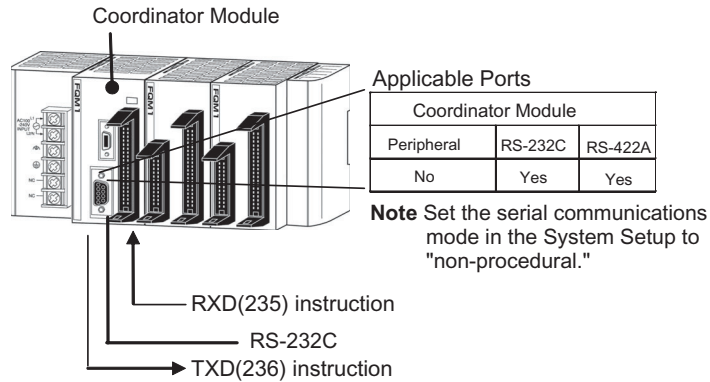
Host Link System (SYSWAY Mode)

The Host Link System allows the I/O memory of the Modules to be read/written and the operating mode to be changed from a host computer (personal computer or Programmable Terminal (PT)) by executing Host Link commands or FINS commands that are preceded by a Host Link header and followed by a terminator. A Host Link System is possible for either the peripheral port or the RS-232C port on the Coordinator Module.



No-protocol (Custom) Communications System via RS-232C Port

No-protocol communications allow simple data transmissions, such as inputting bar code data and outputting printer data using communications port I/O instructions TXD(236) and RXD(235). The start and end codes can be set and, RS and CS signal control is also possible with no-protocol communications.

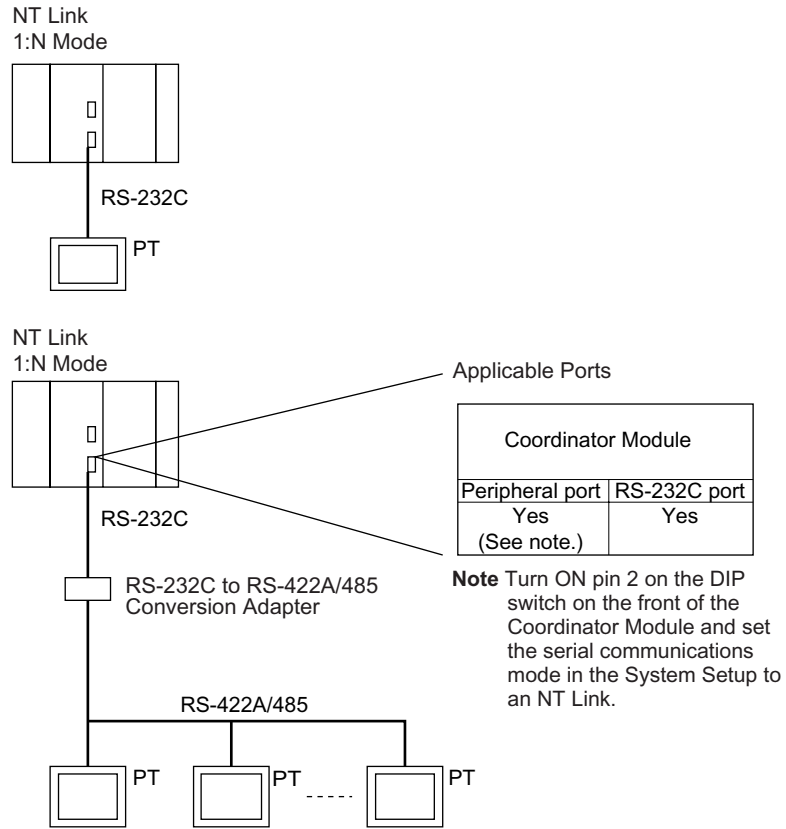


NT Link System (1:N Mode, Standard)

If the FQM1 and a Programmable Terminal (PT) are connected together using the RS-232C port, the allocations for the PT's status control area, status notify area, objects such as touch switches, indicators, and memory maps can be allocated in the I/O memory of the FQM1.

The NT Link System allows the PT to be controlled by the FQM1, and the PT can periodically read data from the status control area of the FQM1, and perform necessary operations if there are any changes in the area. The PT can communicate with the FQM1 by writing data to the status notify area of the FQM1 from the PT. The NT Link System allows the PT status to be controlled and monitored without using FQM1 ladder programming. The ratio of FQM1 Controllers to PTs is 1: n ($n \geq 1$).

Set the PT communications settings for a 1:N or Standard NT Link. An NT Link System is possible for either the peripheral port or the RS-232C port.



- Note**
- (1) The FQM1 can be connected to any PT port that supports 1:N NT Links. It cannot be connected to the RS-232C ports on the NT30 or NT30C, because these ports support only 1:1 NT Links.
 - (2) The Programming Console functionality of a PT (Expansion Function) cannot be used.
 - (3) When more than one PT is connected to the same FQM1, be sure that each PT is assigned a unique unit number. Malfunctions will occur if the same unit number is set on more than one PT.
 - (4) The NT Link System includes 1:1 and 1:N modes. These two modes are not compatible as serial communications modes.

Serial PLC Link Slave

The FQM1 can be connected to a Serial PLC Link by using the Complete Link Method or linking to a Serial PLC Master.

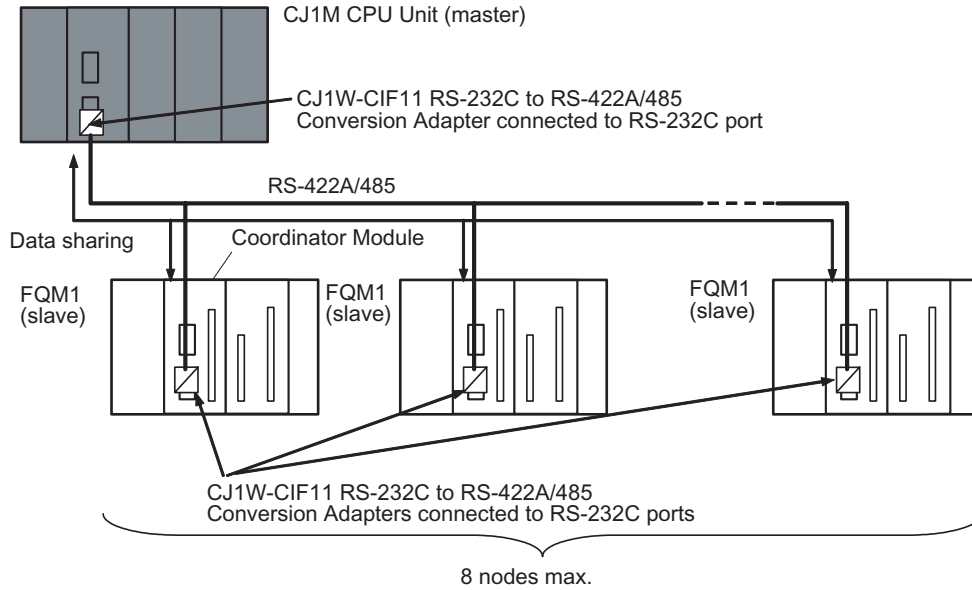
With the Complete Link Method, the CJ1M CPU Unit and FQM1 can perform program-free data exchange with all other nodes.

With the Serial PLC Master Method, the CJ1M CPU Unit acts as a Master and the FQM1 acts as a Slave to provide program-free data exchange between the master and slave. The FQM1 connection is made to the RS-232C port on the Coordinator Module.

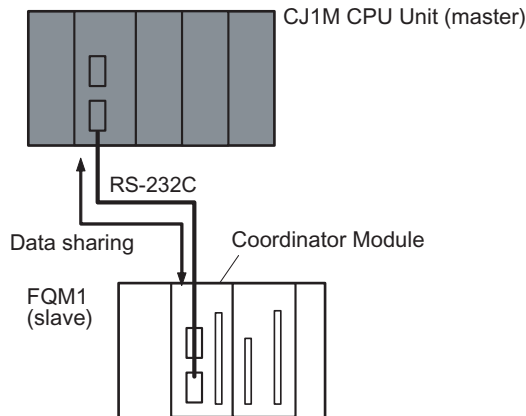
Words CIO 3100 to CIO 3189 in the Coordinator Module's Serial PLC Link Bit Area are shared with the CJ1M master, as shown in the following diagram.

- Note**
- Use a CJ1W-CIF11 RS-232C to RS-422A/485 Conversion Adapter when connecting more than one FQM1 to the same CJ1M CPU Unit (1:N, where N = 8 max.).

1:N Connection between CJ1M and FQM1 Controllers (8 Controllers Max.)



1:1 Connection between CJ1M and FQM1 Controller



Serial Gateway

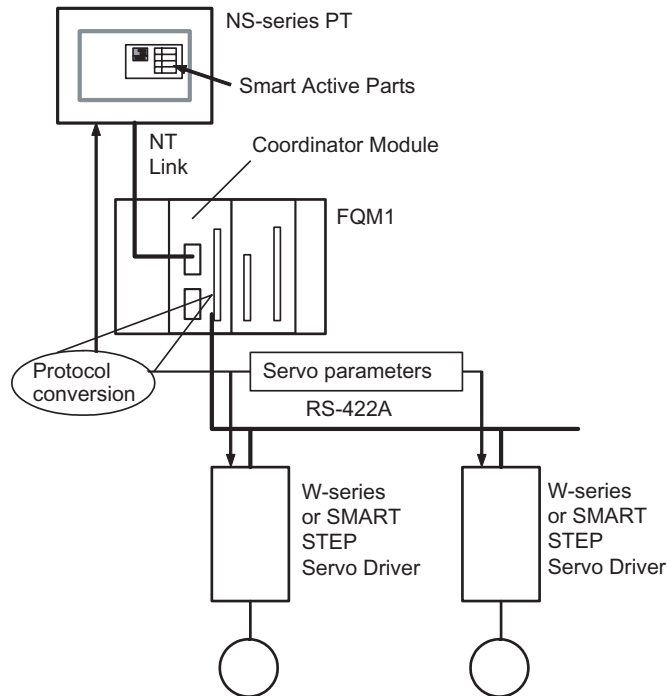
Reading/writing Servo Parameters and other data in Servo Drivers connected via RS-422A can be performed through the FQM1 Coordinator Module from an NS-series PT or computer application running on CX-Server. The serial communications mode for the RS-422A port on the FQM1 Coordinator Module is set to Serial Gateway to achieve this.

Servo Drivers Connectable to RS-422A

OMRON's W-series or SMARTSTEP Servo Drivers can be connected.

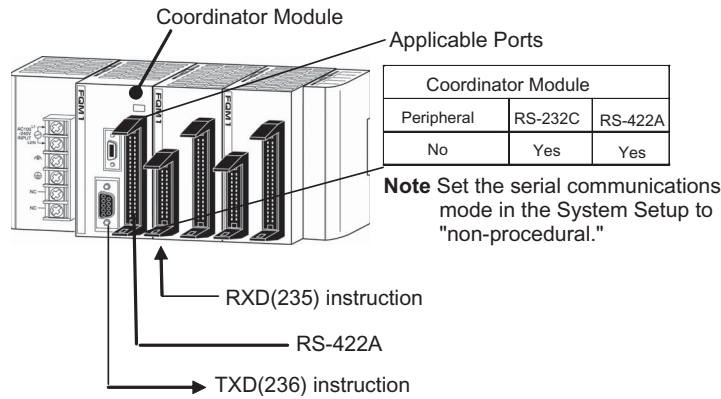
System Configuration Example

Smart Active Parts on an NS-series PT connected via an NT Link can be used to access W-series or SMARTSTEP Servo Drivers.



No-protocol (Custom) Communications System via RS-422A Port

No-protocol communications allow simple data transmissions, such as inputting bar code data and outputting printer data using communications port I/O instructions TXD(236) and RXD(235). The start and end codes can be set with no-protocol communications.



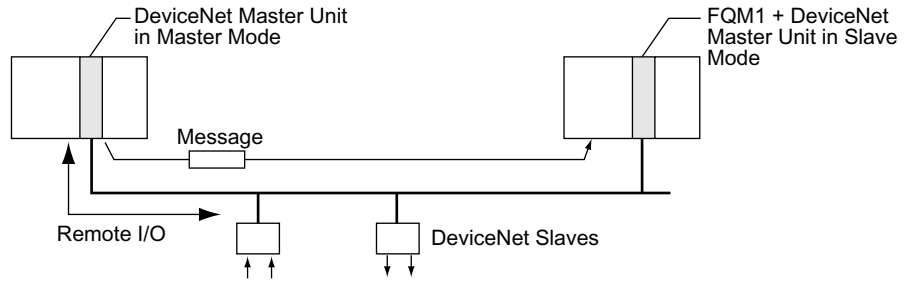
1-5-3 Communications Network Systems

The FQM1 Controllers have the following communications network systems.

DeviceNet

DeviceNet is a multi-bit, multi-vendor network that combines control and data transfers on a machine/line-control level and that conforms to DeviceNet open field network specifications. Remote I/O communications can be achieved between the PLC (Master) and FQM1 (Slave) by mounting a DeviceNet Master Unit in Master mode in the host PLC and mounting a DeviceNet Master Unit in Slave mode in the FQM1 (Coordinator Module). Remote I/O communications provide high I/O capacity and flexible I/O data allocation.

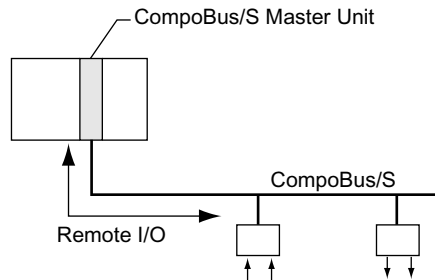
Note The FQM1 can be used in Slave mode only.



- Note**
- (1) The FQM1 supports the CJ1W-DRM21 Master Unit operating in Remote I/O Slave mode only. The Master Unit cannot be used in Master mode.
 - (2) The FQM1 does not support the CJ1W-DRM21 Master Unit's message communications function. Use the Master Unit only as a Remote I/O Slave.
 - (3) To allocate memory from a Programming Device (free allocation), either connect the CX-Integrator to the host PLC (such as a CJ1M) in which the Master Unit is mounted or use a Configurator to make the settings. With the FQM1-CM002, it is also possible to use the FQM1's allocated DM Area.

CompoBus/S

The CompoBus/S network is a high-speed ON/OFF bus for remote I/O. Remote I/O communications can be achieved between the FQM1 (Coordinator Module) and various Slaves by mounting a CompoBus/S Master Unit. CompoBus/S features high-speed communications and can transfer 256 bits of data in a communications cycle time less than 1 ms.



Overview of the Communications Networks

System	Network	Function	Communications	Communications devices
Control system	DeviceNet	Links the PLC and component devices.	High-capacity remote I/O over an open network (fixed or user-set allocation)	DeviceNet Master Unit and Configurator
	CompoBus/S		High-speed remote I/O over an OMRON network (fixed allocation)	CompoBus/S Master Unit

Note The FQM1 does not support the DeviceNet message communications function.

Communications Specifications

Item		Specification	
		DeviceNet	CompoBus/S
Communication methods	Message communications	Supported	---
	Data link	---	---
	Remote I/O	Supported	Supported
Maximum baud rate		500 kbps Communications cycle: About 5 ms (128 inputs and 128 outputs)	750 kbps Communications cycle: About 1 ms max. (128 inputs and 128 outputs)
Total communications distance		100 m (500 m when using thick cable)	100 m
Maximum number of nodes		63 nodes	32 nodes
Communications medium		DeviceNet cable	2-conductor cable or special flat cable
Data link capacity (per network)		---	---
Maximum number of remote I/O points		3,200 points	256 points
Connectable devices		PLCs and Slaves (Slaves include I/O Terminals, Remote Adapters, Sensor Terminals, CQM1 I/O Link Units, Analog Output Terminals, and Analog Input Terminals.)	PLCs and Slaves (Slaves include I/O Terminals, Remote I/O Modules, Sensor Terminals, Sensor Amplifier Terminals, and Bit-chain Terminals.)

1-6 Basic Operating Procedure

The following procedure outlines the normal steps to operate the FQM1.

1,2,3...

1. Installation

Connect the Power Supply Unit, Coordinator Module, Motion Control Modules, and End Module. Refer to *3-1-4 Connecting FQM1 Components* for details.

Mount the FQM1. Refer to *3-1-5 DIN Track Installation* for details
2. Wiring

Connect the power supply wiring and ground. Refer to *3-2-1 Wiring Power Supply Units* for details.

Wiring I/O terminals and connectors. Refer to *3-3 Wiring Module Connectors* for details.
3. Initial Hardware Settings

Set the DIP switch on the front of the Coordinator Module as required. Refer to *2-3 Coordinator Module* for details.
4. Turning ON Power and Checking Initial Operation

Connect the CX-Programmer. Refer to *3-1-4 Connecting FQM1 Components* for details.

Check the power supply wiring and voltage and then turn ON the power supply. Check the RDY indicator and CX-Programmer display. Refer to *8-2 Connecting the CX-Programmer* for details.
5. System Setup Settings Using the CX-Programmer

With the FQM1 in PROGRAM mode, change the settings in the System Setup as necessary from the CX-Programmer online. (Another method is to change the System Setup in CX-Programmer offline and transfer it to the Coordinator Module and Motion Control Modules.) Set the Sync Mode under *Synchronization between Modules* to ASync Mode to make debugging easier. Refer to *System Setup in the Coordinator Module* on page 390 in *Appendix C System Setup, Auxiliary Area Allocations, and Built-in I/O Allocations* for details.

6. Writing the Programs

Write the programs for the Coordinator Module and Motion Control Modules with the CX-Programmer. Refer to *Appendix A Programming* and to the *FQM1 Instructions Reference Manual* (Cat. No. 0011) for details.

7. Transferring the Programs

Transfer the programs from CX-Programmer to the Coordinator Module and Motion Control Modules.

8. Testing Operation

a. Checking I/O Wiring

Output wiring	With the FQM1 in PROGRAM mode, force-set output bits and check the status of the corresponding outputs.
Input wiring	Activate sensors and switches and either check the status of the input indicators or check the status of the corresponding input bits with the CX-Programmer's Bit/Word Monitor operation.

b. Trial Operation

Test operation after switching the FQM1 to MONITOR mode.

c. Monitoring and Debugging

Monitor operation from the CX-Programmer. Use functions such as force-setting/force-resetting bits, tracing, and online editing to debug the program.

Note If the Coordinator and Motion Control Modules are connected at the same time, set the baud rate to 38.4 kpps max.

9. Saving and Printing the Programs

Save the debugged ladder programs and System Setup.

10. Running the Programs

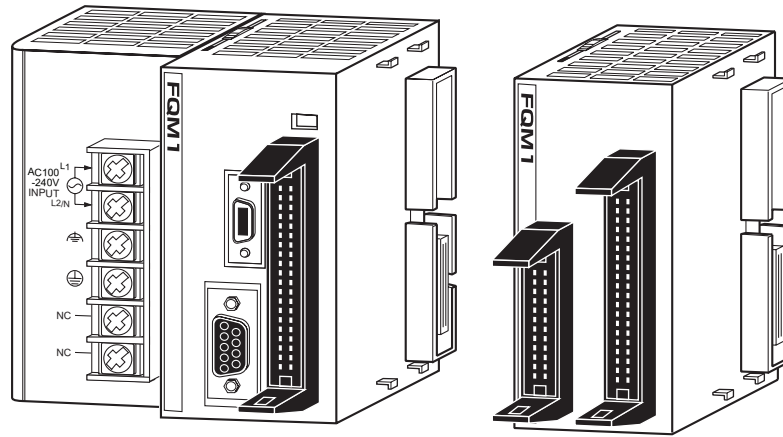
Switch the FQM1 to RUN mode to run the programs.

Note The structure of data areas such as the Auxiliary Area and Cyclic Refresh Bit Area are different in the FQM1-CM001/MMP21/MMA21 and FQM1-CM002/MMP22/MMA22 models, but the data areas can be automatically converted between the CM001 ↔ CM002 formats or MMP21/MMA21 ↔ MMP22/MMA22 formats by changing the PLC model selected in the CX-Programmer.

1-6-1 Examples

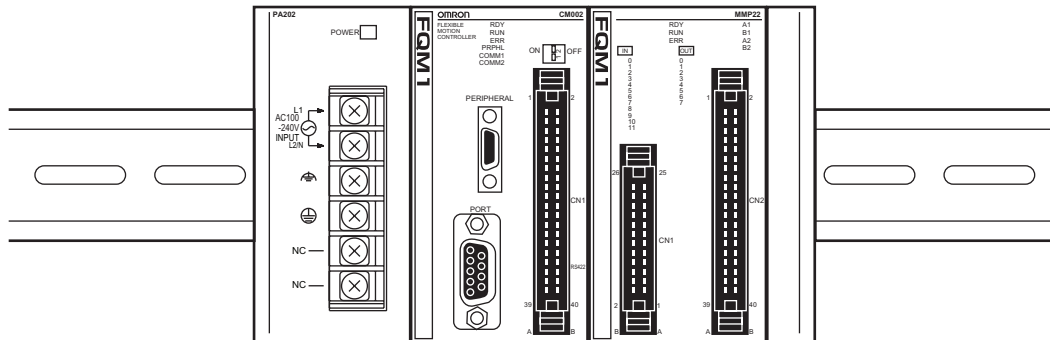
1. Installation

Connect the Power Supply Unit, Coordinator Module, Motion Control Modules, and End Module to assemble the FQM1.



Make sure that the total power consumption of the Modules is less than the maximum capacity of the Power Supply Unit.

Use DIN Track to mount the FQM1 to the control panel.



2. Wiring

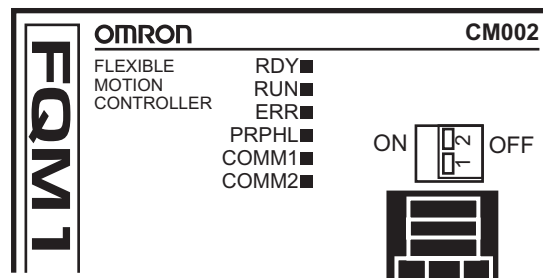
Connect the power supply, ground, and I/O wiring.

3. Initial Hardware Settings

Set the DIP switch on the Coordinator Module. In particular, be sure that the settings for the peripheral port are correct.

Example: When connecting the CX-Programmer to the peripheral port, turn OFF pin 2.

Note When devices other than the CX-Programmer are connected to the peripheral port and RS-232C port, turn ON pin 2.



4. Turning ON Power and Checking Initial Operation

- Note** The System Setup and user programs are backed up in built-in flash memory. When the data is being backed up, a message indicating the data is being transferred will be displayed on the CX-Programmer. Never turn OFF the power supply to the FQM1 while data is being backed up.

5. System Setup Settings

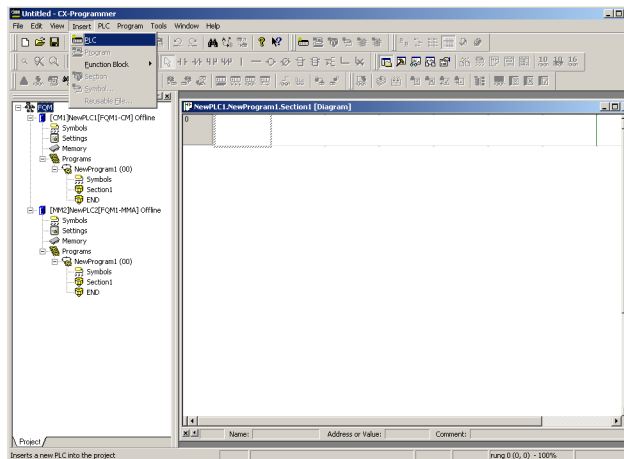
These settings determine the Modules' software configuration. Refer to *Appendix C System Setup, Auxiliary Area Allocations, and Built-in I/O Allocations* for details.

- Note** The FQM1 is set to the Sync Mode by default. This mode must be changed on the Coordinator Module when programming Motion Control Modules, transferring programs, or debugging. Set the mode to ASync Mode in the System Setup of the Coordinator Module to enable changing the operating modes of the Motion Control Modules and creating programs directly from the CX-Programmer.

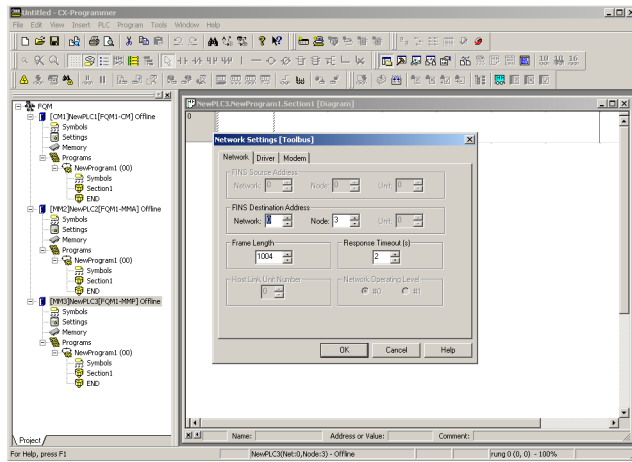
6. Writing the Programs

Write each program with the CX-Programmer, including one cyclic task and the required number of interrupt tasks.

- 1,2,3... 1. Add Motion Control Modules to the tree by executing **Insert - PC** for the number of Motion Control Modules connected to the Coordinator Module.



2. When connecting online to a Motion Control Module through the Coordinator Module, the node set for the FINS destination address in the network settings in the Change PC Type Window determines the Motion Control Module that is connected. Normally the node number is automatically allocated for the Motion Control Module when **Insert - PC** is executed.



7. Transferring the Programs

When the programs has been created in the CX-Programmer, they must be transferred to the Motion Control Modules through the Coordinator Module.

8. Testing Operation

8-a) I/O Wiring Checks

Check Output Wiring

With the FQM1 in PROGRAM mode, force-set and force-reset output bits from the CX-Programmer and verify that the corresponding outputs operate properly.

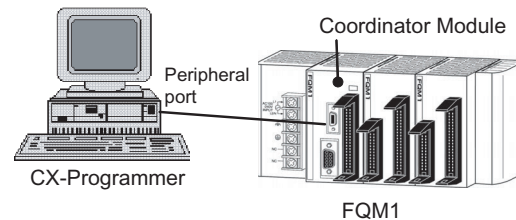
Check Input Wiring

Activate input devices, such as sensors and switches, and verify that the corresponding input indicators light. Also, use the Bit/Word Monitor operation from the CX-Programmer to verify the operation of the corresponding input bits.

8-b) Trial Operation

Use the CX-Programmer to switch each Module to MONITOR mode.

Using the CX-Programmer



Trial operation
 Select **PC - Mode - MONITOR**.
 Actual operation
 Select **PC - Mode - RUN**.

8-c) Monitoring and Debugging

There are several ways to monitor and debug FQM1 operation, including the force-set and force-reset operations, differentiation monitoring, time chart monitoring, data tracing, and online editing.

Force-Set and Force-Reset

When necessary, the force-set and force-reset operations can be used to force the status of bits and check program execution.

From the CX-Programmer, select the bit to be force-set or force-reset and then select **Force On** or **Off** from the PLC menu.

Differentiation Monitor

The differentiation monitor operation can be used to monitor the up or down differentiation of particular bits. Use the following procedure from the CX-Programmer.

- 1,2,3...**
1. Select the bit for differential monitoring.
 2. Select **Differential Monitor** from the PLC Menu. The Differential Monitor Dialog Box will be displayed.
 3. Select **Rising** or **Falling**.
 4. Click the **Start** Button.

Time Chart Monitoring

The CX-Programmer's time chart monitor operation can be used to check and debug program execution.

Data Tracing

The CX-Programmer's data trace operation can be used to check and debug program execution.

Online Editing

When a few lines of the program in a Module have to be modified, they can be edited online with the FQM1 in MONITOR mode or PROGRAM mode from the CX-Programmer. When more extensive modifications are needed, upload the program from the Module to the CX-Programmer, make the necessary changes, and transfer the edited program back to the Module.

9. Save and Print the Programs

To save a program, select **File** and then **Save** (or **Save As**) from the CX-Programmer menus.

To print a program, select **File** and then **Print** from the CX-Programmer menus.

10. Run the Programs

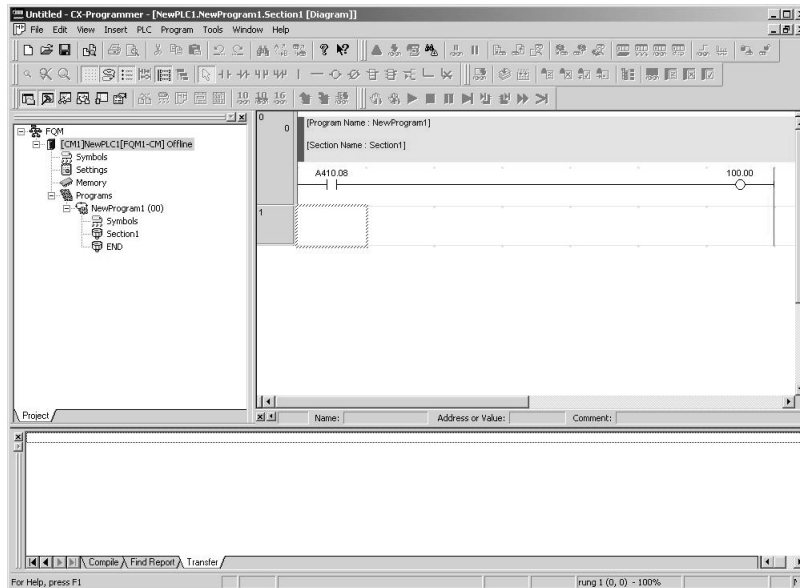
Switch the FQM1 to RUN mode to run the programs.

1-6-2 Converting Programs from Previous Models

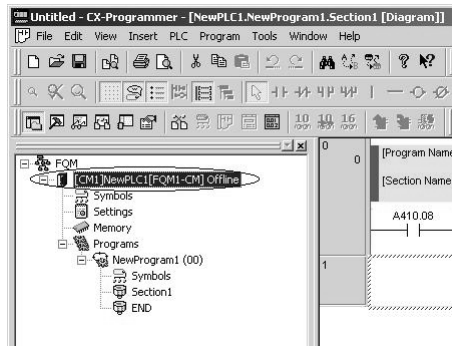
The layout of the Auxiliary Area and Cyclic Refresh Areas differ between the FQM1-CM001, FQM1-MMP21, and FQM1-MMA21 and the FQM1-CM002, FQM1-MMP22, and FQM1-MMA22. Programs can be converted to allow for these difference, however, merely by changing the CPU type setting on the CX-Programmer.

As an example, the procedure for converting a ladder program from the FQM1-CM001 to the FQM1-CM002 is shown here along with the corresponding CX-Programmer windows.

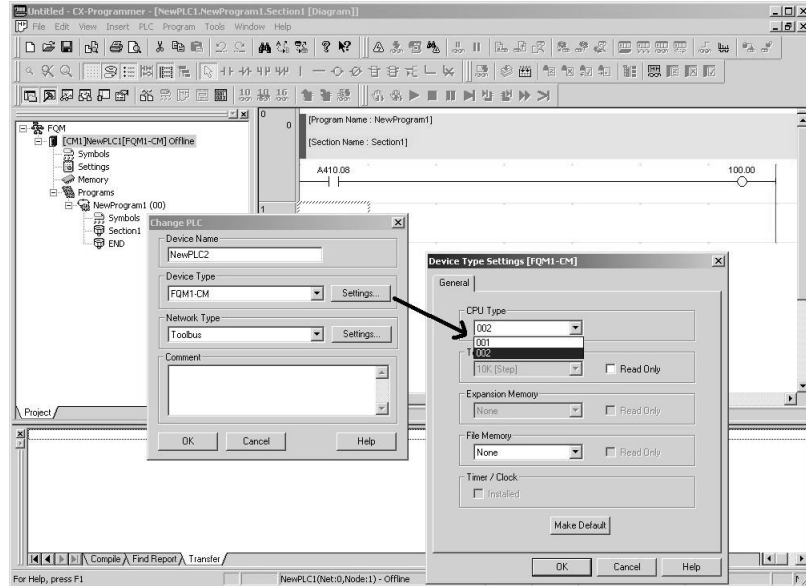
- 1,2,3... 1. Read the ladder program for the FQM1-CM001 on the CX-Programmer. The addresses in the ladder program, such as A410.08 and CIO 100.00 will be converted.



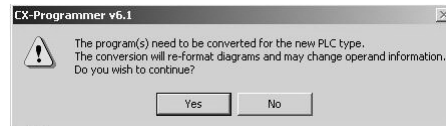
2. Double-click the icon circled in the following window to enable changing the CPU type.



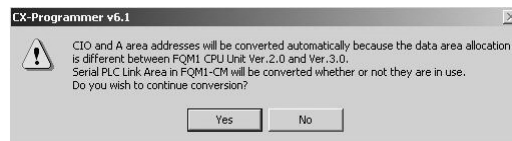
- The Change PLC Dialog Box will be displayed as shown below. Click the **Settings** Button to the right of the *Device Type* Field. The Device Type Settings Dialog Box will be displayed. Change the CPU type to “002” and click the **OK** Button.



- The following dialog box will be displayed. Click the **Yes** Button to convert the program.



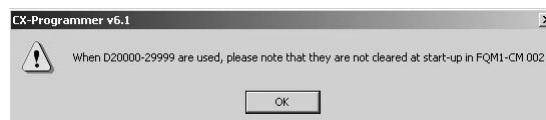
- The following dialog box will be displayed. If the **Yes** Button is clicked, the Serial PLC Link Areas will be converted even if serial PLC links are not being used. If any part of the Serial PLC Link Areas is used as work bits in the program, check the program to be sure that no problems have resulted from conversion (e.g., only part of continuous data may be converted) and manually correct the program as required.



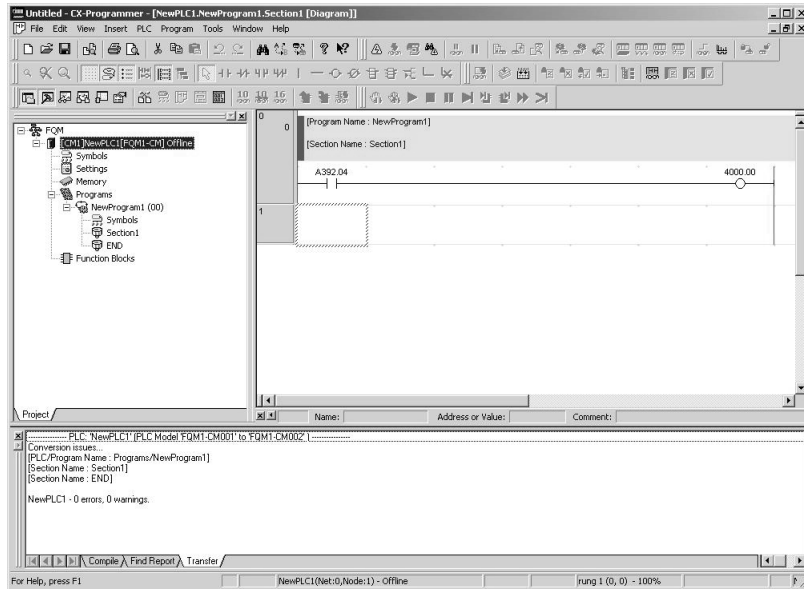
- The conversion will be processed when the **Yes** Button in the following dialog box is clicked. If the following words in the DM Area are continuously written from a PT or using the DM transfer function (excluding writing from the program), the service life of the built-in flash ROM will be exhausted sooner. Use other words to prevent this.

Also, these DM Area words are not cleared at startup for the FQM1-CM002. If they must be cleared at startup, include suitable instructions to clear them from the ladder program.

This dialog box appears only when converting between the FQM1-CM001 and FQM1-CM002.



The program will appear as shown below after conversion, with addresses changed to those for the FQM1-CM002.



1-7 Function Tables Arranged by Purpose

1-7-1 Sync Cycles and Synchronized data

Purpose		Operation	Function used	Details
Synchronizing 3 or more axes	Simple control of all axes operations from the Coordinator Module	Synchronizing all Motion Control Modules to Coordinator Module cycle	Sync Mode, Sync Cycle Time	<p><i>5-1 Synchronous Operation between Modules</i></p> <p>Set Sync Mode to Sync and Sync Cycle Time to 0 ms. Executes Motion Control Module ladder programs at the same time as Coordinator Module ladder program, which makes it easy to control Motion Control Module program execution from the Coordinator Module ladder program.</p>
			Synchronous Data Link Bit Area	<p><i>5-2 Data Exchange between Modules</i></p> <p>If information to be shared between Modules every cycle is placed in the Synchronous Data Link Bit Area, it is automatically shared between Modules every cycle.</p> <p>Synchronous operation is also possible because programs can handle the same data between different Modules.</p> <p>Example: Sending position data for VIRTUAL AXIS (AXIS) instruction from a Module; sending high-speed counter PVs from pulse inputs, etc.</p>
			Constant Cycle Time (Coordinator Module) Sync Cycle Time (matches cycle time)	<p><i>5-1 Synchronous Operation between Modules</i></p> <p>The cycle time of the Coordinator Module can be made constant using the Constant Cycle Time function.</p> <p>This constant cycle time is set as the Sync Cycle Time in the FQM1.</p>
			Cycle Time (Motion Control Modules)	<p><i>5-1 Synchronous Operation between Modules</i></p> <p>The Coordinator Module's constant cycle time is set as the FQM1 Sync Cycle Time (as above). The I/O refresh interval for the Motion Control Module within that Sync Cycle Time is made constant, and the I/O cycle with external interfaces is also made constant.</p>
			Prohibit System Interruption of the Sync Mode	<p><i>5-4-4 Settings</i></p> <p>Used to synchronize, as much as possible, the start of processing between Modules.</p> <p>When system interrupts are prohibited, the variation in the start of processing between Modules is approx. 2 μs.</p>

Purpose		Operation	Function used	Details
Synchronizing 3 or more axes	Make control cycle as short as possible with Modules synchronized	Synchronizing Motion Control Modules only	Sync Mode, Sync Cycle Time	<p><i>5-1 Synchronous Operation between Modules</i></p> <p>Set Sync Mode to Sync and Sync Cycle Time to between 0.1 and 10.0 ms.</p> <p>If the Coordinator Module cycle varies or gets too long after connecting the FQM1 to peripheral devices, Motion Control Module operation can be synchronized to have short control cycles for Motion Control Modules only.</p> <p>The Sync Cycle Time can be set to any value.</p>
			Synchronous Data Link Bit Area	Same as "Synchronous Data Link Bit Area," above.
			Cycle Time (Motion Control Modules)	<p><i>5-1 Synchronous Operation between Modules</i></p> <p>The Coordinator Module's constant cycle time is set as the FQM1 Sync Cycle Time (as above). The I/O refresh interval for the Motion Control Module in that Sync Cycle Time is made constant and the I/O cycle with external interfaces is also made constant.</p>
			Prohibit System Interruption of the Sync Mode	Same as "Prohibit System Interruption of the Sync Mode" above.
	Control operation using pulse and analog data simultaneously	Synchronizing Motion Control Modules to Coordinator Module cycle or synchronizing between Motion Control Modules only	Synchronous Data Selection	<p><i>5-4 Synchronous Data Refresh</i></p> <p>Information for I/O from different Motion Control Modules can be stored within Modules and a control loop created.</p> <p>Select the type of synchronous data.</p> <ul style="list-style-type: none"> • Ladder execution results • High-speed counter PV • Pulse output PV • Analog input values • Analog output values • Built-in I/O inputs
Fast control loops		Changing to Async Mode	Sync Mode	<p><i>5-1 Synchronous Operation between Modules</i></p> <p>Set the Sync Mode to Async.</p> <p>Each Module will no longer be synchronized, bus refreshing will stop, and the Motion Control Module overhead time will be minimized.</p> <p>The minimum overhead time for FQM1-MMP22 is 0.19 ms.</p>

1-7-2 Position and Speed Control

Purpose		Operation	Main functions used	Details
PTP positioning using pulse I/O	Using Servo Driver compatible with an incremental encoder or stepping Servomotor/Servo Driver	Controlling positioning speed	<ul style="list-style-type: none"> Relative pulse output functions Pulse output instructions (SPED(885)(885), ACC(888), PULS(886), and PLS2(887)) 	<p><i>7-6-6 Pulse Output Function Details</i></p> <p>Set operating mode to Relative Pulse Output. The number of pulses is determined from the current position. Instructions to control pulses and speed can be used, depending on what is to be controlled. Speed can be controlled between 20 Hz and 1 MHz.</p> <ul style="list-style-type: none"> Basic I/O can be used for origin signal and other I/O, and pulse inputs can be used for encoder inputs, for Servomotors/Servo Drivers For stepping motors, combination with basic I/O and pulse (CW) + direction control is possible.
		Controlling trapezoidal positioning speed control	<ul style="list-style-type: none"> PLS2(887) instruction 	<p><i>7-6-12 PLS2(887) Pulse Output Direction Priority Mode</i></p> <p>Trapezoidal positioning at any acceleration/deceleration ratio.</p> <p>The system will automatically switch to triangle control (trapezoidal control without constant speed interval) when acceleration/deceleration conditions with specified total output pulses do not lead to trapezoidal control.</p>
			Speed Change Cycle Selection (2 ms/1 ms)	<p><i>7-6-11 Acceleration/Deceleration Rates in ACC(888) and PLS2(887)</i></p> <p>The speed change cycle of ACC(888) and PLS2(887) instructions can be selected. This is useful for fine control of time taken to reach target speed or to reduce positioning time.</p>
		Defining the origin	Pulse Output PV Reset	<p><i>7-5-8 Pulse Input Function Description</i></p> <p>Turn ON the Pulse Output PV Reset Bit at the origin.</p> <p>A876.00 (pulse output 1)/A877.00 (pulse output 2) turn ON.</p>
Using Servo Drivers compatible with an Absolute Encoder	Controlling positioning speed	Controlling positioning speed	<ul style="list-style-type: none"> Absolute Pulse Output Pulse output instructions (SPED(885)(885), ACC(888), PULS(886), and PLS2(887)) 	<p><i>7-6-6 Pulse Output Function Details</i></p> <p>Change operating mode to Absolute Pulse Output. The number of pulses in the command is handled as an absolute position. Everything else is the same as relative pulse output.</p>
		Controlling trapezoidal positioning speed	<ul style="list-style-type: none"> PLS2(887) instruction 	<p>Same as for Servo Drivers compatible with an incremental encoder, outlined above.</p>
			Pulse Output Direction/Absolute Position Priority Mode Setting	<p><i>7-6-12 PLS2(887) Pulse Output Direction Priority Mode</i></p> <p>Can switch between giving priority to CW/CCW output direction specification for PLS2(887) instructions or absolute position specification to determine output direction.</p>

Purpose		Operation	Main functions used	Details
PTP positioning using pulse I/O	Using Servo Drivers compatible with an Absolute Encoder	Reading PV from Servo Driver	<ul style="list-style-type: none"> • Absolute counter operation (absolute linear/circular) • High-speed counter absolute encoder read 	<p><i>7-7 Functions for Servo Drivers Compatible with Absolute Encoders</i></p> <p>Set counter operation to Absolute Linear (CW-), Absolute Circular, or Absolute Linear (CW+). Uses OMRON W-series Servo Drivers and reads the absolute position from the Servo Driver before operation starts. Once the origin has been set, it is easier to find the origin by reading the absolute position before operation starts.</p>
		Presetting the absolute position to the pulse output counter.	Pulse output counter PV convert (INI(880) instruction)	<p><i>7-6-6 Pulse Output Function Details</i></p> <p>Reflects in the pulse output instruction the absolute value read using the absolute encoder read instruction outlined above.</p>
PTP positioning using analog I/O	Using Servo Driver compatible with an incremental encoder	Position control in semi-closed loop using virtual pulse output function	<ul style="list-style-type: none"> • Virtual axis (AXIS instruction) • High-speed counter (FB pulse) • Analog output instructions with position deviation using virtual axis and high-speed counter 	<p><i>7-8 Virtual Pulse Output Function</i></p> <p>Uses virtual axis (AXIS instruction) in relative mode. The current position output for the AXIS instruction is used as the command pulse to create a position loop with the high-speed counter PV (the feedback pulse from the Servo Driver). A control loop for the analog output instruction is generated according to this deviation and used.</p>
		Use Servo Drivers compatible with Absolute Encoder	Position control in semi-closed loop using virtual pulse output function	As above	7-8 Virtual Pulse Output Function Uses virtual axis (AXIS instruction) in absolute mode. Everything else is the same as above.
		Reading current position from Servo Driver	<ul style="list-style-type: none"> • Absolute counter mode (absolute linear/circular) • High-speed counter absolute encoder read 	Same as PTP positioning with pulse I/O when Servo Drivers compatible with Absolute Encoder used.
		Presets absolute position in AXIS instruction	<ul style="list-style-type: none"> • High-speed counter PV • MOVL instruction 	<p><i>7-8 Virtual Pulse Output Function</i></p> <p>Presets the high-speed counter PV read using the high-speed counter absolute encoder read instruction outlined above, and presets and uses this PV as the current position output in the AXIS instruction. The PV is preset before executing AXIS instruction.</p>

Purpose		Operation	Main functions used	Details
PTP positioning using analog I/O	Simple positioning using inverters	Stepped or sloped analog output corresponding to the high-speed counter PV	<ul style="list-style-type: none"> • Target value match instruction (CTBL(882) instruction) for high-speed counter • Analog output instruction (SPED(885) instruction) or analog output slope variation (ACC(888) instruction) in interrupt tasks 	<p><i>7-10 Analog Outputs</i></p> <p>Used when positioning only using speed command according to analog output.</p> <p>Applicable when speed patterns have been determined based on specified positions.</p> <p>An instruction to change the output variable every time instructions are executed (SPED(885) instruction) and an instruction to change analog outputs at a specified rate of change every 2 ms (ACC(888) instruction) are available for analog outputs.</p> <p>Fine speed control loops can be included using the FQM1 high-speed cycle time and analog output conversion functions (approx. 40 μs).</p>
Path control	Drawing path with linear interpolation	Executing electronic cam control for 2 axes synchronized to virtual axis	<ul style="list-style-type: none"> • Virtual axis (AXIS instruction) • Create path tables using ladder program (APR instruction) • Electronic cam pulse output (PULS(886) instruction) 	<p><i>7-8 Virtual Pulse Output Function</i></p> <p>Pulse output operation mode set to electronic cam control mode (linear).</p> <p>Virtual axis used as basic axis. Path can be drawn by synchronizing 2 pulse output axes (controlled as slave axes) with the basic axis.</p> <p>Set the desired path pattern to the broken-line approximation instruction (APR instruction) table data, and execute pulse output control based on the APR instruction calculation result for the basic axis.</p> <p>The maximum number of line points for one APR instruction is 256, but multiple APR instructions can be used in ladder programs so the number of curve points can be increased by setting the table data across multiple APR instructions.</p>
	Drawing path with circular interpolation	As above	As above	
	Drawing elliptical and other special locus	As above	As above	
Synchronous control	Slave axis control synchronized to real axis.	Electronic cam: Changing target position and speed every cycle based on input pulse (position or angle for one rotation, etc.) to execute positioning.	<ul style="list-style-type: none"> • High-speed counter PV • Cam curve generation or cam curve table every cycle based on ladder programming (APR instruction) • Pulse output with specified target position and frequency (PULS(886) instruction) • Constant cycle time 	<p><i>7-6-14 Pulse Output Function Examples</i></p> <p>Set pulse output operation mode to electronic cam control mode (linear) or electronic cam control mode (circular).</p> <p>Makes Motion Control Module cycle times constant, specifies target position and speed, and executes pulse outputs to Servo Driver for the slave axis according to high-speed counter PV.</p> <p>If cam curves are generated using ladder programming, the cam curves can be changed during operation.</p> <p>High-precision, synchronized control with external axes is possible with FQM1 high-speed cycle.</p>

Purpose		Operation	Main functions used	Details
Synchronous control	Slave axis control synchronized to virtual axis.	Electronic cam: Changing target position and speed every cycle based on virtual pulse output (position or speed) to execute positioning.	<ul style="list-style-type: none"> • Virtual axis (AXIS instruction) • Cam curve generation or cam curve table every cycle based on ladder programming (APR instruction) • Pulse output with specified target position and frequency (PULS(886) instruction) • Constant cycle time 	<p><i>7-8 Virtual Pulse Output Function</i></p> <p>Execute pulse output control of slave axis based on virtual axis position and speed using AXIS instruction, instead of high-speed counter PV for real axis outlined above.</p> <p>Instead of the slave axis operation reflecting the real machinery operation outlined above, this method is used to operate position control for multiple axes using the same timing.</p>
	Control of a particular axis operation at a speed with a uniform ratio applied	Electronic gear operation: Pulse outputs based on input pulses multiplied by a set factor.	<ul style="list-style-type: none"> • High-speed counter PV • Straight-line table (APR instruction) • Pulse outputs with specified target position and frequency (PULS(886) instruction) • Constant cycle time 	<p><i>7-6-13 Pulse Output Function Procedures</i></p> <p>Set pulse output operating mode to electronic cam control (circular).</p> <p>Prepare a straight line table whose slope becomes the multiplier for APR instruction and use APR instructions to calculate the pulse output target position for slave axis corresponding to high-speed counter PV and executes pulse output control.</p> <p>Speed is set and controlled to enable distribution of specified number of pulses within FQM1 control cycle.</p>
Speed control	Creating any trapezoidal speed control pattern (e.g., S-curve acceleration/deceleration) (fine control of acceleration/deceleration using time)	Electronic cam operation: Changing target position and speed every cycle according to time axis and perform positioning.	<ul style="list-style-type: none"> • Cam curve generation or cam curve table every cycle based on ladder programming (APR instruction) • Pulse output with specified target position and frequency (PULS(886) instruction) • Constant cycle time 	<p><i>7-6-13 Pulse Output Function Procedures</i></p> <p>Set pulse output operation mode to electronic cam control mode (linear) or electronic cam control mode (circular).</p> <p>Used for applications such as creating ideal Servomotor control patterns.</p> <p>Makes the Motion Control Module cycle time constant, generates a time axis using ladder programming, specifies the target position and speed for the Servo Driver of the slave axis based on that time axis and gives pulse outputs.</p> <p>The time unit can be set to milliseconds, allowing fine control in FQM1 high-speed cycles.</p>

Purpose		Operation	Main functions used	Details
Speed control	Torque control (position + torque control) Individual axis control for molding equipment and similar applications	Switching between position and torque control modes. During torque control, performing speed control using high-speed control loops based on feedback from torque sensors.	<ul style="list-style-type: none"> Analog input Pulse input (for Servo Drivers compatible with Absolute Encoders) Analog output Feedback calculations using ladder programs 	<p>7-9 Analog Input Functions</p> <p>7-10 Analog Outputs</p> <p>Uses 2 analog outputs for speed and torque commands for Servo Driver.</p> <p>Can switch freely between position and torque control modes in ladder program, allowing for operations such as position control → torque control → position control.</p> <p>Speed and torque commands to Servo Drivers can be freely controlled during torque control based on feedback from torque sensors via analog inputs.</p> <p>Fine speed control is possible in FQM1 high-speed cycle.</p>
	Line control (winding/feeding control) Tension control, etc.	Performing analog output control based on feedback using analog inputs	<ul style="list-style-type: none"> Analog input Analog output Feedback calculations using ladder programs 	<p>7-9 Analog Input Functions</p> <p>7-10 Analog Outputs</p> <p>Performs speed control of winding and feeding motors while executing feedback calculations in ladder programs based on analog input information from dancer rollers or tension detectors.</p> <p>High-speed feedback loops can be created using FQM1 high-speed cycles and analog I/O conversion (approx. 40 μs).</p>
	Simple speed control corresponding to time axis using inverter	Controlling stepped or trapezoidal analog outputs based on time	<ul style="list-style-type: none"> Timer instructions Analog output instructions (SPED(885) and ACC(888) instructions) 	<p>7-10 Analog Outputs</p> <p>Used to create any speed change pattern using an inverter.</p> <p>The speed pattern is based on the time axis, and the speed can be changed to any value once a set time has passed.</p>

1-7-3 Measuring Input Pulses

Purpose		Operation	Main functions used	Details
Detecting position and length using rotary encoder inputs	High-precision positioning	Counts high-speed encoder output using high-speed counter	Counting at 2 MHz (phase differential × 4)	<p>7-5-8 Pulse Input Function Description</p> <p>Set counter operation to phase differential × 4 and counting speed to 500 kHz.</p> <p>Can be used when high-speed pulse inputs need to be counted using high-speed counter for positioning in μm-units.</p>
	Reading high-speed counter PV when mark has gone past mark sensor	Latching high-speed counter PV when sensor turns ON for latch input	High-speed counter PV latch	<p>7-5-8 Pulse Input Function Description</p> <p>High-speed counter PV captured to latch register when external latch inputs change from OFF to ON.</p> <p>The values can be read using the PRV(881) instruction.</p> <p>Can be quickly read using hardware latch circuits.</p>

Purpose		Operation	Main functions used	Details
Detecting speed using rotary encoder inputs	Detecting speed and use in output control while managing position using encoder inputs	Measuring displacement of workpiece per unit time	Monitoring High-speed Counter Movement (cycle time)	<p><i>7-5-8 Pulse Input Function Description</i></p> <p>Outputs the change in the high-speed counter PV each cycle, while outputting number of input pulses as high-speed counter PV.</p> <p>Used for applications such as detecting speed of external master axis during synchronous control.</p>
			Monitoring High-speed Counter Movement (sampling time specified)	<p><i>7-5-8 Pulse Input Function Description</i></p> <p>Outputs the change in the high-speed counter PV each sampling cycle (1 to 9,999 ms) specified asynchronously to Motion Control Module cycle.</p> <p>Used for applications such as detecting external device speed or number of pulses within a specified time (not used for output control).</p>
	Monitoring speed while managing workpiece position using encoder input	Measure input pulse cycle	Counter frequency measurement (pulse input 1 only)	<p><i>7-5-8 Pulse Input Function Description</i></p> <p>Number of input pulses can be monitored simultaneously as high-speed counter PV and pulse frequency.</p>

1-7-4 High-speed Analog I/O Control

Purpose		Operation	Main functions used	Details
Measuring undulation, distortion, thickness, height, or diameter, etc., of an object	High-speed tracing of analog data when external signal turns ON	Storing analog input value in memory at specified time (constant cycle)	<ul style="list-style-type: none"> Interval timer interrupts PRV(881) instruction 	<p><i>7-9-3 Analog Input Function Specifications</i></p> <p>Can perform analog sampling at a constant cycle, using scheduled interrupt processing in analog input immediate refresh mode.</p> <p>Sampling can be executed at small time intervals using analog input conversion (40 μs).</p> <p>Data stored in memory can also be displayed on PT and other display devices, e.g., to show trends.</p>
	High-speed tracing of analog data synchronized with target object position	Storing analog inputs to DM Area synchronous with position (pulse input)	High-speed analog sampling function	<p><i>7-9-7 High-speed Analog Sampling (FQM1-MMA22 Only)</i></p> <p>Sampling of target measurement object position as compared to the sampling based on time.</p> <p>Interrupt tasks, as outlined above, are not used, so even more detailed sampling is possible.</p> <p>Used for applications such as generating displacement data for the measurement object from one position to another position.</p>

Purpose		Operation	Main functions used	Details
Control using measurement results for undulation, distortion, thickness, height, diameter, etc., of an object	Judgment processing based on measurement results	Reading analog input values in high-speed cycles and performing judgment processing using ladder program	Analog input + ladder programming	<p><i>7-9 Analog Input Functions</i></p> <p>Uses analog sensors to detect objects that can't be detected with ON/OFF sensors and performs judgment by comparing the analog input value and internally held threshold values.</p> <p>Processing with faster tact time is possible using high-speed analog input conversion (40 μs) and high-speed cycle times (approximately 2 μs minimum when only analog inputs are enabled).</p> <p>Also, analog sampling at 50-μs intervals (min.) is possible if analog inputs are set to immediate refresh and PRV(881) instructions are used in parallel processing in the ladder program.</p>
	Position control using measurement results	Performing sync control using high-speed counter PV position information and analog input information simultaneously	Synchronous Data Link Bit Area	<p><i>7-6 Pulse Outputs</i></p> <p><i>7-9 Analog Input Functions</i></p> <p>Can perform synchronous control while performing position control on slave axis synchronized with position based on pulse input or synchronous control while adding analog value from displacement sensor as position control compensation.</p> <p>MMP21 and MMA21 used together for this application.</p>
Responding quickly to external signals with analog control	Changing analog output amount as soon as signal turns ON	Immediate refresh of analog output	<ul style="list-style-type: none"> • Settings for immediate refresh • SPED(885)/ACC(888) instructions 	<p><i>7-10 Analog Outputs</i></p> <p>SPED(885) or ACC(888) instructions can be used to directly refresh analog outputs.</p> <p>Used to change output amount immediately after external signal triggers.</p>
	Reading analog input value as soon as signal turns ON	Immediate refresh of analog input	<ul style="list-style-type: none"> • Settings for immediate refresh • PRV(881) instructions 	<p><i>7-9 Analog Input Functions</i></p> <p>PRV(881) instructions can be used to directly refresh analog inputs.</p> <p>Used to read input values immediately after external signal triggers.</p>
Holding analog output at the maximum value or at the value at that time when set conditions or errors occur.	---	Determining analog output value at output enable OFF or error	Analog output hold function	<p><i>7-10 Analog Outputs</i></p> <p>The analog output status can be held at the maximum value, cleared, or held at the current value at output enable OFF or system errors.</p>

1-7-5 Controlling Timing

Purpose		Operation	Main functions used	Details
Responding quickly to external signals and operate	Executing processing as soon as change in external input signal detected	Starting interrupt processing when an input bit turns ON and/or OFF.	<ul style="list-style-type: none"> Input function settings Interrupt inputs (MSKS(690) instructions) 	7-3 Input Interrupts - <i>Input Interrupt Mode</i> Set input function to Interrupt inputs. Executes interrupt tasks when Motion Control Module built-in input bits (input No. 0.00 to 0.03) turn ON and/or OFF.
	Executing processing after set amount of external signal changes counted	Starting interrupt processing once the specified number of input bit rising edges, falling edges, or both have been counted	<ul style="list-style-type: none"> Input function settings Counting interrupts in counter mode (MSKS(690) instruction) 	7-3 Input Interrupts - <i>Counter Mode</i> Set input function to Interrupt input and counter mode using MSKS(690) instructions. Decrements the PV each time the Motion Control Module built-in input bit (input numbers 0000.00 to 0000.03) turns ON and/or OFF and executes interrupt tasks when the PV reaches 0.
	Repeating processes each time specified period passes	Starting interrupt processing at scheduled time	<ul style="list-style-type: none"> Interval timer interrupt (scheduled interrupt: STIM(980) instruction) 	7-4 Interval Timer Interrupts - <i>7-4-3 Interval Timer Interrupt Modes</i> Repeats interrupt task execution at scheduled intervals. Can be used within interrupt tasks because special timer used.
	Executing processing once specified timer interval passes after startup signal input	Starting interrupt processing once only, after specified interval has elapsed	<ul style="list-style-type: none"> Interval timer interrupt (one-shot interrupt: STIM(980) instruction) 	7-4 Interval Timer Interrupts - <i>7-4-3 Interval Timer Interrupt Modes</i> Executes interrupt task once only after specified period elapses. Can be used within interrupt tasks because special timer used.
		Starting interrupt processing once periods of any set time have elapsed from timer start	<ul style="list-style-type: none"> Pulse output Target value comparison interrupt (CTBL(882) instruction) 	7-6-9 Target-value Comparison Interrupts from Pulse Output PVs Executes specified interrupt task when target value in registered table matches the pulse output counter PV.
	Starting processing when high-speed counter PV reaches set value	Starting interrupt processing when high-speed counter PV reaches specified value	<ul style="list-style-type: none"> High-speed counter target value comparison interrupt (CTBL(882) instruction) 	7-5 Pulse Inputs Executes specified interrupt task when target value in registered table matches high-speed counter PV.

Purpose		Operation	Main functions used	Details
Operation with highly precise timing	Increasing accuracy of external output ON time. (Feeding, hole opening, tape winding, gluing, and other applications)	High-precision ON outputs, with minimum unit of 0.01 ms	<ul style="list-style-type: none"> One-shot pulse outputs (STIM(980) instruction) 	<p><i>7-5 Pulse Inputs</i></p> <p>Set pulse output operation mode to one-shot output.</p> <p>Specified outputs turn ON during specified interval (0.01 ms to 9,999 ms).</p> <p>Output OFF after specified time elapses is performed by hardware, which gives accurate ON time with no fluctuation.</p> <p>Can be used within interrupt tasks because uses special timer.</p>
	Highly accurate measurement of external input signal ON/OFF time	Starting/stopping high-precision timer at 0.001-ms unit min.	<ul style="list-style-type: none"> Pulse output counter measurement mode (time measurement) (Unit: 0.001 ms min.) 	<p><i>7-6-8 Time Measurement with the Pulse Counter</i></p> <p>Time measurement starts/stops with input interrupt (MSKS(690) instruction) + STIM(980) instruction within interrupt tasks. The elapsed time is stored in Motion Control Module Auxiliary Area. This data can be read using the PRV instruction.</p> <p>Note Pulse output 1 or pulse output 2 must be set to pulse counter time measurement in System Setup.</p>
	Various processing (instruction execution) at each one of multiple time intervals, using high-precision timer	Outputting ON/OFF pattern when pulse output counter PV is within set value range.	<ul style="list-style-type: none"> Pulse output counter measurement mode (time measurement) Range comparison bit pattern output 	<p><i>7-6-8 Time Measurement with the Pulse Counter</i></p> <p>Can be used to obtain output pattern each time interval elapsed after timer start.</p> <p>Timer accuracy can be selected from as low as 0.001 ms.</p>
Timing output according to workpiece position	Timing output using high-speed counter PV	Outputting ON/OFF pattern when high-speed counter PV within certain range	<ul style="list-style-type: none"> High-speed counter range comparison bit pattern output (Executes comparison at execution of CTBL(882) instructions) 	<p><i>7-5-8 Pulse Input Function Description</i></p> <p>Outputs set bit pattern when high-speed counter PV enters the range between set upper and lower limits.</p>

1-8 Comparison with Functions in Earlier Models

1-8-1 Existing Models and Corresponding Replacement Models

New model	Description	Existing model being replaced
FQM1-CM002	Equipped with a peripheral port, RS-232C/RS-422 port, 24 built-in I/O points, support for function blocks and ST programming, and support for CJ-series I/O expansion functions	FQM1-CM001
FQM1-MMP22	Pulse I/O model equipped with 20 I/O points, 2 pulse inputs, 2 pulse outputs, and support for function blocks and ST programming	FQM1-MMP21
FQM1-MMA22	Analog I/O model equipped with 20 I/O points, 2 pulse inputs, 1 analog input, 2 analog outputs, and support for function blocks and ST programming	FQM1-MMA21
FQM1-IC101	Allows one Expansion Rack with CJ-series Units to be connected and also allows CJ-series Units to be mounted to the right of this Unit in the FQM1 Rack. (Use together with the CJ1W-IC101.)	---
FQM1S-MC233	This basic set of Units provides pulse outputs for two axes. CJ1W-PA202 + FQM1-CM002 + FQM1-MMP22 + FQM1-TER01	FQM1S-MC231
FQM1S-MC224	This basic set of Units provides analog outputs for two axes. CJ1W-PA205R + FQM1-CM002 + FQM1-MMA22 + FQM1-TER01	FQM1S-MC222

1-8-2 Differences between Existing and Replacement Models

Functions Changed in All Units

(FQM1-CM001/MMP21/MMA21 to FQM1-CM002/MMP22/MMA22)

Function	Specification	Reference
UM capacity and memory area expansion	The user memory capacity has been increased from 5 KW for previous models to 10 KW. The following memory areas have also been expanded. <ul style="list-style-type: none"> • CIO Area: CIO 0000 to CIO 0255 has been expanded to CIO 0000 to CIO 6143. • Index Registers: IR0 and IR1 has been expanded to IR0 to IR15. • Data Registers: Expanded to DR0 to DR15 (not previously supported). 	B-3 CIO Area B-15 Index Registers B-16 Data Registers
Function block functions	Standard IEC 61131-3 function blocks are supported.	5-9 Function Block (FB) Functions
Improved user memory protection	Previous models were equipped with a password protection function that prevented reading and writing of the user program from the CX-Programmer. The new function can also prevent the clearing of data.	5-7-2 Program Protection
Changes to data area structure (AR and CIO Areas)	The FQM1's special AR and CIO Area structure was changed to conform to the data area structure of CJ-series CPU Units. When an existing (FQM1-CM001/MMP21/MMA21) ladder program is read in the CX-Programmer, the program can be converted to the new format automatically by changing the model number to FQM1-CM002/MMP22/MMA22.	1-8-4 Data Area Structure Changes from Previous Models
Added instructions	GETID, MOV, MOVW, TST, TSTN, SETB, RSTB, OUTB, XCGL, NASL, NASR, NSLL, NSRL, SIGN, FOR, NEXT, BREAK, JMP0, JME0, SETA, and RSTA instructions FIX, FLT, XFRB, NOT, UP, DOWN, CJP, CJP, FIXD, FIXLD, DBL, DBLL, +D, -D, /D, RADD, DEGD, SIND, COSD, TAND, ASIND, ACOSD, ATAND, SQRTD, EXPD, LOGD, PWRD, and double-precision floating-point data comparison instructions (such as LD+=D, AND+=D, OR+=D)	D-3 FQM1 Instruction Execution Times and Number of Steps
Exchanging data between a PT and MM	Data can be exchanged between the PT and a Motion Control Module (via the Coordinator Module) as well as the PT and Coordinator Module itself.	6-1-3 NT Link (1:N Mode)

Function	Specification	Reference
Comment Memory (built-in flash memory)	Comments are stored in flash memory built into the FQM1. The following comment and section information can be read and written. <ul style="list-style-type: none"> • Symbol table files (CX-Programmer symbol names and I/O comments) • Comment files (CX-Programmer line comments and annotations) • Program index files (CX-Programmer section names, section comments, and program comments) 	5-7-4 Comment Memory Function
Free running timers added to enable calculating time intervals without using timer instructions	Free running timers have been added in the Auxiliary Area (A000 and A001) as system timers that operate after power is turned ON. A000 is reset to 0000 hex at startup and is incremented by 1 every 10 ms. When it reaches FFFF hex (655,350 ms), it returns to 0 in a ring operation and continues timing. A001 is reset to 0000 hex at startup and is incremented by 1 every 100 ms. When it reaches FFFF hex (6,553,500 ms), it returns to 0 in a ring operation and continues timing. Example: The difference between the value of A000 at process time A and the value of A000 at process time B can be calculated to measure the time (in 10-ms increments) between process A and process B without using a timer instruction.	D-1 Auxiliary Area Allocations in Order of Address

Functions Changed from FQM1-CM001 to FQM1-CM002)

Function	Specification	Reference
Support for CJ-series Units	CJ-series Units can be used by mounting an FQM1-IC101 I/O Control Module. There are some limitations on the models of CJ-series Units that can be mounted. See the reference sections for details.	6-2 I/O Allocation to CJ-series Units, 6-3 Data Exchange between Coordinator Module and Units
Creating data links with the PLC over an open network	A CJ1W-DRM21 DeviceNet Master Unit can be mounted in the FQM1 to use the FQM1 as a DeviceNet Slave. Data can be exchanged without programming by establishing a data link from a host PLC (such as a CJ1M) that has a DeviceNet Master mounted. Note The FQM1 supports the CJ1W-DRM21 Master Unit in Slave mode only. The Master Unit cannot be used in Master mode.	6-2 I/O Allocation to CJ-series Units, 6-3 Data Exchange between Coordinator Module and Units, B-8 DeviceNet Area
Serial PLC Link function supports the Complete Link Method	The Serial PLC Link function can use both the Complete Link Method and Master Link Method. With the Complete Link Method, the CJ1M CPU Unit and FQM1 can perform program-free data exchange with all other nodes.	6-1-4 Serial PLC Links
Increase in the DM Area words automatically saved to flash memory	For the FQM1-CM001, D30000 to D32767 are automatically saved to flash memory when they are written to using the DM transfer function or from a PT and then the data in flash memory is automatically restored to the DM Area the next time power is turned ON. These words have been increased to D20000 to D32767 in the FQM1-CM002.	6-4 Automatic DM Data Backup Function

Functions Changed from FQM1-MMP21/MMA21 to FQM1-MMP22/MMA22

Function	Specification	Reference
DM Area data retention	A control bit operation can save part of the Motion Control Module's DM Area (D00000 to D29999) to flash memory. The saved DM Area data can be restored automatically at startup when the system settings are set to restore the data.	7-11 DM Data Storage Function
Changing acceleration, deceleration, and target value during acceleration or deceleration for ACC(888)	Previously, the acceleration, deceleration, and target speed could not be changed during pulse output acceleration or deceleration for ACC(888). This is possible with the new versions. ACC(888) can also be used in the same way during analog outputs to change the slop or the output value setting during sloped outputs.	7-6-15 Pulse Output Starting Conditions 7-10-4 Applicable Instructions

1-8-3 Functional Differences between Models

Item		Previous model specifications (CM001/MMP21/MMA21)		MMP22/MMA22	CM002
Control method		Stored program		←	←
I/O control method		Cyclic scan		←	←
Programming language		Ladder diagram		←	←
Instruction length		1 to 7 steps per instruction		←	←
Ladder instructions		Coordinator Module (CM)	Motion Control Module (MM)	Approx. 300	Approx. 300
		Approx. 260	Approx. 270		
Common processing (overhead) time		Synchronous mode: 390 μs (with 1 MM) Asynchronous mode: 180 μs	MMP21: Synchronous mode: 250 μs Asynchronous mode: 190 μs MMA21: Synchronous mode: 340 μs Asynchronous mode: 280 μs	←	Only Motion Control Modules mounted: Same as previous models. With CJ-series Units mounted: Overhead time in previous model + 21 bus processing overhead + each CJ-series Unit's I/O refreshing time
Execution time	Basic instructions	0.1 μs (LD)		←	←
	Special instructions	0.5 μs (MOV)		←	←
Program capacity	Ladder	5 Ksteps		10 Ksteps	10 Ksteps
	Comment storage	None		Supported	Supported
Number of Units connectable		Motion Control Modules: 4 Modules max.		←	Motion Control Modules: 4 Modules max. CJ-series Units can be mounted if an FQM1-IC101 is used. Up to 10 Motion Control Modules and CJ-series Units (Basic I/O Units, Special I/O Units, and CPU Bus Units)
Number of Expansion Racks		None		None	1 Rack max.
Function blocks		None		Ladder language or ST language can be used in FB definitions.	Ladder language or ST language can be used in FB definitions.
Number of tasks		1 task (cyclic tasks: 1, interrupt tasks: 50)		←	←
Subroutines		256		←	←
JMP instructions		256		←	←
Number of basic I/O points (built-in I/O)		CM	MM	← (20 points)	← (24 points)
		24	20		
Input bits (built-in)		16 (1 word) 0000.00 to 0000.15	12 (1 word) 0000.00 to 0000.11	12 (1 word) 2960.00 to 2960.11	12 (1 word) 2960.00 to 2960.15
Output bits (built-in)		8 (1 word) 0001.00 to 0001.07	8 (1 word) 0001.00 to 0001.07	8 (1 word) 2961.00 to 2961.07	8 (1 word) 2961.00 to 2961.07

Item		Previous model specifications (CM001/MMP21/MMA21)		MMP22/MMA22	CM002
Cyclic Refresh Bit Area		640 bits (40 words)	CM: CIO 0100 to CIO 0139 MM: CIO 0100 to CIO 0109	CIO 4000 to CIO 4009	CIO 4000 to CIO 4039
Synchronous Data Link Bit Area		320 bits (20 words)	CIO 0200 to CIO 0219 (0200.00 to 0219.15)	CIO 1200 to CIO 1219	CIO 1200 to CIO 1219
Serial PLC Link Bit Area		CM	MM	← (None in MM)	CIO 3100 to CIO 3189 (Complete Link Method) CIO 3100 to CIO 3119 (Master Link Method)
		320 bits (20 words): CIO 0080 to CIO 0099	---		
I/O Bit Area (CJ-series Basic I/O Units)		None		←	320 bits (20 words): CIO 0000 to CIO 0019
CPU Bus Unit Area		None		←	6,400 bits (400 words): CIO 1500 to CIO 1899
Special I/O Unit Area		None		←	13,760 bits (860 words): CIO 2100 to CIO 2959
DeviceNet Area		None		←	9,600 bits (600 words): CIO 3200 to CIO 3799 These words are used when the default fixed allocation is set for the DeviceNet Slave function.
FB Instance Area		None		CIO 5000 to CIO 5999 (1000 words) TIM 206 to TIM 255 (50 timers/counters) CNT 206 to CNT 255 (50 timers/counters)	CIO 5000 to CIO 5999 (1000 words) TIM 206 to TIM 255 (50 timers/counters) CNT 206 to CNT 255 (50 timers/counters)
Work Areas	CIO Area	1,088 bits	CIO 0002 to CIO 0079 CIO 0140 to CIO 0199 CIO 0220 to CIO 0255	MMP22/MMA22: 5,112 words (The CIO Area is expanded to CIO 0000 to CIO 6143.)	3,112 words (The CIO Area is expanded to CIO 0000 to CIO 6143.)
	WR Area	4,096 bits	W000 to W255	←	←
Auxiliary Area	Read only	5,568 bits	A000 to A099 A200 to A447	←	←
	Read/Write	3,232 bits	A448 to A659 (A550 to A649: Pulse/analog I/O)	A448 to A959 (8,192 bits) (Both the read-only and read/write area structure were changed from the previous model structure to the CJ1 Series structure.)	A448 to A959 (8,192 bits) (Both the read-only and read/write area structure were changed from the previous model structure to the CJ1 Series structure.)
	Error log	100 words	A100 to A199 (Holds 20 records.)	←	←
Temporary Relay Area		16 bits	(TR0 to TR15)	←	←
Holding Area		None		←	←
Timer Area		256 timers	T0000 to T0255 (1-ms, 10-ms, and 100-ms timers)	←	←

Item		Previous model specifications (CM001/MMP21/MMA21)		MMP22/MMA22	CM002
Counter Area		256 counters	C0000 to C0255 (decrementing counters and reversible counters)	←	←
DM Area	Read/Write (not retained)	30,000 words	D00000 to D29999 (Status not retained in CM or MM when power is turned OFF.)	← Same as previous models if the PLC Setup is set to automatically transfer DM data at startup.	20,000 words: D00000 to D19999
	Read/Write (retained)	2,768 words	D30000 to D32767 The CM data is retained in flash memory. (Data in the MM is backed up for about 1 day by a capacitor.)			Data in the Motion Control Module (MM) is maintained by a capacitor and a control bit operation can also be used to automatically restore the data from flash memory when the power is turned ON.	12,768 words: D20000 to D32767 (Flash memory storage: Data is automatically saved when the data is written by the CX-Programmer, PT, or DM Transfer operation.)
PLC Setup		Contains settings such as shared Coordinator Module/Motion Control Module settings, peripheral service settings, motion parameter settings.		←	←
Index Registers		IR0 and IR1 used with JSB instruction.		IR0 to IR15 (IR0 and IR1 are also used with JSB instruction.) IR16 to IR63 are used by the system for function blocks/structured text.	IR0 to IR15 (IR0 and IR1 are also used with JSB instruction.) IR16 to IR63 are used by the system for function blocks/structured text.
Data Registers		None		DR0 to DR15 DR16 to DR63 are used by the system for function blocks/structured text.	DR0 to DR15 DR16 to DR63 are used by the system for function blocks/structured text.
Interrupt Functions	Module	CM	MM	←	←
	Input interrupts	None	4 interrupts		
	Timer interrupts	1 interrupt	1 interrupt		
Memory backup	Super capacitor backup	Error log	Error log, part of DM Area (for momentary power interruptions)	←	←
	Flash memory	User programs, System Setup, part of DM Area	User programs, System Setup		

Item	Previous model specifications (CM001/MMP21/MMA21)		MMP22/MMA22	CM002
Peripheral servicing	Servicing for devices connected to peripheral port (only CX-Programmer), RS-232C port (Host Links, no-protocol communications, NT Links, and Serial PLC Link), RS-422A port (for Servo Driver), and event request servicing	Servicing for event requests from Coordinator Module	←	←
Power OFF detection time	AC: 10 to 25 ms (variable)	---	←	←
User-set Power OFF detection delay time	0 to 10 ms	---	←	←
RUN output	1 (when CJ1W-PA205R used)	---	←	←
Momentary power interrupt backup function	Super capacitor		←	←
Trace memory	4,000 words		←	←
Momentary power interrupt backup function	Super capacitor		←	←
Self diagnosis function	CPU errors (WDT) and memory errors		←	←
Program check	Programs checked from the CX-Programmer.		←	←
Super-capacitor backup time	Approximately 100 hours at 25°C		←	←
Clock function	None		←	←

1-8-4 Data Area Structure Changes from Previous Models

Data Area Changes

Changes from FQM1-CM001 to FQM1-CM002

Item	FQM1-CM001	FQM1-CM002
Input bits (built-in)	16 (1 word): CIO 0.00 to CIO 0.15	16 (1 word): CIO 2960.00 to CIO 2960.15
Output bits (built-in)	8 (1 word): CIO 1.00 to CIO 1.07	8 (1 word): CIO 2961.00 to CIO 2961.07
Cyclic Refresh Bit Area	CIO 0100 to CIO 0139	CIO 4000 to CIO 4039
Synchronous Data Link Bit Area	CIO 0200 to CIO 0219	CIO 1200 to CIO 1219
Serial PLC Link Bit Area	CIO 0080 to CIO 0099	CIO 3100 to CIO 3119
Auxiliary Area	Refer to the following Auxiliary Area table for details.	

Note Serial PLC Link Bit Area words CIO 3100 to CIO 3119 are used for the Master Link Method, which was the only link method supported in the previous model (FQM1-CM001). When the Complete Link Method is being used, words CIO 3100 to CIO 3189 are allocated.

Changes from FQM1-MMP21/MMA21 to FQM1-MMP22/MMA22

Item	FQM1-MMP21/MMA21	FQM1-MMP22/MMA22
Input bits (built-in)	12 (1 word): CIO 0.00 to CIO 0.11	12 (1 word): CIO 2960.00 to CIO 2960.11
Output bits (built-in)	8 (1 word): CIO 1.00 to CIO 1.07	8 (1 word): CIO 2961.00 to CIO 2961.07
Cyclic Refresh Bit Area	CIO 0100 to CIO 0109	CIO 4000 to CIO 4009
Synchronous Data Link Bit Area	CIO 0200 to CIO 0219	CIO 1200 to CIO 1219
Auxiliary Area	Refer to the following Auxiliary Area table for details.	

Auxiliary Area Changes

A000 to A447 (Read-only)

CM001/MMP21/MMA21	Bits	CM002/MMP22/MMA22	Bits	Name
---	---	A000	00 to 15	10 ms incrementing timer
---	---	A001	00 to 15	100 ms incrementing timer
A000 to A015	00 to 15	A019 to A034	00 to 15	Subroutine Input Condition Flags
---	---	A050	00 to 07	Basic I/O Unit Information Area (Rack 0, Slot 0)
---	---		08 to 15	Basic I/O Unit Information Area (Rack 0, Slot 1)
---	---	A051 to A059	00 to 15	Basic I/O Unit Information Area (Rack 0, Slot 2 to Rack 1, Slot 9) (The FQM1's maximum rack number is Rack 1.)
A100 to A199	00 to 15	Same	00 to 15	Error Log Area
A200	11	Same	11	First Cycle Flag
	12		12	Step Flag
A201	10	Same	10	Online Editing Waiting Flag
	11		11	Online Editing Processing Flag
---	---	A220 to A259	00 to 15	Basic I/O Unit input response time
A206 to A207	00 to 15	A262 to A263	00 to 15	Maximum Cycle Time
A208 to A209	00 to 15	A264 to A265	00 to 15	Present Cycle Time
A202	00	A270	00	Motion Control Module slot 1
	01		01	Motion Control Module slot 2
	02		02	Motion Control Module slot 3
	03		03	Motion Control Module slot 4
A405	11	A295	11	No END Error Flag
	12		12	Task Error Flag
	13		13	Differentiation Overflow Error Flag
	14		14	Illegal Instruction Error Flag
	15		15	UM Overflow Error Flag
A408	00 to 15	A300	00 to 15	Error Log Pointer
---	---	A302	00 to 15	CPU Bus Unit Initializing Flag
A404	05	A316	05	Constant Cycle Time Exceeded Flag
	06		06	Sync Cycle Time Too Long Flag
	14		14	Memory Not Held Flag

CM001/ MMP21/ MMA21	Bits	CM002/ MMP22/ MMA22	Bits	Name	
A414	02	A318	02	RS-422A Port Error Flags	Parity Error Flag
	03		03		Framing Error Flag
	04		04		Overrun Error Flag
	05		05		Timeout Error Flag
	08		08	RS-422A Port Communications Error Flag	
	09		09	RS-422A Port Send Ready Flag (no-protocol mode)	
	10		10	RS-422A Port Reception Completed Flag (no-protocol mode)	
	11		11	RS-422A Port Reception Overflow Flag (no-protocol mode)	
	15		15	RS-422A Port Settings Changing Flag	
A415	00 to 15	A319	00 to 15	RS-422A Port Reception Counter (no-protocol mode)	
---	---	A330 to A335	00 to 15	Special I/O Unit Initializing Flag	
---	---	A336	00 to 15	Number of Units Recognized at Startup (Racks 0 and 1)	
---	---	A345	00	FB Program Data Flag	
	---		01	Variable Table File Flag	
	---		02	Comment File Flag	
	---		03	Program Index File Flag	
	---		04	FROM Backup DM Data Flag	
A410	08	A392	04	RS-232C Port Error Flag	
	09		05	RS-232C Port Send Ready Flag (No-protocol mode)	
	10		06	RS-232C Port Reception Completed Flag (No-protocol mode)	
	11		07	RS-232C Port Reception Overflow Flag (No-protocol mode)	
A412	08		12	Peripheral Port Communications Error Flag	
A411	00 to 15	A393	00 to 15	RS-232C Port Reception Counter (No-protocol mode)	
	00 to 07		00 to 07	RS-232C Port PT Communicating Flags	
	08 to 15		08 to 15	RS-232C Port PT Priority Registered Flags	
A413	00 to 07	A394	00 to 07	Peripheral Port PT Communicating Flags	
	08 to 15		08 to 15	Peripheral Port PT Priority Registered Flags	
A400	00 to 15	Same	00 to 15	Error code	
A401	06	Same	06	FALS Error Flag (Fatal error)	
	08		08	Cycle Time Too Long Flag (Fatal error)	
	09		09	Program Error Flag (Fatal error)	
	10		10	I/O Setting Error Flag	
	---		11	Too Many I/O Points Flag	
	---		13	Duplication Error Flag	
	14		14	I/O Bus Error Flag	
	15		15	Memory Error Flag (Fatal error)	
A402	05	Same	05	Motion Control Module Monitoring Error	
	---		06	Special I/O Unit Error Flag	
	---		07	CPU Bus Unit Error Flag	
	13		08	Coordinator Module WDT Error Flag	
	10		10	System Setup Error Flag	
	14		14	Coordinator Module Fatal Error Flag (Motion Control Modules only)	
	15		15	FAL Error Flag	

CM001/ MMP21/ MMA21	Bits	CM002/ MMP22/ MMA22	Bits	Name	
A403	00	Same	00	UM Error Flag	
	04		04	System Setup Error Flag	
	10		10	Flash Memory Error Flag	
	13		13	Analog Offset/Gain Error Flag	
	14		14	Flash Memory DM Checksum Error Flag	
---	---	A404	00 to 07	I/O Bus Error Slot Number	
	---		08 to 15	I/O Bus Error Rack Number	
A409	00 to 15	A406	00 to 15	System Setup Error Location	
---	---	A407	00 to 12	Too Many I/O Points, Details	
	---		13 to 15	Too Many I/O Points, Cause	
---	---	A410	00 to 15	CPU Bus Unit Number Duplication Flags	
---	---	A411 to A416	00 to 15	Special I/O Unit Number Duplication Flags	
---	---	A417	00 to 15	CPU Bus Unit Error, Unit Number Flags	
---	---	A418 to A423	00 to 15	Special I/O Unit Error, Unit Number Flags	
---	---	A450	00 to 15	CIO Area, Area ID Code	
---	---	A451	00 to 15	WR Area, Area ID Code	
---	---	A452	00 to 15	HR Area, Area ID Code	
---	---	A459	00 to 15	IR Area, Area ID Code	
---	---	A460	00 to 15	DM Area, Area ID Code	
---	---	A461 to A473	00 to 15	EM Banks 0 to C, Area ID Code	
A500	14	Same	14	Error Log Reset Bit	
---	---	A501	00 to 15	CPU Bus Unit Restart Bits	
---	---	A502 to A507	00 to 15	Special I/O Unit Restart Bits	
A508	09	Same	09	Differentiate Monitor Completed Flag	
	11		11	Trace Trigger Monitor Flag	
	12		12	Trace Completed Flag	
	13		13	Trace Busy Flag	
	14		14	Trace Start Bit	
	15		15	Sampling Start Bit	
A502	00	A526	00	RS-232C Port Restart Bit	
	01		01	Peripheral Port Restart Bit	
	02		07	RS-422A Port Restart Bit	
A528	00 to 07	A527	00 to 07	Online Editing Disable Bit Validator Code	
	09		09	Online Editing Disable Bit	
A410	02	A528	02	RS-232C Port Error Flags	Parity error
	03				Framing error
	04				Overrun error
	05				Timeout error
A412	02		10	Peripheral Port Error Flags	Parity error
	03				Framing error
	04				Overrun error
	05				Timeout error
A520	00 to 15	A532	00 to 15	Interrupt Counter 0 Counter SV	
A521	00 to 15	A533	00 to 15	Interrupt Counter 1 Counter SV	

CM001/ MMP21/ MMA21	Bits	CM002/ MMP22/ MMA22	Bits	Name	
A522	00 to 15	A534	00 to 15	Interrupt Counter 2 Counter SV	
A523	00 to 15	A535	00 to 15	Interrupt Counter 3 Counter SV	
A524	00 to 15	A536	00 to 15	Interrupt Counter 0 Counter PV	
A525	00 to 15	A537	00 to 15	Interrupt Counter 1 Counter PV	
A526	00 to 15	A538	00 to 15	Interrupt Counter 2 Counter PV	
A527	00 to 15	A539	00 to 15	Interrupt Counter 3 Counter PV	
A510 to A514	00 to 15	A540 to A544	00 to 15	Macro Area Input Words	
A515 to A519	00 to 15	A545 to A549	00 to 15	Macro Area Output Words	
A507	00 to 15	A554	00 to 15	Data Trace Period	
A509	15	A555	15	Constant Cycle Time Exceeded Error Clear Bit	
A530	00	A556	00	DM Write Request Bit (Coordinator Module to Motion Control Module)	
	01		01	DM Read Request Bit (Motion Control Module to Coordinator Module)	
A531	00 to 15	A557	00 to 15	Slot No. of Motion Control Module for DM Transfer	
A532	00 to 15	A558	00 to 15	DM Transfer Size (number of words)	
A533	00 to 15	A559	00 to 15	First DM Transfer Source Word	
A534	00 to 15	A560	00 to 15	First DM Transfer Destination Word	
A535	14	A561	14	DM Transfer Error Flag	
	15		15	DM Transfer Busy Flag	
A412	15	A619	01	Peripheral Port Settings Changing Flag	
A410	15		02	RS-232C Port Settings Changing Flag	
---	---	A751	11	Saved DM Data Invalid Flag	
			12	DM Save Settings Incorrect Flag	
			13	DM Backup Error Flag	
			14	Saving DM Flag	
			15	Save DM Start Bit	
---	---	A752	00 to 15	Save DM Password	
A550	00 to 15	A800	00 to 15	Analog Input PV	
A552	00	A802	00	Analog Input Status	User Adjustment Completed
	07		07	Analog Sampling Started	
	08		08	Factory Adjustment Data Error	
	09		09	User Adjustment Data Error	
	15		15	Analog Sampling Overlap	
A559	00 to 15	A809	00 to 15	Number of Analog Samples	
A560	00 to 15	A810	00 to 15	Analog Output 1 Output Value	
A561	00 to 15	A811	00 to 15	Analog Output 2 Output Value	
A862	00	A812	00	Analog Output 1 Flags	User Adjustment Completed
	04		04	Operating	
	08		08	Output SV Error	
	12		12	Factory Adjustment Value	
	14		14	User Adjustment Value Error	
A563	00	A813	00	Analog Output 2 Flags	User Adjustment Completed
	04		04	Operating	
	08		08	Output SV Error	
	12		12	Factory Adjustment Value	
	14		14	User Adjustment Value Error	
A564	00	A814	00	Analog Output 1 Conversion Enable Bit	

CM001/ MMP21/ MMA21	Bits	CM002/ MMP22/ MMA22	Bits	Name		
A565	00	A815	00	Analog Output 2 Conversion Enable Bit		
A570	00	A820	00	Adjustment Mode Command Bits (Effective only when A825 is 5A5A hex.)	Analog Input Analog Output 1 Analog Output 2	
	02		02		Adjustment Mode Specifier	
	03		03		Adjustment Value Increment	
	07		07		Adjustment Value Decrement	
	12		12		Adjustment Value Clear (to factory default)	
	13		13		Adjustment Value Set	
	14		14			
	15		15			
A571	00	A821	00	Adjustment Mode Status	Adjustment Operation Error	
	15		15		Adjustment Mode Started	
A572	00 to 15	A822	00 to 15	Adjustment Mode Monitor (Effective only when A825 is 5A5A hex.)	Both Analog Input and Analog Outputs 1 and 2	Setting Offset Monitor
A573	00 to 15	A823	00 to 15			Gain Value Monitor
A574	00 to 15	A824	00 to 15		Analog Input	Number of Average Value Samples in Adjustment Mode
A575	00 to 15	A825	00 to 15	Adjustment Mode Password		
A600 to A601	00 to 15	A850 to A851	00 to 15	High-speed Counter 1 PV		
A602 to A603	00 to 15	A852 to A853	00 to 15	High-speed Counter 2 PV		
A604 to A605	00 to 15	A854 to A855	00 to 15	High-speed Counter 1	Absolute number of rotations PV	
					Monitor data	
A606 to A607	00 to 15	A856 to A857	00 to 15	High-speed Counter 2	Absolute number of rotations PV	
					Monitor data	
A608	00	A858	00	High-speed counter 1 status	Target Comparison In-progress Flag	
	01		01		PV Overflow/Underflow Flag	
	03		03		Phase Z Input Reset Flag (ON for one cycle)	
	04		04		Absolute No. of Rotations Read Error Flag	
	05		05		Absolute No. of Rotations Read Completed Flag	
	06		06		Measuring Flag (measurement mode 1 or 2) Note Valid when Counter Data Display in System Setup is set to Counter Movements (mode 1) or Frequency (mode 2).	
	07		07		High-speed Counter Operating Flag	
	08		08		Count Latched Flag	
	12		12		Absolute Offset Preset Error Flag	
	A609		00		A859	00	High-speed counter 1 status	Target Comparison In-progress Flag
01		01	PV Overflow/Underflow Flag			
03		03	Phase Z Input Reset Flag (ON for one cycle)			
04		04	Absolute No. of Rotations Read Error Flag			
05		05	Absolute No. of Rotations Read Completed Flag			
06		06	Measuring Flag			
07		07	High-speed Counter Operating Flag			
08		08	Count Latched Flag			
12		12	Absolute Offset Preset Error Flag			

CM001/ MMP21/ MMA21	Bits	CM002/ MMP22/ MMA22	Bits	Name	
A610	00	A860	00	High-speed counter 1 command bits	Start Bit
	01		01		Reset Bit
	02		02		Measurement Start Bit Note Valid when Counter Data Display in System Setup is set to Counter Movements (mode 1) or Frequency (mode 2).
	03		03		Measurement Direction Bit (measurement mode 2)
	04		04		Range Comparison Results Clear Bit
	05		05		Absolute Offset Preset Bit
	06		06		Absolute Present Value Preset Bit
	07		07		Absolute Number of Rotations Read Bit
	08		08		Latch Input 1 Enable Bit
	09		09		Latch Input 2 Enable Bit
A611	00	A861	00	High-speed counter 2 command bits	Start Bit
	01		01		Reset Bit
	02		02		Measurement Start Bit (measurement mode 1)
	04		04		Range Comparison Results Clear Bit
	05		05		Absolute Offset Preset Bit
	06		06		Absolute Present Value Preset Bit
	07		07		Absolute Number of Rotations Read Bit
	08		08		Latch Input 1 Enable Bit
	09		09		Latch Input 2 Enable Bit
	A612		00 to 15		A862	00 to 15	High-speed counter 1 monitor data	Range Comparison Execution Results Flags
A613	00 to 15	A863	00 to 15	Output Bit Pattern	
A614	00 to 15	A864	00 to 15	High-speed counter 2 monitor data	Range Comparison Execution Results Flags
A615	00 to 15	A865	00 to 15		Output Bit Pattern
A620 to A621	00 to 15	A870 to A871	00 to 15	Pulse Output 1 PV Note These words contain the Pulse Output 1 PV when the operation mode is set to relative pulse output, absolute pulse output in linear mode, absolute pulse output in circular mode, or electronic cam mode.	
				One-shot Pulse Output 1 ON Time Note These words contain the One-shot Pulse Output 1 ON Time when the operation mode is set to one-shot output mode.	
				Pulse Time Measurement 1 Note These words contain the Pulse Time Measurement 1 when the operation mode is set to time measurement mode using a pulse counter.	
A622 to A623	00 to 15	A872 to 873	00 to 15	Pulse Output 2 PV	
				One-shot Pulse Output 2 ON Time	
				Pulse Time Measurement 2	
A624	00	A874	00	Pulse Output 1 Status	Pulse Output Completed Flag
	01		01		Pulse Output Set Flag
	02		02		Target Frequency Not Reached Flag
	03		03		Target Comparison Flag
	04		04		Independent Pulse Output Flag
	05		05		PLS2 Positioning Flag
	06		06		Accelerating/Decelerating Flag
	07		07		Pulse Output Flag
	---		08		Pulse Output Direction Flag

CM001/ MMP21/ MMA21	Bits	CM002/ MMP22/ MMA22	Bits	Name	
A625	00	A875	00	Pulse Output 2 Status	Pulse Output Completed Flag
	01		01		Pulse Output Set Flag
	02		02		Target Frequency Not Reached Flag
	03		03		Target Comparison Flag
	04		04		Independent Pulse Output Flag
	05		05		PLS2 Positioning Flag
	06		06		Accelerating/Decelerating Flag
	07		07		Pulse Output Flag
	---		08		Pulse Output Direction Flag
A626	00	A876	00	Pulse Output 1 Com- mand Bits	PV Reset Bit
	01		01		Range Comparison Results Clear Bit
A627	00	A877	00	Pulse Output 2 Com- mand Bits	PV Reset Bit
	01		01		Range Comparison Results Clear Bit
A628	07	A878	07	Shared Pulse Output Control Bits	Speed Change Cycle Bit
	14		14		PLS2 Pulse Output Direction Priority Mode Bit
A630	00 to 15	A880	00 to 15	Pulse Output 1 Monitor	Data Range Comparison Results
A631	00 to 15	A881	00 to 15		Output Bit Pattern
A632	00 to 15	A882	00 to 15	Pulse Output 2 Monitor	Data Range Comparison Results
A633	00 to 15	A883	00 to 15		Output Bit Pattern

Note The structure of data areas such as the Auxiliary Area and Cyclic Refresh Bit Area are different in the FQM1-CM001/MMP21/MMA21 and FQM1-CM002/MMP22/MMA22 models, but the data areas can be automatically converted between the CM001 ↔ CM002 formats or MMP21/MMA21 ↔ MMP22/MMA22 formats by changing the PLC model selected in the CX-Programmer.

SECTION 2

Specifications and Nomenclature

This section provides the specifications of the FQM1 and describes the parts and their functions on the Coordinator Module and Motion Control Modules.

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2-1 List of Models

Name	Type	Model	Specifications
Coordinator Module	Standard (with built-in I/O)	FQM1-CM002	Program capacity: 10 Ksteps 16 general-purpose inputs, 8 general-purpose outputs Peripheral port, RS-232C port, RS-422A port
Motion Control Modules	Pulse I/O	FQM1-MMP22	Program capacity: 10 Ksteps 2 pulse inputs, 2 pulse outputs, 12 general-purpose inputs, 8 general-purpose outputs
	Analog I/O	FQM1-MMA22	Program capacity: 10 Ksteps 2 pulse inputs, 1 analog input, 2 analog outputs, 12 general-purpose inputs, 8 general-purpose outputs
End Module (FQM1 Rack)	Standard	FQM1-TER01	Connects to the right end of the FQM1.
I/O Control Module	---	FQM1-IC101	Use to connect CJ-series Units to the FQM1. (This includes connection of an Expansion Rack.)
I/O Interface Unit	---	CJ1W-II101	Use to connect an Expansion Rack. The I/O Interface Unit connects to the right side of the Expansion Rack's Power Supply Unit.
End Cover	Standard	CJ1W-TER01	Connects to the right end of the Expansion Rack. Also connects to the right end of the FQM1 Rack if an I/O Control Module is being used.
Servo Relay Units	---	XW2B-80J7-1A	Simplifies wiring from the Motion Control Module to two Servo Drivers, wiring for all switches, sensors, and other general-purpose I/O, and wiring the RS-422A line.
FQM1 Flexible Motion Controller Set	Set for pulse I/O	FQM1S-MC233	A set including the CJ1W-PA202, FQM1-CM002, FQM1-MMP22, and FQM1-TER01
	Set for analog I/O	FQM1S-MC224	A set including the CJ1W-PA205R, FQM1-CM002, FQM1-MMA22, and FQM1-TER01
Programming Device	CX-Programmer Ver. 6.11 or later	WS02-CXPC1-E-V6	Used for System Setup setting, programming, and monitoring for Coordinator Modules and Motion Control Modules.

2-2 General Specifications

General Specifications

Item	Specifications
Insulation resistance	20 M Ω min. (at 500 VDC) between AC external and GR terminals (See note 1.)
Dielectric strength	2,300 V AC 50/60 Hz for 1 min between AC external and GR terminals (See notes 1 and 2.) Leakage current: 10 mA max.
	720 V AC 50/60 Hz for 1 min between DC external and GR terminals (See note 1.) Leakage current: 10 mA max.
Noise immunity	2 kV on power supply line (conforming to IEC61000-4-4)
Vibration resistance	10 to 57 Hz, 0.075-mm amplitude, 57 to 150 Hz, acceleration: 9.8 m/s ² in X, Y, and Z directions for 80 minutes total (Time coefficient: 8 minutes \times coefficient factor 10 = total time 80 min.) (conforming to JIS C0040)
Shock resistance	147 m/s ² 3 times each in X, Y, and Z directions (conforming to JIS C0041)
Ambient operating temperature	0 to 55°C
Ambient operating humidity	10% to 90% (with no condensation)
Atmosphere	Must be free from corrosive gases
Ambient storage temperature	-20 to 75°C
Grounding	Less than 100 Ω
Enclosure	Mounted in a panel.

Item	Specifications
Dimensions	49 × 90 × 80 mm (W × H × D) (not including cables)
Weight	All models are each 5 kg max.
Safety measures	Conforms to EC directives and C-Tick. (UL certification pending.)

- Note**
- (1) Disconnect the Power Supply Unit's LG terminal from the GR terminal when testing insulation and dielectric strength. Testing the insulation and dielectric strength with the LG and GR terminals connected will damage internal circuits.
 - (2) Do not apply more than 600 V when testing the dielectric strength of analog I/O terminals. Applying more than 600 V may damage the internal elements.

Power Supply Unit Specifications

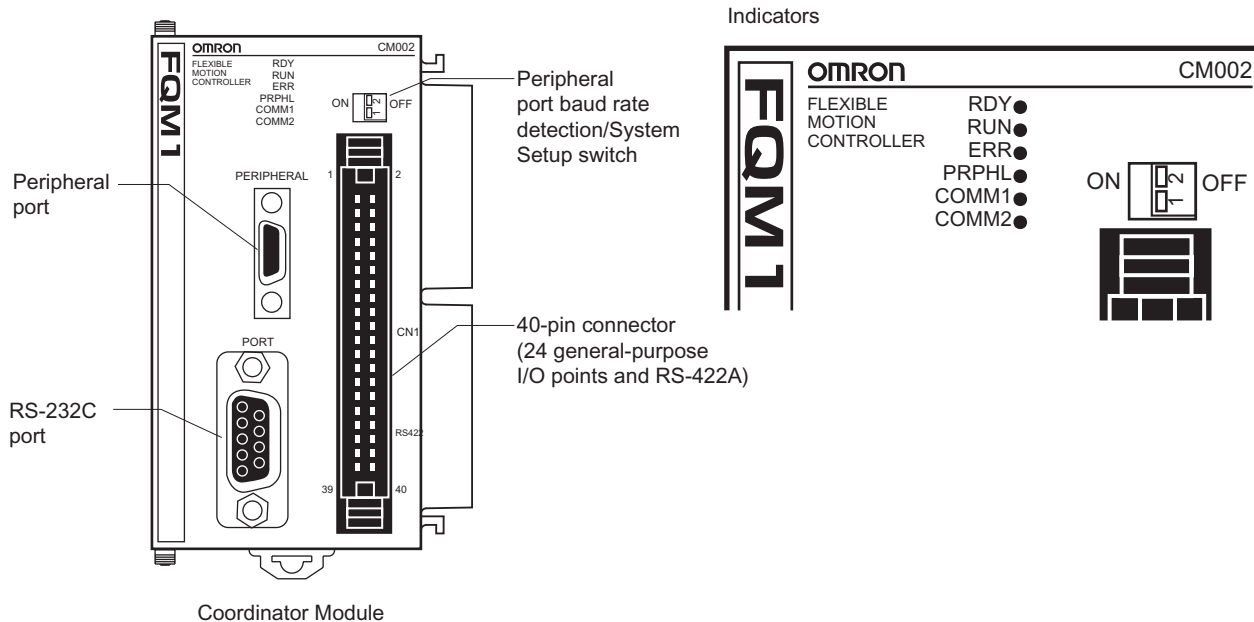
Item	Specifications	
Power Supply Unit	CJ1W-PA205R	CJ1W-PA202
Supply voltage	100 to 240 V AC (wide-range), 50/60 Hz	
Operating voltage and frequency ranges	85 to 264 V AC, 47 to 63 Hz	
Power consumption	100 VA max.	50 VA max.
Inrush current (See note 1.)	At 100 to 120 V AC: 15 A/8 ms max. for cold start at room temperature At 200 to 240 V AC: 30 A/8 ms max. for cold start at room temperature	At 100 to 120 V AC: 20 A/8 ms max. for cold start at room temperature At 200 to 240 V AC: 40 A/8 ms max. for cold start at room temperature
Output capacity	5.0 A, 5 VDC (including supply to Modules)	2.8 A, 5 VDC (including supply to Modules)
	0.8 A, 24 VDC	0.4 A, 24 VDC
	Total 25 W max.	Total 14 W max.
Output terminal	Not provided.	
RUN output	Contact configuration: SPST-NO Switching capacity: 250 V AC, 2 A (resistive load) 120 V AC, 0.5 A (inductive load) 24 VDC, 2 A (resistive load) 24 VDC, 2 A (inductive load)	Not provided.
Insulation resistance	20 MΩ min. (at 500 VDC) between AC external and GR terminals (See note 2.)	
Dielectric strength	2,300 V AC 50/60 Hz for 1 min between AC external and GR terminals (See note 2.) Leakage current: 10 mA max.	
	1,000 V AC 50/60 Hz for 1 min between DC external and GR terminals (See note 1.) Leakage current: 10 mA max.	
Noise immunity	2 kV on power supply line (conforming to IEC61000-4-4)	
Vibration resistance	10 to 57 Hz, 0.075-mm amplitude, 57 to 150 Hz, acceleration: 9.8 m/s ² in X, Y, and Z directions for 80 minutes total (Time coefficient: 8 minutes × coefficient factor 10 = total time 80 min.) (conforming to JIS C0040)	
Shock resistance	147 m/s ² 3 times each in X, Y, and Z directions (conforming to JIS C0041)	
Ambient operating temperature	0 to 55°C	
Ambient operating humidity	10% to 90% (with no condensation)	
Atmosphere	Must be free from corrosive gases.	
Ambient storage temperature	-20 to 75°C	
Grounding	Less than 100 Ω	

Item	Specifications	
Enclosure	Mounted in a panel.	
Weight	5 kg. total max.	
Dimensions	80 × 90 × 65 mm (W × H × D)	45 × 90 × 65 mm (W × H × D)
Safety measures	Conforms to cULus and EC Directives.	

- Note**
- (1) The inrush current is given for a cold start at room temperature with an AC power supply. The AC inrush control circuit uses a thermistor element with a low-temperature current control characteristic. If the ambient temperature is high or the FQM1 is hot-started, the thermistor will not be sufficiently cool, and the inrush currents given in the table may be exceeded by up to twice the given values. When selecting fuses or breakers for external circuits, allow sufficient margin in shut-off performance. If the FQM1 is hot-started, the capacitor will not be discharged, and the inrush currents given in the table may be exceeded by up to twice the given values.
 - (2) Disconnect the Power Supply Unit's LG terminal from the GR terminal when testing insulation and dielectric strength. Testing the insulation and dielectric strength with the LG terminal and the GR terminals connected will damage internal circuits.

2-3 Coordinator Module

Nomenclature



- Note** Cover the peripheral port and RS-232C port with the supplied covers when the ports are not being used to prevent dust contamination.

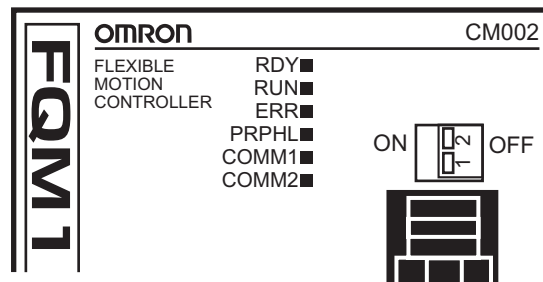
Indicators

Indicator	Color	Name	Status	Meaning
RDY	Green	Module operation	Lit	The Module is operating normally.
			Not lit	Module error (e.g., WDT error).
RUN	Green	Program execution	Lit	Executing internal Module program.
			Not lit	Internal Module program stopped.

Indicator	Color	Name	Status	Meaning
ERR	Red	Module error	Lit	Fatal error.
			Flash- ing	Non-fatal error.
			Not lit	Module operating normally.
PRPHL	Yellow	Peripheral port communications	Lit	Communicating via the peripheral port.
			Not lit	All other times.
COMM1	Yellow	RS-232C communications	Lit	Communicating via the RS-232C port.
			Not lit	All other times.
COMM2	Yellow	RS-422A communications	Lit	Communicating via RS-422A port (for Servo Driver)
			Not lit	All other times

Switch on Front Panel

Peripheral Port Baud Rate Detection/System Setup Switch



SW2	Peripheral port baud rate detection/System Setup	ON	System Setup settings
		OFF	Automatic baud rate detection
SW1	Reserved	---	

Function Specifications

Item		Specifications
Control method		Stored program
I/O control method		Cyclic scan
Programming		Ladder diagram
Instruction length		1 to 7 steps per instruction
Ladder instructions		Approx. 300
Execution time	Basic instructions	0.1 μs min.
	Special instructions	0.3 μs min.
Common processing (overhead) time		Sync Mode: 390 μs ASync Mode: 180 μs (when only Motion Control Modules are connected) 180 μs + 21 Bus processing overhead + each CJ-series Unit's I/O refreshing time (when CJ-series Units are connected)
Program capacity	Ladder	10 Ksteps
	Comment storage	Yes
Number of tasks		Cyclic tasks: 1, interrupt tasks: 50
Subroutines		256
JMP instructions		256
Number of basic I/O		24

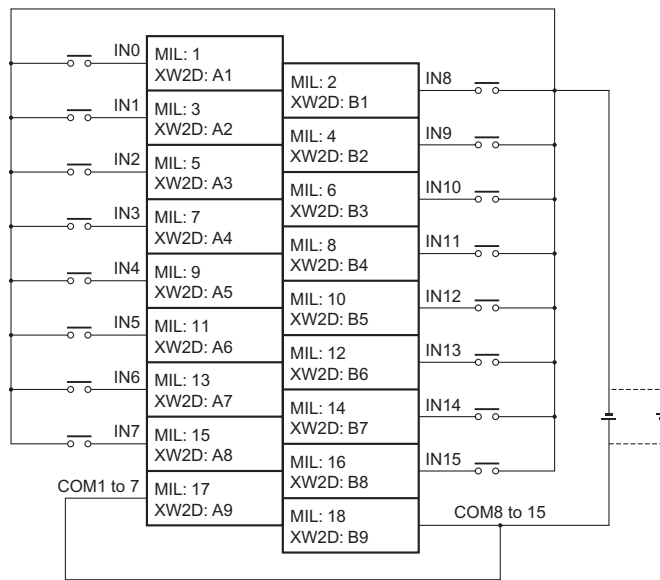
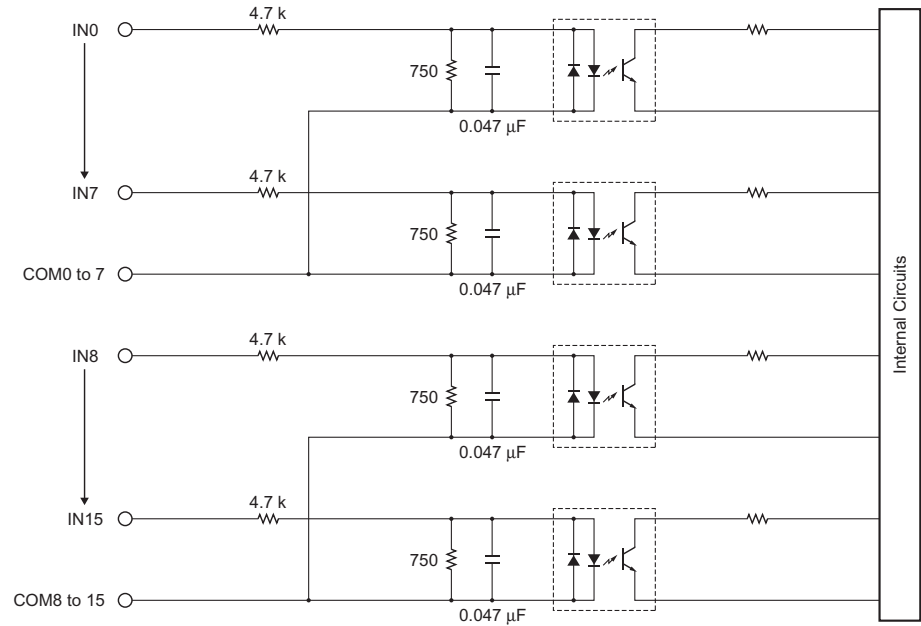
Item		Specifications
CIO Area	Input Bit Area	16 bits (1 word): CIO 2960.00 to CIO 2960.15
	Output Bit Area	8 bits (1 word): CIO 2961.00 to CIO 2961.07
	I/O Bit Area	320 bits (20 words): CIO 0000 to CIO 0019
	CPU Bus Unit Area	6,400 bits (400 words): CIO 1500 to CIO 1899
	Special I/O Unit Area	13,760 bits (860 words): CIO 2100 to CIO 2959
	Cyclic Refresh Bit Area	640 bits (40 words): CIO 4000 to CIO 4039 Refresh words for Motion Control Module # 1: CIO 4000 to CIO 4009 Refresh words for Motion Control Module # 2: CIO 4010 to CIO 4019 Refresh words for Motion Control Module # 3: CIO 4020 to CIO 4029 Refresh words for Motion Control Module # 4: CIO 4030 to CIO 4039
	Synchronous Data Link Bit Area	320 bits (20 words): CIO 1200 to CIO 1219 Sent from Coordinator Module: CIO 1200 to CIO 1203 Sent from Motion Control Module #1: CIO 1204 to CIO 1207 Sent from Motion Control Module #2: CIO 1208 to CIO 1211 Sent from Motion Control Module #3: CIO 1212 to CIO 1215 Sent from Motion Control Module #4: CIO 1216 to CIO 1219
	Serial PLC Link Bit Area (for Complete Link Method)	1,440 bits (90 words): CIO 3100 to CIO 3189 CIO 3100 to CIO 3109: CJ1M to FQM1 CIO 3110 to CIO 3189: FQM1 to CJ1M and all FQM1 nodes other than the source node (10 words for each node number) Can be connected as a Serial PLC Link slave to the host PLC (CJ1M).
	Serial PLC Link Bit Area (for Master Link Method)	320 bits (20 words): CIO 3100 to CIO 3119 CIO 3100 to CIO 3109: CJ1M to FQM1 CIO 3110 to CIO 3119: FQM1 to CJ1M Can be connected as a Serial PLC Link slave to the host PLC (CJ1M).
DeviceNet Area	9,600 bits (600 words): CIO 3200 to CIO 3799	
Work Bit Areas	CIO Area	49,792 bits: CIO 0020 to CIO 1199, CIO 1220 to CIO 1499, CIO 1900 to CIO 2099, CIO 2962 to CIO 3099, CIO 3190 to CIO 3199, CIO 3800 to CIO 3899, CIO 4040 to CIO 4999, and CIO 6000 to CIO 6143
	Work Area	4,096 bits: W000 to W255
Auxiliary Area	Read/Write	Read-only: 7,168 bits: A000 to A447 Read/write: 8,192 bits: A448 to A959
	Error Log	100 words: A100 to A199 (20 records)
Temporary Area		16 bits: TR0 to TR15
Holding Area		None
Timer Area		256 timers: T0000 to T0255 (1-ms, 10-ms, and 100-ms timers)
Counter Area		256 counters: C0000 to C0255 (decrementing counters and reversible counters) Note Status not retained when power turned OFF.
DM Area	Read/Write (not retained)	20,000 words: D00000 to D19999 (Status not retained when power is turned OFF.)
	Read/Write (retained)	12,768 words: D20000 to D32767 (Status retained in flash memory. Not retained if written by a ladder program, but retained in flash memory if written using the CX-Programmer.)
System Setup		System Setup area (Coordinator Module/Motion Control Module settings and peripheral service settings), peripheral service setting area
FB Address Allocation Areas	CIO Area	16,000 bits (1,000 words): CIO 5000 to CIO 5999
	Timers	50 bits: T0206 to T0255
	Counters	50 bits: C0206 to C0255
Index Registers		IR0 to IR15 (IR0 and IR1 are used with JSB instruction.) Note IR16 to IR63 are used by the system for function blocks/structured text.
Data Registers		DR0 to DR15 Note DR16 to DR63 are used by the system for function blocks/structured text.
Interrupt Functions	Input interrupts	None
	Timer interrupts	1 (Scheduled or one-shot interrupt)

Item		Specifications
Power interruption hold function (momentary power interruption)		Super capacitor
Memory backup		Super capacitor backup
		Error log
		Flash memory
		User programs, System Setup, part of DM Area
Trace memory		4,000 words
Peripheral servicing		Servicing for devices connected to peripheral port (only CX-Programmer), RS-232C port (Host Links, no-protocol communications, NT Links, and Serial PLC Links (slave)), and RS-422A port (for Servo Driver)
Self-diagnosis function		CPU errors (WDT) and memory errors
Program check		Programs checked from the CX-Programmer.
Super-capacitor backup time		Approximately 100 hours at 25°C
Clock		None
Fixed Power OFF detection time		AC: 10 to 25 ms (variable)
User-set Power OFF detection time		0 to 10 ms
RUN output		1 (when CJ1W-PA205R used)
Individual functions	Serial communications	Peripheral port: Peripheral bus (Toolbus), Host Links, NT Links Built-in RS-232C port on Coordinator Module: Peripheral bus (Toolbus), Host Links, no-protocol communications, NT Links, and Serial PLC Links (slave). Built-in RS-422A port on Coordinator Module: Servo Driver interface

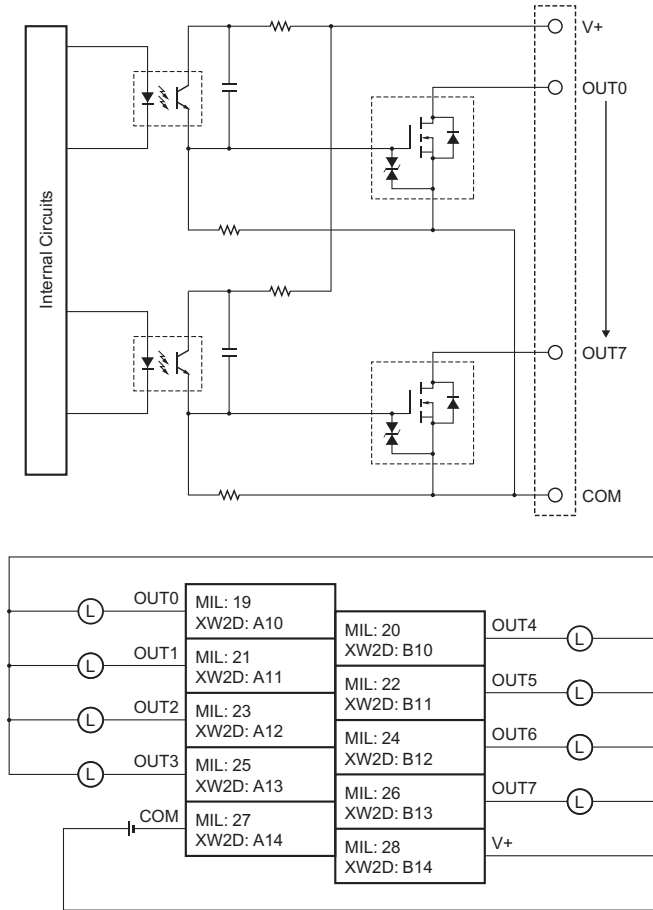
I/O Specifications

Built-in General-purpose I/O

Item		Specifications
Inputs	Number of inputs	16
	Input voltage	20.4 to 26.4 V
	Input response	Inputs for normal input (16 points): ON delay time: 100 μs OFF delay time: 1 ms max. 8 points/common



Item		Specifications
Outputs	Number of outputs	8
	Output type	NPN transistor
	Switching capacity	4.5 to 30 V DC, 0.3 A per output
	ON delay time	0.1 ms max.
	OFF delay time	1 ms max.



2-4 Motion Control Modules

Motion Control Module

FQM1-MMP22 (Pulse I/O)

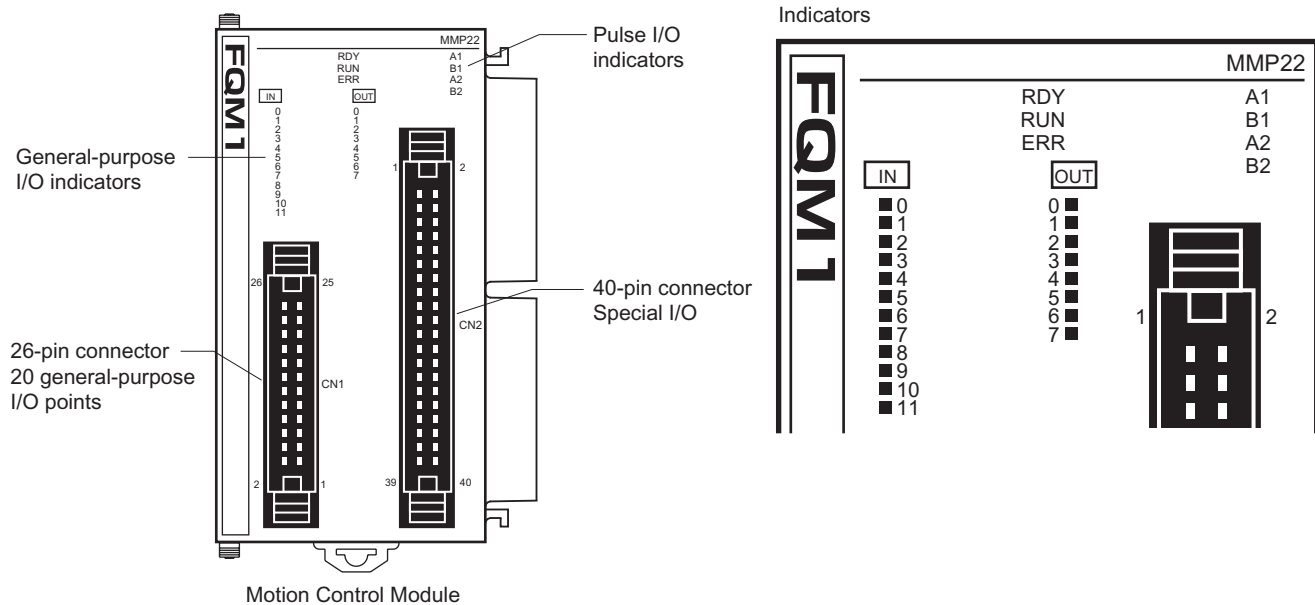
Item		Specifications	
I/O	Pulse I/O	Pulse inputs: 2 (compatible with Servo Drivers with absolute encoders) Pulse outputs: 2	40-pin connector
	General-purpose I/O	General-purpose inputs: 12 General-purpose outputs: 8	26-pin connector

Item		Specifications
Functions	Pulse outputs	The following operations are supported: <ul style="list-style-type: none"> • Speed control (fixed, acceleration, deceleration) • Positioning (Fixed-speed positioning; trapezoid, acceleration/deceleration positioning, and deceleration positioning) • Speed control according to the present position (pulse output target value comparison or range comparison) • Electronic cam operation (Positioning according to the rotation position of the real or virtual axis.) • One-shot pulse output (Output ON only for specified time. minimum increment: 0.01 ms) • Time measurement using pulse counter (minimum increment: 0.0001 ms)
	Pulse inputs	<ul style="list-style-type: none"> • High-speed counters: Phase, Increment/decrement, Pulse + direction inputs (50 kHz/1 MHz), or phase differential (50 kHz/500 kHz; phase differential × 4, 2 MHz) • High-speed counter can be started/stopped using counter start bit. • Changes in high-speed counter present value can be measured. • High-speed counter frequency can be measured.
Program	Program capacity	10 Ksteps

FQM1-MMA22 (Analog I/O)

Item		Specifications	
I/O	Pulse inputs	Pulse inputs: 2 (compatible with Servo Drivers with absolute encoders)	40-pin connector
	Analog I/O	<ul style="list-style-type: none"> • Analog inputs: 1 (-10 to 10 V, 0 to 10 V, 0 to 5 V, 1 to 5 V, and 4 to 20 mA), conversion speed: 40 μs/input • Analog outputs: 2 (-10 to 10 V, 0 to 10 V, 0 to 5 V, and 1 to 5 V), conversion speed: 40 μs/output 	
	General-purpose I/O	General-purpose inputs: 12 General-purpose outputs: 8	26-pin connector
Functions	Analog output	<ul style="list-style-type: none"> • Slope • Output hold • Offset/gain adjustment 	
	Analog input	• Offset/gain adjustment	
Program	Program capacity	10 Ksteps	

Nomenclature



Indicators

Indicator	Color	Name	Status	Meaning
RDY	Green	Module operation	Lit	Module operating normally.
			Not lit	Module error (e.g., WDT error)
RUN	Green	Program execution	Lit	Executing internal Module program
			Not lit	Internal Module program stopped.
ERR	Red	Module error	Lit	Fatal error.
			Flashing	Non-fatal error.
			Not lit	Module operating normally.
IN0 to IN11	Yellow	Inputs	Lit	Input signal ON
			Not lit	Input signal OFF
OUT0 to OUT7	Yellow	Outputs	Lit	Output signal ON
			Not lit	Output signal OFF
A1/B1 A2/B2	Yellow	Pulse inputs	Lit	Input signal ON
			Not lit	Input signal OFF

Note IN0 to IN 11, OUT0 to OUT7, and A1 to B2 are all controlled by hardware.

Functional Specifications

Item	Specifications	
Control method	Stored program	
I/O control method	Cyclic scan	
Programming language	Ladder diagram	
Instruction length	1 to 7 steps per instruction	
Number of instructions	Approx. 300	
Instruction execution time	Basic instructions	0.1 μ s min.
	Special instructions	0.3 μ s min.
Common processing time (over-head)	MMP22	Sync Mode: 250 μ s ASync Mode: 190 μ s
	MMA22	Sync Mode: 340 μ s ASync Mode: 280 μ s Each analog input when analog output is disabled: 190 μ s When analog output disabled: 230 μ s
Program capacity	Ladder	10 Ksteps
	Comment storage	Yes
Number of tasks	Cyclic tasks: 1, interrupt tasks: 50	
Subroutines	256	
JMP instructions	256	
Number of basic I/O	20 per Module	
CIO Area	Input Bit Area	12 bits (1 word): CIO 2960.00 to CIO 2960.11
	Output Bit Area	8 bits (1 word): CIO 2961.00 to CIO 2961.07
	Cyclic Refresh Bit Area	160 bits (10 words): CIO 4000 to CIO 4009 Input refresh for Coordinator to Motion Control Module: CIO 4000 to CIO 4004 Output refresh for Motion Control Module to Coordinator Module: CIO 4005 to CIO 4009
	Synchronous Data Link Bit Area	320 bits (20 words): CIO 1200 to CIO 1219 Sent from Coordinator Module: CIO 1200 to CIO 1203 Sent from Motion Control Module #1: CIO 1204 to CIO 1207 Sent from Motion Control Module #2: CIO 1208 to CIO 1211 Sent from Motion Control Module #3: CIO 1212 to CIO 1215 Sent from Motion Control Module #4: CIO 1216 to CIO 1219
Work Area	CIO Area	81,792 bits: CIO 0000 to CIO 1199, CIO 1220 to CIO 2959, CIO 2962 to CIO 3999, CIO 4010 to CIO 4999, CIO 6000 to CIO 6143
	WR Area	4,096 bits: W000 to W255

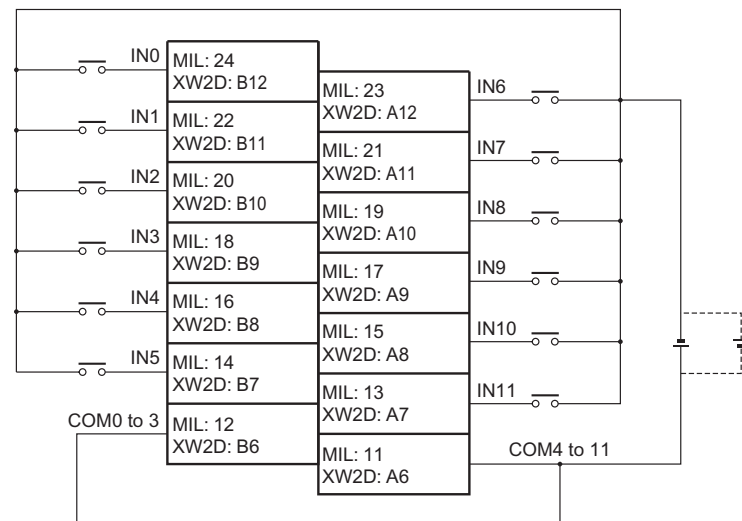
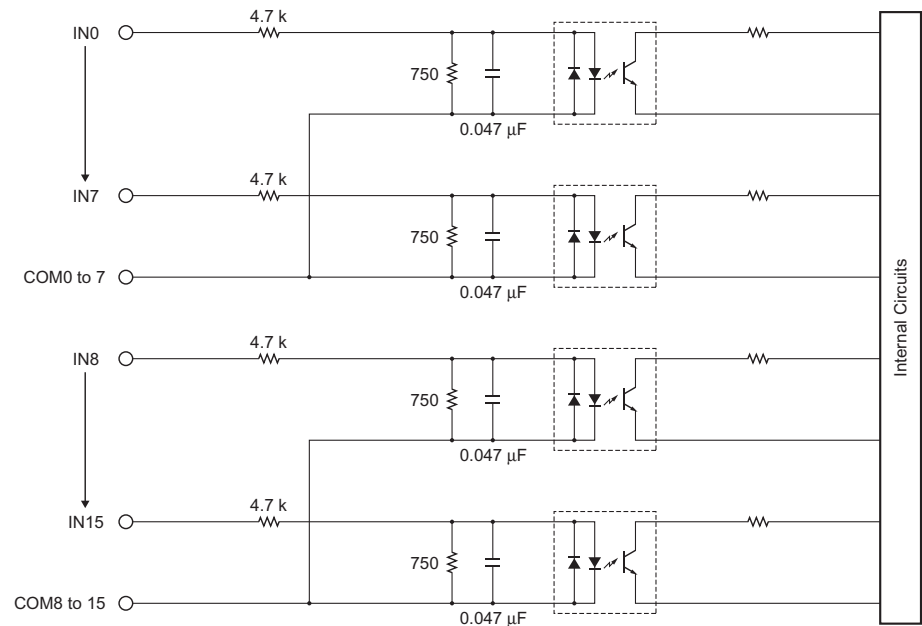
Item		Specifications		
Auxiliary Area	Read/Write	Read-only: 7,168 bits: A000 to A447 Read/write: 8,192 bits: A448 to A959		
	Error Log	100 words: A100 to A199 (20 records)		
Temporary Area		16 bits: TR0 to TR15		
Holding Area		None		
Timer Area		256 timers: T0000 to T0255 (1-ms, 10-ms, and 100-ms timers)		
Counter Area		256 counters C0000 to C0255 (decrementing counters and reversible counters) Note Status not retained when power turned OFF.		
DM Area	Read/write (not retained)	30,000 words: D00000 to D29999 (Status not retained when power is turned OFF.) This data can be saved to flash memory using a bit operation, and a parameter in the system settings can be set to automatically restore the DM Area data from flash memory when power is turned ON.		
	Read/write (retained)	2,768 words: D30000 to D32767 (Retained by super capacitor.)		
System Setup		System Setup Area (Coordinator Module/Motion Control Module settings), motion parameter setting area		
FB Address Allocation Areas	CIO Area	16,000 bits (1,000 words): CIO 5000 to CIO 5999		
	Timers	50 bits: T0206 to T0255		
	Counters	50 bits: C0206 to C0255		
Index Registers		IR0 to IR15 (IR0 and IR1 are used with JSB instruction.) Note IR16 to IR63 are used by the system for function blocks/structured text.		
Data Registers		DR0 to DR15 Note IR16 to IR63 are used by the system for function blocks/structured text.		
Interrupt Functions	Input interrupts	4 (with adjustment down mode)		
	Timer interrupts	1(Scheduled or one-shot interrupt)		
Power interruption hold function (momentary power interruption)		Super capacitor		
Memory backup	Super capacitor backup	Error log, part of DM Area (backup for momentary power interruptions)		
	Flash memory	User programs, System Setup (part of DM Area (via control bit))		
Trace memory		4,000 words		
Peripheral servicing		Event requests from Coordinator Module		
Self-diagnosis function		CPU errors (WDT) and memory errors		
Program check		Programs checked from the CX-Programmer.		
Super-capacitor backup time		Approximately 100 hours at 25°C		
Clock		None		
Individual functions	High-speed counters	Phase pulse inputs, Up/down pulse inputs, Pulse + direction pulse inputs (50 kHz/1 MHz)	FQM1-MMP22 (pulse I/O)	
		Phase differential inputs (50 kHz/500 kHz; phase differential × 4, 2 MHz)		
	High-speed pulse outputs	CW and CCW (1 MHz: Line-driver)		
		One-shot pulse output		
	High-speed counters	Single phase pulse inputs/Up/down pulse inputs /Pulse + direction pulse inputs (50 kHz/1 MHz)		FQM1-MMA22 (analog I/O)
		Phase differential inputs (50 kHz/500 kHz; phase differential × 4, 2 MHz)		
Analog input	Conversion speed: 40 μs/input			
	Resolution: -10 to 10 V: 1/16,000; 0 to 10 V: 1/8,000; 0 to 5 V: 1/4,000; 1 to 5 V: 1/4,000; 4 to 20 mA: 1/4,000			
Analog outputs	Conversion speed: 40 μs/output			
	Resolution: -10 to 10 V: 1/10,000; 0 to 10 V/0 to 5 V/1 to 5 V: 1/4,000			

I/O Specifications

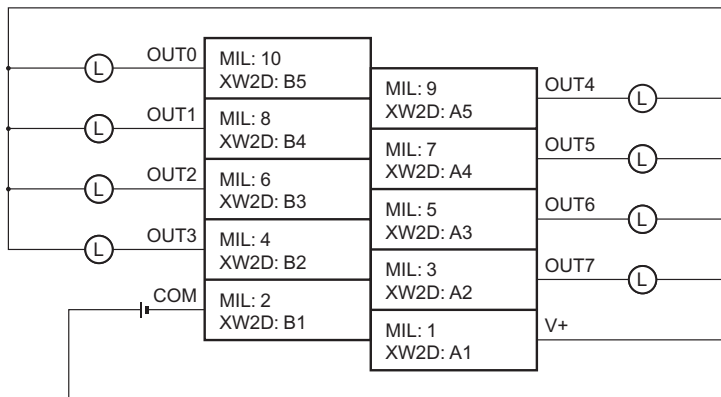
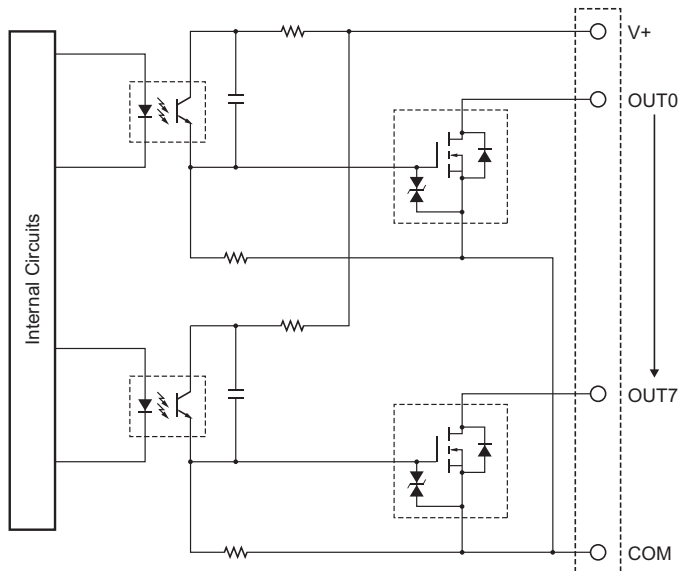
General-purpose I/O Specifications

Common Specifications for FQM1-MMP22 (Pulse I/O) and FQM1-MMA22 (Analog I/O)

Item		Specifications	
Inputs	Number of inputs	12 inputs	
	Input voltage	20.4 to 26.4 V	
	Input response	Interrupt input (4 points with one common)	ON delay time: 30 μ s OFF delay time: 0.2 ms max. 4 points/common
		Normal input (8 points with one common)	ON delay time: 100 μ s OFF delay time: 1 ms max. 8 points/common



Item		Specifications
Outputs	Number of outputs	8 outputs
	Output type	Transistor (NPN)
	Switching capacity	4.5 to 30 V DC, 0.3 A per output
	ON delay time	0.1 ms max.
	OFF delay time	1 ms max.



Pulse I/O Specifications

FQM1-MMP22 (Pulse I/O)

Item		Specifications	
Pulse inputs	Number of counters	2	
	Counter operations	Linear counter and circular counter	
	Input signals	Two words each for phase A, phase B, and phase Z.	
	Signal levels	24 V DC, line-driver	
	Input method	Phase differential ×1 Phase differential ×2 Phase differential ×4 Increment/decrement Pulse + direction	
	Counting speed	Voltage	50 k Hz
		Line-driver	50 k Hz/500k Hz (phase differential × 4, 2 MHz)
Absolute Servo Driver interfaces	2 SEN output specifications: 5 V PNP output, output current: 5 mA When SEN signal is output to Servo Driver, Servo Driver will transmit the number of encoder's rotations to this Module. After that, it transmits pulse train corresponding to displacement of the number of turns to the Module.		
Pulse outputs	Number of outputs	2	
	Output signal	CW/CCW	
	Signal levels	Line-driver (equivalent to AM26LS31) Max. output current: 20 mA	
	Output speed	1 MHz	
One-shot pulse outputs	Number of outputs	2	
	Output type	Open collector (NPN)	
	Max. switching capacity	80 mA/5 to 24 V DC ± 10%	
	Min. switching capacity	7 mA/5 to 24 VDC ± 10%	
	Output pulse width	Set time ± 1 μs or 0.1% of set time	

Pulse Inputs and Analog I/O Specifications

FQM1-MMA22 (Analog I/O)

Item		Specifications		
Pulse inputs	Number of counters	2		
	Counter operations	Linear counter, circular counter		
	Input signals	Two words each for phase A, phase B, and phase Z.		
	Signal levels	CH1: 24 V DC, line-driver CH2: Line-driver		
	Input method	Phase differential ×1 Phase differential ×2 Phase differential ×4 Increment/decrement Pulse + direction		
	Counting speed	Voltage	50 kHz	
		Line-driver	50 k Hz/500k Hz (phase differential × 4, 2 MHz)	
Absolute Servo Driver interfaces	2 SEN output specifications: 5 V PNP output, output current 5 mA When SEN signal is output to Servo Driver, Servo Driver will transmit the number of encoder's rotations to this Module. After that, it transmits pulse train corresponding to displacement of the number of rotations to the Module.			
Analog input	Number of analog inputs	1		
	Input signals	Voltage inputs: -10 to 10 V 0 to 10 V 1 to 5 V 0 to 5 V	Current inputs: 4 to 20 mA	
	Maximum rated input (per point)	Voltage inputs: ±15 V	Current inputs: ±30 mA	
	External input impedance	Voltage inputs: 1 MΩ min.	Current inputs: 250 Ω (rated)	
	Resolution	-10 to 10 V: 14 bits (1/16,000) 0 to 10 V: 13 bits (1/8,000) 0 to 5 V: 12 bits (1/4,000) 1 to 5 V/4 to 20 mA: 12 bits (1/4,000)		
	Accuracy (FS)	Voltage input: ± 0.2% (23 ± 2°C) ± 0.4% (0 to 55°C)	Current input: ± 0.4% (23 ± 2°C) ± 0.6% (0 to 55°C)	
	Conversion speed	40 μs max./input Total: 1.5 ms max.		
Analog outputs	Number of outputs	2		
	Output signal	-10 to 10 V, 0 to 10 V, 1 to 5 V, 0 to 5 V		
	External output impedance	0.5 Ω max.		
	Maximum external output current	2.4 mA		
	Resolution	-10 to 10 V: 14 bits (1/1,0000) 0 to 10 V: 12 bits (1/4,000) 0 to 5 V: 12 bits (1/4,000) 1 to 5 V: 12 bits (1/4,000)		
	Accuracy (FS)	±0.3% (23 ± 2°C), ± 05% (0 to 55°C)		
	Conversion speed	40 μs max./output Total: 200 μs max.		

2-5 CJ-series Unit Tables

2-5-1 CJ-series Basic I/O Units

Input Units

Name	Specifications	Model	Number of bits allocated	Compatible Rack	
				FQM1 CPU Rack	CJ-series Expansion Rack
DC Input Units	Terminal block, 12 to 24 V DC, 8 inputs	CJ1W-ID201	16 (See note 2.)	Yes	Yes
	Terminal block, 24 V DC, 16 inputs	CJ1W-ID211	16	Yes	Yes
	Fujitsu-style connector, 24 V DC, 32 inputs	CJ1W-ID231 (See note 1.)	32	Yes	Yes
	MIL connector, 24 V DC, 32 inputs	CJ1W-ID232 (See note 1.)	32	Yes	Yes
	Fujitsu-style connector, 24 V DC, 64 inputs	CJ1W-ID261 (See note 1.)	64	Yes	Yes
	MIL connector, 24 V DC, 64 inputs	CJ1W-ID262 (See note 1.)	64	Yes	Yes
AC Input Units	Terminal block, 200 to 240 V AC, 8 inputs	CJ1W-IA201	16 (See note 2.)	Yes	Yes
	Terminal block, 100 to 120 V AC, 16 inputs	CJ1W-IA111	16	Yes	Yes
B7A Interface Unit	64 inputs	CJ1W-B7A14	64	Yes	Yes

Output Units

Name	Specifications	Model	Number of bits allocated	Compatible Rack	
				FQM1 CPU Rack	CJ-series Expansion Rack
Relay Output Units	Terminal block, 250 V AC/24 V DC, 2 A, 8 outputs, independent contacts	CJ1W-OC201	16 (See note 2.)	Yes	Yes
	Terminal block, 250 V AC/24 V DC, 2 A, 16 outputs	CJ1W-OC211	16	Yes	Yes
Triac Output Unit	Terminal block, 250 V AC, 0.6 A, 8 outputs	CJ1W-OA201	16 (See note 2.)	Yes	Yes
Transistor Output Units (Sinking outputs)	Terminal block, 12 to 24 V DC, 2 A, 8 outputs	CJ1W-OD201	16 (See note 2.)	Yes	Yes
	Terminal block, 12 to 24 V DC, 0.5 A, 8 outputs	CJ1W-OD203	16 (See note 2.)	Yes	Yes
	Terminal block, 12 to 24 V DC, 0.5 A, 16 outputs	CJ1W-OD211	16	Yes	Yes
	Fujitsu-style connector, 12 to 24 V DC, 0.5 A, 32 outputs	CJ1W-OD231 (See note 1.)	32	Yes	Yes
	MIL connector, 12 to 24 V DC, 0.3 A, 32 outputs	CJ1W-OD233 (See note 1.)	32	Yes	Yes
	Fujitsu-style connector, 12 to 24 V DC, 0.3 A, 64 outputs	CJ1W-OD261 (See note 1.)	64	Yes	Yes
	MIL connector, 12 to 24 V DC, 0.3 A, 64 outputs	CJ1W-OD263 (See note 1.)	64	Yes	Yes

Name	Specifications	Model	Number of bits allocated	Compatible Rack	
				FQM1 CPU Rack	CJ-series Expansion Rack
Transistor Output Units (Sourcing outputs)	Terminal block, 24 V DC, 2 A, 8 outputs, load short-circuit protection, line disconnection detection	CJ1W-OD202	16 (See note 2.)	Yes	Yes
	Terminal block, 24 V DC, 0.5 A, 8 outputs, load short-circuit protection	CJ1W-OD204	16 (See note 2.)	Yes	Yes
	Terminal block, 24 V DC, 0.5 A, 16 outputs, load short-circuit protection	CJ1W-OD212	16	Yes	Yes
	MIL connector, 24 V DC, 0.5 A, 32 outputs, load short-circuit protection	CJ1W-OD232 (See note 1.)	32	Yes	Yes
	MIL connector, 12 to 24 V DC, 0.3 A, 64 outputs	CJ1W-OD262 (See note 1.)	64	Yes	Yes
B7A Interface Unit	64 outputs	CJ1W-B7A04	64	Yes	Yes

Mixed I/O Units

Name	Specifications	Model	Number of bits allocated	Compatible Rack	
				FQM1 CPU Rack	CJ-series Expansion Rack
24-V DC Input/Transistor Output Units (Sinking outputs)	Fujitsu-style connector 16 inputs: 24 V DC 16 outputs: 12 to 24 V DC, 0.5 A	CJ1W-MD231 (See note 1.)	32	Yes	Yes
	Fujitsu-style connector 32 inputs: 24 V DC 32 outputs: 12 to 24 V DC, 0.3 A	CJ1W-MD261 (See note 1.)	64	Yes	Yes
	MIL connector 16 inputs: 24 V DC 16 outputs: 12 to 24 V DC, 0.5 A	CJ1W-MD233 (See note 1.)	32	Yes	Yes
	MIL connector 32 inputs: 24 V DC 32 outputs: 12 to 24 V DC, 0.3 A	CJ1W-MD263 (See note 1.)	64	Yes	Yes
24-V DC Input/Transistor Output Units (Sourcing outputs)	MIL connector 16 inputs: 24 V DC 16 outputs: 12 to 24 V DC, 0.5 A, load short-circuit protection	CJ1W-MD232 (See note 1.)	32	Yes	Yes
TTL I/O Unit	MIL connector 32 inputs: TTL (5 V DC) 32 outputs: TTL (5 V DC, 35 mA)	CJ1W-MD563 (See note 1.)	64	Yes	Yes
B7A Interface Unit	32 inputs and 32 outputs	CJ1W-B7A22	64	Yes	Yes

- Note**
- (1) Connectors are not included with the Unit. Either purchase the connectors separately, use an OMRON Terminal Block Adapter Unit, or use an I/O Terminal.
 - (2) Even though these Units have only 8 external I/O points, 16 I/O bits (1 word) are allocated and the Units are treated as 16-point I/O Units in the I/O tables.

2-5-2 CJ-series Special I/O Units

Name	Specifications	Model	Allocated words (See note.)	Compatible Rack		Unit numbers
				FQM1 CPU Rack	CJ-series Expansion Rack	
CompoBus/S Master Unit	CompoBus/S remote I/O, 256 bits max.	CJ1W-SRM21	10 words or 20 words	Yes	Yes	10 to 95 or 10 to 94

Note Words are allocated in the Special I/O Unit Area (CIO 2100 to CIO 2959) based on the unit number. (Words CIO 2000 to CIO 2099 are not used for Special I/O Units because unit numbers 0 to 9 cannot be used.)

2-5-3 CJ-series CPU Bus Units

Name	Specifications	Model	Allocated words (See note.)	Compatible Rack		Unit numbers
				FQM1 CPU Rack	CJ-series Expansion Rack	
SPU Unit (Data Collection Unit)	Automatically collects the specified data through the CJ bus at intervals of a few ms.	CJ1W-SPU01	25 words	Yes	Yes	0 to F
MECHA- TROLINK-II Position Control Unit	Controls up to 16 axes across a MECHATROLINK-II high-speed field network.	CJ1W-NCF71	25 words	Yes	Yes	0 to F

Note Words are allocated in the CPU Bus Unit Area (CIO 1500 to CIO 1899) based on the unit number.

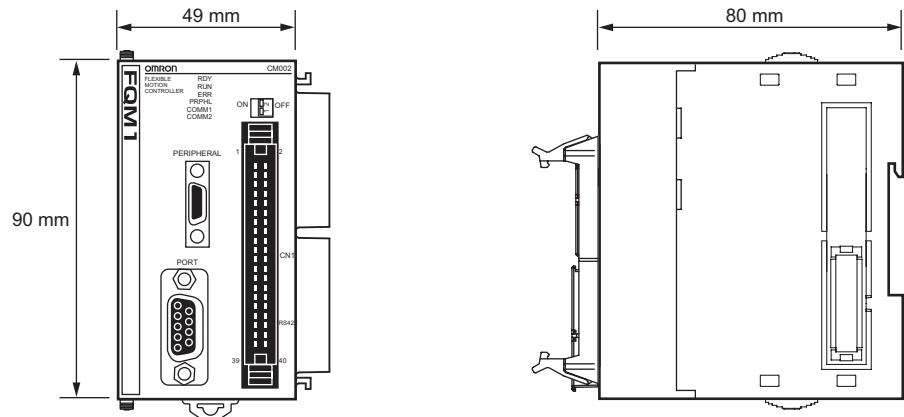
2-5-4 CJ-series Communications Units

Name	Specifications	Model	Allocated words (See note.)	Compatible Rack		Unit numbers
				FQM1 CPU Rack	CJ-series Expansion Rack	
DeviceNet Unit	Provides DeviceNet remote I/O communications (Slave functions only) for 3,200 bits. Data can be allocated freely even without a Configurator.	CJ1W-DRM21	25 words	Yes	Yes	0 to F

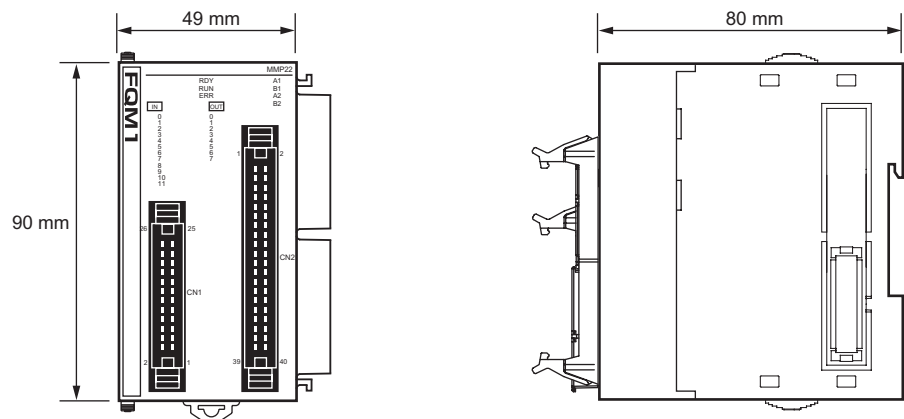
Note Words are allocated in the DeviceNet Area (CIO 3200 to CIO 3799) based on the unit number.

2-6 Dimensions

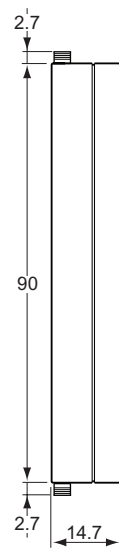
FQM1-CM002 Coordinator Module



FQM1-MMP22/MMA22 Motion Control Modules

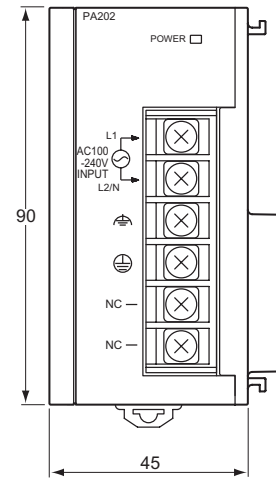
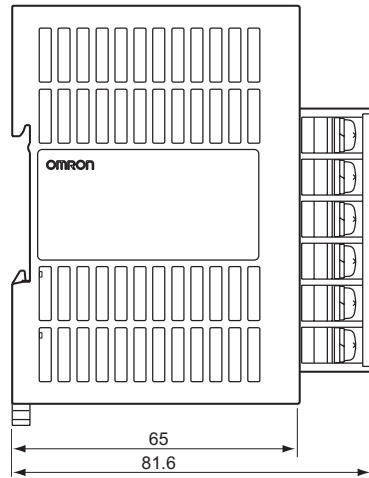


FQM1-TER01 End Module

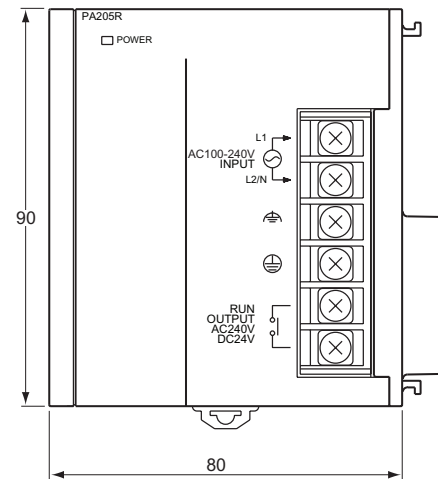
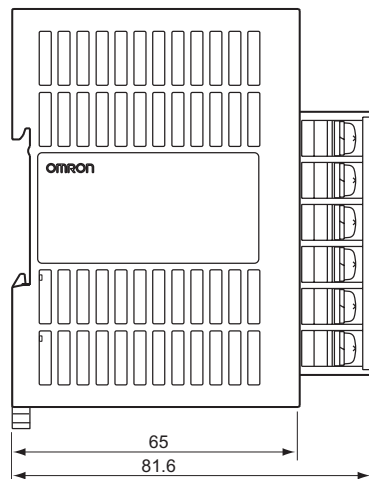


Power Supply Units

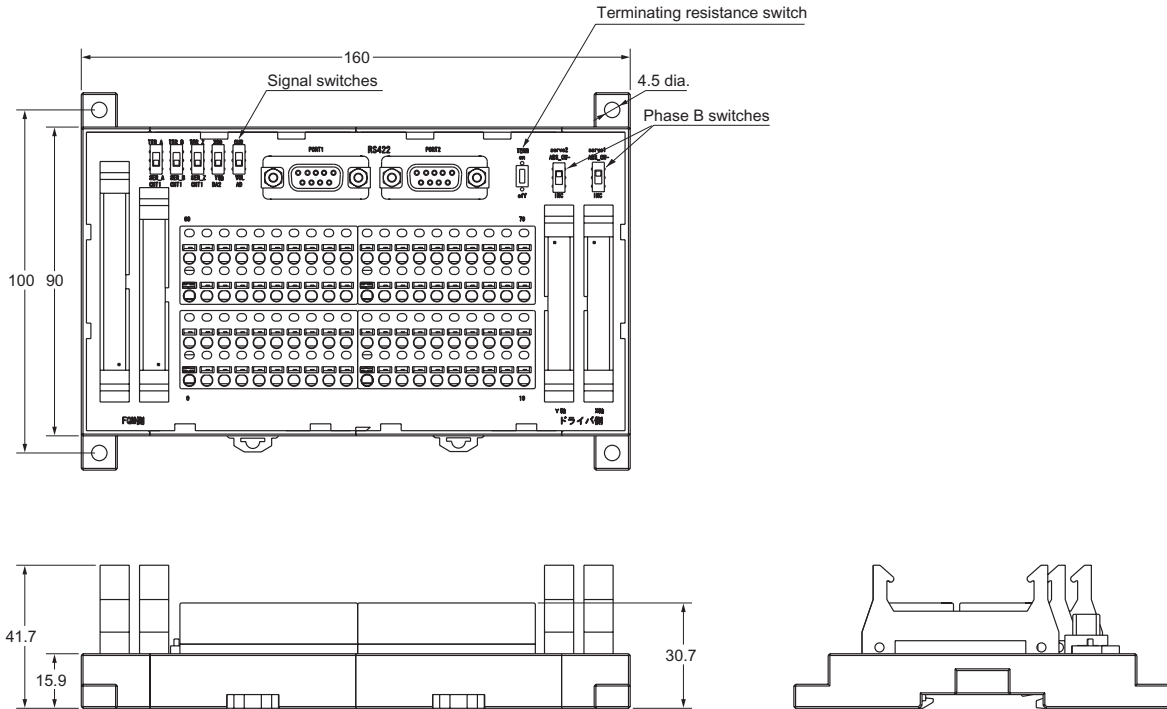
CJ1W-PA202



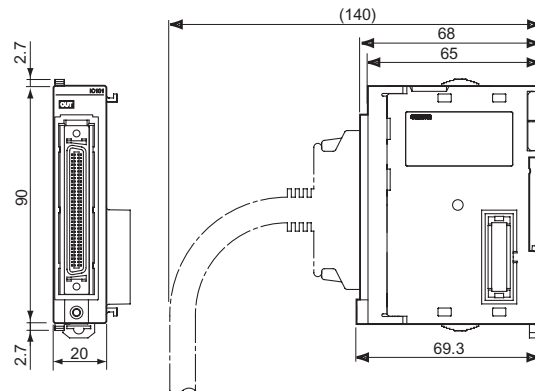
CJ1W-PA205R



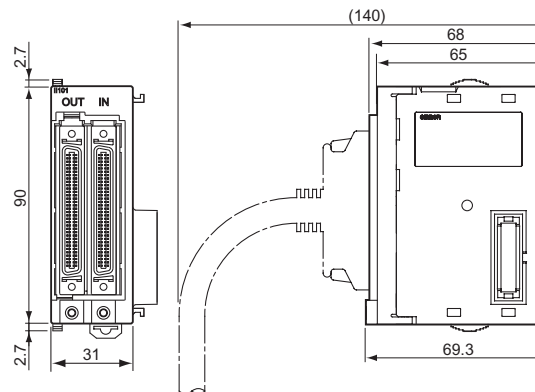
XW2B-80J7-1A Servo Relay Unit



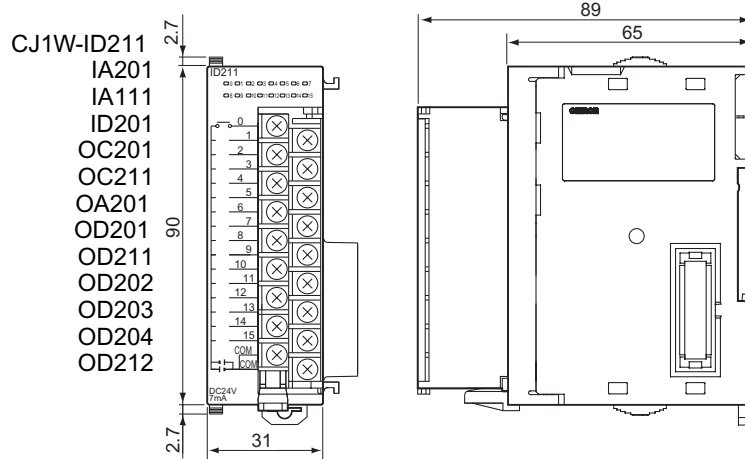
CJ1W-IC101 I/O Control Unit



CJ1W-II101 I/O Interface Unit



Dimensions of Units with 18-point Terminal Blocks

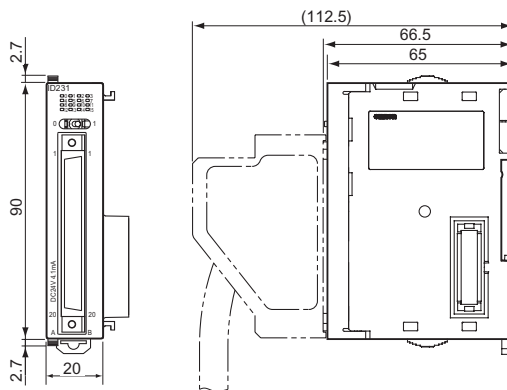


32-point Basic I/O Units (Input Units and Output Units)

■ **Units with Fujitsu-compatible Connector (40-pin x 1)**

CJ1W-ID231 (32 inputs: 24 V DC)

CJ1W-OD231 (32 outputs: 12 to 24 V DC, 0.5 A)

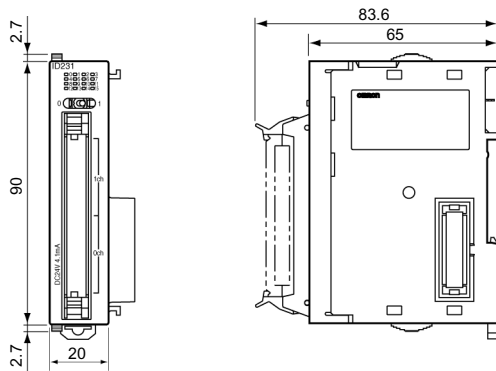


■ **Units with MIL Connector (40-pin x 1)**

CJ1W-ID232 (32 inputs: 24 V DC)

CJ1W-OD232 (32 outputs: 24 V DC, 0.5 A, load short-circuit protection)

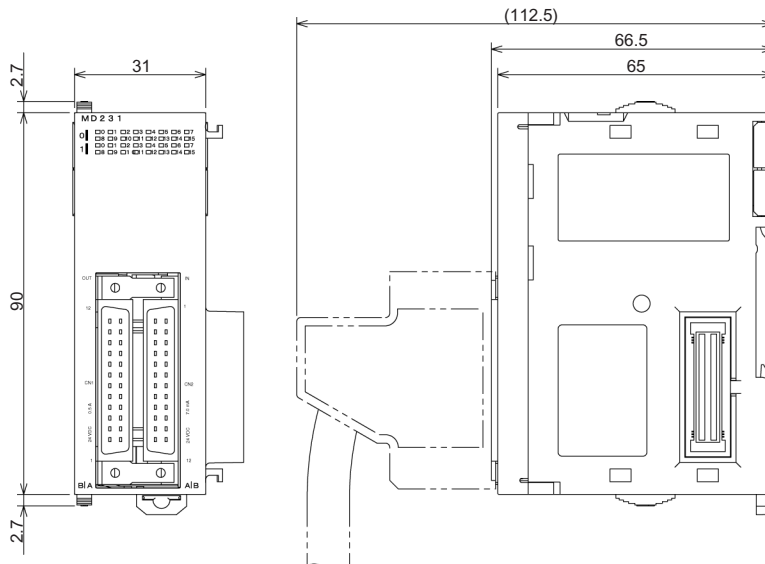
CJ1W-OD233 (32 outputs: 12 to 24 V DC, 0.5 A)



32-point Basic I/O Units (24-V DC Input/Transistor Output Units)

■ Units with Fujitsu-compatible Connector (24-pin x 2)

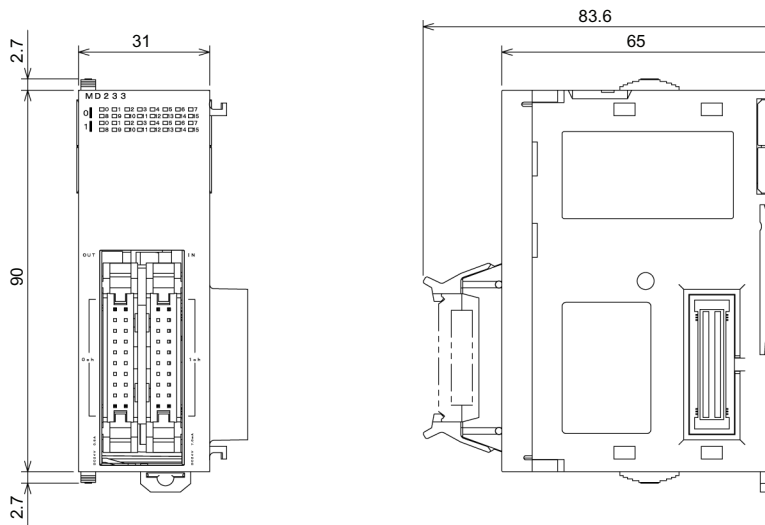
CJ1W-MD231 (16 inputs: 24 V DC, 16 outputs: 12 to 24 V DC, 0.5 A)



■ Units with MIL Connector (20-pin x 2)

CJ1W-MD232 (16 inputs: 24 V DC, 16 outputs: 24 V DC, 0.5 A, load short-circuit protection)

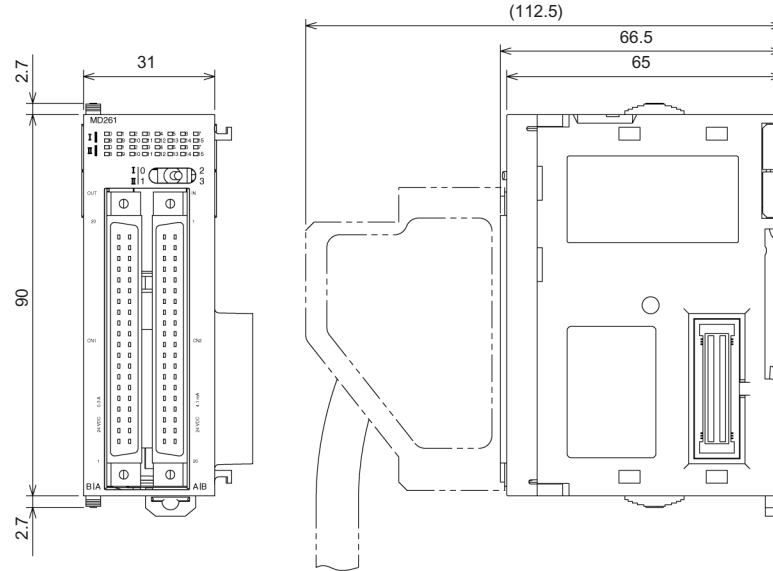
CJ1W-MD233 (16 inputs: 24 V DC, 16 outputs: 12 to 24 V DC, 0.5 A)



64-point Basic I/O Units (Input Units, Output Units, 24-V DC Input/Transistor Output Units, and TTL I/O Units)

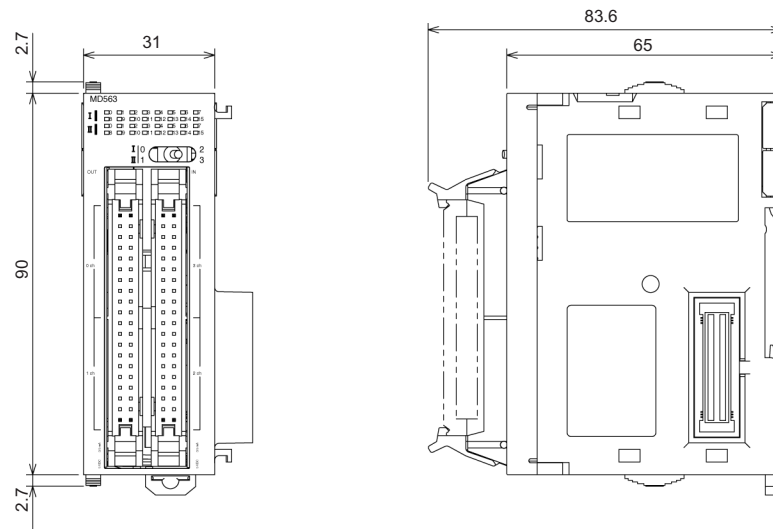
■ **Units with Fujitsu-compatible Connector (40-pin x 2)**

- CJ1W-ID261 (64 inputs: 24 V DC)
- CJ1W-OD261 (64 outputs: 12 to 24 V DC, 0.3 A)
- CJ1W-MD261 (32 inputs: 24 V DC, 32 outputs: 12 to 24 V DC, 0.3 A)

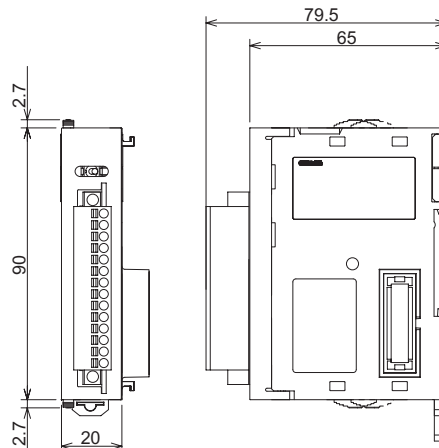


■ **Units with MIL Connector (40-pin x 2)**

- CJ1W-ID262 (64 inputs: 24 V DC)
- CJ1W-OD262 (64 outputs: 12 to 24 V DC, 0.3 A)
- CJ1W-OD263 (64 outputs: 12 to 24 V DC, 0.3 A)
- CJ1W-MD263 (32 inputs: 24 V DC, 32 outputs: 12 to 24 V DC, 0.3 A)
- CJ1W-MD563 (32 TTL inputs, 32 TTL outputs (5 V DC, 35 mA))



Basic I/O Units: B7A Interface Unit



2-7 Module Current Consumption

The amount of current/power that can be supplied to the Modules mounted in the FQM1 is limited. Refer to the following tables when designing your system so that the total current consumption of the mounted Modules does not exceed the maximum current for each voltage system and the total power consumption does not exceed the maximum for the Power Supply Unit.

Maximum Current and Maximum Total Power Consumption

The following table shows the maximum currents and power that can be supplied by Power Supply Units to the Controller.

Power Supply Unit	Max. current consumption			Max. total power consumption
	5-V system (internal logic)	24-V system (analog)	24-V system (service)	
CJ1W-PA202	2.8 A	0.4 A	None	14 W
CJ1W-PA205R	5.0 A	0.8 A	None	25 W

Current Consumption for Each Module

Current Consumption for 5-V System

Name	Model	5-V system current consumption (A)
Coordinator Module Note The listed value includes the current consumption for the CX-Programmer.	FQM1-CM002	0.37
End Module	FQM1-TER01	Included in Coordinator Module current consumption
I/O Control Module	FQM1-IC101	0.02
I/O Interface Unit	CJ1W-II101	0.13
Motion Control Module	Pulse I/O	FQM1-MMP22 0.824
	Analog I/O	FQM1-MMA22 0.772

Current Consumption for 24-V Systems

Name	Type	Model	24-V system current consumption (A)
Motion Control Module	Analog I/O	FQM1-MMA22	0.095

For details on the current consumption of other CJ-series Units, refer to 2-6-3 Current Consumption Tables in the SYSMAC CJ Series Programmable Controllers Operation Manual (W393).

Example Calculation of Current and Power Consumption

Example for CJ1W-PA202 Power Supply Unit with the Following Modules Mounted

Name	Model	Quantity	Voltage system	
			5 V	24 V
Coordinator Module	FQM1-CM002	1	0.37 A	---
Motion Control Module	FQM1-MMP22	1	0.824 A	---
	FQM1-MMA22	1	0.772 A	0.095 A
I/O Control Module	FQM1-IC101	1	0.02 A	---
CompoBus/S Master Unit	CJ1W-SRM21	1	0.15 A	---
Current consumption	Calculation		0.37 + 0.824 + 0.772 + 0.02 + 0.15	0.095 A
	Result		2.118 A (≤ 2.8 A)	0.095 A (≤ 0.4 A)
Power consumption	Calculation		2.136 × 5 V = 10.68 W	0.095 × 24 V = 2.28 W
	Result		10.68 + 2.28 = 12.96 W (≤ 14 W)	

Combining Power Supply Units, Motion Control Modules, and CJ-series Units

The following table shows the Power Supply Units that can be connected for different numbers of Motion Control Modules.

Number of axes	Number of connected Motion Control Modules		Power Supply Unit
	FQM1-MMP22	FQM1-MMA22	
2	1	0	CJ1W-PA202 (or CJ1W-PA205R)
	0	1	
4	2	0	
	1	1	
	0	2	
6	3	0		CJ1W-PA205R
	2	1	
	1	2	
	0	3	
8	4	0	
	3	1	
	2	2	
	1	3	
	0	4	Not possible (See note 1.)

- Note**
- (1) These combinations are not possible because the current consumption exceeds the capacity of the Power Supply Unit.
 - (2) The power consumption of each CJ-series Unit is different, so add the power consumption of each Unit and verify that the total does not exceed the Power Supply Unit's capacity.

2-8 Memory Block Diagram

Coordinator Module and Motion Control Module memory has the following block configurations.

- I/O Memory Area: Memory accessible from user programs.
- User Memory (UM): User programs and parameter area (See note 1.)

The following tables show the backup methods for these memory areas.

- Coordinator Modules

Area	Backup method
User memory	Flash memory
I/O memory area (part of DM Area)	Flash memory

- Motion Control Modules

Area	Backup method
User memory	Flash memory
I/O memory area (part of DM Area)	Super capacitor

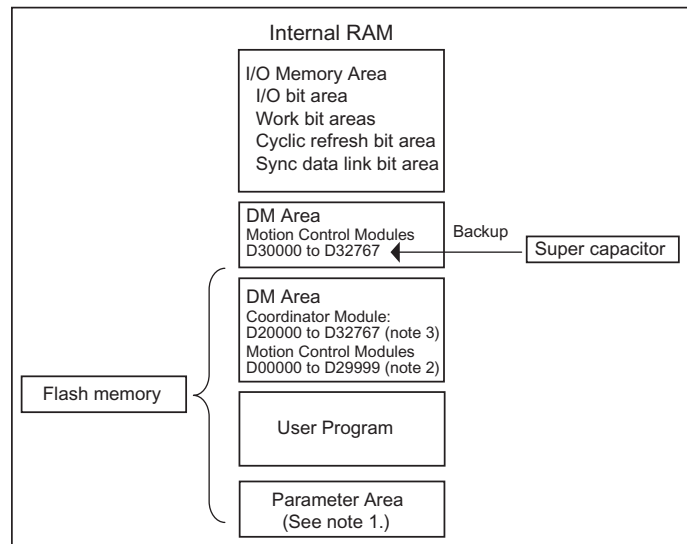
Areas Backed Up by Super Capacitors

Data backed up by super capacitors is lost if the super capacitor voltage drops.

Areas Backed Up to Flash Memory

Data backed up to flash memory is not lost if the super capacity voltage drops. Data transferred from the CX-Programmer or edited online and written to the user program or parameters in the user memory is automatically backed up to flash memory. This means that user memory data (both user program and parameter area data) is not lost if the super capacitor voltage drops.

Coordinator Module/Motion Control Module



- Note**
- (1) The parameter area stores the Coordinator Module system information, such as the System Setup.
 - (2) The Motion Control Module’s data can be saved to flash memory by a control bit operation.
 - (3) Data transferred to the Coordinator Module, e.g., from the CX-Programmer, is saved to flash memory.

SECTION 3

Installation and Wiring

This section describes how to install and wire the FQM1.

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3-1 Installation

3-1-1 Installation and Wiring Precautions

Be sure to consider the following factors when installing and wiring the FQM1 to improve the reliability of the system and make the most of the FQM1's functions.

Ambient Conditions

Do not install the FQM1 in any of the following locations.

- Locations subject to ambient temperatures lower than 0°C or higher than 55°C.
- Locations subject to drastic temperature changes or condensation.
- Locations subject to ambient humidity lower than 10% or higher than 90%.
- Locations subject to corrosive or flammable gases.
- Locations subject to excessive dust, salt, or metal filings.
- Locations that would subject the FQM1 to direct shock or vibration.
- Locations exposed to direct sunlight.
- Locations that would subject the FQM1 to water, oil, or chemical reagents.

Be sure to enclose or protect the FQM1 sufficiently in the following locations.

- Locations subject to static electricity or other forms of noise.
- Locations subject to strong electromagnetic fields.
- Locations subject to possible exposure to radioactivity.
- Locations close to power lines.

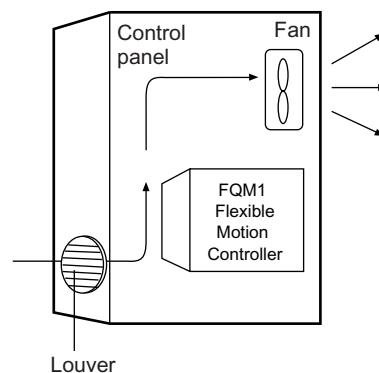
Installation in Cabinets or Control Panels

Temperature Control

When the FQM1 is being installed in a cabinet or control panel, be sure to provide proper ambient conditions as well as access for operation and maintenance.

The ambient temperature within the enclosure must be within the operating range of 0°C to 55°C. When necessary, take the following steps to maintain the proper temperature.

- Provide enough space for good air flow.
- Do not install the FQM1 above equipment that generates a large amount of heat such as heaters, transformers, or high-capacity resistors.
- If the ambient temperature exceeds 55°C, install a cooling fan or air conditioner.

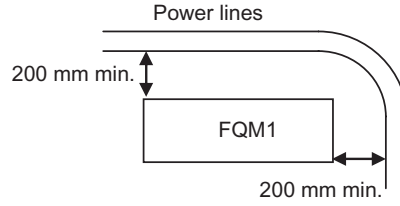


Accessibility for Operation and Maintenance

- To ensure safe access for operation and maintenance, separate the FQM1 as much as possible from high-voltage equipment and power equipment.

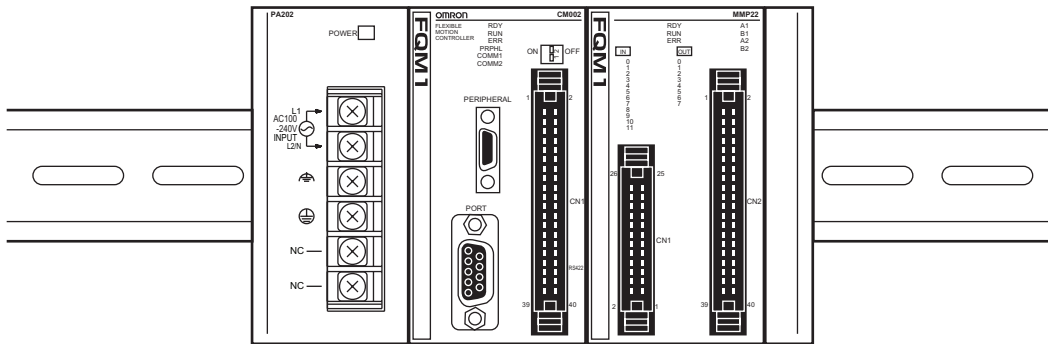
Improving Noise Resistance

- The FQM1 will be easiest to install and operate if it is mounted at a height of about 1.0 to 1.6 m.
- Do not mount the FQM1 in a control panel containing high-voltage equipment.
- Install the FQM1 at least 200 mm away from power lines.

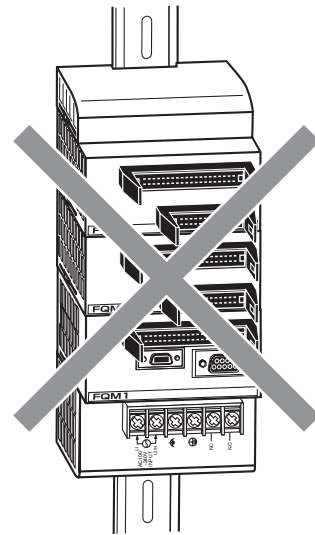
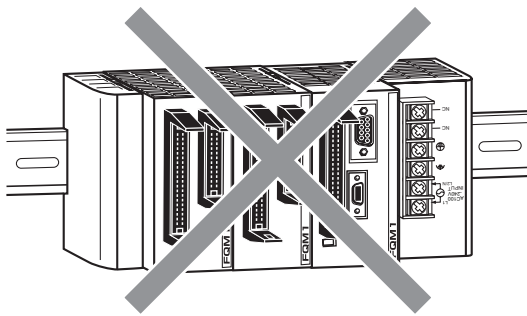
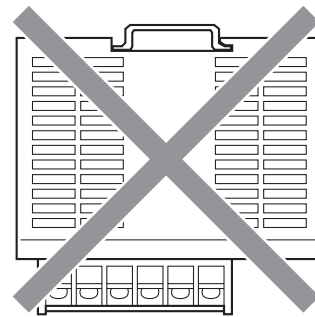
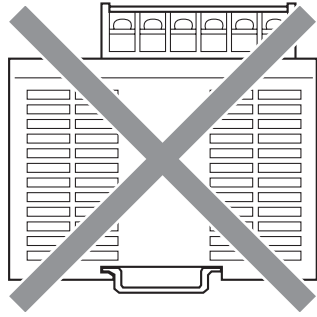


FQM1 Orientation

- Ground the mounting plate between the FQM1 and the mounting surface.
- The FQM1 must be mounted in an upright position to provide proper cooling.

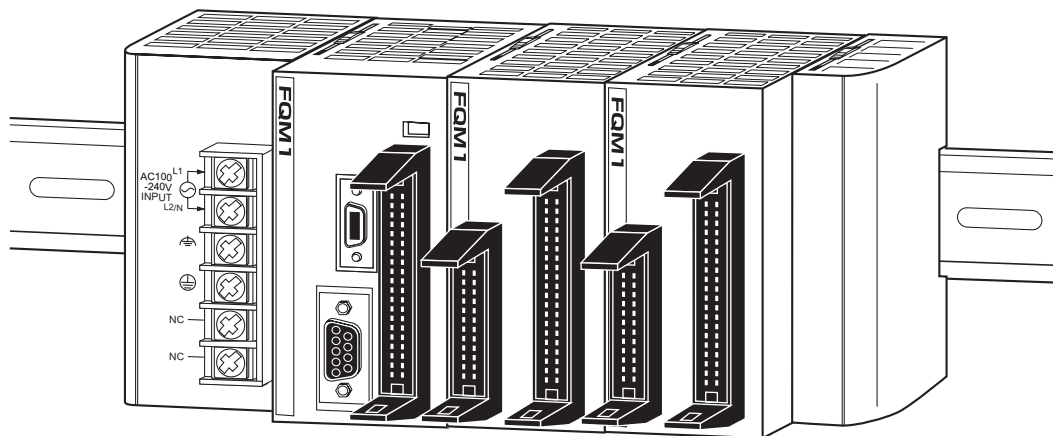


- Do not install the FQM1 in any of the following positions.



3-1-2 Installation in a Control Panel

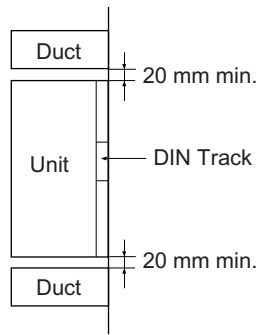
The FQM1 must be mounted inside a control panel on DIN Track.



Note The FQM1 must be mounted on DIN Track. It cannot be mounted with screws.

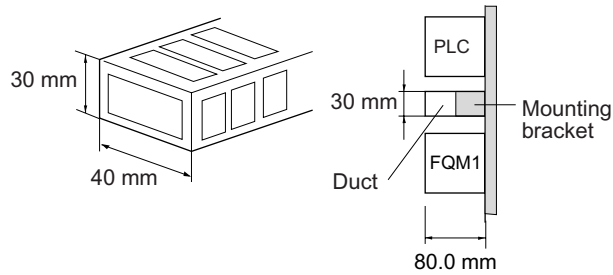
Wiring Ducts

Use wiring ducts to wire the FQM1's built-in I/O. Install the wiring ducts to facilitate wiring the built-in I/O. It is handy to have the duct at the same height as the FQM1.



Wiring Duct Example

The following example shows the proper installation of wiring ducts.

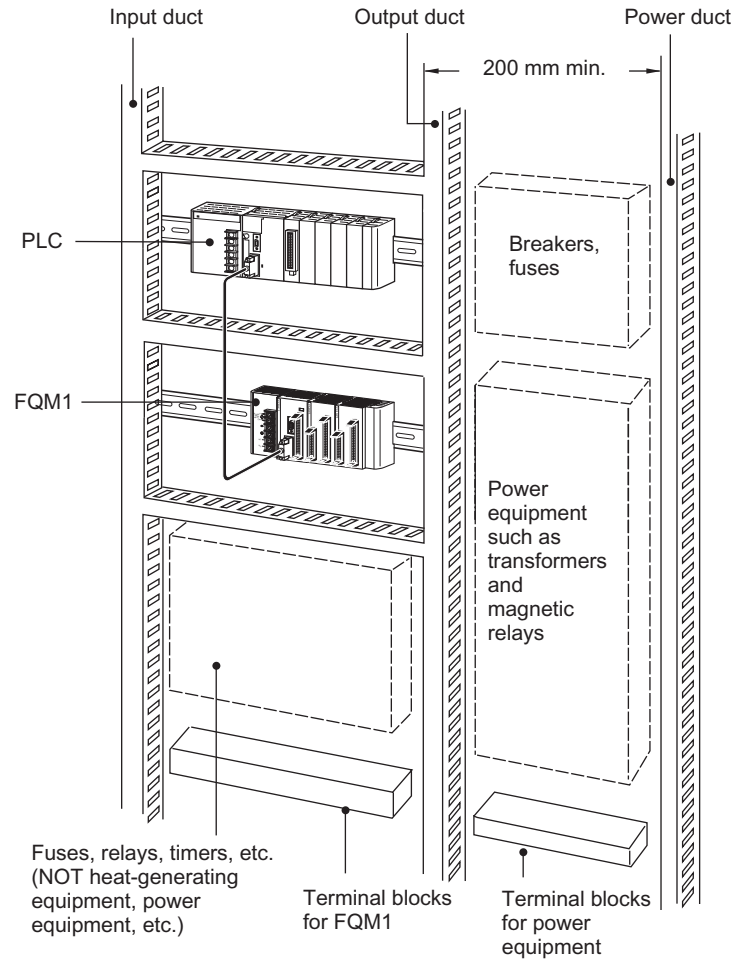


Note Tighten terminal block screws and cable screws to the following torques.

- Terminal Screws
 M4: 1.2 N·m
 M3: 0.5 N·m

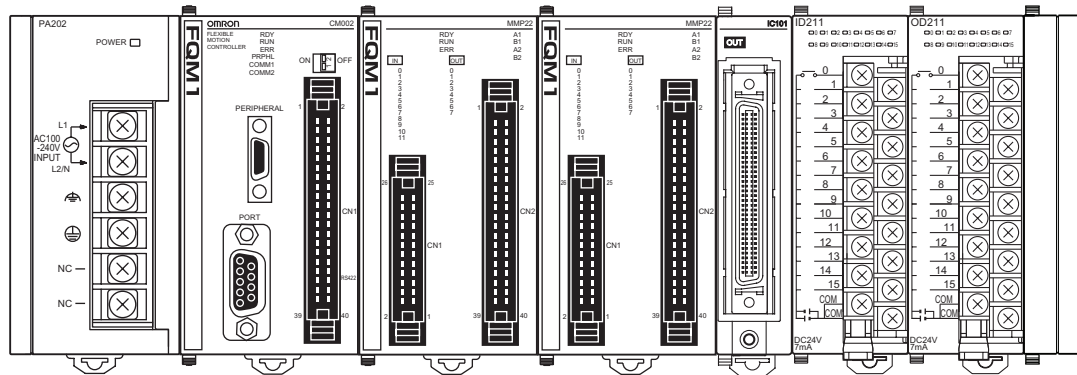
Routing Wiring Ducts

Install the wiring ducts at least 20 mm away from the FQM1 and any other objects, (e.g., ceiling, wiring ducts, structural supports, and devices) to provide enough space for air circulation and replacement of Modules.

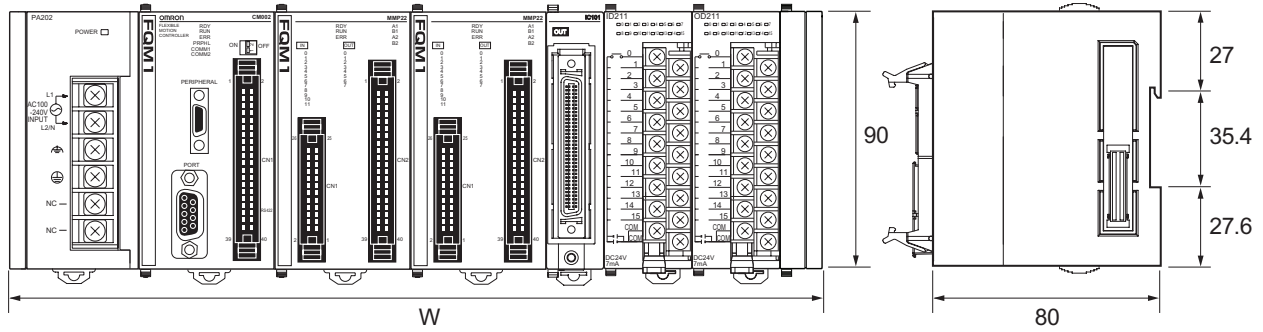


3-1-3 Assembled Appearance and Dimensions

The Modules and CJ-series Units that make up the FQM1 are connected to each other, and an End Module is connected to the right end.



Assembled Dimensions



$W = a + 49 + 49 \times n^* + 20 + b \times m^* + 14.7$
 (In an Expansion Rack: $W = a + 31 + b \times m^* + 14.7$)

* n is the number of connected Motion Control Modules (Up to 4 can be connected.)
 m is the number of connected CJ-series Units ($n + m \leq 10$)

Power Supply Unit width: "a" mm

Name	Model	Specifications	Unit width
Power Supply Unit	CJ1W-PA202	100 to 240 V AC, 14 W	45 mm
	CJ1W-PA205R	100 to 240 V AC, 25 W	80 mm

Coordinator Module width: 49 mm

Name	Model	Module width
Coordinator Module	FQM1-CM002	49 mm

Motion Control Module width: 49 mm

Name	Model	Module width	
Motion Control Module	Pulse I/O	FQM1-MMP22	49 mm
	Analog I/O	FQM1-MMA22	

I/O Control Module width: 20 mm

Name	Model	Module width
I/O Control Module	FQM1-IC101	20 mm

Note Mount an I/O Control Module only if CJ-series Units are being used.

I/O Interface Unit width: 31 mm

Name	Model	Module width
I/O Interface Unit	CJ1W-II101	31 mm

Note Mount an I/O Interface Unit only if an Expansion Rack is being used.

CJ-series Unit width: b (mm)

Unit name		Model	Unit width
Basic I/O Units	32-point I/O Units	CJ1W-ID231	20 mm
		CJ1W-OD231	
		CJ1W-ID232	
		CJ1W-OD232	
		CJ1W-OD233	
	B7A Interface Units	CJ1W-B7A14	31 mm
		CJ1W-B7A04	
		CJ1W-B7A22	
All other Units		---	31 mm
CPU Bus Units	SPU Units	CJ1W-SPU01	31 mm
	MECHATROLINK-II Position Control Unit	CJ1W-NCF71	31 mm
Special I/O Units	CompoBus/S Master Unit	CJ1W-SRM21	20 mm
Communications Units	DeviceNet Unit	CJ1W-DRM21	31 mm

Note Mount only if CJ-series Units are being used.

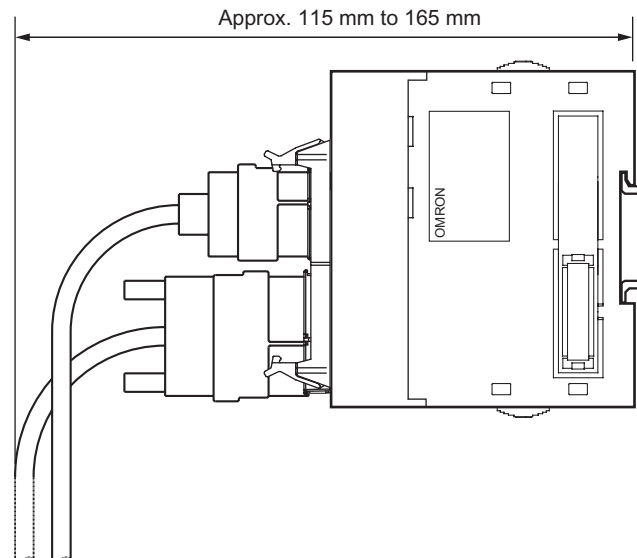
End Module width: 14.7 mm

Name	Model	Module width
End Module	FQM1-TER01 (for CPU Rack) CJ1W-TER01 (for Expansion Rack)	14.7 mm

Installation Height

The installation height of the FQM1 varies from 115 to 165 mm.

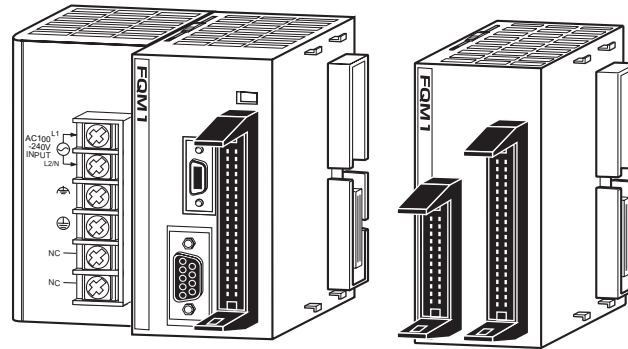
When a CX-Programmer or connecting cables are connected, however, even greater height is required. Allow sufficient depth in the control panel containing the FQM1.



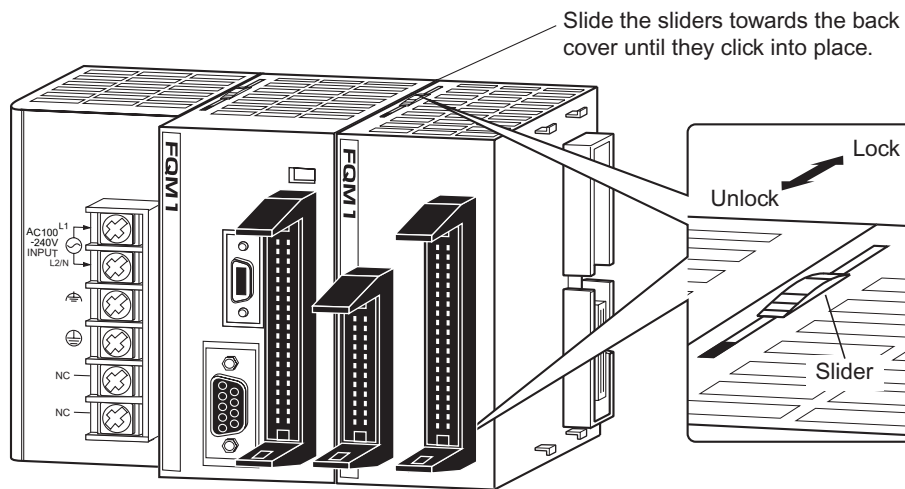
3-1-4 Connecting FQM1 Components

The Modules that make up the FQM1 can be connected simply by pressing the Modules together and locking the sliders. The End Module is connected on the far right side of the FQM1.

- 1,2,3... 1. Insert the two hooks on the top of the Module to the hook holes on the other Module, and join the Modules so that the connectors fit exactly.

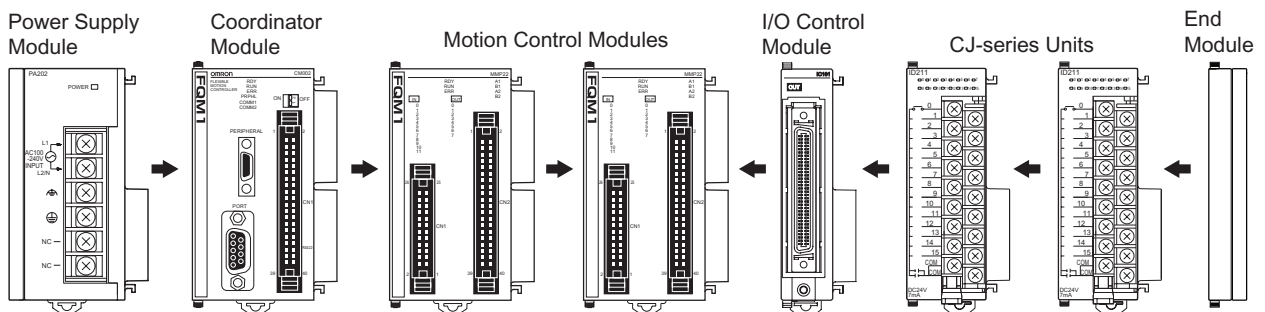


2. Move the yellow sliders at the top and bottom of each Module until they click into place to lock the Modules together.



Note If the locking tabs are not secured properly, the FQM1 may not function properly. Be sure to slide the locking tabs until they are securely in place.

3. Attach the End Module to the Module or Unit on the far right side of the FQM1.



- Note**
- (1) Mount an I/O Control Module if CJ-series Units are being used.
 - (2) Always mount an End Module on the right end of each Rack. If an End Module is not mounted, a fatal I/O bus error will occur and the Controller will not operate. (The error flags listed below will show details on the I/O bus error.)
 - (3) If the last Module on the right side of the Rack is a Motion Control Module, mount an FQM1-TER01 End Module.

If an FQM1-IC101 I/O Control Module has been used to mount CJ-series Units and the last Module on the right side of the Rack is a CJ-series Unit, mount a CJ1W-TER01 End Module.

- (4) If the wrong End Module is mounted, an I/O bus error will occur and the Coordinator Module will not start operating.

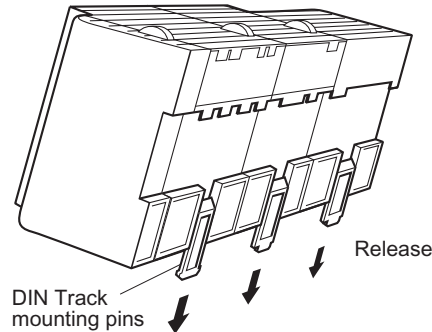
Flag changed	Address	Status
I/O Bus Error Flag	A401.14	ON
I/O Bus Error Slot Number	A404.00 to A404.07	0E hex
I/O Bus Error Rack Number	A404.08 to A404.15	0E hex

- (5) Always turn OFF the power supply when mounting Units or Modules.
- (6) When performing maintenance, first remove the FQM1 from the DIN Track and then replace Modules.
- (7) The total number of Modules/Units connected to the CPU Rack and Expansion Rack cannot exceed 10 Units. If 11 Units are mounted, a fatal Too Many I/O Points Error will occur and the Coordinator Module will not start operating in RUN mode or MONITOR mode. In this case, the I/O Overflow Error Flag (A401.11) will be turned ON and the 3-digit binary value in A40713 to A40715 will indicate the cause of the error.

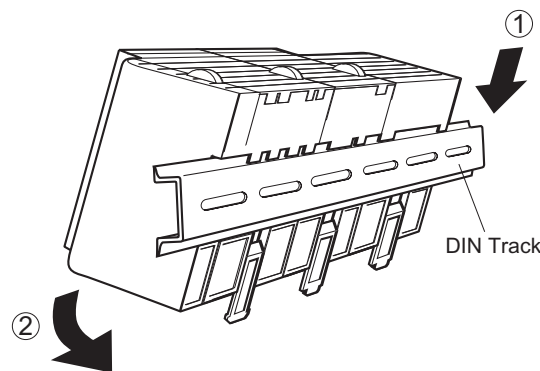
3-1-5 DIN Track Installation

Use the following procedure to install the FQM1 on DIN Track.

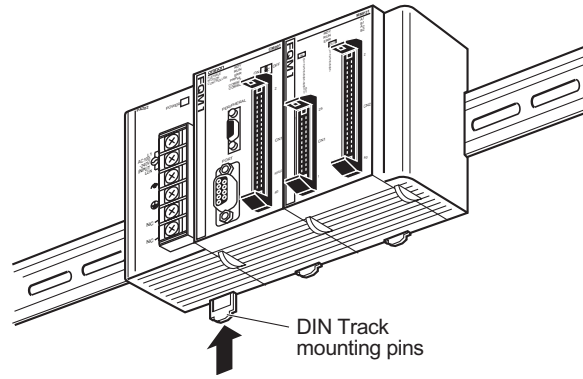
- 1,2,3... 1. Release the pins on the backs of the Modules.



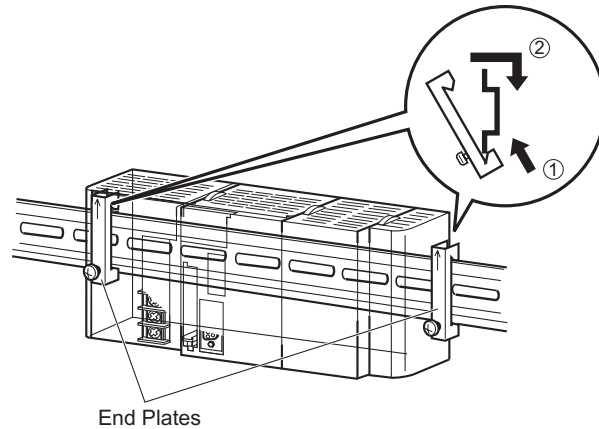
2. Fit the back of the FQM1 onto the DIN Track by inserting the FQM1 onto the top of the Track and then pressing in at the bottom of the FQM1, as shown below.



3. Lock the pins on the backs of the Modules.



4. Install a DIN Track End Plate on each end of the FQM1. To install an End Plate, hook the bottom on the bottom of the track, rotate the Plate to hook the top of the Plate on the top of the track, and then tighten the screw to lock the Plate in place.

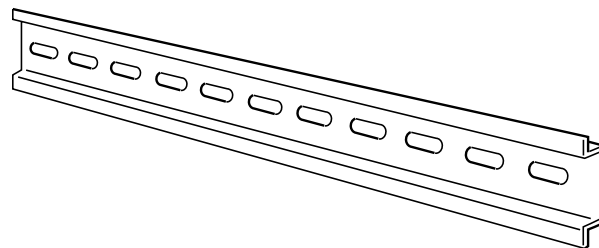


DIN Track and Accessories

Use the DIN Track and DIN Track End Plates shown below.

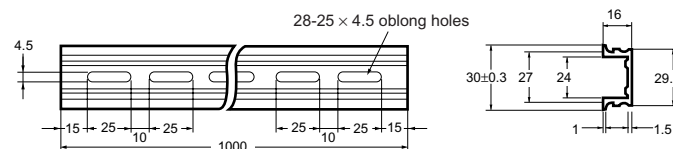
• **DIN Track**

Model numbers: PFP-50N (50 cm), PFP-100N (100 cm), and PFP-100N2 (100 cm)

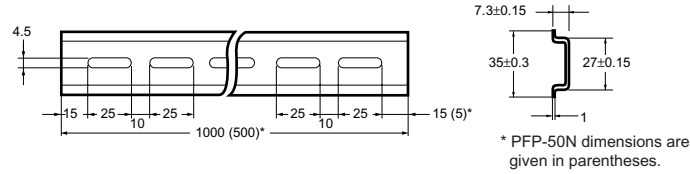


Secure the DIN Track to the control panel using M4 screws separated by 210 mm (6 holes) or less and using at least 3 screws. The tightening torque is 1.2 N·m.

PFP-100N2 DIN Track

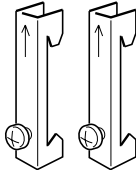


PFP-100N/50N DIN Track



DIN Track End Plates (2 Required)

Model number: PFP-M



3-1-6 Connecting a CJ-series Expansion Rack

CS/CJ-series I/O Connecting Cables are used to connect the FQM1 CPU Rack and Expansion Rack.

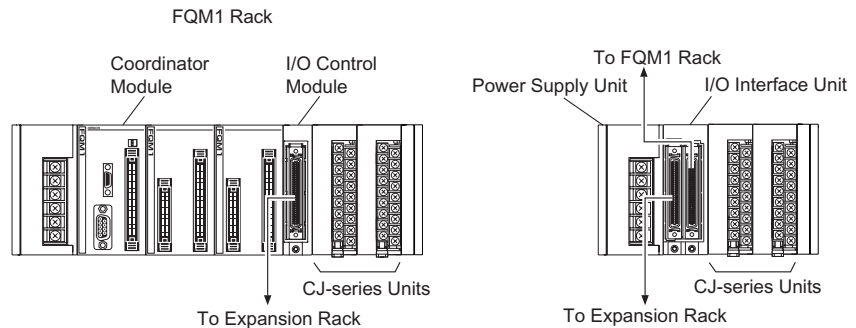
CS/CJ-series I/O Connecting Cables



- The CS/CJ-series I/O Connecting Cable has connectors with a simple lock mechanism is used to connect the CPU Rack to an Expansion Rack.

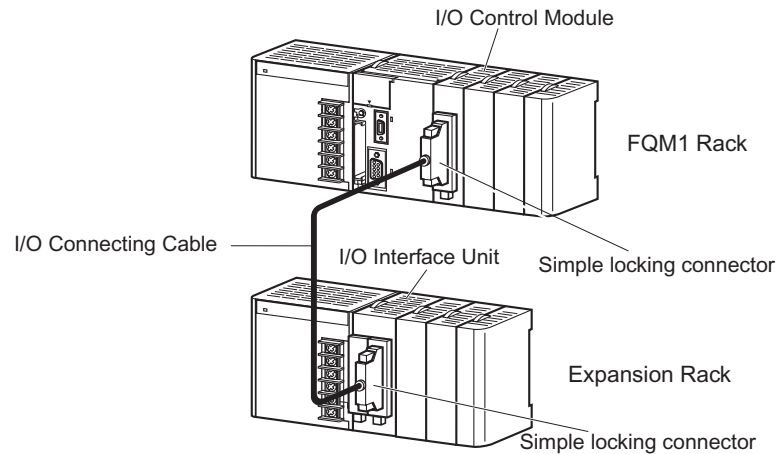
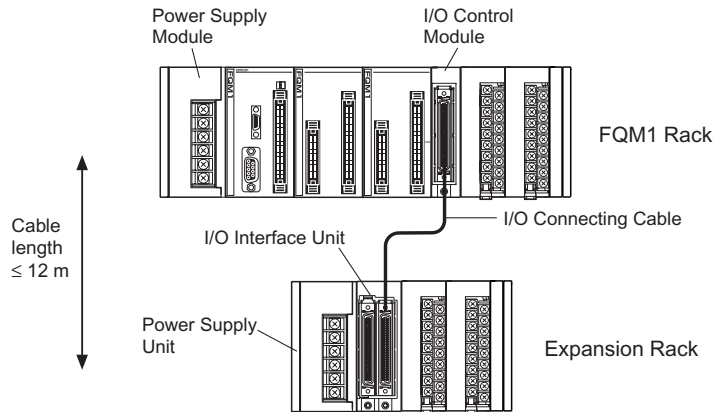
Model number	Cable length
CS1W-CN313	0.3 m
CS1W-CN713	0.7 m
CS1W-CN223	2 m
CS1W-CN323	3 m
CS1W-CN523	5 m
CS1W-CN133	10 m
CS1W-CN133B2	12 m

- Use the CS/CJ-series I/O Connecting Cable to connect the FQM1 Rack's I/O Control Module to the CJ-series Expansion Rack's I/O Interface Unit.
- The total length of the I/O Connecting Cable from the FQM1 Rack to the Expansion Rack must not exceed 12 m.
- The following diagram shows where the I/O Connecting Cable must be connected on each Rack. The Rack will not operate if the cables aren't connected properly.



Connecting Cables

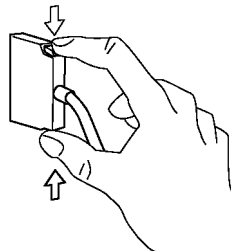
Connect the simple locking connectors to the FQM1 Rack's I/O Control Modules and the CJ-series Expansion Rack's I/O Interface Unit.



- The top and bottom of the connector are different. Be sure the connector is facing the correct direction before connecting it.

Connecting the Simple Locking Connectors

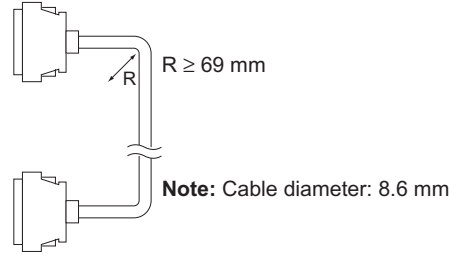
Press the tabs on the end of the connector and insert the connector until it locks in place. The PLC will not operate properly if the connector isn't inserted completely.



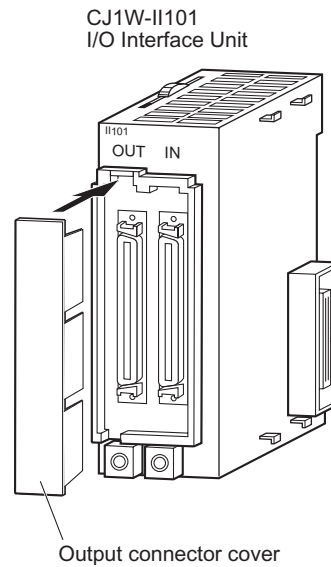
Note

- (1) When using an I/O Connecting Cable with a locking connector, be sure that the connector is firmly locked in place before using it.
- (2) Always turn OFF the power supply to the PLC before connecting a cable.
- (3) An I/O bus error will occur and the PLC will stop if an I/O Connecting Cable's connector separates from the Rack. Be sure that the connectors are secure.

- (4) A 63-mm hole will be required if the I/O Connecting Cable must pass through a hole when connecting an Expansion Rack.
- (5) The cables can withstand a pulling force up to 49 N (11 lbs), so be sure that they aren't pulled too forcefully.
- (6) The I/O Connecting Cables mustn't be bent too severely. The minimum bending radii are shown in the following diagram.

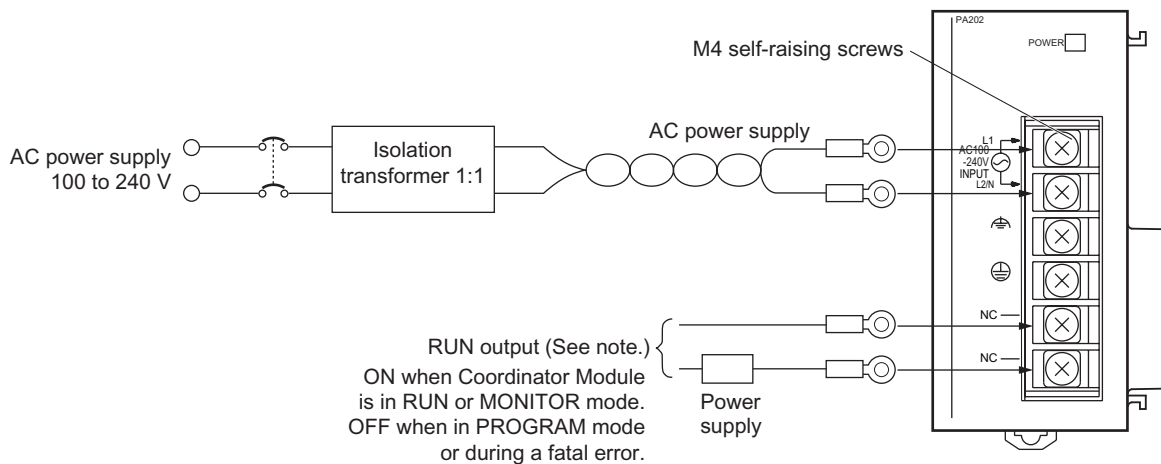


- (7) Always attach the cover to the output connector (left side) on the I/O Interface Unit on the Expansion Rack to protect it from dust.



3-2 Module Wiring

3-2-1 Wiring Power Supply Units



Note The RUN output function is provided only for the CJ1W-PA205R Power Supply Unit. It is not provided on the CJ1W-PA202 Power Supply Unit.

AC Power Source

- Supply 100 to 240 V AC.
- Keep the voltage fluctuations within the specified range.

Supply voltage	Allowable voltage fluctuations
100 to 240 V AC	85 to 264 V AC

- If one power supply phase of the equipment is grounded, connect the grounded phase side to the L2/N terminal.

Isolation Transformer

The FQM1's internal noise isolation circuits are sufficient to control typical noise in power supply lines, but noise between the FQM1 and ground can be significantly reduced by connecting a 1-to-1 isolation transformer. Do not ground the secondary coil of the transformer.

Power Supply Capacity

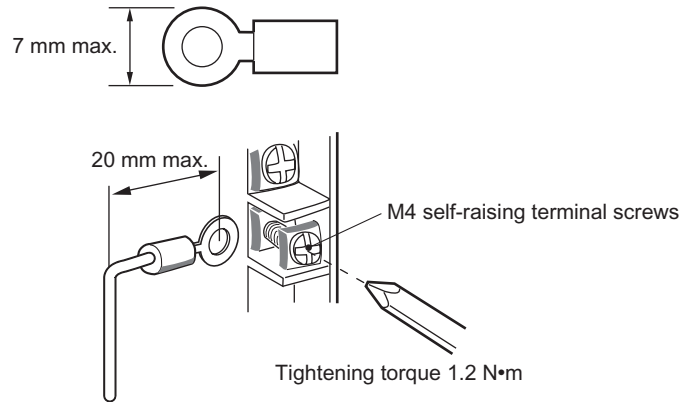
The power consumption will be 100 VA max. for the CJ1W-PA205R and 50 VA for the CJ1W-PA202, but there will be a surge current of at least 5 times the max. current when the power is turned ON.

Terminal Screws and Crimp Terminals

The terminals on the Power Supply Unit use M4, self-raising terminal screws.

- Note**
- (1) Use crimp terminals for wiring.
 - (2) Do not connect bare stranded wires directly to terminals.
 - (3) Tighten the terminal block screws to a torque of 1.2 N·m. Use M4 crimp terminals for AC power supplies.

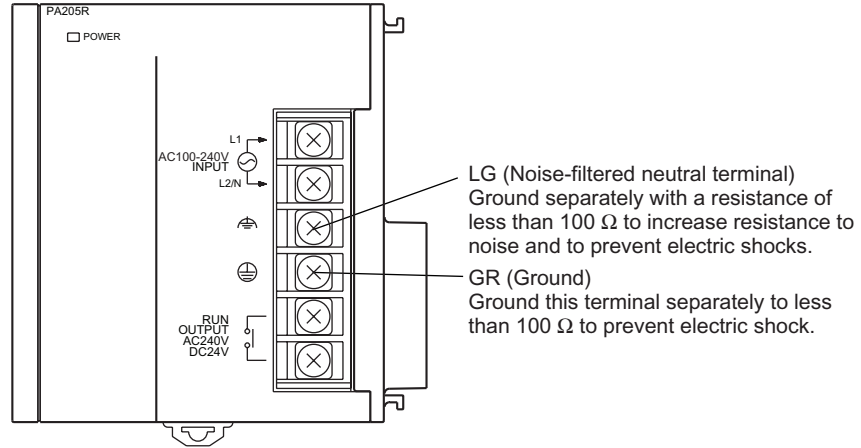
Crimp Terminals for AC Power Supply



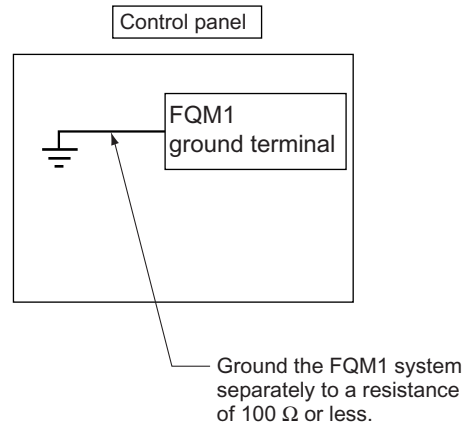
Caution Tighten AC power supply terminal block screws to a torque of 1.2 N·m. Loose screws may cause shorts, malfunctions, or fire.

- Note**
- (1) Supply power to all of the Power Supply Units from the same source.
 - (2) Do not remove the protective label from the top of the Power Supply Unit until the wiring has been completed. This label prevents wire strands and other foreign matter from entering the Unit during wiring procedures.
 - (3) Do not forget to remove the label from the top of the Power Supply Unit after wiring the Unit. The label will block air circulation needed for cooling.

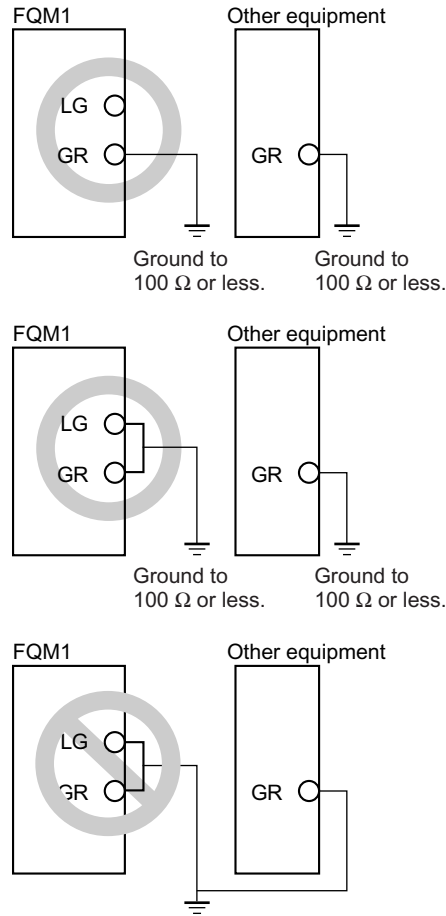
Grounding



- GR is the ground terminal. To help prevent electric shock, ground this terminal to less than 100 Ω and use special ground wire (minimum cross-sectional area of 2 mm²).
- LG is a noise-filtered neutral terminal. If noise is a significant source of errors and to prevent electrical shocks, connect the line ground terminal to the ground terminal and ground both with a ground resistance of less than 100 Ω or less.
- If connecting the line ground and ground terminals, always ground both to less than 100 Ω to prevent electrical shock.
- The ground wire should not be more than 20 m long.
- The FQM1 is designed to be mounted so that it is isolated (separated) from the mounting surface to protect it from the effects of noise in the installation environment (e.g., the control panel).



- Do not share the FQM1's ground with other equipment or ground the FQM1 to the metal structure of a building. Doing so may worsen operation.

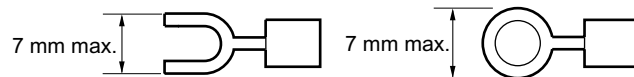


Terminal Screws and Crimp Terminals

The terminals on the Power Supply Unit use M4 self-raising terminal screws.

- Note**
- (1) Use crimp terminals for wiring.
 - (2) Do not connect bare stranded wires directly to terminals.
 - (3) Tighten the terminal block screws to a torque of 1.2 N·m.
 - (4) Use M4 crimp terminals for AC power supplies.

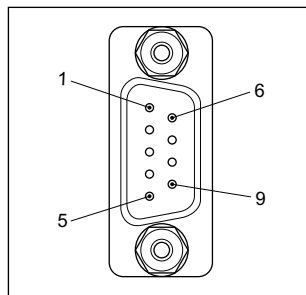
Crimp Terminals for Ground Wire



3-2-2 RS-232C Port Wiring

Connector Pin Arrangement

Pin No.	Signal	Name	Direction
1	FG	Protection earth	---
2	SD (TXD)	Send data	Output
3	RD (RXD)	Receive data	Input
4	RS (RTS)	Request to send	Output
5	CS (CTS)	Clear to send	Input
6	5V	Power supply	---
7	DR (DSR)	Data set ready	Input
8	ER (DTR)	Data terminal ready	Output
9	SG (0V)	Signal ground	---
Connector hood	FG	Protection earth	---

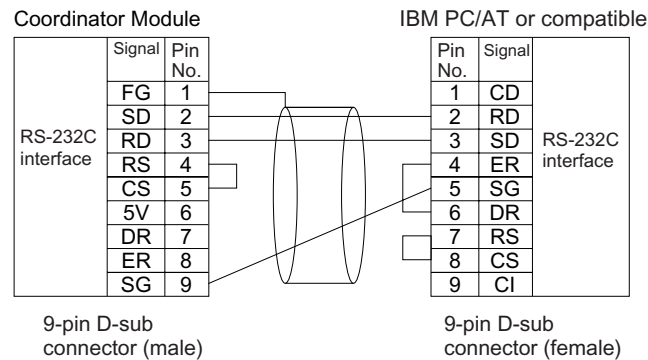


Note Do not connect the 5-V power supply on pin number 6 of the RS-232C port to any devices other than a NT-AL0001 Converter. Doing so may damage the external device and the Coordinator Module.

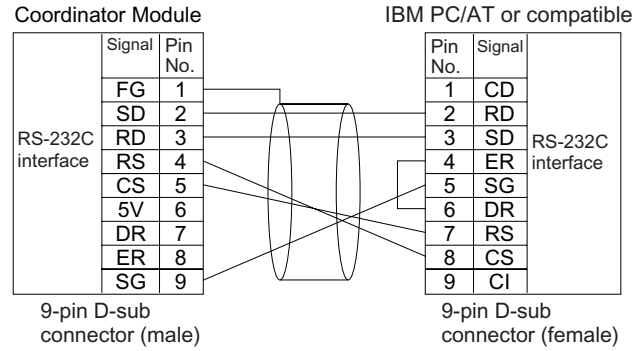
Connection Methods

1:1 Connections with Personal Computers

Host Link Serial Communications Mode



Peripheral Bus (Toolbus) Serial Communications Mode



Use the following connectors and cables if making the RS-232C cable for RS-232C port connections.

Applicable Connectors

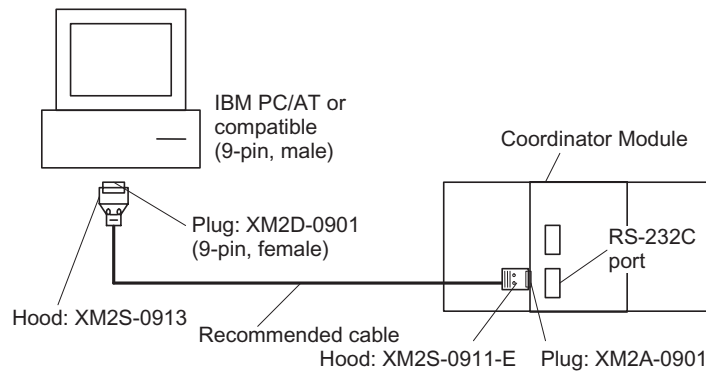
■ **Coordinator Module Connector**

Item	Model	Specifications
Plug	XM2A-0901	9-pin male
Hood	XM2S-0911-E	9-pin, millimeter screws, static resistant

■ **IBM PC/AT or Compatible Connector (9-pin, Male)**

Item	Model	Specifications
Plug	XM2D-0901	9-pin female
Hood	XM2S-0913	9-pin, inch screws, static resistant

■ **Connecting to an IBM PC/AT or Compatible**



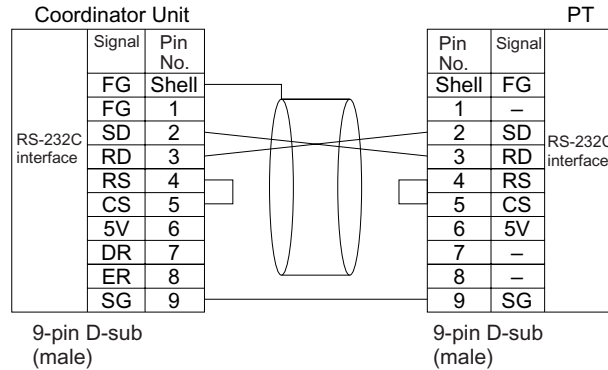
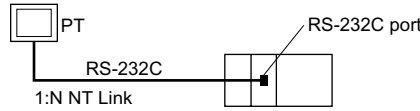
Recommended Cables

- Fujikura Ltd.: UL2464 AWG28 × 5P IFS-RVV-SB (UL product)
AWG 28 × 5P IFVV-SB (non-UL product)
- Hitachi Cable, Ltd.: UL2464-SB (MA) 5P × 28AWG (7/0.127) (UL product)
CO-MA-VV-SB 5P × 28AWG (7/0.127) (non-UL product)

Note Use the special cables provided from OMRON for all connections whenever possible. If cables are produced in-house, be sure they are wired correctly. External devices and the Coordinator Module may be damaged if general-purpose (e.g., computer to modem) cables are used or if wiring is not correct.

Connection Example to Programmable Terminal (PT)

Direct Connection from RS-232C to RS-232C



- Communications Mode: NT Link (1:N, N = 1 node only)
- OMRON Cables with Connectors: XW2Z200T (2 m)
XW2Z500T (5 m)

RS-232C Port Specifications

Item	Specification
Communications method	Half duplex
Synchronization	Asynchronous
Baud rate	0.3, 0.6, 1.2, 2.4, 4.8, 9.6, 19.2, 38.4, or 57.6 kbps (See note.)
Transmission distance	15 m max.
Interface	EIA RS-232C
Protocol	Host Link, 1:N NT Link, No-protocol, or Peripheral Bus (Toolbus)

Note Baud rates for the RS-232C are specified only up to 19.2 kbps. The FQM1 supports serial communications from 38.4 kbps to 57.6 kbps, but some computers cannot support these speeds. Lower the baud rate if necessary.

3-2-3 Wiring CJ-series Basic I/O Units with Terminal Blocks

I/O Unit Specifications

Check Specifications

Double-check the specifications for the I/O Units. In particular, do not apply a voltage that exceeds the input voltage for Input Units or the maximum switching capacity for Output Units. Doing so may result in breakdown, damage, or fire.

When the power supply has positive and negative terminals, be sure to wire them correctly.

Electric Wires

The following wire gauges are recommended.

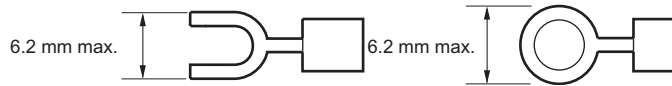
Terminal Block Connector	Wire Size
18-terminal	AWG 22 to 18 (0.32 to 0.82 mm ²)

- The current capacity of electric wire depends on factors such as the ambient temperature and insulation thickness as well as the gauge of the conductor.

Crimp Terminals

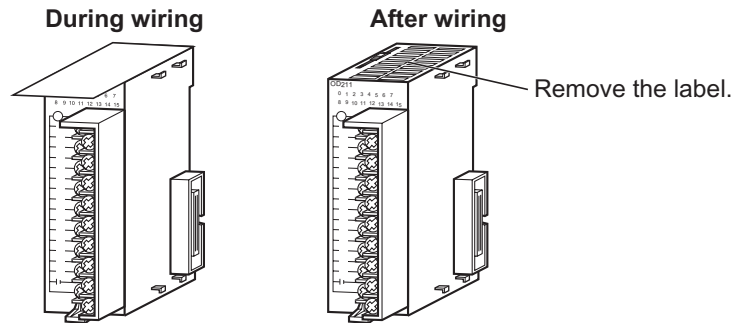
The terminals on the I/O Unit are M3, self-raising terminals with screws.

- Note**
- (1) Use crimp terminals for wiring.
 - (2) Do not connect bare stranded wires directly to terminals.
 - (3) Tighten the terminal block screws to the torque of 0.5 N·m.
 - (4) Use crimp terminals (M3) having the dimensions shown below.

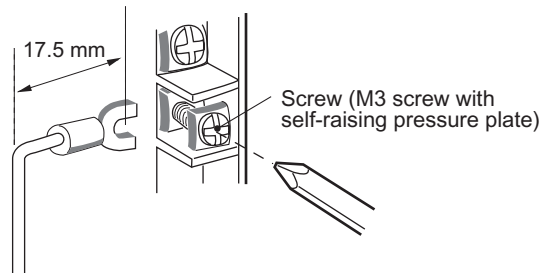


Wiring

- Verify that each Unit is mounted securely.
- Do not remove the protective label from the top of the Unit until wiring has been completed. This label prevents wire strands and other foreign matter from entering the Unit during wiring procedures.
- Remove the label after wiring has been completed to allow air circulation needed for cooling.



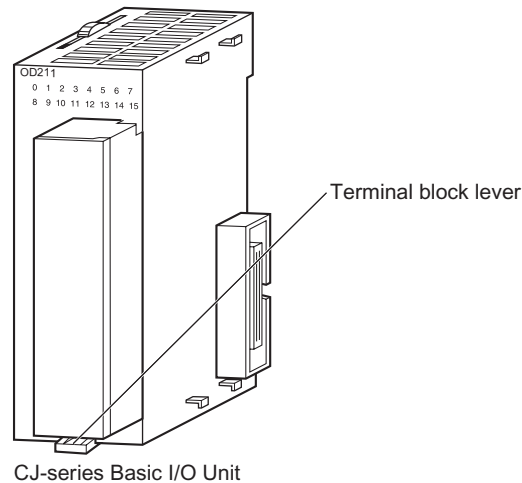
- Wire the Units so that they can be easily replaced.
- Make sure that the I/O indicators are not covered by the wiring.
- Do not place the wiring for I/O Units in the same duct or raceway as power lines. Inductive noise can cause errors in operation.
- Tighten the terminal screws to the torque of 0.5 N·m.



Terminal Blocks

- The I/O Units are equipped with removable terminal blocks.

- The lead wires do not have to be removed from the terminal block to remove it from an I/O Unit.



3-2-4 Wiring CJ-series I/O Units with Connectors

This section describes wiring for the following Units:

- CJ-series Basic I/O Units with Connectors (32- and 64-point Units)

CJ-series Basic I/O Units with connectors use special connectors to connect to external I/O devices. The user can combine a special connector with cable or use a pre-assembled OMRON cable to connect to a terminal block or I/O Terminal. The available OMRON cables are described later in this section.

- Note**
- (1) Be sure not to apply a voltage that exceeds the input voltage for Input Units or the maximum switching capacity for Output Units.
 - (2) When the power supply has positive and negative terminals, be sure to wire them correctly
 - (3) Use reinforced insulation or double insulation on the DC power supply connected to DC I/O Units when required by EC Directives (low voltage).
 - (4) When connecting the connector to the I/O Unit, tighten the connector screws to a torque of 0.2 N • m.
 - (5) Turn on the power after checking the connector's wiring.
 - (6) Do not pull the cable. Doing so may disconnect or damage the cable.
 - (7) Do not bend the cable too sharply. Doing so may damage or break wiring in the cable.
 - (8) CJ-series Basic I/O Units with 32 or 64-point Fujitsu connectors have the same connector pin allocations as the C200H High-density I/O Units and CS-series I/O Units with connectors to make them compatible.

Available Connectors

Use the following connectors when assembling a connector and cable.

CJ-series 32- and 64-point I/O Units with Fujitsu-compatible Connectors

Applicable Units

Model	Specifications	Pins
CJ1W-ID231	Input Unit, 24 V DC, 32 inputs	40
CJ1W-ID261	Input Unit, 24 V DC, 64 inputs	
CJ1W-OD231	Transistor Output Unit with Sinking Outputs, 32 outputs	
CJ1W-OD261	Transistor Output Unit with Sinking Outputs, 64 outputs	
CJ1W-MD261	24-V DC Input/Transistor Output Units, 32 Inputs, 32 Outputs	
CJ1W-MD231	24-V DC Input/Transistor Output Units, 16 Inputs, 16 Outputs	24

Applicable Cable-side Connectors

Connection	Pins	OMRON set	Fujitsu parts
Solder-type	40	C500-CE404	Socket: FCN-361J040-AU Connector cover: FCN-360C040-J2
	24	C500-CE241	Socket: FCN-361J024-AU Connector cover: FCN-360C024-J2
Crimped	40	C500-CE405	Socket: FCN-363J040 Connector cover: FCN-360C040-J2 Contacts: FCN-363J-AU
	24	C500-CE242	Socket: FCN-363J024 Connector cover: FCN-360C024-J2 Contacts: FCN-363J-AU
Pressure-welded	40	C500-CE403	FCN-367J040-AU
	24	C500-CE243	FCN-367J024-AU/F

CJ-series 32- and 64-point I/O Units with MIL Connectors

Applicable Units

Model	Specifications	Pins
CJ1W-ID232	Input Unit, 24 V DC, 32 inputs	40
CJ1W-ID262	Input Unit, 24 V DC, 64 inputs	
CJ1W-OD232	Transistor Output Unit with sourcing outputs, 32 outputs	
CJ1W-OD262	Transistor Output Unit with sourcing outputs, 64 outputs	
CJ1W-OD233	Transistor Output Unit with sinking outputs, 32 outputs	
CJ1W-OD263	Transistor Output Unit with sinking outputs, 64 outputs	
CJ1W-MD263	24-V DC Input/Transistor Output Units, 32 Inputs, 32 Outputs	20
CJ1W-MD563	TTL Input/TTL Output Units, 32 Inputs, 32 Outputs	
CJ1W-MD232	24-V DC Input/Transistor Output Units, 16 Inputs, 16 Outputs	
CJ1W-MD233	24-V DC Input/Transistor Output Units, 16 Inputs, 16 Outputs	

Applicable Cable-side Connectors

Connection	Pins	OMRON set	Daiichi Denko Industries part
Pressure-welded	40	XG4M-4030-T	FRC5-A040-3T0S
	20	XG4M-2030-T	FRC5-A020-3T0S

Wire Size

We recommend using cable with wire gauges of AWG 24 or AWG 28 (0.2 mm² to 0.08 mm²). Use cable with external wire diameters of 1.61 mm max.

Wiring Procedure

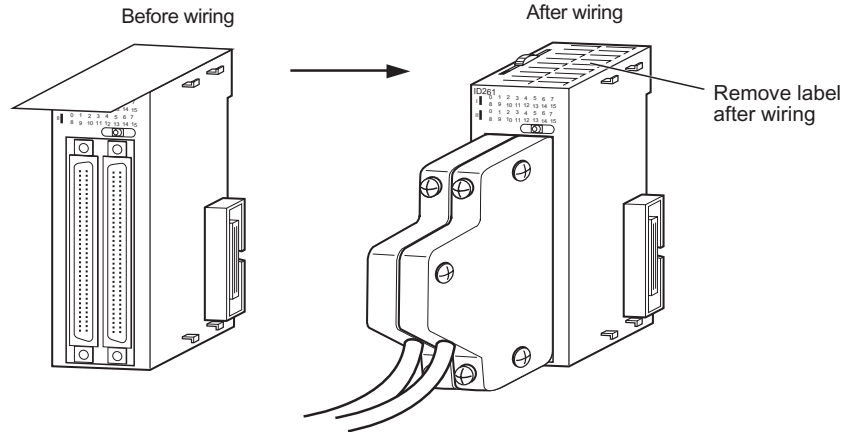
Use the following procedure when wiring. Fujitsu-style connectors are used in this example.

1,2,3...

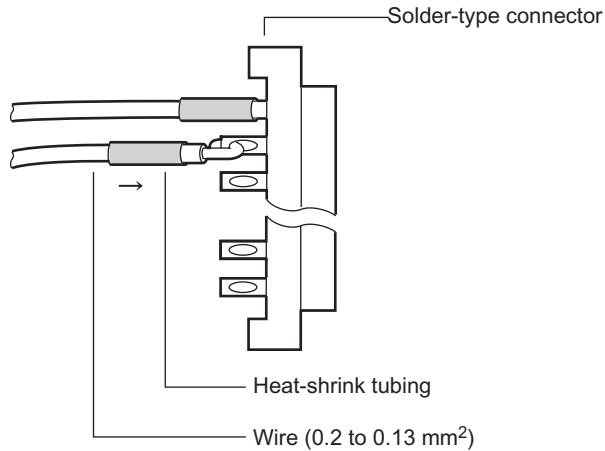
1. Check that each Unit is installed securely.

Note Do not force the cables.

2. Do not remove the protective label from the top of the Unit until wiring has been completed. This label prevents wire strands and other foreign matter from entering the Unit during wiring. (Remove the label after wiring has been completed to allow air circulation needed for cooling.)

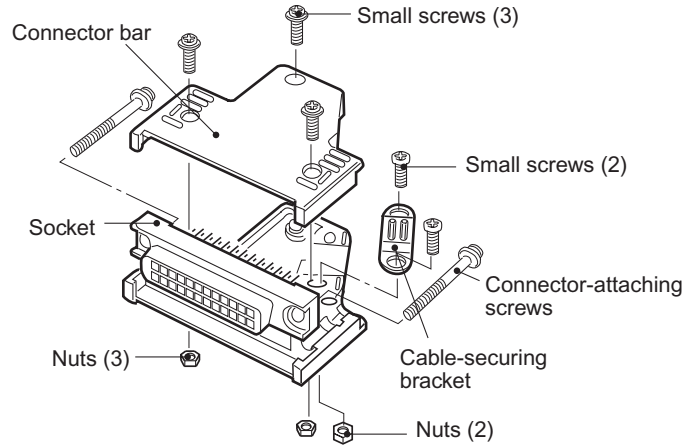


3. When solder-type connectors are being used, be sure not to accidentally short adjacent terminals. Cover the solder joint with heat-shrink tubing.

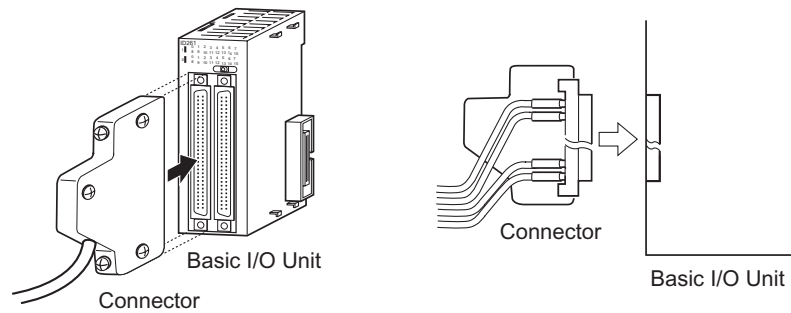


Note Double-check to make sure that the Output Unit's power supply leads haven't been reversed. If the leads are reversed, the Unit's internal fuse will blow and the Unit will not operate.

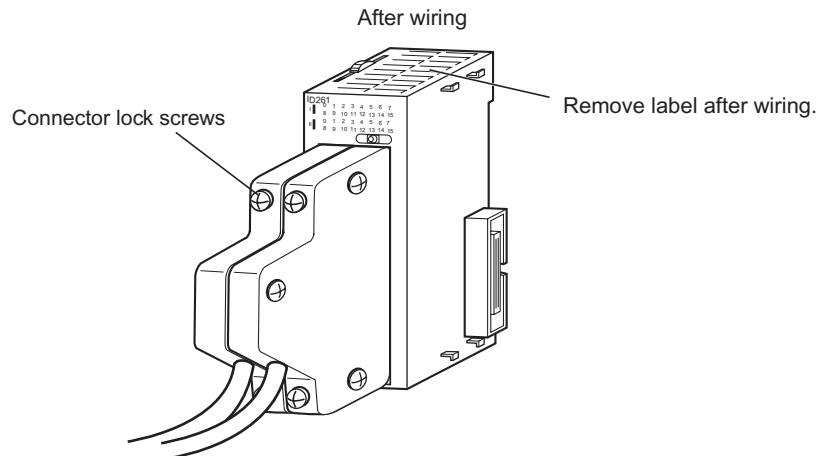
4. Assemble the connector (purchased separately).



5. Insert the wired connector.



6. Remove the protective label after wiring has been completed to allow air circulation needed for cooling.



Tighten the connector-attaching screws to a torque of 0.2 N·m.

3-2-5 Connecting I/O Devices

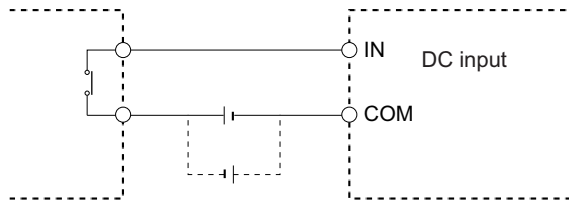
Input Devices

Use the following information for reference when selecting or connecting input devices.

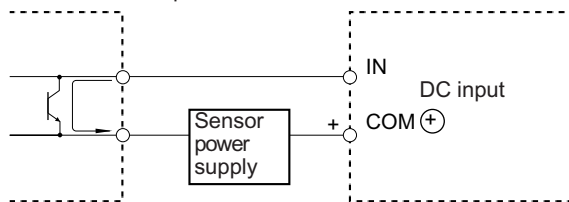
DC Inputs

The following types of DC input devices can be connected.

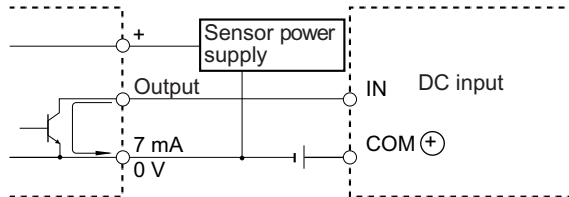
Contact output

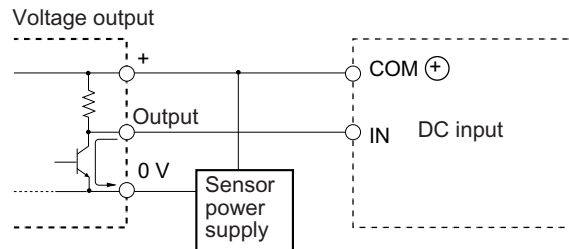
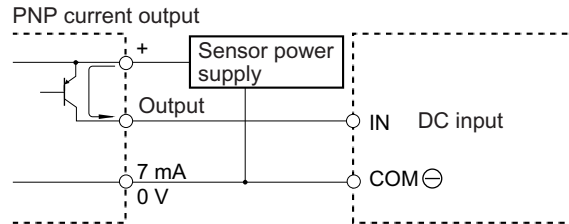
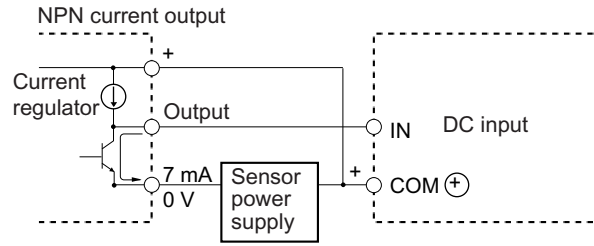


Two-wire DC output

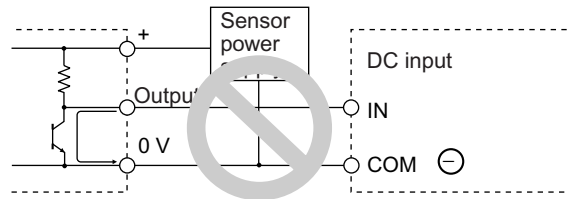


NPN open-collector output



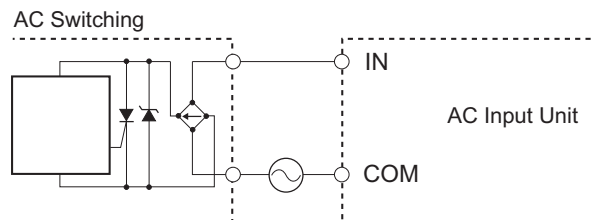
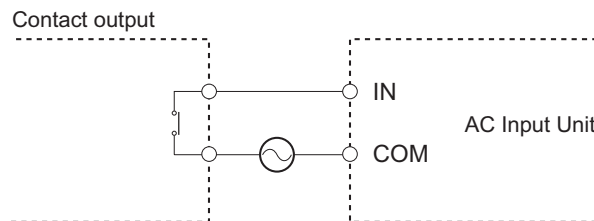


- The circuit below should **NOT** be used for I/O devices having a voltage output.



AC Input Units

The following types of AC input devices can be connected.



Note When using a reed switch as the input contact for an AC Input Unit, use a switch with an allowable current of 1 A or greater. If Reed switches with

Precautions when Connecting a Two-wire DC Sensor

smaller allowable currents are used, the contacts may fuse due to surge currents.

When using a two-wire sensor with a 24-V DC input device, check that the following conditions have been met. Failure to meet these conditions may result in operating errors.

1,2,3...

1. Relation between the FQM1 ON voltage and the sensor residual voltage:

$$V_{ON} \leq V_{CC} - V_R$$

2. Relation between the FQM1 ON current and sensor control output (load current):

$$I_{OUT} \text{ (min.)} \leq I_{ON} \leq I_{OUT} \text{ (max.)}$$

$$I_{ON} = (V_{CC} - V_R - 1.5 \text{ [FQM1 internal residual voltage]}) / R_{IN}$$

If I_{ON} is smaller than I_{OUT} (min), connect a bleeder resistor R. The bleeder resistor constant can be calculated as follows:

$$R \leq (V_{CC} - V_R) / (I_{OUT} \text{ (min.)} - I_{ON})$$

$$\text{Power } W \geq (V_{CC} - V_R)^2 / R \times 4 \text{ [allowable margin]}$$

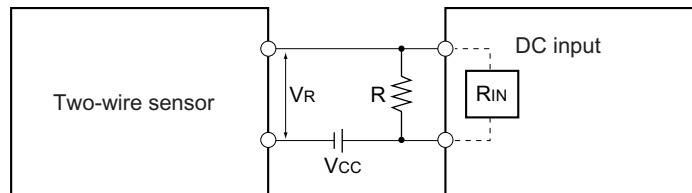
3. Relation between FQM1 OFF current and sensor leakage current:

$$I_{OFF} \geq I_{leak}$$

Connect a bleeder resistor R if I_{leak} is greater than I_{OFF} . Use the following equation to calculate the bleeder resistance constant.

$$R \leq (R_{IN} \times V_{OFF}) / (I_{leak} \times R_{IN} - V_{OFF})$$

$$\text{Power } W \geq (V_{CC} - V_R)^2 / R \times 4 \text{ [allowable margin]}$$



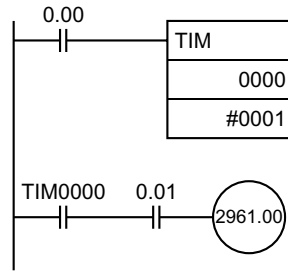
- V_{CC} : Power voltage
- V_{ON} : FQM1 ON voltage
- V_{OFF} : FQM1 OFF voltage
- I_{ON} : FQM1 ON current
- I_{OFF} : FQM1 OFF current
- R_{IN} : FQM1 input impedance
- V_R : Sensor output residual voltage
- I_{OUT} : Sensor control current (load current)
- I_{leak} : Sensor leakage current
- R : Bleeder resistance

4. Precautions on Sensor Surge Current

An incorrect input may occur if a sensor is turned ON after the FQM1 has started up to the point where inputs are possible. Determine the time required for sensor operation to stabilize after the sensor is turned ON and take appropriate measures, such as inserting into the program a timer delay after turning ON the sensor.

Programming Example

In this example, the sensor's power supply voltage is used as the input to CIO 0000.00 and a 100-ms timer delay (the time required for an OMRON Proximity Sensor to stabilize) is created in the program. After the Completion Flag for the timer turns ON, the sensor input on CIO 0000.01 will cause output bit CIO 0001.00 to turn ON.



Output Wiring Precautions

Output Short-circuit Protection

If a load connected to the output terminals is short-circuited, output components and printed circuit boards may be damaged. To guard against this, incorporate a fuse in the external circuit. Use a fuse with a capacity of about twice the rated output.

Transistor Output Residual Voltage

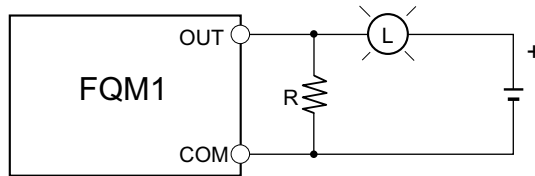
A TTL circuit cannot be connected directly to a transistor output because of the transistor's residual voltage. It is necessary to connect a pull-up resistor and a CMOS IC between the two.

Output Surge Current

When connecting a transistor or triac output to an output device having a high surge current (such as an incandescent lamp), steps must be taken to avoid damage to the transistor or triac. Use either of the following methods to reduce the surge current.

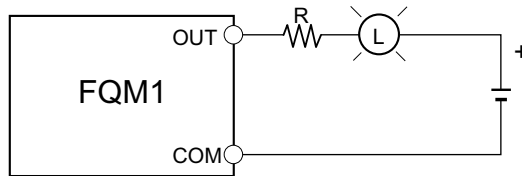
Method 1

Add a resistor that draws about 1/3 of the current consumed by the bulb.



Method 2

Add a control resistor as shown in the following diagram.



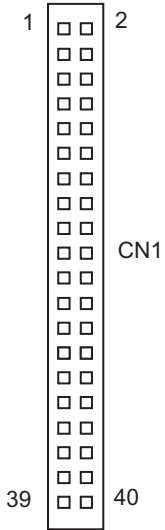
3-3 Wiring Module Connectors

3-3-1 Connector Pin Arrangement

The following tables provide the connector pin arrangement for FQM1 Modules.

FQM1-CM002 Coordinator Module

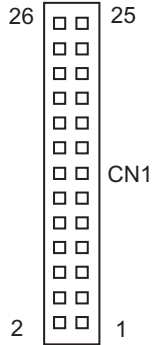
General-purpose I/O 40-pin Connector



Pin No.	Name	Address	Pin No.	Name	Address
1	External input 0	CIO 2960.00	2	External input 8	CIO 2960.08
3	External input 1	CIO 2960.01	4	External input 9	CIO 2960.09
5	External input 2	CIO 2960.02	6	External input 10	CIO 2960.10
7	External input 3	CIO 2960.03	8	External input 11	CIO 2960.11
9	External input 4	CIO 2960.04	10	External input 12	CIO 2960.12
11	External input 5	CIO 2960.05	12	External input 13	CIO 2960.13
13	External input 6	CIO 2960.06	14	External input 14	CIO 2960.14
15	External input 7	CIO 2960.07	16	External input 15	CIO 2960.15
17	Common for external inputs 0 to 7	---	18	Common for external inputs 8 to 15	
19	External output 0	CIO 2961.00	20	External output 4	CIO 2961.04
21	External output 1	CIO 2961.01	22	External output 5	CIO 2961.05
23	External output 2	CIO 2961.02	24	External output 6	CIO 2961.06
25	External output 3	CIO 2961.03	26	External output 7	CIO 0001.07
27	Common for external outputs 0 to 8		28	Power supply for external outputs 0 to 8	
29	Not used.		30	Not used.	
31	Not used.		32	Not used.	
33	SDA- (RS-422A)		34	RDA- (RS-422A)	
35	SDB+ (RS-422A)		36	RDB+ (RS-422A)	
37	Not used.		38	Not used.	
39	Not used.		40	Not used.	

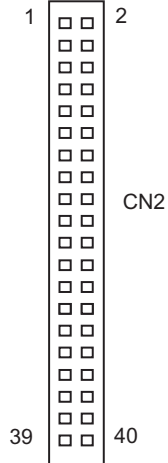
FQM1-MM□22 Motion Control Modules

General-purpose I/O 26-pin Connector



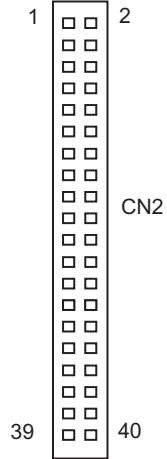
Pin No.	Name	Address	Pin No.	Name	Address
26	Not used.		25	Not used.	
24	External input 0 (interrupt input)	CIO 2960.00	23	External input 6	CIO 2960.06
22	External input 1 (interrupt input)	CIO 2960.01	21	External input 7	CIO 2960.07
20	External input 2 (interrupt input)	CIO 2960.02	19	External input 8	CIO 2960.08
18	External input 3 (interrupt input)	CIO 2960.03	17	External input 9	CIO 2960.09
16	External input 4	CIO 2960.04	15	External input 10	CIO 2960.10
14	External input 5	CIO 2960.05	13	External input 11	CIO 2960.11
12	Common for external inputs 0 to 3		11	Common for external inputs 4 to 11	
10	External output 0	CIO 2961.00	9	External output 4	CIO 2961.04
8	External output 1	CIO 2961.01	7	External output 5	CIO 2961.05
6	External output 2	CIO 2961.02	5	External output 6	CIO 2961.06
4	External output 3	CIO 2961.03	3	External output 7	CIO 2961.07
2	Common for external outputs 0 to 7		1	Power supply for external outputs 0 to 7	

FQM1-MMP22 Pulse I/O 40-pin Connector



Pin No.	Name		Pin No.	Name		
1	Counter 1	Phase A 24 V	2	Counter 2	Phase A 24 V	
3		Phase A LD+	4		Phase A LD+	
5		Phase A LD-/0 V	6		Phase A LD-/0 V	
7		Phase B 24 V	8		Phase B 24 V	
9		Phase B LD+	10		Phase B LD+	
11		Phase B LD-/0 V	12		Phase B LD-/0 V	
13		Phase Z 24 V	14		Phase Z 24 V	
15		Phase Z LD+	16		Phase Z LD+	
17		Phase Z LD-/0 V	18		Phase Z LD-/0 V	
19		Latch signal 1 input	20		Latch signal 2 input	
21	Latch signal common	22	Latch signal common			
23	Counter 1 SEN output signal for absolute Servo Driver	SEN output	24	Counter 2 SEN output signal for absolute Servo Driver	SEN output	
25		SEN_0 V	26		Power supply for pulse outputs	5-V GND
27		5-V power for SEN output	28			5-V power for pulse outputs
29	Pulse 1	CW+	30	Pulse 2	CW+	
31		CW-	32		CW-	
33		CCW+	34		CCW+	
35		CCW-	36		CCW-	
37		One-shot pulse output 1	38		One-shot pulse output 2	
39		Common for one-shot pulse output	40		24-V power for one-shot pulse output	

FQM1-MMA22 Analog I/O 40-pin Connector



Pin. No.	Name		Pin. No.	Name		
1	Counter 1	Phase A 24 V	2	Counter 2	Not used.	
3		Phase A LD+	4		Phase A LD+	
5		Phase A LD-/0 V	6		Phase A LD-/0 V	
7		Phase B 24 V	8		Not used.	
9		Phase B LD+	10		Phase B LD+	
11		Phase B LD-/0 V	12		Phase B LD-/0 V	
13		Phase Z 24 V	14		Not used.	
15		Phase Z LD+	16		Phase Z LD+	
17		Phase Z LD-/0 V	18		Phase Z LD-/0 V	
19		Latch signal 1 input	20		Latch signal 2 input	
21	Latch signal common	22	Latch signal common			
23	Counter 1 SEN output signal for absolute Servo Driver	SEN output	24	Counter 2 SEN output signal for absolute Servo Driver	SEN output	
25		SEN_0 V	26		---	Not used.
27		5-V power for SEN output	28		---	Not used.
29	---	Not used.	30	---	Not used.	
31	---	Not used.	32	---	Not used.	
33	Analog input	Voltage input (+)	34	Analog input	Current input (See note.)	
35		Voltage input (-)	36		(Current input common)	
37	Analog output 1	Voltage output (+)	38	Analog output 2	Voltage output (+)	
39		Voltage output (-)	40		Voltage output (-)	

Note Connect the voltage input (+) and the current input when using with a current input between 4 and 20 mA.

3-3-2 External Connection Diagrams

The connections with the Servo Drivers, the main type of device connected, are outlined in the following tables.

FQM1-MM□22 Motion Control Modules

Pulse Outputs

Motion Control Module			W-series Servo Driver	
General-Purpose I/O Connector (26 pin)	Inputs	Positioning Completed Signal	INP1	Positioning completed output
		Origin Proximity Input Signal		
		CCW Limit Input		
		CW Limit Input		
	Outputs	Servo ON	RUN	RUN command input
		Alarm reset	RESET	Alarm reset input
Error Counter Reset		ECRST	Error Counter Reset Input	
Special I/O Connector (40 pin)	Inputs	Phase Z LD+	+Z	Encoder output phase Z
		Phase Z LD-	-Z	Encoder output phase Z
	Outputs	Pulse output CCW	CCW	Forward pulse
		Pulse output CW	CW	Reverse pulse

Analog Outputs

Motion Control Module			W-series Servo Driver	
General-purpose I/O Connector (26 pin)	Inputs	Origin Proximity Input Signal		
		CCW Limit Input		
		CW Limit Input		
	Outputs	Servo ON	RUN	Run command input
Alarm reset		RESET	Alarm reset input	
Special I/O Connector (40 pin)	Inputs	Phase A LD+	+A	Encoder output phase A
		Phase A LD-	-A	Encoder output phase A
		Phase B LD+	+B	Encoder output phase B
		Phase B LD-	-B	Encoder output phase B
		Phase Z LD+	+Z	Encoder output phase Z
		Phase Z LD-	-Z	Encoder output phase Z
	Outputs	Analog output 1 (+)	REF	Speed command input
		Analog output 1 (-)	AGND	Speed command input
		Analog output 2 (+)	TREF	Torque command input
		Analog output 2 (-)	AGND	Torque command input

3-3-3 Wiring Examples

Connecting Pulse

**Inputs (FQM1-MMP22/
MMA22)**

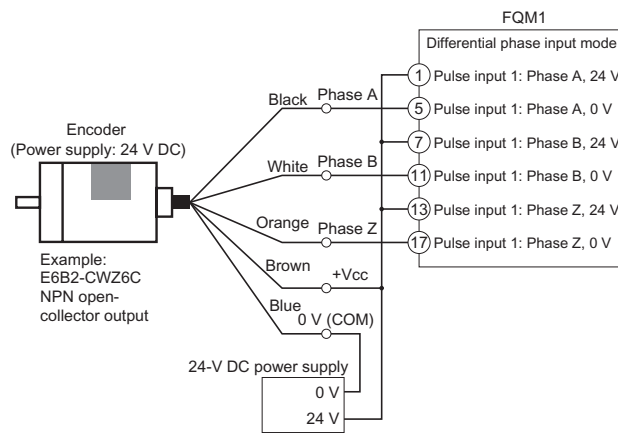
Connect the output from an encoder to the connector in the following way, according to the port's counter operation.

Port 1 Pin number	Port 2 Pin number	Signal name	Encoder output		
			Phase Differential Input Mode	Increment/Decrement Pulse Input Mode	Pulse + Direction Input Mode
24 V: 1 (5)	24 V: 2 (6)	Encoder input A	Encoder phase-A input	Increment pulse input	Pulse input
24 V: 7 (11)	24 V: 8 (12)	Encoder input B	Encoder phase-B input	Decrement pulse input	Direction signal input

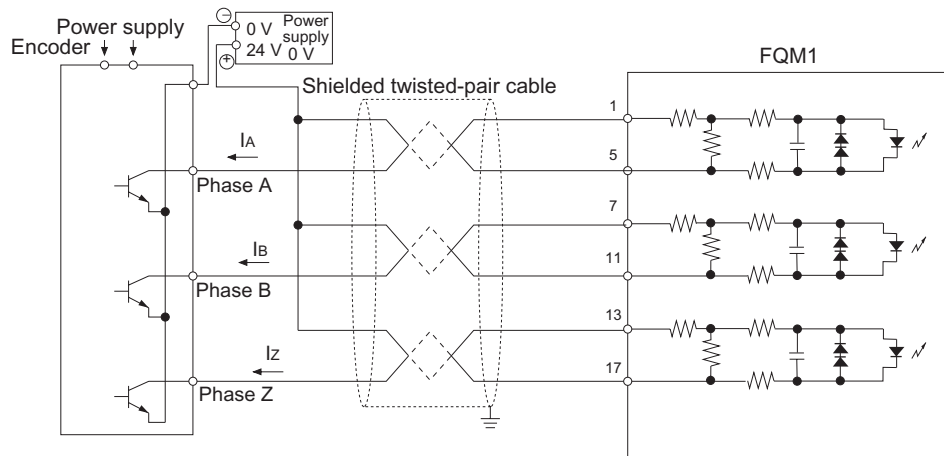
Note The numbers in parentheses are the pin numbers on the negative side.

Example

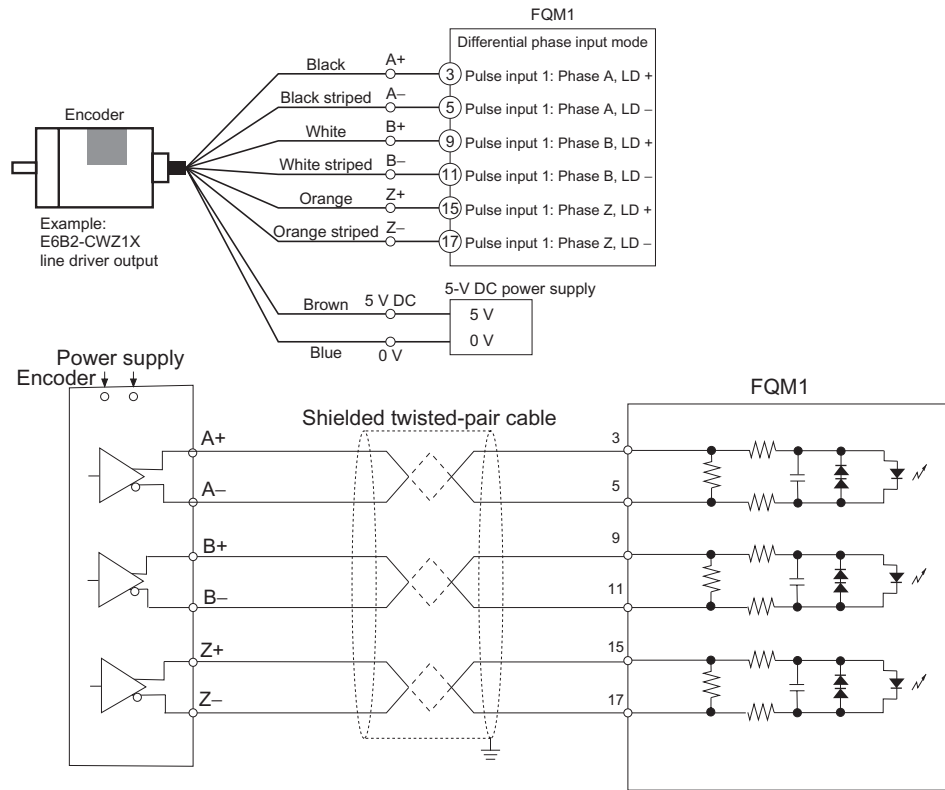
- The wiring for an encoder (24 V) with an open-collector output is shown below. These examples are for encoders with phases A, B, and Z.



Do not share the power supply with other I/O)

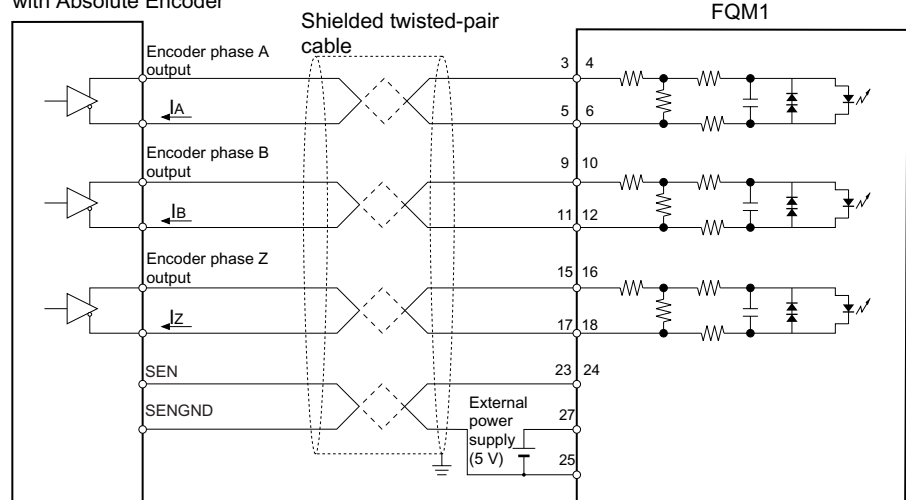


- The wiring for an encoder with a line-driver output (Am26LS31 or equivalent) is shown below.

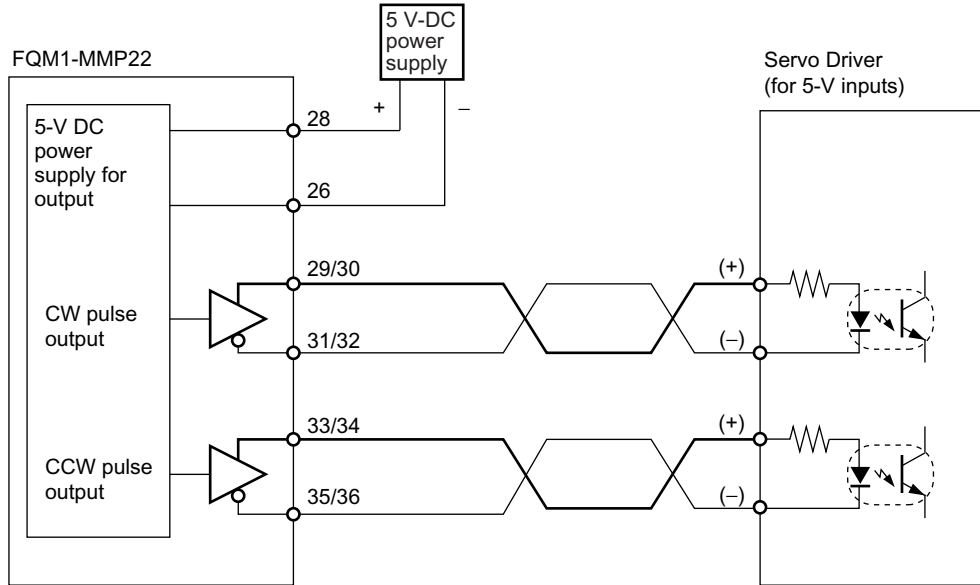


Connecting a Servo Driver (OMRON's W Series) Compatible with an Absolute Encoder (FQM1-MMP22/MMA22)

OMRON W-series Servo Driver Compatible with Absolute Encoder

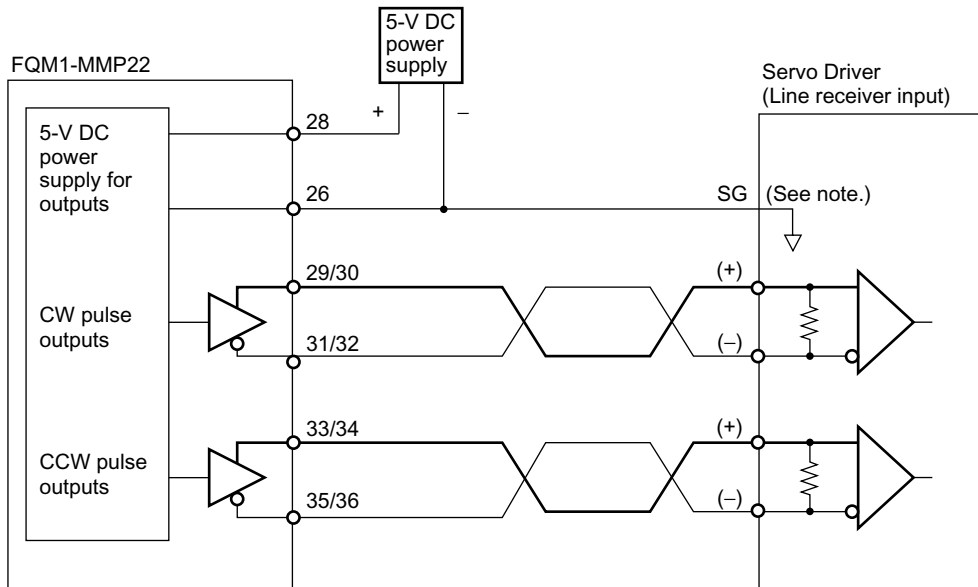


Connecting Pulse Outputs (FQM1-MMP22)



Example

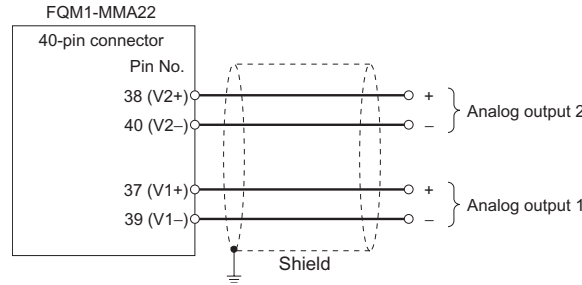
Connections with a Servo Driver are given below, as an example.



Note: When connecting a line receiver, connect the signal ground (SG for the Servo Driver's line receiver input and the GND for the 5-V DC power supply).

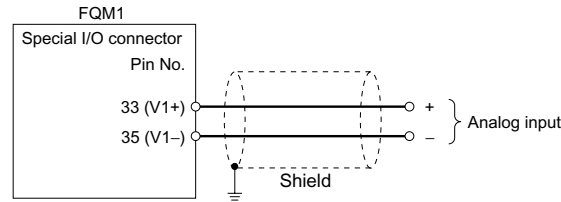
Connecting Analog Outputs (FQM1-MMA22)

Output signals are connected as shown in the following diagram.

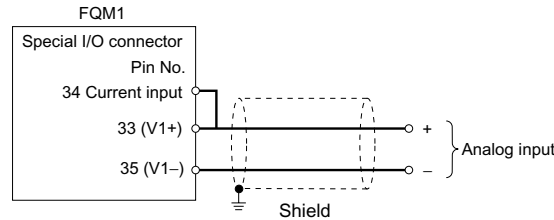


Connecting Analog Inputs (FQM1-MMA22)

Voltage Input



Current Input



3-3-4 Wiring Methods

Either make a cable using the special connector (purchased separately), or connect to a terminal block using an OMRON special cable with a connector.

- Note**
- (1) Do not apply voltages that exceed the maximum switching capacity of output circuits and the input voltage of I/O circuits.
 - (2) Do not mistake positive and negative when wiring power supply, where there are positive and negative terminals.
 - (3) To conform to the EC Low Voltage Directive, use a DC power supply for I/O that has reinforced or double insulation.
 - (4) Check that the connector wiring has been performed correctly before supplying power.
 - (5) Do not pull on cables. Doing so may result in disconnection.
 - (6) Do not bend cables beyond their natural limit. Doing so may result in disconnection.

Connectors

Connecting MIL Connectors

Connector type	Number of pins	Ordering as a set (OMRON)	DDK Ltd.
Pressure welded	26 pins	XG4M-2630-T	FRC5-A026-3T0S
	40 pins	XG4M-4030-T	FRC5-A040-3T0S

Applicable Connector-Terminal Block Conversion Units

Connecting Cable	Connector-Terminal Block Conversion Unit	Number of pins	Size
XW2Z-□□□K	XW2D-40G6	40 pins	Miniature
	XW2B-40G5		Standard
	XW2B-40G4		Standard
XW2Z-□□□J-A28	XW2D-34G6	34 pins	Miniature

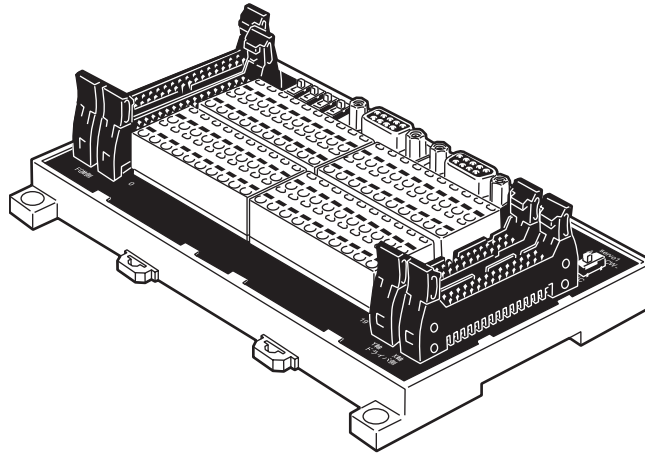
Recommended Wire Size

The recommended size for cable wires is AWG24 to AWG26 (0.2 to 0.13 mm²). Use a cable with an outer diameter of less than 1.61 mm.

3-4 Wiring Servo Relay Units

XW2B-80J7-1A Servo Relay Units can be used to connect Motion Control Modules and Servo Drivers.

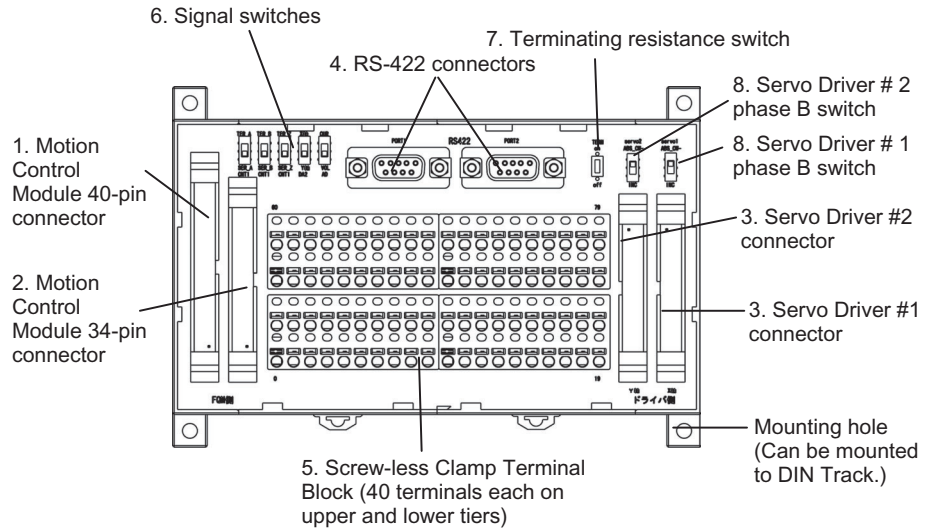
A Servo Relay Unit simplifies wiring, e.g., from a Motion Control Module to two Servo Drivers, for general-purpose I/O wiring, such as for switches and sensors, and for RS-422A line wiring.



The Servo Relay Unit uses a special cable and simplifies connections from one Motion Control Module to two Servo Drivers, such as the W Series and SMARTSTEP Series.

Servo Relay Units can be mounted to DIN Track or on the panel itself.

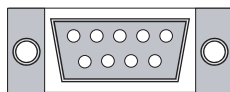
Nomenclature and Functions



- 1,2,3...**
1. Motion Control Module 40-pin Connector
Connects to the 40-pin connector on the Motion Control Module.
 2. Motion Control Module 34-pin Connector
Connects to the 26-pin connector on the Motion Control Module. The Motion Control Module general-purpose I/O is allocated to the clamp terminal block.
 3. Servo Driver Connectors
Connects to two Servo Drivers.

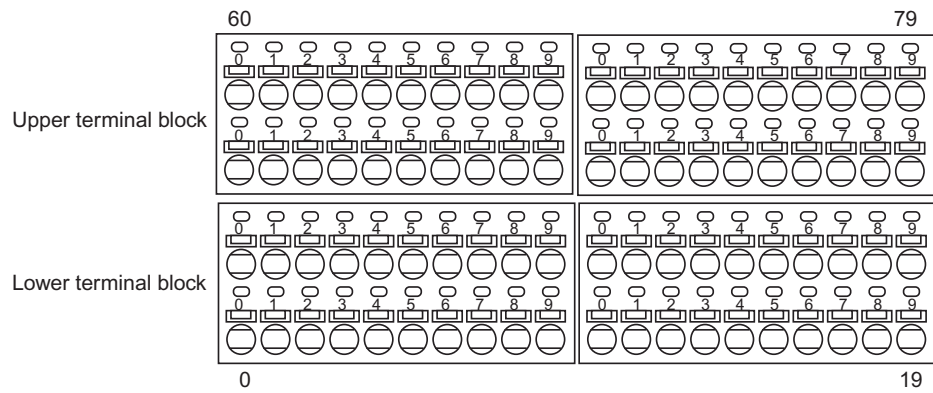
Motion Control Module	Corresponding connecting cable	Servo Driver cable	Servo Driver
FQM1-MMP22	XW2Z-□□□J-A28 XW2Z-□□□J-A30	XW2Z-□□□J-B9	W-series Servo Driver
		XW2Z-□□□J-B10	SMARTSTEP
FQM1-MMA22	XW2Z-□□□J-A28 XW2Z-□□□J-A31	XW2Z-□□□J-B13	W-series Servo Driver

4. RS-422 Connector



Pin No.	Signal
1	TXD-
2	TXD+
3	---
4	---
5	---
6	RXD-
7	---
8	RXD+
9	---
Case	FG

5. Screw-less, Clamp Terminal Block (80 Terminals)
The clamp terminal block is used for the Motion Control Module general-purpose I/O and the Servo Driver control signals. It is also used for external device connections, such as analog inputs and latch signal inputs.



Upper Terminal Block Pin Arrangement

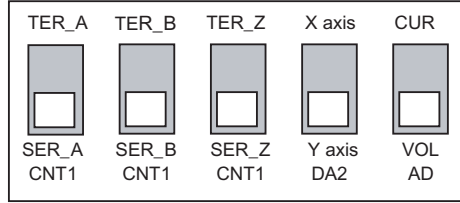
No.	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
Signal name	5 V (See note 2.)	Latch signal input 1	Latch signal input 2	CNT1 phase A LD + input	CNT1 phase B LD + input	Servo # 1 phase Z LD + output	Voltage input (+) (See note 1.)	Servo #1 ALM	Servo #1 TGON	IN4	IN5	IN6	IN7	---	Servo #1 RUN	Servo #1 RESET	Servo #1 ECRST	Servo #1 MING	TXD+	RXD+
No.	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
Signal name	0 V	Latch signal 1 common (0 V)	Latch signal 2 common (0 V)	CNT1 phase A LD -	CNT1 phase B LD -	Servo #1 phase Z LD -	Voltage input (-) (See note 1.)	Servo #1 INP	Common (0 V)	Common (0 V)	Common (0 V)	Common (0 V)	Common (0 V)	---	OUT0	OUT1	OUT2	OUT3	TXD-	RXD-

Lower Terminal Block Pin Arrangement

No.	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Signal name	+24 V (See note 3.)	+24 V (See note 4.)	IN0	IN1	IN2	IN3	---	Servo #2 ALM	Servo #2 TGON	IN8	IN9	IN10	IN11	---	Servo #2 RUN	Servo #2 RESET	Servo #2 ECRST	Servo #2 MING	---	FG
No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Signal name	0 V	0 V	Common (0 V)	Common (0 V)	Common (0 V)	Common (0 V)	---	Servo #2 INP	Common (0 V)	Common (0 V)	Common (0 V)	Common (0 V)	Common (0 V)	---	OUT4	OUT5	OUT6	OUT7	---	FG

- Note**
- (1) Allocated when connecting an FQM1-MMA22 Analog I/O Motion Control Module.
 - (2) Used as the power supply for FQM1-MMP22 pulse outputs or SEN outputs for Servo Drivers compatible with absolute encoder.
 - (3) IN4 to IN11 and OUT0 to OUT7 are used for the servo control signal power supply.
 - (4) IN0 to IN3 (interrupt inputs) are used for the latch input power supply.

6. Signal Switches

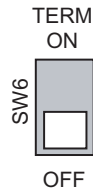


Switch	Setting details	
CNT1 SER_A	SER_A	Connects the Servo #1 phase A to the Motion Control Module's CNT1 phase A.
	TER_A	Connects the external encoder phase A to the Motion Control Module's CNT1 phase A. (See note a.)
CNT1 SER_B	SER_B	Connects the Servo #1 phase B to the Motion Control Module's CNT1 phase B.
	TER_B	Connects the external encoder phase B to the Motion Control Module's CNT1 phase B. (See note a.)
CNT1 SER_Z	SER_Z	Connects the Servo #1 phase Z to the Motion Control Module's CNT1 phase Z.
	TER_Z	Outputs the Servo #1 phase Z output from the terminal.
DA2 (See note c.)	Y axis	Connects FQM1-MMA22 analog output 2 to Servo #2 REF.
	X axis	Connects FQM1-MMA22 analog output 2 to Servo #1 TREF.
AD	VOL	Sets analog inputs as voltage inputs.
	CUR	Sets analog inputs as current inputs. (See note b.)

- Note** (a) An external encoder with a line-driver output can be connected.
 (b) For 4 to 20 mA current inputs, voltage input (+) and current input do not need to be connected.
 (c) When using an FQM1-MMP22, always set the Y axis.

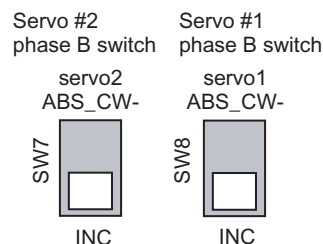
7. Terminating Resistance Switch

Set this terminating resistance switch to ON when the Servo Relay Unit is at the end of the RS-422A line and the PORT2 terminal is not connected to PORT1 on another Servo Relay Unit.

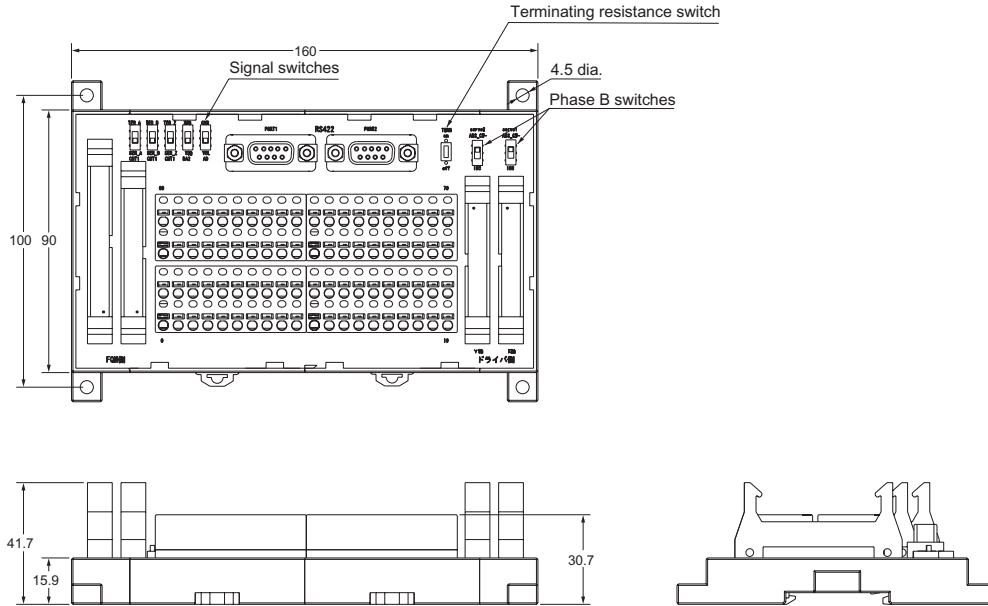


8. Servo Driver Phase B Switches

Inverse of the phase of encoder output phase B from the Servo Driver when inputting the signal. The signals can be inverted by the settings on the ABS_CW- switches.



External Dimensions



Wiring Screw-less Clamp Terminal Blocks

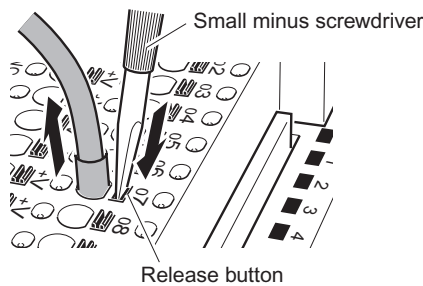
Screw-less clamp terminal blocks use clamps to attach wires, and do not require screws. In addition to control signal wiring to Servo Drivers, clamp terminal blocks can be used to connect sensors and external devices. A ferrule, however, must be connected to the sensor or external device cable when connecting to clamp terminal blocks.

The following table shows the suitable ferrules.

Manufacturer	Model	Applicable wire
Phoenix Contact Inc.	AI-0.5-10	0.5 mm ² (20AWG)
	AI-0.75-10	0.75 mm ² (18AWG)
	AI-1.5-10	1.25 mm ² (16AWG)
Nihon Weidmuller Co. Ltd.	H 0.5/16 D	0.5 mm ² (20AWG)
	H 0.75/16 D	0.75 mm ² (18AWG)
	H 1.5/16 D	1.25 mm ² (16AWG)

Wiring Method

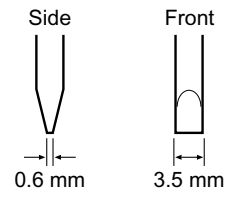
- **Inserting Wires**
Insert the ferrule into the terminal hole.
- **Removing Wires**
Push and hold the release button on top of the terminal hole with a small flat-blade screwdriver and remove the wire.



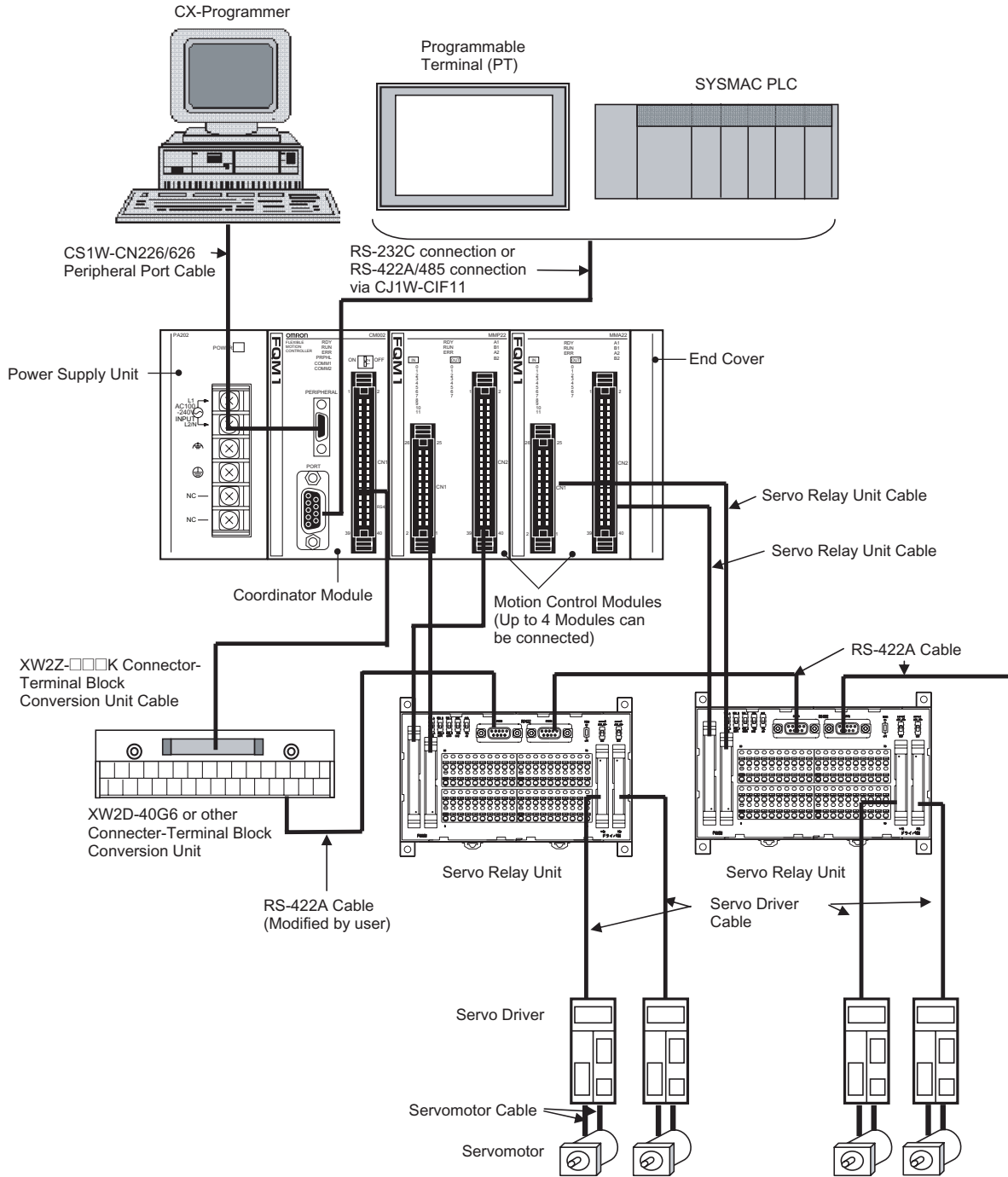
The following screwdriver can be used when removing wires.

Recommended Screwdriver

Model	Manufacturer
SZF1	Phoenix Contact Inc.

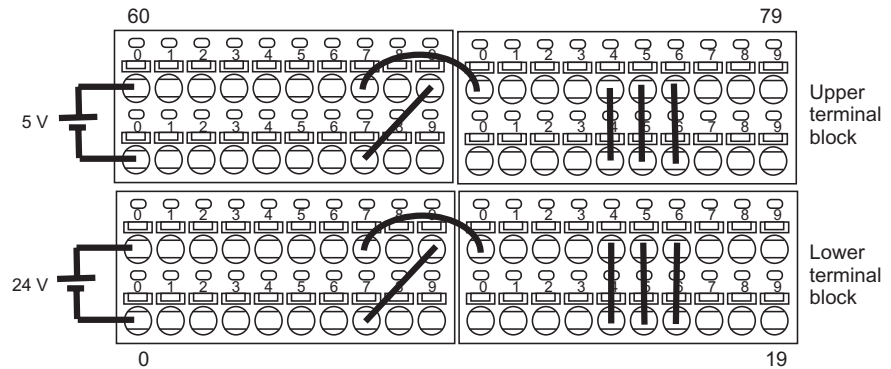


Wiring when Using Servo Relay Units

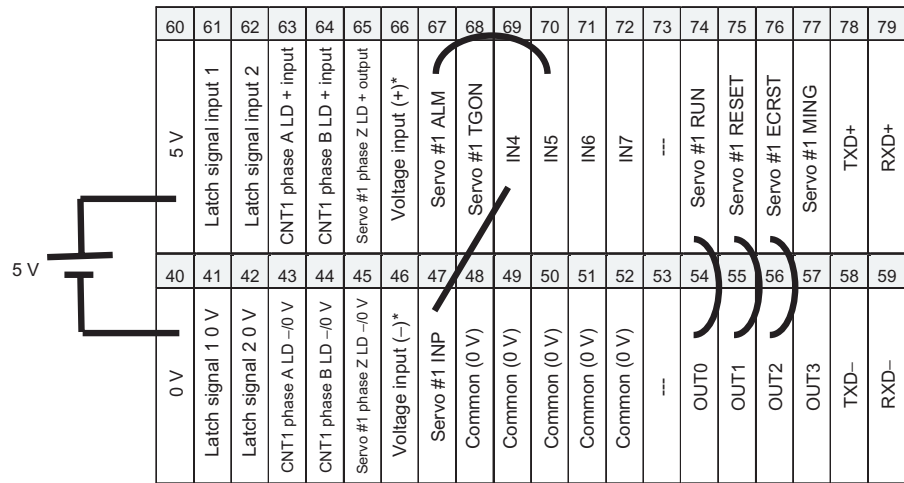


Example Servo Relay Unit Wiring

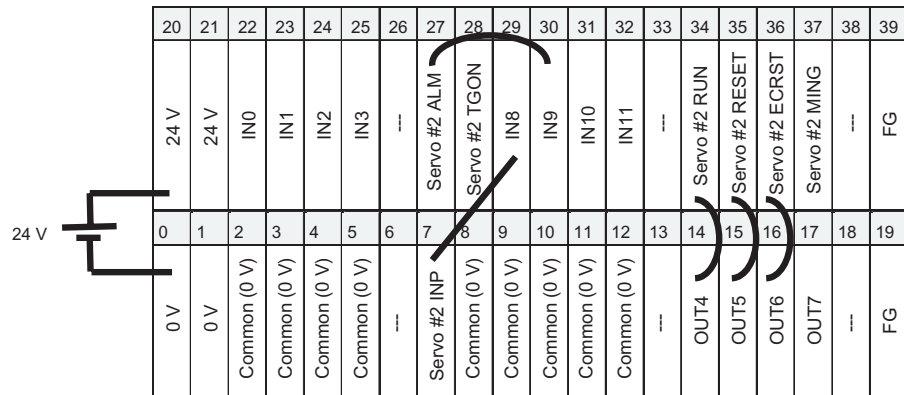
When Servo Relay Units for the FQM1 are used, the I/O power supply is provided from terminals 20-0, 21-1, and 60-40. The only additional wiring required are the connections between the signals, as shown in the following diagram.



Upper Terminal Block Arrangement

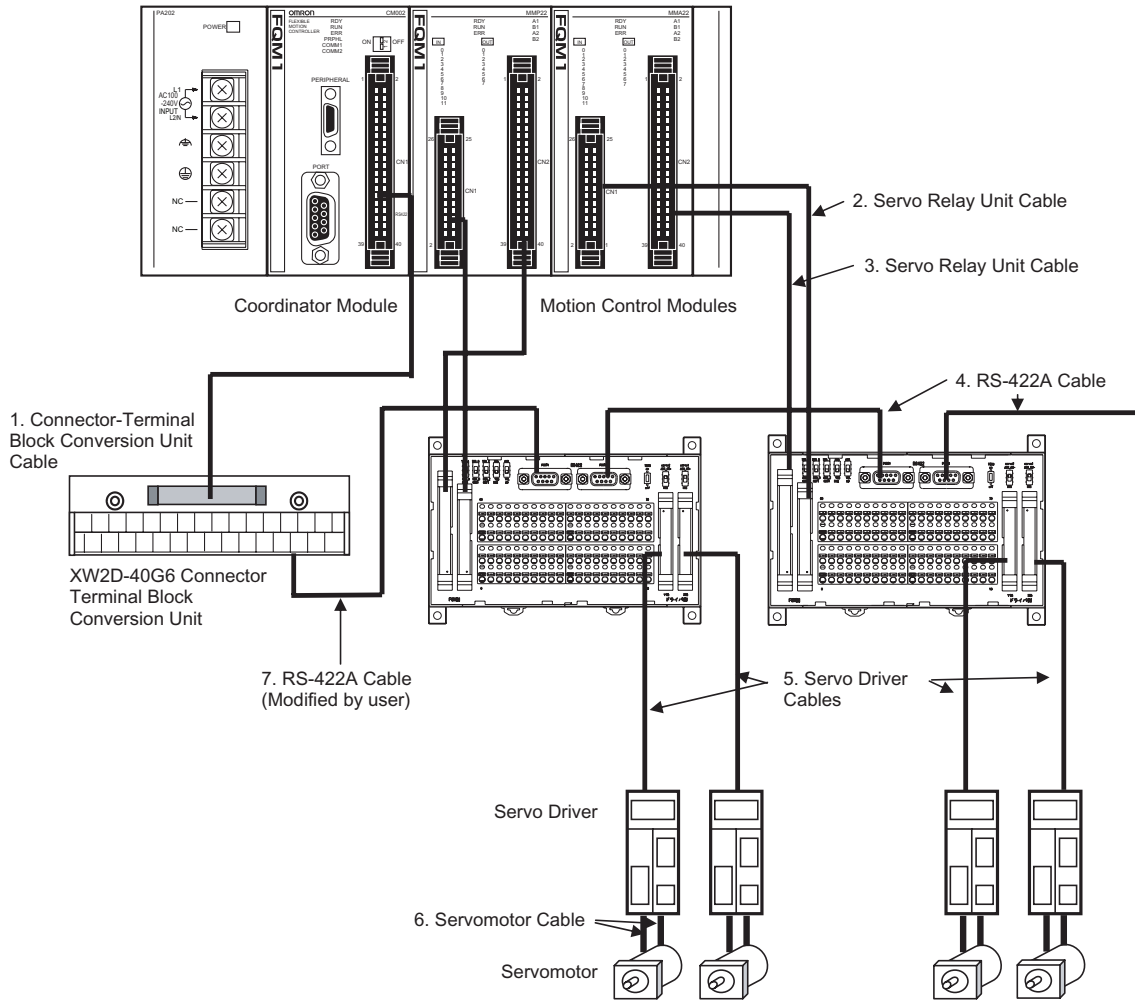


Lower Terminal Block Arrangement



3-5 List of FQM1 Connecting Cables

It is recommended that special cables are used when connecting Coordinator and Motion Control Modules to Servo Relay Units.



Connecting Cable Models

- 1,2,3...** 1. Connector-Terminal Block Conversion Unit Cables (for FQM1-CM002, 40-pin MIL Connector)

Specifications	Model	
Connects FQM1-CM002 and XW2D-40G6 Connector-Terminal Block Conversion Unit.	1 m	XW2Z-100K
	1.5 m	XW2Z-150K
	2 m	XW2Z-200K
	3 m	XW2Z-300K
	5 m	XW2Z-500K

2. Servo Relay Unit Connecting Cables (for FQM1-MMP22/MMA22, 26-pin MIL Connector)

Specifications	Model	
Connects FQM1-MMP22 and Servo Relay Unit.	0.5 m	XW2Z-050J-A28
	1 m	XW2Z-100J-A28

- Servo Relay Unit Connecting Cables (for FQM1-MMP22/MMA22, 40-pin MIL Connector)

Specifications		Model
Connects FQM1-MMP22 and Servo Relay Unit.	0.5 m	XW2Z-050J-A30
	1 m	XW2Z-100J-A30
Connects FQM1-MMA22 and Servo Relay Unit.	0.5 m	XW2Z-050J-A31
	1 m	XW2Z-100J-A31

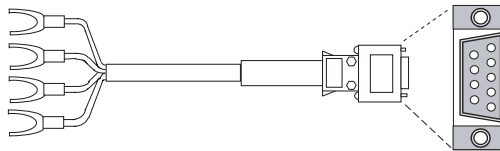
- RS-422A Connecting Cables (with 9-pin D-sub Connector)

Specifications		Model
Connects RS-422A between Servo Relay Units.	1 m	XW2Z-100J-C1
	2 m	XW2Z-200J-C1

- Servo Driver Connecting Cables (Servo Relay Unit to Servo Driver)

Specifications			Model
FQM1-MMP22	Connects Servo Relay Unit and W-series Servo Driver.	1 m	XW2Z-100J-B9
		2 m	XW2Z-200J-B9
	Connects Servo Relay Unit and SMARTSTEP.	1 m	XW2Z-100J-B10
		2 m	XW2Z-200J-B10
FQM1-MMA22	Connects Servo Relay Unit and W-series Servo Driver.	1 m	XW2Z-100J-B13
		2 m	XW2Z-200J-B13

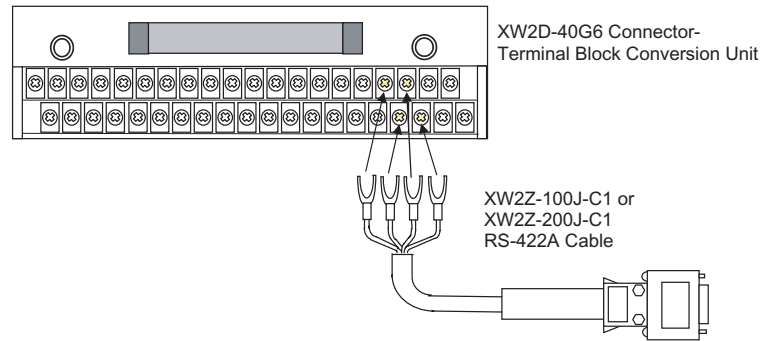
- Servomotor Connecting Cables
Refer to the catalog for the Servo Driver or Servomotor to be connected.
- RS-422A Cable, connects Connector-Terminal Block Conversion Unit and Servo Relay Unit.
 - Cut off one end of the RS-422A cable listed above (4.) and attach crimp terminals.



Pin No.	Signal
1	TXD-
2	TXD+
3	---
4	---
5	---
6	RXD-
7	---
8	RXD+
9	---
Case	FG

Note The Servo Relay Unit Connecting Cable and Servo Driver Connecting Cable must be connected in the correct direction. Match the label with the model number attached to the connector and the connected device.

- Attach the modified cable to the XW2D-40G6 Connector-Terminal Block Conversion Unit.



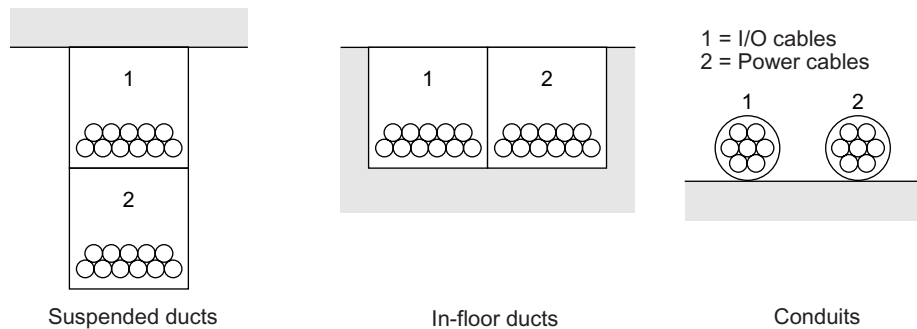
RS-422A Connecting Cable		Connector-Terminal Block Conversion Unit terminal number
No.	Signal	
2	SDB+	A18
1	SDA-	A17
8	RDB+	B18
6	RDA-	B17

3-6 Wiring Precautions

3-6-1 Reducing Electrical Noise

I/O Signal Wiring

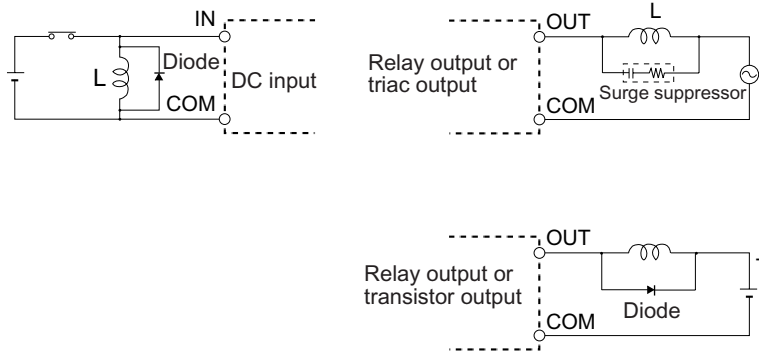
Whenever possible, place I/O signal lines and power lines in separate ducts or raceways both inside and outside of the control panel.



If the I/O wiring and power wiring must be routed in the same duct, use shielded cable and connect the shield to the GR terminal to reduce noise.

Inductive Loads

When an inductive load is connected to I/O, connect a surge suppressor or diode in parallel with the load as shown below.



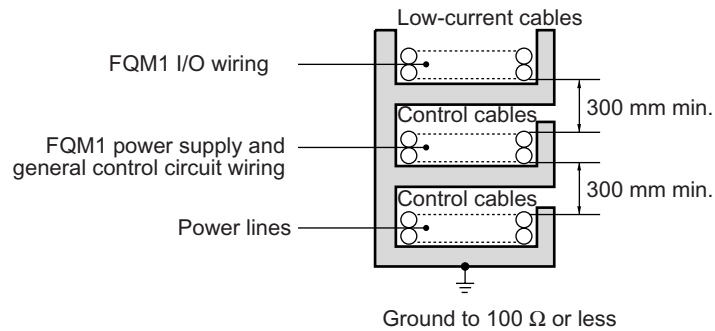
Note Use surge suppressors and diodes with the following specifications.

Surge suppressor specifications	Diode specifications
Resistor: 50 Ω Capacitor: 0.47 μF Voltage: 200 V	Breakdown voltage: 3 times load voltage min. Mean rectification current: 1 A

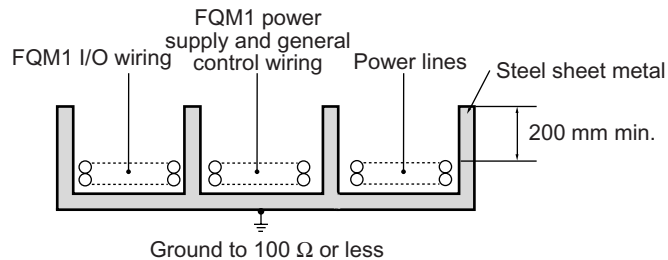
External Wiring

Observe the following precautions for I/O wiring, power supply wiring, and power line wiring.

- When multi-conductor signal cable is being used, do not combine I/O wires and other control wires in the same cable.
- If wiring racks are parallel, allow at least 300 mm between the racks.



- If the I/O wiring and power cables must be placed in the same duct, they must be shielded from each other using grounded steel sheet metal.



SECTION 4

Operation

This section describes the operation of the FQM1.

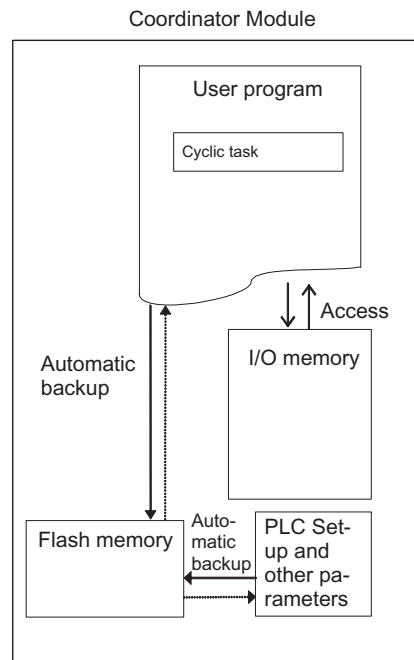
4-1	Coordinator Module	130
4-1-1	Outline	130
4-1-2	Coordinator Module Operation.....	131
4-1-3	I/O Refreshing and Peripheral Servicing	132
4-1-4	Startup Initialization	133
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4-4-2	Instruction Execution for Power Interruptions	141

4-1 Coordinator Module

The FQM1 Coordinator Module and each Motion Control Module have separate ladder programming. Each Module independently processes the ladder programming, I/O, and peripheral servicing to achieve high-speed I/O response somewhat like a system of multiple CPU Units.

4-1-1 Outline

The Coordinator Module mainly manages FQM1 operation and performs peripheral servicing. It has 24 general-purpose I/O, a peripheral port, RS-232C port, and RS-422 port. The following diagram shows the internal structure of the Coordinator Module.



User Program

The CX-Programmer (see note) is used to create the user programs, which are transferred to the Coordinator Module via the peripheral port. The user program includes a cyclic task, which is executed once per cycle, and interrupt tasks, which are executed at synchronous data refresh. The cyclic task is executed every cycle.

Instructions written in a program are executed in order from the beginning of the program, and these instructions are used to read from and write to I/O memory. Once the cyclic task has been completed, cyclic refreshing with the Motion Control Modules is executed, and then the cyclic task is executed again (cyclic scan method).

I/O Memory

I/O memory is the RAM memory area accessed by the user programs. Part of I/O memory area is cleared and part of the memory area is retained when the power is turned OFF and ON again.

I/O memory is also divided into an area that exchanges data with the Motion Control Modules and an area that is used for internal processing.

System Setup

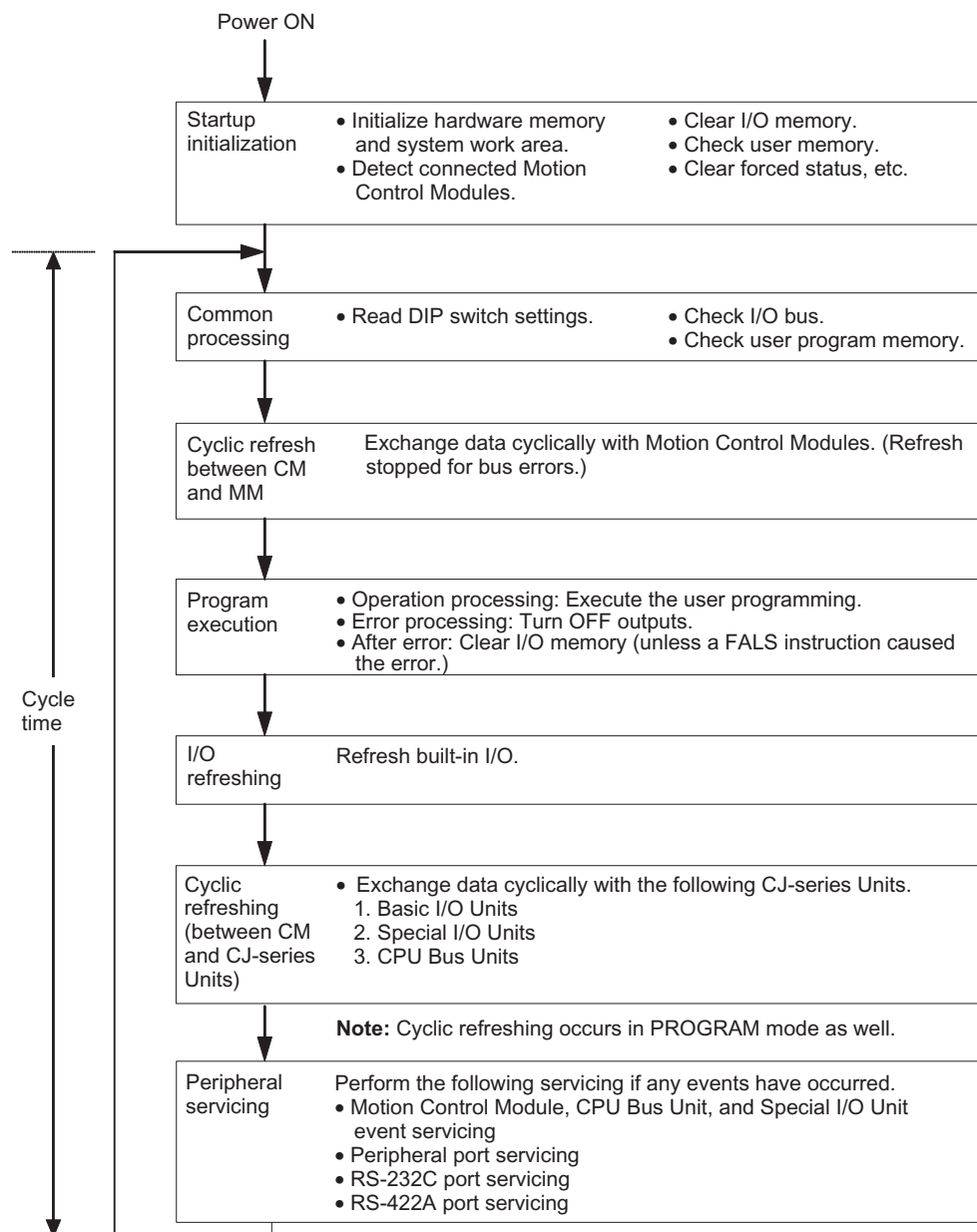
The System Setup contains software switches used to make initial settings and other settings. As shown in *Appendix C System Setup, Auxiliary Area Allocations, and Built-in I/O Allocations*, addresses (words and bits) are allocated for settings in the System Setup. The addresses can normally be ignored when making the settings, however, because the settings follow CX-Programmer menus.

Flash Memory

When the user writes to the Coordinator Module, the user program, System Setup settings, other parameters, and part of the DM Area are automatically backed up to flash memory.

4-1-2 Coordinator Module Operation

The following flowchart shows the operation of the Coordinator Module. Programming is executed before I/O is refreshed and peripherals are serviced. This cycle is executed repeatedly.



4-1-3 I/O Refreshing and Peripheral Servicing

I/O Refreshing

I/O refreshing updates general-purpose I/O status. All I/O is refreshed in the same cycle (i.e., time slicing is not used). I/O refreshing is always performed after program execution.

Cyclic Refreshing (Between Coordinator Module and Motion Control Modules)

Data is exchanged every cycle between predetermined areas and the Motion Control Modules.

Cyclic Refreshing (Between Coordinator Module and CJ-series Units)

Data is exchanged cyclically with external devices using preset words in memory. Cyclic refreshing includes the following:

- Refreshing between Basic I/O Units and I/O words in the CIO Area
- Refreshing between Special I/O Units and CPU Bus Units, and the words allocated to those Units in the CIO Area (and for CPU Bus Units, words allocated in the DM Area)
- Refreshing Unit-specific data for Special I/O Units and CPU Bus Units (such as data links and remote I/O communications)

All I/O refreshing is performed in the same cycle (i.e., time slicing is not used). I/O refreshing is always performed after program execution.

Units		Max. data exchange	Data exchange area	
Basic I/O Units		Depends on the Unit.	I/O Bit Area	
Special I/O Units	Words allocated in CIO Area	10 words/Unit (Depends on the Unit.)	Special I/O Unit Area	
	Unit-specific data	CompoBus/S Master Unit	Remote I/O Communications Area	
CPU Bus Units	Words allocated in CIO Area	25 words/Unit	CPU Bus Unit Area (CIO)	
	Words allocated in DM Area	100 words/Unit	CPU Bus Unit Area (DM)	
	Unit-specific data (examples)	DeviceNet Unit	Depends on the Unit.	Words set for remote I/O communications (for either fixed or user-set allocations)
		Position Control Unit (CJ1W-NCF71)	Depends on the Unit.	Words set for each Servo Driver (user-set allocation)

Peripheral Servicing

Peripheral servicing involves servicing non-scheduled events for external devices. This includes both processing for service requests from external devices and service requests to external devices. Most peripheral servicing involves FINS commands.

The time specified in the system is allocated to each type of servicing and executed every cycle. If the servicing is finished before the end of the allocated time, the remaining time is not used and the next servicing is started.

Servicing	Contents
Event servicing for Motion Control Modules, CPU Bus Units, and Special I/O Units	<ul style="list-style-type: none"> • Non-scheduled servicing for FINS commands from Motion Control Modules, CPU Bus Units, or Special I/O Units. • Non-scheduled servicing for FINS commands from the Coordinator Module to Motion Control Modules, CPU Bus Units, or Special I/O Units.
Peripheral port servicing	<ul style="list-style-type: none"> • Non-scheduled servicing for FINS or Host Link commands received via the peripheral or RS-232C ports from the CX-Programmer, PTs, or host computers (e.g., requests for program transfer, monitoring, forced-set/reset operations, or online editing). • Non-scheduled servicing from the Coordinator Module transmitted from the peripheral or RS-232C port.
RS-232C port servicing	
RS-422A port servicing	<ul style="list-style-type: none"> • Non-scheduled servicing to Servo Driver.

Note Servicing for Motion Control Modules, peripheral ports, RS-232C ports, and RS-422A ports is allocated 6.25% of the immediately preceding cycle time by default. If servicing is separated over more than one cycle, delaying completion of the servicing, set the actual amount of time for *Set Time to All Events* (same time for all services) rather than a percentage on the *Timer/Peripheral Service* Tab Page in the System Setup.

4-1-4 Startup Initialization

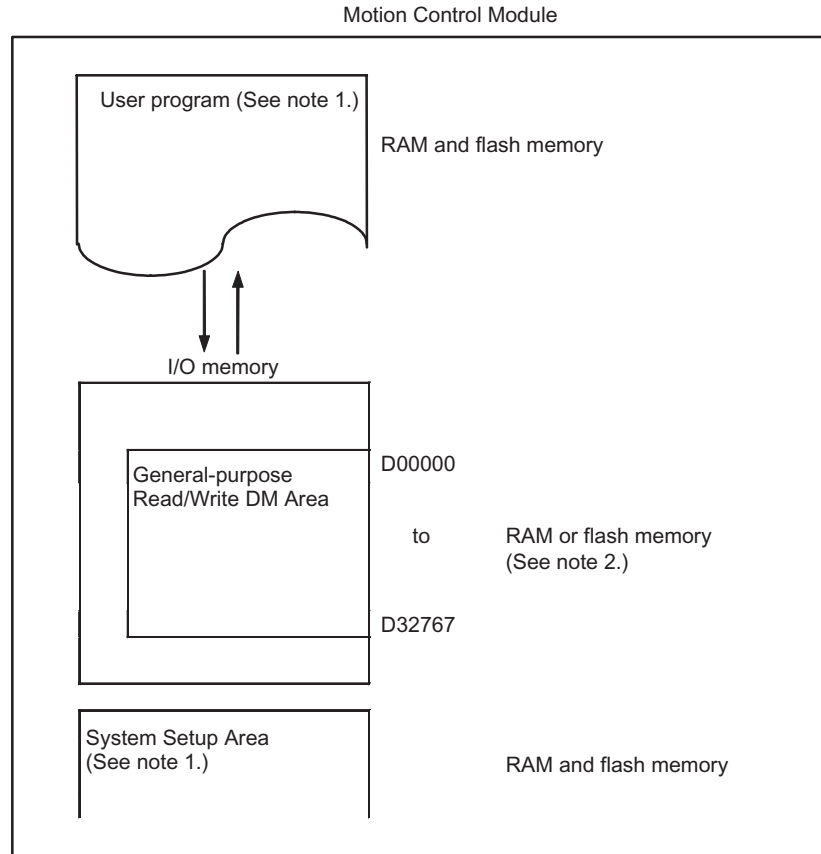
The following initialization is performed once each time the power is turned ON.

- Detecting mounted Modules and CJ-series Units
- Clearing the non-retained areas of I/O memory
- Clearing forced-set/reset status
- Performing self-diagnosis (user memory check)
- Restoring the user program
- Restoring retained DM Area data

4-2 Motion Control Modules

4-2-1 Outline

Motion Control Modules each have independent ladder programming, which perform processing independently from other Modules. The following diagram shows the internal structure of Motion Control Modules.



- Note**
- (1) User Memory (UM) Protect
The following data can be write-protected using settings in the System Setup.
- User program
 - System Setup Area
- These Areas are stored in RAM and flash memory.
- (2) Part of the DM Area in the I/O Memory Area is backed up by a super capacitor.

4-2-2 Description of Each Area

User Program Area

The CX-Programmer is used to create the Motion Control Module ladder programs and set the System Setup. Programs and settings are transferred to each Motion Control Module through the peripheral port on the Coordinator Module.

The user program is written using ladder diagram programming and executed using a cyclic scan method.

Broadly speaking, the user program consists of a cyclic task and interrupt tasks, which are executed for interrupts. The cyclic task is executed every cycle. The user program is stored in RAM and flash memory. Data is not lost, therefore, even if the super capacitor backup time is exceeded.

I/O Memory

I/O memory is the area accessed by the user program and the CX-Programmer. Part of I/O Memory Area is cleared and part of it is retained when the power is turned OFF and ON again.

I/O memory is also divided into an area that exchanges data with other Motion Control Modules and an area that is used for internal processing.

System Setup

The System Setup contains software switches used to make initial settings and other settings for the Motion Control Module. Addresses are allocated for the settings in the System Setup, but these addresses can normally be ignored when making the settings, because the settings follow CX-Programmer menus.

The System Setup is stored in RAM and flash memory, so the data is not lost even if the super capacitor backup time is exceeded.

Read/Write DM Area (D00000 to D32767)

The Read/Write DM Area can be accessed from the user program.

D00000 to D29999 data can be saved to flash memory with a control bit operation.

D30000 to D32767 data is retained for a set period by the super capacitor. The data is lost when the super capacitor backup time has been exceeded.

4-2-3 Motion Control Module Operation

Operation between the Coordinator Module and the Motion Control Modules can be set to synchronous ("Sync") or asynchronous ("ASync") modes using a setting in the System Setup of the Coordinator Module.

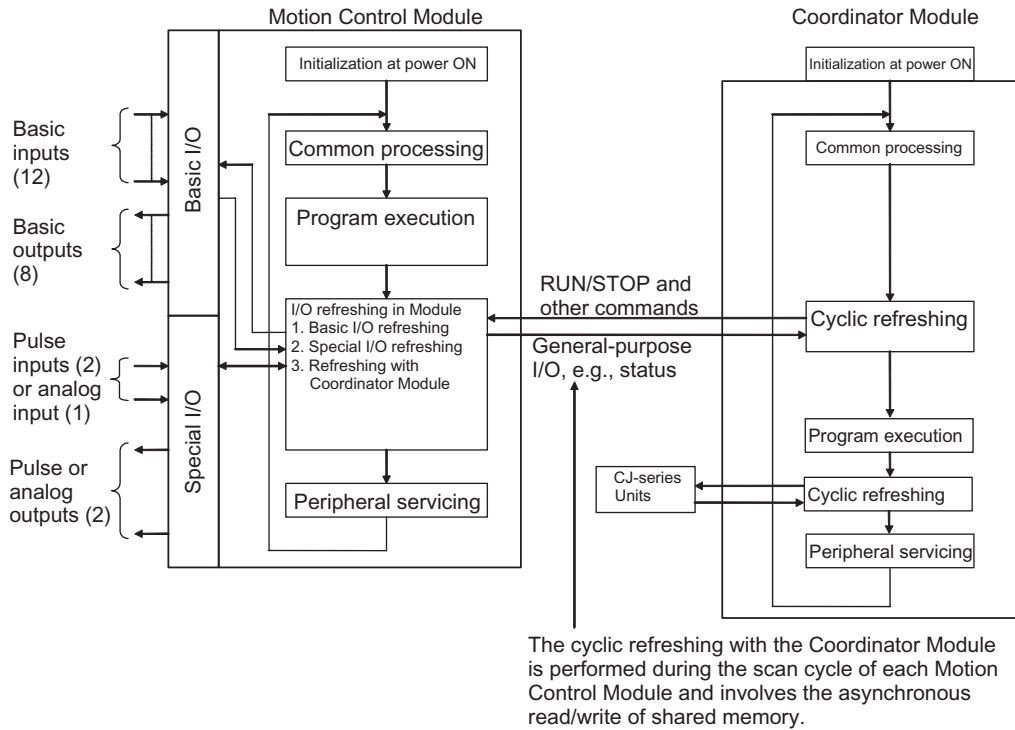
System Setup Using CX-Programmer

Tab page	Item	Settings
Module Settings	Synchronization between Modules	<ul style="list-style-type: none"> • Sync Mode • ASync Mode

ASync Mode Operation

In ASync Mode, scan processing by the Motion Control Modules is not synchronized with the Coordinator Module. Motion Control Module built-in I/O refreshing is executed within the scan cycle in the Motion Control Module. I/O refreshing with the Coordinator Module is determined by the Coordinator Module and is executed asynchronously to the Motion Control Module scan processing.

Synchronous Data Link Bit Area refreshing is not executed in ASync Mode.



Sync Mode Operation

In Sync Mode, the Motion Control Module's cyclic scan is synced with the Coordinator Module's cyclic scan or the sync cycle time set in the System Setup. The program in each Motion Control Module is thus executed at the same time.

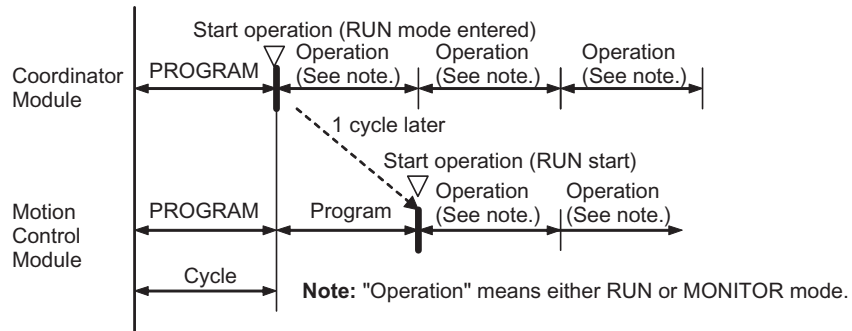
When operation is synchronized to the Coordinator Module cycle scan, the start of program execution in every cycle is the same for all Modules. When operation is synchronized to the sync cycle time, the start of program execution in every cycle is the same for all Motion Control Modules.

Motion Control Modules send all synchronous data link bits to the Coordinator Module and all other Motion Control Modules each Coordinator Module cyclic scan or at the specified sync cycle time. (See note 1.)

Each Module can access the synchronous data link bits from all other Modules. (Refer to 5-4 Synchronous Data Refresh for details.)

- Note**
- (1) This depends on the sync cycle time set in the System Setup of the Coordinator Module (0.1 to 10.0 ms, 0.1-ms increments).
 - (2) High-speed counter inputs, pulse outputs, or any other data can be set for each Module.

Caution When the Coordinator Module changes from PROGRAM mode to RUN or MONITOR modes, the Motion Control Modules will switch to RUN or MONITOR mode one cycle later. Similarly, when the Coordinator Module switches from RUN or MONITOR modes to PROGRAM mode, the Motion Control Modules will switch one cycle later. The operating modes for all Motion Control Modules will switch in the same cycle.



Initialization at At power ON

Internal Module initialization (determining the operating mode, initializing user memory, clearing specified memory areas, checking for memory corruption, reading the System Setup, etc.) is performed and the bus that exchanges data with the Coordinator Module is initialized.

Common Processing

Common processing, which does not depend on special I/O, is performed.

Program Execution

The Motion Control Module's ladder program is executed. Basic I/O is refreshed whenever the IORF instruction is executed. Special I/O can also be refreshed for Modules with analog I/O.

Cycle Time Calculation

The execution time for one cycle is monitored. If a constant cycle time is set, processing is performed to make the cycle time constant. (Refer to 5-6-1 Constant Cycle Time Function for information on constant cycle time processing.)

Motion Control Module Built-in I/O Refreshing

The following 3 types of built-in I/O refreshing are performed by Motion Control Modules.

- 1,2,3...
1. Basic I/O Refreshing
Output bits to output contacts, inputs contacts to input bits
 2. Special I/O Refreshing
Pulse inputs, pulse outputs, analog inputs, analog outputs, etc.
 3. Coordinator Module Refreshing
Data exchange with Coordinator Module

- Note**
- (1) Special I/O refreshing refreshes high-speed counter present values and other special I/O.
 - (2) Motion Control Module built-in I/O refreshing is also executed in PROGRAM mode and during fatal errors (including FALS instructions) (input refresh only).
 - (3) Coordinator Module cyclic refreshing (allocated data exchange) is executed at the same time as the Coordinator Module scan processing. This refreshing exchanges data between the Coordinator Module and the Motion Control Modules, so it is asynchronous with the Motion Control Module's cyclic refreshing. Coordinator Module cyclic refreshing is also executed in PROGRAM mode and during fatal errors (including FALS instructions).

Peripheral Servicing

Event servicing requests from the Coordinator Module are serviced.

4-3 Operating Modes

4-3-1 Operating Modes

Coordinator and Motion Control Modules have three operating modes that control the user program.

PROGRAM

Programs are not executed and preparations, such as initializing the System Setup and other settings, transferring programs, checking programs, force-setting, force-resetting, and checking wiring can be executed prior to program execution. Motion Control Module built-in I/O refreshing and Coordinator Module cyclic refreshing are, however, executed in this mode.

MONITOR

Programs are executed, but some operations, such as online editing and changing present values in I/O memory, are enabled for trial operation and other adjustments.

RUN

Programs are executed but some operations, such as online editing and changing the present values in I/O memory using CX-Programmer, cannot be performed. The CX-Programmer can monitor the program execution status (program and I/O memory monitoring). The main system operation is performed in RUN mode.

- Note**
- (1) The operating mode of Motion Control Modules cannot be changed independently in Sync Mode. Always change the operating mode of the Coordinator Module in Sync Mode.
 - (2) To debug Motion Control Module programs, change the Coordinator Module to ASync Mode under the System Setup and change the operating mode for that Motion Control Module.

4-3-2 Status and Operations in Each Operating Mode

PROGRAM, RUN, and MONITOR are the three FQM1 operating modes. The following tables list status and operations for each mode.

Mode		PROGRAM	RUN	MONITOR
Program execution (See note.)		Stopped	Performed	Performed
I/O refresh		Executed	Executed	Executed
External outputs		OFF	Controlled by program	Controlled by program
I/O Memory	Cleared areas	Clear	Controlled by program	Controlled by program
	Retained areas	Retained		
CX-Programmer operations	I/O Memory monitoring		OK	OK
	Program monitoring		OK	OK
	Program transfers	FQM1 to computer	OK	OK
		Computer to FQM1	OK	×
	Program check		OK	×
	System Setup changes		OK	×
	Program changes		OK	×
	Force-set/reset		OK	×
	Changing timer/counter SV		OK	×
	Changing timer/counter PV		OK	×
Changing I/O Memory PV		OK	×	

Note The following table shows the relationship of operating modes to tasks.

Mode	Cyclic task status	Interrupt task status
PROGRAM	Disabled	Stopped
RUN	Enabled	Executed if interrupt condition is met.
MONITOR		

4-3-3 Operating Mode Changes and I/O Memory

Mode Changes	Cleared areas	Retained areas
	<ul style="list-style-type: none"> • I/O bits • Data Link bits • Work bits • Timer PV 	<ul style="list-style-type: none"> • DM Area • Counter PV
RUN or MONITOR to PROGRAM	Cleared (See note 1.)	Retained
PROGRAM to RUN or MONITOR	Cleared (See note 1.)	Retained
RUN to MONITOR or MONITOR to RUN	Retained (See note 2.)	Retained

- Note**
- (1) The cycle time will increase by approximately 10 ms when the operating mode is changed from MONITOR to RUN mode. This will not cause an error for exceeding the maximum cycle time limit.
 - (2) In Sync Mode, the Motion Control Module operating mode will change one cycle after the Coordinator Module operating mode has changed.

4-4 Power OFF Operation

4-4-1 Power OFF Operation

The following processing is performed if FQM1 power is interrupted during operation. The following power OFF processing will be performed if the power supply falls below 85% of the minimum rated voltage while in RUN or MONITOR mode.

- 1,2,3...**
1. The Motion Control Modules and Coordinator Module will stop.
 2. All outputs from all Modules will be turned OFF.

85% of the rated voltage (AC power):

85 V AC for 100 V

170 V AC for 200 V

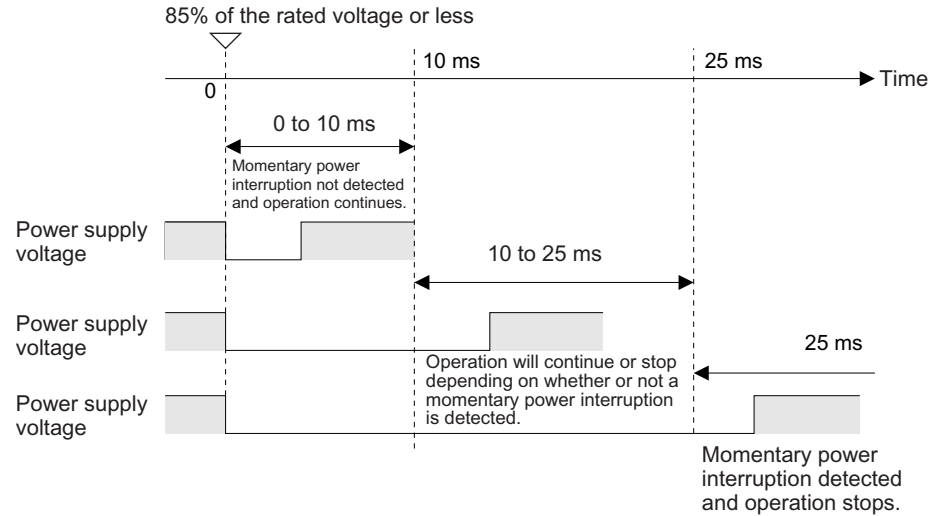
85 V AC for 100 to 240 V (wide range)

The following processing will be performed if power drops only momentarily (momentary power interruption).

- 1,2,3...**
1. The system will continue to run unconditionally if the momentary power interruption lasts less than 10 ms, i.e., the time it takes the minimum rated voltage at 85% or less to return to 85% or higher is less than 10 ms.
 2. A momentary power interruption that lasts more than 10 ms but less than 25 ms is difficult to determine and a power interruption may or may not be detected.
 3. The system will stop unconditionally if the momentary power interruption lasts more than 25 ms.

It thus requires between 10 and 25 ms to detect a power interruption. This time can be increased by setting the User-set Power OFF Detection Time (0 to 10 ms) in the System Setup.

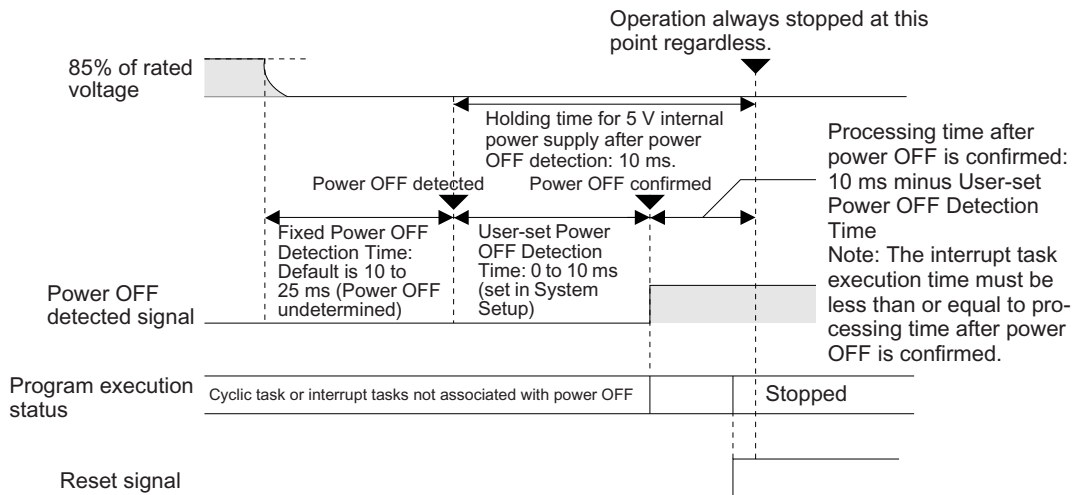
Note The User-set Power OFF Detection Time appears in the System Setup simply as the “Power OFF Detection Time.”



Note The above timing chart shows an example when the User-set Power OFF Detection Time is set to 0 ms.

The following timing chart shows the Coordinator Module power OFF operation in more detail.

Power OFF Timing Chart



Fixed Power OFF Detection Time

The time it takes to detect power OFF after the power supply falls below 85% of the minimum rated voltage.

User-set Power OFF Detection Time

The time after power OFF is detected until it is confirmed. This can be set in the System Setup within a range from 0 to 10 ms (default: 0 ms).

If an unstable power supply is causing power interruptions, set a longer User-set Power OFF Detection Time (10 ms max.) in the System Setup.

Power Holding Time

The maximum amount of time (fixed at 10 ms) that 5 V will be held internally after power interruption is detected.

Description of Operation

Power OFF will be detected if the 100 to 240 V AC power supply stays below 85% of the minimum rated voltage for the Fixed Power OFF Detection Time (variable between 10 to 25 ms.)

If the User-set Power OFF Detection Time is set (0 to 10 ms) in the System Setup, the reset signal will turn ON and the Module will be reset immediately after the User-set Power OFF Detection Time expires.

4-4-2 Instruction Execution for Power Interruptions

If power is interrupted and the interruption is confirmed when the Coordinator Module or Motion Control Module is operating in RUN or MONITOR mode, the instruction currently being executed will be completed and then the Module will be reset.

SECTION 5

Module Functions and Data Exchange

This section describes the functions common to both the Coordinator Module and Motion Control Modules and the methods to transfer data between the Coordinator Module and Motion Control Modules.

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5-1 Synchronous Operation between Modules

Sync and ASync Modes

Sync Mode

The Coordinator Module and Motion Control Modules are normally set to operate using the same cycle time, i.e., synchronously. Synchronous operation is the default setting in the System Setup. With this setting, all Motion Control Modules synchronize operation with the Coordinator Module cycle time. This allows synchronous control of up to 8 axes.

System Setup	Default	Settings
Module Settings Tab Page	Sync Mode	Use in Sync Mode (default).
Synchronization between Modules	Sync Cycle Time = 0 ms Coordinator Module cycle time	To operate only the Motion Control Modules with high-speed synchronous operation, set a value for the Coordinator Module sync cycle time.

ASync Mode

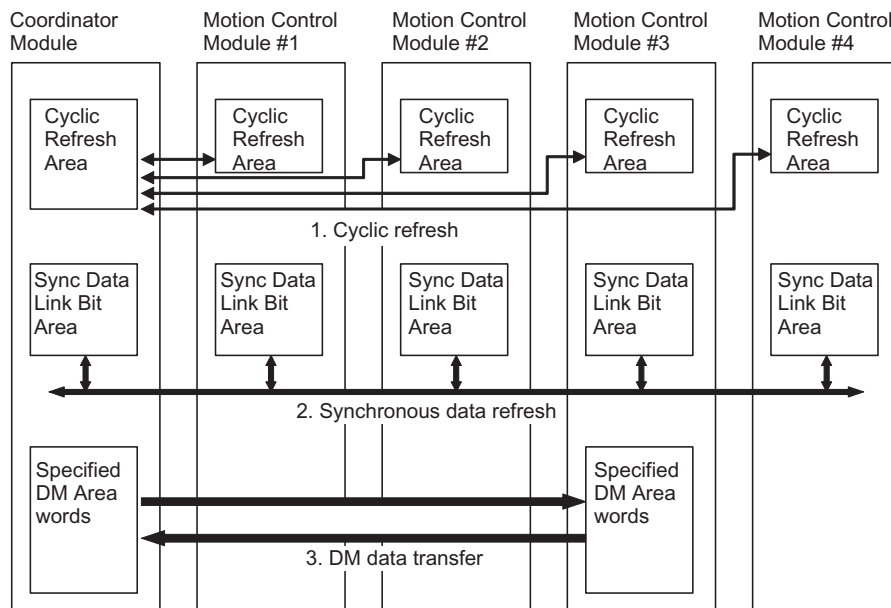
The Motion Control Modules can be operated at high-speed in ASync Mode. Some delays in peripheral servicing may occur, but ASync Mode is useful for increasing the speed of overall system operation.

System Setup	Default	Settings
Module Settings Tab Page	Sync Mode	Set to ASync Mode.
Synchronization between Modules		

5-2 Data Exchange between Modules

The three methods for data exchange between Coordinator and Motion Control Modules are outlined in the following table. These methods can be used simultaneously.

Method	Outline	Description
1. Cyclic refresh	Exchanges data each Coordinator Module cycle.	A Cyclic Refresh Area is allocated for each Motion Control Module in the Coordinator Module.
2. Synchronous data refresh	Broadcasts data at a specified sync cycle.	Specified synchronous data is broadcast from each Motion Control Module and the Coordinator Module. All other Modules receive and share the data in the Synchronous Data Link Bit Area.
3. DM data transfer	Transfers large volumes of data between a specified Motion Control Module and the Coordinator Module when required.	Data is transferred in the specified direction between the specified DM Area words of a specified Motion Control Module and the specified DM Area words of the Coordinator Module when the DM Write Request Bit (A530.00) or DM Read Request Bit (A530.01) in the Auxiliary Area of the Coordinator Module is turned ON.

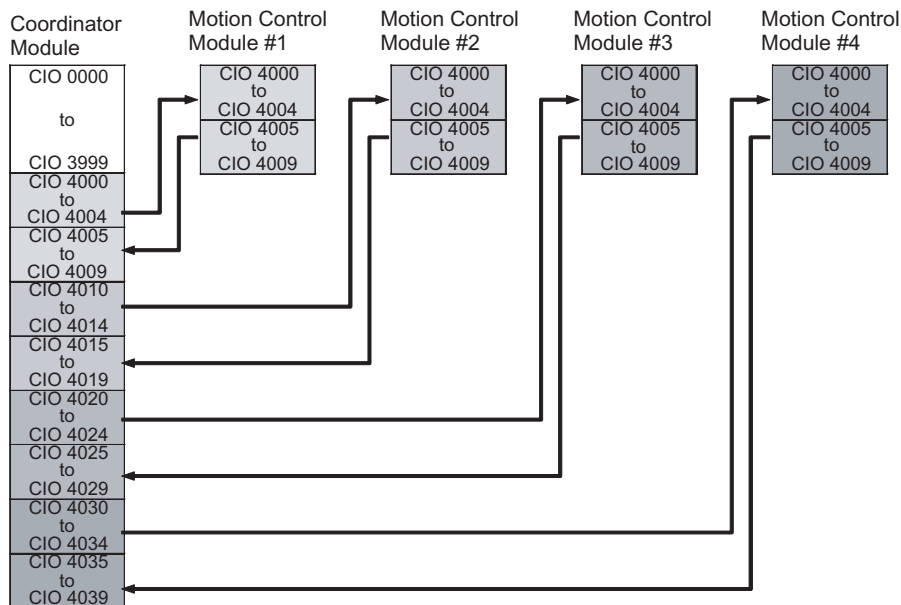


5-3 Cyclic Refresh

5-3-1 Outline

Status information, general-purpose I/O, and other information for each Motion Control Module in the Cyclic Refresh Area of the Coordinator Module are refreshed every Coordinator Module cycle (asynchronous to the Motion Control Module cycles).

As shown in the following diagram, 10 words per Motion Control Module (5 output words and 5 input words) are allocated according to the Motion Control Module slot number (#1 to #4 in the following diagram) in the Cyclic Refresh Area of the Coordinator Module (CIO 0100 to CIO 0139).



Note Cyclic refreshing between the Coordinator Module and Motion Control Modules is asynchronous. Information may take up to 2 cycles to be received.

5-3-2 Applications

In addition to the Synchronous Data Link Bit Area, normal data exchange between the Coordinator Module and Motion Control Modules is possible using the Cyclic Refresh Area.

Information for which high-speed data exchange between Modules is not required can be allocated anywhere, and a ladder program written for the Coordinator Module and Motion Control Modules to access these areas during operation can be created.

5-3-3 Cyclic Refresh Area Details

Coordinator Module Cyclic Refresh Area

CIO 4000 to CIO 4039 in each Motion Control Module is allocated to ten words between CIO 4000 to CIO 4009 in the Coordinator Module according to the slot number for the Motion Control Module.

CM: Coordinator Module
MM: Motion Control Module

Word address	Bits	Details	
CIO 4000 to CIO 4004	00 to 15	CM Output Refresh Area (CM to MM) The data in this area is allocated to the MM Input Refresh Area (CM to MM) for Motion Control Module #1.	
CIO 4005	00 to 07	Reserved.	
	08	Refresh Area for MM #1 CM Input Refresh Area (MM to CM) The data in the MM Output Refresh Area (MM to CM) for MM #1 is allocated here.	Reserved
	09		Cycle time over warning OFF: No error ON: Cycle time exceeded 10 ms.
	10		MM #1 non-fatal error (including FAL instructions) OFF: No non-fatal error ON: Non-fatal error
	11		MM #1 fatal error (including FALS instructions) OFF: No fatal error ON: Fatal error
	12 to 14		Reserved
	15		MM #1 program status OFF: Stopped (PROGRAM mode) ON: Executing (RUN or MONITOR mode)
CIO 4006 to CIO 4009	00 to 15		CM Input Refresh Area (MM to CM) The data in the MM Output Refresh Area (MM to CM) for MM #1 is allocated to this area.
CIO 4010 to CIO 4019	00 to 15	Refresh Area for MM #2	Same as for MM #1. These areas can be used as work bits by the Coordinator Module when no Motion Control Modules are connected.
CIO 4020 to CIO 4029	00 to 15	Refresh Area for MM #3	
CIO 4030 to CIO 4039	00 to 15	Refresh Area for MM #4	

Motion Control Module Cyclic Refresh Areas

Motion Control Modules use CIO 4000 to CIO 4009, as shown in the following table.

CM: Coordinator Module
MM Motion Control Module

Word address	Bits	Details	
CIO 4000	00 to 15	MM Input Refresh Area (CM to this MM) The data in the Coordinator Module's CM Output Refresh Area (CM to MM) is allocated to this area.	General-purpose refresh data from CM to MM.
CIO 4001	00 to 15		
CIO 4002	00 to 15		
CIO 4003	00 to 15		
CIO 4004	00 to 15		

Word address	Bits	Details	
CIO 4005	00 to 07	MM Output Refresh Area (This MM to CM) Data from this area is allocated to the Coordinator Module's CM Input Refresh Area (MM to CM).	Reserved
	08		Reserved
	09		Cycle time over warning OFF: No error ON: MM cycle time exceeded 10 ms.
	10		Non-fatal error for this Motion Control Module (including FAL instructions) OFF: No non-fatal error ON: Non-fatal error
	11		Fatal error for this Motion Control Module (including FALS instructions) OFF: No fatal error ON: Fatal error
	12 to 14		Reserved
	15		Program status for this Motion Control Module OFF: Stopped (PROGRAM mode) ON: Executing (RUN or MONITOR mode)
CIO 4006	00 to 15	General-purpose refresh data from MM to CM	
CIO 4007	00 to 15		
CIO 4008	00 to 15		
CIO 4009	00 to 15		

5-3-4 Cyclic Refresh Area Allocations

CM: Coordinator Module
MM: Motion Control Module

Direction	Motion Control Module allocation			Coordinator Module allocation							
	Word address	Bits	Details	#1		#2		#3		#4	
				Word address	Bit	Word address	Bit	Word address	Bit	Word address	Bit
CM to MM	CIO 4000	00 to 15	General-purpose refresh data from CM to MM	CIO 4000	00 to 15	CIO 4010	00 to 15	CIO 4020	00 to 15	CIO 4030	00 to 15
	CIO 4001	00 to 15		CIO 4001	00 to 15	CIO 4011	00 to 15	CIO 4021	00 to 15	CIO 4031	00 to 15
	CIO 4002	00 to 15		CIO 4002	00 to 15	CIO 4012	00 to 15	CIO 4022	00 to 15	CIO 4032	00 to 15
	CIO 4003	00 to 15		CIO 4003	00 to 15	CIO 4013	00 to 15	CIO 4023	00 to 15	CIO 4033	00 to 15
	CIO 4004	00 to 15		CIO 4004	00 to 15	CIO 4014	00 to 15	CIO 4024	00 to 15	CIO 4034	00 to 15
MM to CM	CIO 4005	00 to 07	Reserved	CIO 4005	00 to 07	CIO 4015	00 to 07	CIO 4025	00 to 07	CIO 4035	00 to 07
		08	Reserved		08		08		08		08
		09	Cycle time over warning		09		09		09		09
		10	Non-fatal error		10		10		10		10
		11	Fatal error		11		11		11		11
		12 to 14	Reserved		12 to 14		12 to 14		12 to 14		12 to 14
		15	Program status		15		15		15		15
	CIO 4006	00 to 15	General-purpose refresh data from MM to CM	CIO 4006	00 to 15	CIO 4016	00 to 15	CIO 4026	00 to 15	CIO 4036	00 to 15
	CIO 4007	00 to 15		CIO 4007	00 to 15	CIO 4017	00 to 15	CIO 4027	00 to 15	CIO 4037	00 to 15
	CIO 4008	00 to 15		CIO 4008	00 to 15	CIO 4018	00 to 15	CIO 4028	00 to 15	CIO 4038	00 to 15
	CIO 4009	00 to 15		CIO 4009	00 to 15	CIO 4019	00 to 15	CIO 4029	00 to 15	CIO 4039	00 to 15

5-4 Synchronous Data Refresh

5-4-1 Outline

If Sync is set under Synchronization between Modules in the System Setup, each Module will broadcast the specified data (2 types data, 4 words max.) to the Synchronous Data Link Bit Areas each Coordinator Module cycle or specified sync cycle.

Each other Module receives this data. Every Module can access the synchronous data for every other linked Module.

If Synchronization between Modules is set to Sync, the cycle for every Motion Control Module will be automatically synchronized to the Coordinator Module or specified sync cycle, which enables the use of the synchronous Data Link Bit Areas as synchronous data.

The Synchronous Data Link Bit Area is from CIO 1200 to CIO 1219, with 4 words allocated to each Module (Coordinator Module and all Motion Control Modules).

Sync Cycle Time

When Sync Mode is set, the Sync Cycle Time can be set under Sync Cycle Time in the Coordinator Module's System Setup. (Default: Coordinator Module cycle time. Setting range: 0.1 to 10.0 ms, Unit: 0.1 ms.)

Note

Set the Sync Cycle Time longer than the longest cycle time among the synchronized Motion Control Modules.

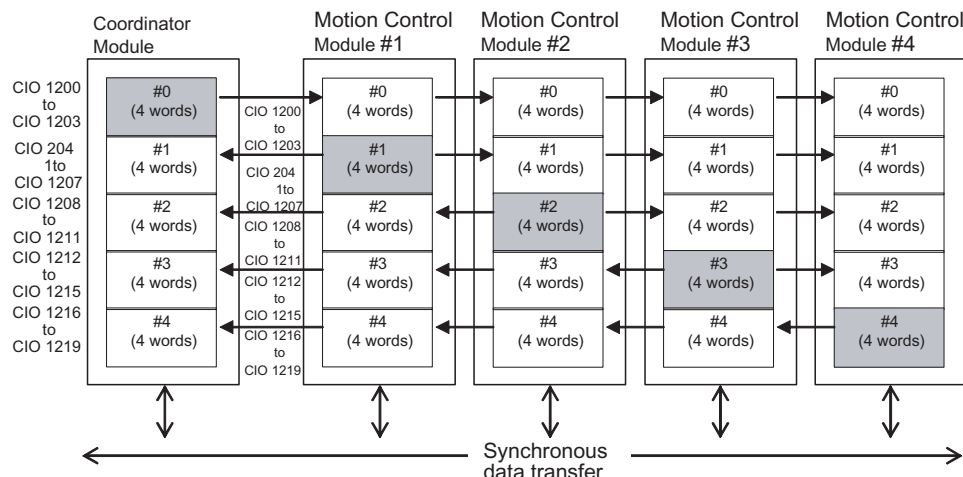
Synchronous Data

Any of the following data can be set as synchronous data for each Module (4 words max.)

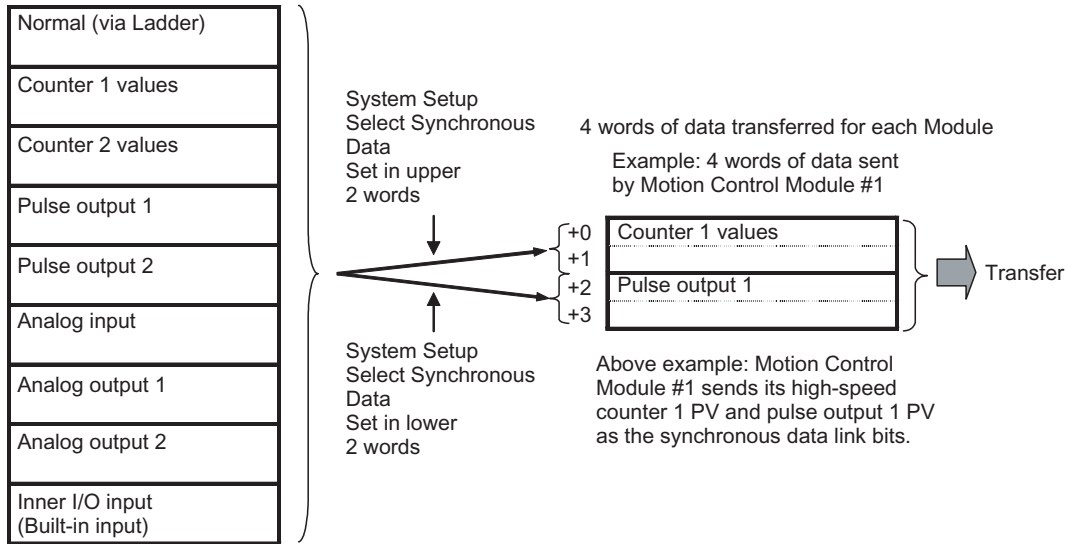
- Ladder execution results
- High-speed counter 1/2 PV
- Pulse output 1/2 PV
- Analog input value
- Analog 1/2 output value
- Built-in I/O input

5-4-2 Applications

An example application would be the creation of a virtual axis in any Module for all Modules to refer to when synchronizing operation. Another application is for the results of ladder program execution to be used as synchronous data.



Synchronous Data



- Note**
- (1) Synchronous data for Coordinator Modules is fixed to general-purpose (ladder execution results) data.
 - (2) If there is no synchronous data to be sent, select no data for *Select Synchronous Data* in the System Setup to shorten the synchronous data transfer time.
 - (3) Auxiliary Area data is transferred when input and output refresh method is set to *Immediate refresh* and the synchronous data is set to an analog input or analog output value in the System Setup.

5-4-3 Synchronous Data Link Bit Area

Synchronous Data Link Bit Areas in Coordinator and Motion Control Modules	Word address (See note 1.)	Bits	Method for selecting type of synchronous data
Sent from Coordinator Module	CIO 1200	00 to 15	Fixed to general-purpose data (e.g., ladder execution results)
	CIO 1201	00 to 15	
	CIO 1202	00 to 15	Fixed to general-purpose data (e.g., ladder execution results)
	CIO 1203	00 to 15	
Sent from Motion Control Module #1	CIO 1204	00 to 15	Set using upper 2 words of <i>Select Synchronous Data</i> in the System Setup for Motion Control Module #1.
	CIO 1205	00 to 15	
	CIO 1206	00 to 15	Set using lower 2 words of <i>Select Synchronous Data</i> in the System Setup for Motion Control Module #1.
	CIO 1207	00 to 15	
Sent from Motion Control Module #2	CIO 1208	00 to 15	Set using upper 2 words of <i>Select Synchronous Data</i> in the System Setup for Motion Control Module #2.
	CIO 1209	00 to 15	
	CIO 1210	00 to 15	Set using lower 2 words of <i>Select Synchronous Data</i> in the System Setup for Motion Control Module #2.
	CIO 1211	00 to 15	
Sent from Motion Control Module #3	CIO 1212	00 to 15	Set using upper 2 words of <i>Select Synchronous Data</i> in the System Setup for Motion Control Module #3.
	CIO 1213	00 to 15	
	CIO 1214	00 to 15	Set using lower 2 words of <i>Select Synchronous Data</i> in the System Setup for Motion Control Module #3.
	CIO 1215	00 to 15	

Synchronous Data Link Bit Areas in Coordinator and Motion Control Modules	Word address (See note 1.)	Bits	Method for selecting type of synchronous data
Sent from Motion Control Module #4	CIO 0216	00 to 15	Set using upper 2 words of <i>Select Synchronous Data</i> in the System Setup for Motion Control Module #4.
	CIO 0217	00 to 15	
	CIO 0218	00 to 15	Set using lower 2 words of <i>Select Synchronous Data</i> in the System Setup for Motion Control Module #4.
	CIO 0219	00 to 15	

- Note**
- (1) Addresses are the same for the Coordinator Module and all Motion Control Modules.
 - (2) When the synchronous data is one-word data (analog input values, analog output values, built-in I/O, etc.), the other word can be used for general-purpose data.

5-4-4 Settings

The following settings must be made beforehand when using the synchronous data refresh function.

System Setup (Coordinator Module)

Synchronization between Modules and *Sync Cycle Time* must be set in the Coordinator Module's System Setup.

Synchronization between Modules

Name	Settings	Default	Description	Auxiliary Area Flags	Enabled
Module Settings Tab Page Sync Mode	Sync/Async	Sync	Synchronization between Modules	---	At power ON

Sync Cycle Time

Name	Settings	Default	Description	Auxiliary Area Flags	Enabled
Module Settings Tab Page Sync Cycle Time	Default (cycle time) (0.1 to 10.0 ms)	CM cycle time	Sync cycle time (unit: 0.1 ms)	A316.06 Sync Cycle Time Too Long Flag	At power ON

When the Sync Cycle Time is specified, all Motion Control Modules will synchronize with the Coordinator Module cycle time in PROGRAM mode. The specified Sync Cycle Time is enabled in RUN and MONITOR modes, and the Motion Control Module cycle times will change to the set Sync Cycle Time when in these modes.

Synchronous data link bits will be broadcast from each Module at the time specified under Sync Cycle Time.

If an interrupt task 000 is created, it can be used as a regular interrupt task executed each Sync Cycle Time.

When the Sync Cycle Time is on the default setting, the synchronous data link bits are broadcast from each Module each Coordinator Module cycle. The Motion Control Module cycles are synchronous with the Coordinator Module cycle.

- Note**
- If the Sync Cycle Time Too Long Flag (A316.06) turns ON in the Coordinator Module, it means that the Motion Control Module cycle time is longer than the Sync Cycle Time. Either change the Sync Cycle Time or check the Motion Control Module ladder program and shorten the Motion Control Module cycle time to less than the Sync Cycle Time.

System Setup (Motion Control Modules)

Selecting Synchronous Data

Select the type of synchronous data to be sent by each Motion Control Module in the System Setup for that Motion Control Module, as shown in the following table.


Tab page	Function		Settings	Enabled
Module Settings	Select Synchronous Data	Upper 2 words (+0 and +1)	Normal (via Ladder) Counter 1 values	At power ON
		Lower 2 words (+2 and +3)	Counter 2 values Pulse output 1 Pulse output 2 Analog input Reserved Analog output 1 Analog output 2 Inner I/O input (built-in input) No data (See note.)	

Note The time for synchronous data exchange can be shortened by selecting No data.

Prohibit System Interruption of the Sync Mode

Use this function to keep the timing of the calculation start for each Motion Control Module as close as possible, when using Sync Mode.

Name	Function	Settings	Enabled
Module Settings Tab Page Execution Process	Prohibit system interruption of the sync mode	OFF: Allow system interruption of the sync mode ON: Prohibit system interruption of the sync mode	At start of operation

 **Caution** Do not set this function to *Prohibit system interruption of the sync mode* when the cycle time is 10 ms or longer. Doing so may cause the System Clock Bits to malfunction.

5-5 DM Data Transfer

5-5-1 Outline

Large volumes of any DM data can be transferred between the Coordinator Module and a Motion Control Module at any specified timing.

- Only DM Area words can be used for transfer in both the Coordinator Module and Motion Control Modules.
- Up to 499 words can be transferred.

Data is transferred in the specified direction between the specified DM Area words in a specified Motion Control Module and the specified DM Area words in the Coordinator Module when the DM Write Request Bit (A530.00) or DM Read Request Bit (A530.01) in the Auxiliary Area of the Coordinator Module is turned ON.

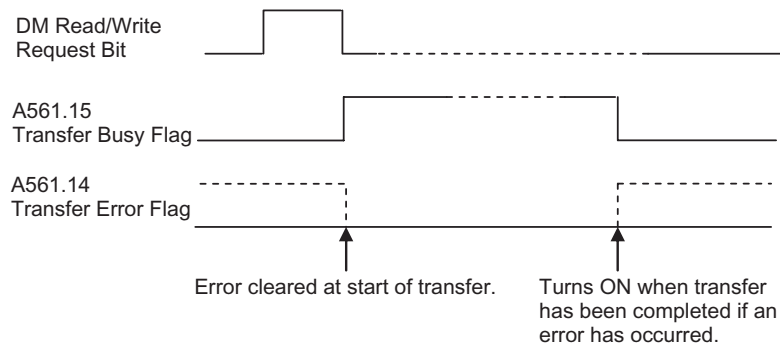
This function is used, for example, to manage data in the Coordinator Module for use by Motion Control Modules when the data must be backed up.

DM data transfer is possible in PROGRAM, RUN, or MONITOR mode for the Coordinator Module and Motion Control Modules.

5-5-2 Settings Details

The settings for using the DM data transfer function are made in the Auxiliary Area.

Name	Address	Description	Read/write
DM Write Request Bit (Coordinator Module to Motion Control Module)	A556.00	DM data transfer is executed from the Coordinator Module to Motion Control Module when this bit turns ON.	Enabled
DM Read Request Bit (Motion Control Module to Coordinator Module)	A556.01	DM data transfer is executed from the Motion Control Module to Coordinator Module when this bit turns ON.	
Slot No. of Motion Control Module for DM Transfer	A557	Specifies the slot number (in 4-digit hexadecimal) for the Motion Control Module with which DM data is to be transferred. 0001: Motion Control Module #1 0002: Motion Control Module #2 0003: Motion Control Module #3 0004: Motion Control Module #4	
DM Transfer Size (number of words)	A558	Specifies the size, in number of words, of the DM data to be transferred. 0001 to 01F3 hex (1 to 499 words)	
First DM Transfer Source Word	A559	Specifies the first address of the DM transfer source in the Coordinator Module or Motion Control Module. 0000 to 7FFF hex	
First DM Transfer Destination Word	A560	Specifies the first address of the DM transfer destination in the Coordinator Module or Motion Control Module. 0000 to 7FFF hex	
Transfer Error Flag	A561.14	Turns ON when a DM data transfer error occurs.	
Transfer Busy Flag	A561.15	Turns ON during DM data transfer and turns OFF when the transfer has been completed.	



Note More than one execution cycle in the Coordinator Module is required to transfer DM Area data. The flow of the transfer is as follows:

1. The DM Read Request Bit or DM Write Request Bit is turned ON.
2. The Transfer Busy Flag turns ON.
3. A request is sent to the Motion Control Module (more than one cycle may be required depending on the amount of data).
4. The Motion Control Module acknowledges the request and performs read/write processing (more than one cycle may be required depending on the amount of data).
5. The Motion Control Module notifies the Coordinator Module when processing the request has been completed.

6. The Coordinator Module acknowledges the notification and turns OFF the Transfer Busy Flag.

Note If there is excessive data to transfer or the cycle of the Motion Control Module is longer than the cycle of the Coordinator Module, more Coordinator Module cycles will be required to complete the transfer.

5-5-3 Executing DM Data Transfer

Step 1: Make Auxiliary Area Settings

To transfer data, the Auxiliary Area settings, described earlier, must be made. The following settings are made in the Auxiliary Area.

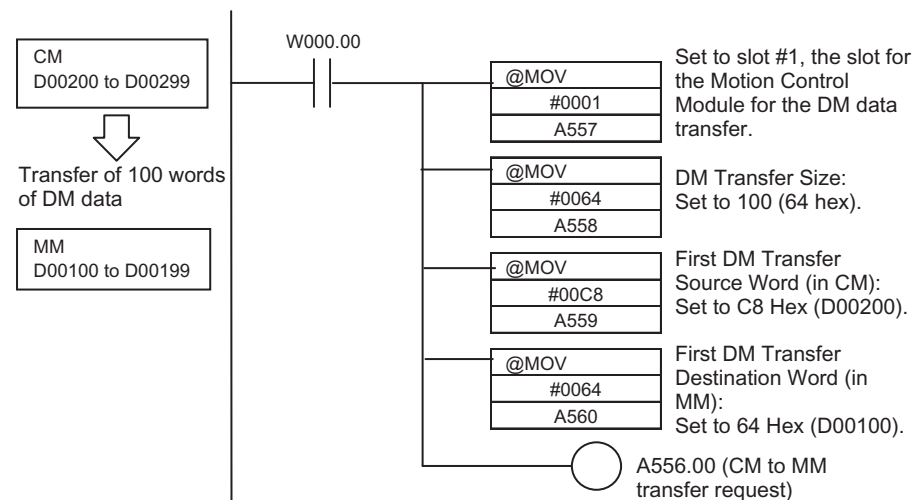
- Slot No. of Motion Control Module for DM Transfer
Specifies the slot number for the Motion Control Module to which DM data is being transferred.
- Transfer details
 - DM Transfer Size (number of words)
 - First DM Transfer Source Word
 - First DM Transfer Destination Word

Step 2: Turn ON Request Bit

- Transferring DM Data from the Coordinator Module to a Motion Control Module: Turn ON the DM Write Request Bit (Coordinator Module to Motion Control Module) (A556.00).
- Transferring DM Data from a Motion Control Module to the Coordinator Module: Turn ON the DM Read Request Bit (Motion Control Module to Coordinator Module) (A556.01).

Programming Example

The following diagram shows a programming example for the Coordinator Module when transferring DM data from the Coordinator Module (CM) to the Motion Control Module mounted to slot #1 (MM).



Note When executing a DM data transfer from a Motion Control Module to the Coordinator Module (DM read request), do not set the First DM Transfer Source Word to D20000 or higher. If data is written to D20000 to D32767, the DM Area data will be backed up to flash memory. Frequently writing to flash memory will shorten its service life.

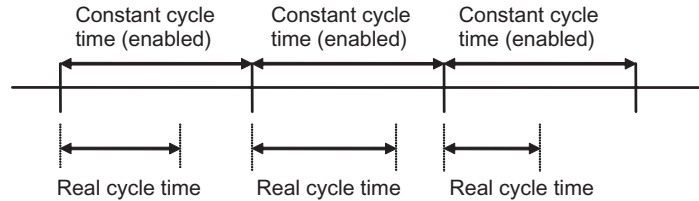
5-6 Cycle Time Settings

This section describes the constant cycle time function, the watch cycle time function, and the cycle time monitoring function.

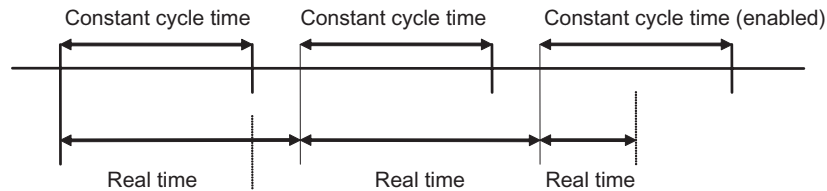
5-6-1 Constant Cycle Time Function

A constant cycle time can be set with the FQM1 Series. Programs are executed at standard intervals, which allows the control cycles for Servomotors to be constant.

The constant cycle time is set using the Cycle Time setting in the System Setup (0.1 to 100.0 ms, unit: 0.1 ms).



If the real cycle time is longer than the set cycle time, the constant cycle time function will be ignored and operation will be based on the real cycle time.



System Setup

Tab page	Name	Settings	Default
Timer/Peripheral servicing or Cycle Time	Cycle Time	0.1 to 100.0 ms, 0.1 ms units	Variable

Constant Cycle Time Exceeded Flag

Name	Address	Description
Constant Cycle Time Exceeded Flag	A316.05	This flag turns ON when the constant cycle time function is used and the cycle time exceeds the constant cycle time set value.

Constant Cycle Time Exceeded Error Clear Bit

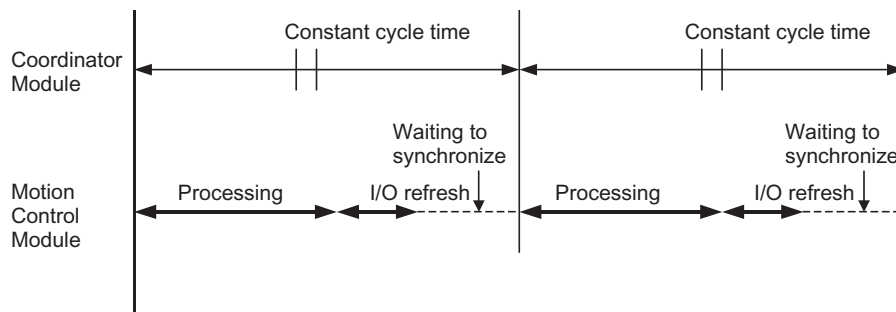
Name	Address	Description
Constant Cycle Time Exceeded Error Clear Bit	A555.15	The constant cycle time function can be enabled again after the cycle time has exceeded the constant cycle time and A316.05 has turned ON.

Constant Cycle Time Function in Sync Mode

When in Sync Mode with a Sync Cycle Time set for the Coordinator Module cycle time (default), and the constant cycle time function is used, the cycle time for Motion Control Modules will be as described below.

Constant Cycle Time Function Enabled for Coordinator Module

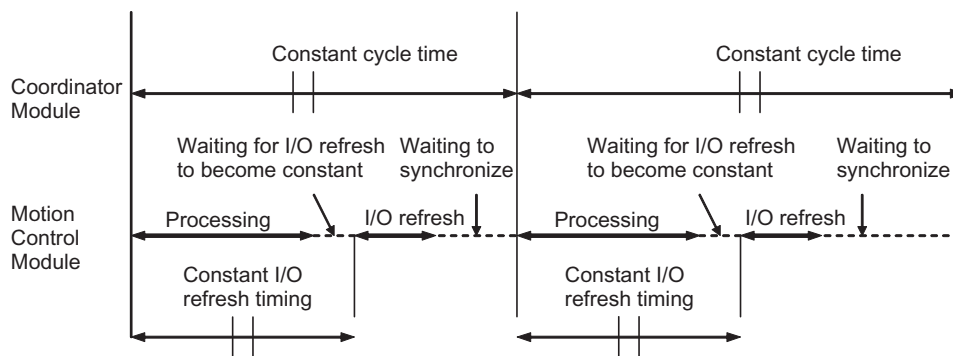
The Motion Control Module cycle time is synchronized with the Coordinator Module constant cycle time, and will therefore be constant.



Constant Cycle Time Function Enabled for Motion Control Module

The Motion Control Module cycle time is synchronized with the Coordinator Module constant cycle time, and gradually is made constant, while the Motion Control Module's built-in I/O refresh timing is made constant.

The time from when the processing starts in the Motion Control Module until the I/O refresh will be constant.



Note When the constant cycle time function is enabled for the Motion Control Module in ASync Mode, the Motion Control Module's cycle time will be constant.

5-6-2 Watch Cycle Time Function

If the real cycle time is longer than the set watch cycle time, operation will stop for all Modules and the Cycle Time Too Long Flag (A401.08) in the Auxiliary Area will turn ON.

System Setup

Tab page	Name	Details	Default
Timer/Peripheral Servicing or Cycle Time	Cycle Time	0.1 to 100.0 ms (unit: 0.1 ms)	Variable
	Watch Cycle Time	1 to 100 ms (unit: 1 ms)	50 ms

Caution If the Cycle Time Too Long Flag turns ON for one Module in Sync Mode, the Cycle Time Too Long Flag will turn ON for all Modules.

Note The settings are made using CX-Programmer Ver. 5.0□ menus.

Cycle Time Too Long Flag

Name	Address	Details
Cycle Time Too Long Flag	A401.08	Turns ON if the cycle time PV exceeds the Watch Cycle Time in the System Setup.

5-6-3 Cycle Time Monitoring Function

Every cycle, the maximum cycle time is stored in A262 and A263 and the PV is stored in A264 and A265 in the Auxiliary Area.

Auxiliary Area Words

Name	Addresses	Meaning
Maximum Cycle Time	A262 to A263	The maximum cycle time value is stored in binary each cycle. The time is measured in 0.01-ms units.
Cycle Time PV	A264 to A265	The cycle time PV is stored in binary each cycle. The time is measured in 0.01-ms units.

The average cycle time for the last 8 scans can also be read from the CX-Programmer.

Note The FQM1 can skip program areas that do not need to be executed by using the JMP-JME instructions to shorten cycle times.

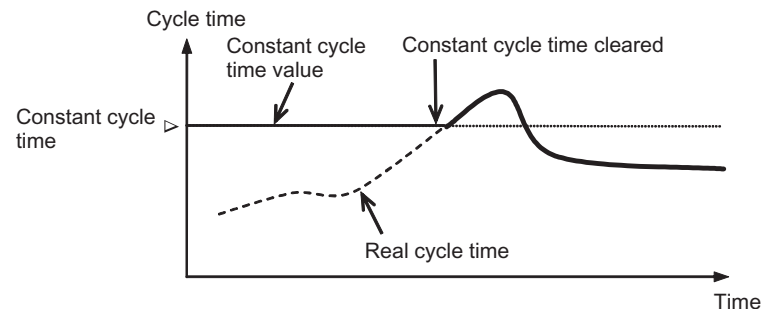
5-6-4 Clearing Constant Cycle Time Exceeded Errors

When using the constant cycle time function, normally the cycle time will no longer stay constant (i.e., will vary depending on the real cycle time) if the constant cycle time is exceeded once. To return to a constant cycle time even if the cycle time has been exceeded once, turn ON the Constant Cycle Time Exceeded Error Clear Bit (A555.15) (i.e., set to 1).

This function allows a constant cycle time to be restored and variations in I/O processing time to be kept to a minimum even if the cycle time is temporarily long as a result of special processing, e.g., initialization at the start of user programs in each Module.

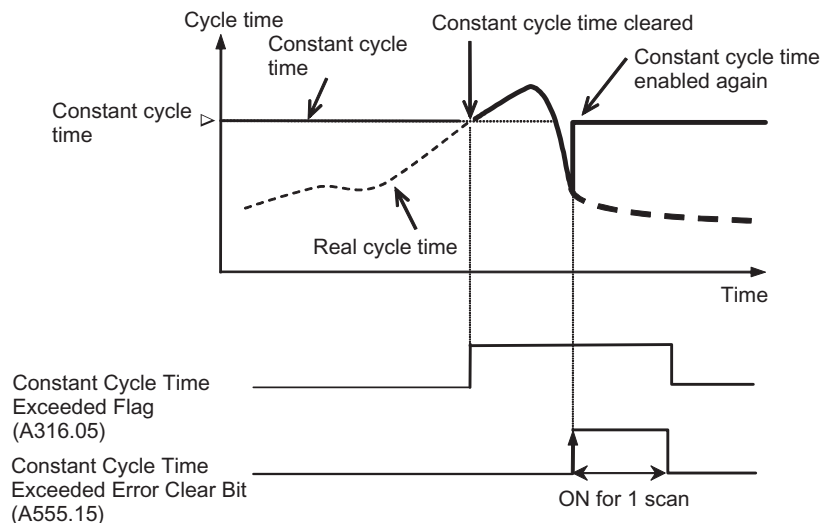
Normal Operation

The constant cycle time function is cleared if the cycle time exceeds the set constant cycle time.



Constant Cycle Time Exceeded Error Clear Function

The constant cycle time function can be enabled again by turning ON the Constant Cycle Time Exceeded Clear Bit.



Auxiliary Area Bits

	Bit	Function	Controlled by
Constant Cycle Time Exceeded Error Clear Bit	A555.15	OFF to ON: Constant cycle time exceeded error cleared.	User

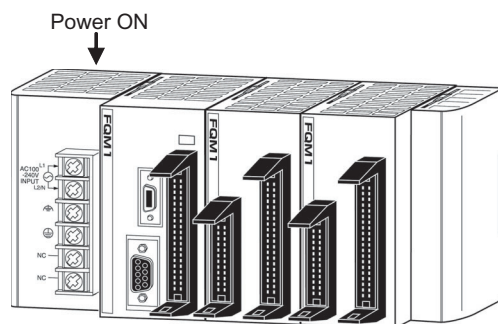
5-7 Operation Settings at Startup and Maintenance Functions

This section describes the following operation settings at startup and maintenance functions.

- Operating mode at startup
- Program protection
- Remote programming and monitoring
- Flash memory

5-7-1 Specifying the Startup Mode

The operating mode when the power is turned ON can be specified in the System Setup.



System Setup

Tab page	Name	Details	Settings	Default
Startup	Startup Mode	Specifies the initial operating mode when the power is turned ON.	System Setup disabled • RUN mode System Setup enabled • PROGRAM mode • MONITOR mode • RUN mode	System Setup disabled

Note The operating mode at startup for Motion Control Modules will be the same as that for the Coordinator Module when in Sync Mode, but will be RUN mode when in ASync Mode.

5-7-2 Program Protection

The FQM1 provides the following kinds of protection for user programs.

Read Protection Using Passwords

Read and display access to the user program area can be blocked from the CX-Programmer. Protecting the program will prevent unauthorized copying of the program and loss of intellectual property.

A password is set for program protection from the CX-Programmer and read access is prevented to the whole program.

- Note**
- (1) If you forget the password, the program in the FQM1 cannot be transferred to the computer.
 - (2) If you forget the password, programs can be transferred from the computer to the FQM1. Programs can be transferred from the computer to the FQM1 even if the password protection has not been released.

Password Protection

- 1,2,3...
1. Register a password either online or offline.
 - a. Select the Module in the Device Type drop-down menu and select **Properties** from the View Menu.
 - b. Select **Protection** from the PLC Properties Dialog Box and input the password.
 2. Set password protection online.
 - a. Select **PLC/Protection/Set**. The Protection Setting Dialog Box will be displayed.
 - b. Click the **OK** Button.

Password Protection against Clearing

The program can be protected against unauthorized clearing by inputting the password "5A5A5A5A" in step 1b of the procedure above. Once this password has been input, the password protection cannot be cleared by inputting the password again. The Memory All Clear operation must be executed from the CX-Programmer in order to clear the password protection.

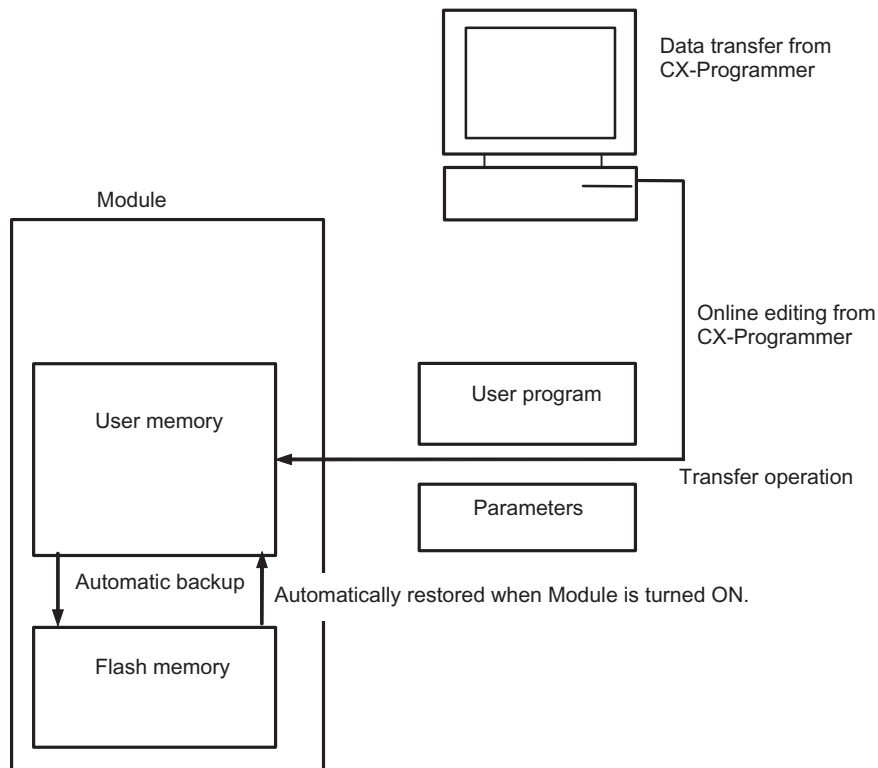
5-7-3 Flash Memory

Automatic Backup to Flash Memory

The user program and parameters are automatically backed up in flash memory whenever they are written.

- The following data is backed up automatically: User program, parameters (including the System Setup, absolute offset data, and analog I/O offset gain adjustment values), and some DM Area data (only for the Coordinator Module).

- The automatic backup is executed whenever the Module user program or parameter area is written (e.g., for data transfer operations from the CX-Programmer and online editing).
- The user program and parameter data written to flash memory is automatically transferred to user memory at startup.



Note The backup status will be displayed in a Memory Backup Status Window by the CX-Programmer when backing up data from the CX-Programmer for transfer operations other than normal data transfers (**PLC/Transfer**). To obtain this window, display of the backup status dialog box must be selected in the PLC properties and **Window/PLC Memory Backup Status** must be selected from the View Menu. For normal transfer operations (**PLC/Transfer**), the backup status will be displayed in the transfer window after the transfer status for the program and other data. Never turn OFF the FQM1 power during these backup operations. The flash memory will be corrupted if the power is turned OFF.

Auxiliary Area Flags

Name	Address	Meaning
Flash Memory Error Flag	A403.10	Turns ON when the flash memory is corrupted.

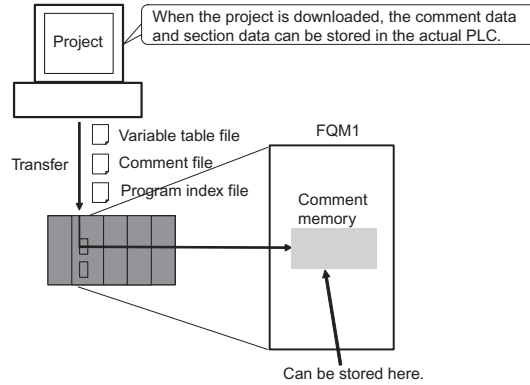
5-7-4 Comment Memory Function

The internal flash memory in the FQM1 contains a comment memory area. The following comment data and section data can be stored in or read from the comment memory.

- Variable table file (includes the CX-Programmer's variable names and I/O comments)
- Comment file (CX-Programmer's rung comments and annotations)

- Program index file (CX-Programmer’s section names, section comments, and program comments)

Ver. 6.11 or higher



Auxiliary Area Flags

Name	Address	Function
Symbol Table File Flag	A345.01	Turns ON when the comment memory contains a variable table file.
Comment File Flag	A345.02	Turns ON when the comment memory contains a comment file.
Program Index File Flag	A345.03	Turns ON when the comment memory contains a program index file.

5-8 Diagnostic Functions

This section provides a brief overview of the following diagnostic and debugging functions.

- Error Log
- Failure Alarm Functions (FAL(006) and FALS(007))

5-8-1 Error Log

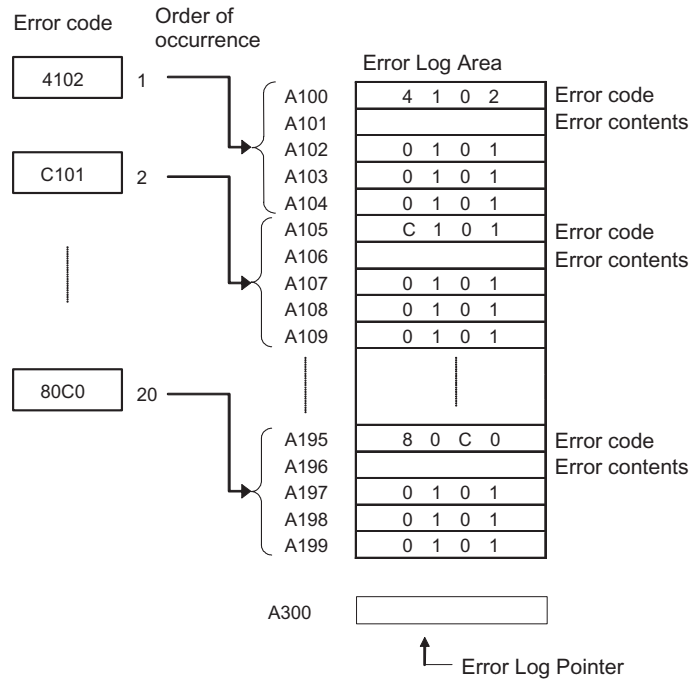
Each time that an error occurs, the Module stores error information in the Error Log Area. The error information includes the error code (stored in A400) and error contents. Up to 20 records can be stored in the Error Log.

In addition to system-generated errors, the Module records user-defined FAL(006) and FALS(007) errors, making it easier to track the operating status of the system.

Refer to *SECTION 9 Error Processing* for details.

Note A user-defined error is generated when FAL(006) or FALS(007) is executed in the program. The input conditions of these instructions constitute the user-defined error conditions. FAL(006) generates a non-fatal error and FALS(007) generates a fatal error that stops program execution.

When more than 20 errors occur, the oldest error data (in A100 to A104) is deleted, the remaining 19 records are shifted down by one record, and the newest record is stored in A195 to A199.



The number of records is stored in binary in the Error Log Pointer (A300). The pointer is not incremented when more than 20 errors have occurred.

Note The FQM1 does not support a clock and the time data in the error log will always be 0101.

5-8-2 Failure Alarm Functions

The FAL(006) and FALS(007) instructions generate user-defined errors. FAL(006) generates a non-fatal error and FALS(007) generates a fatal error that stops program execution.

When the user-defined error conditions (input conditions for FAL(006) or FAL(007)) are met, the Failure Alarm instruction will be executed and the following processing will be performed.

- 1,2,3... 1. The FAL Error Flag or FALS Error Flag in the Auxiliary Area is turned ON.
2. The corresponding error code is written to the Auxiliary Area.
3. The error code is stored in the Error Log.
4. The error indicator on the front of the Modules will flash or light.
5. If FAL(006) has been executed, the Modules will continue operating. If FALS(007) has been executed, the Modules will stop operating. (Program execution will stop.)

Operation of FAL(006)



When input condition A goes ON, an error with FAL number 2 is generated and A402.15 (FAL Error Flag) is turned ON. Program execution continues.

Errors generated by FAL(006) can be cleared by executing FAL(006) with FAL number 00 or performing the error read/clear operation from the CX-Programmer.

Operation of FALS(007)



When input condition B goes ON, an error with FALS number 3 is generated and A401.06 (FALS Error Flag) is turned ON. Program execution is stopped.

Errors generated by FALS(007) can be cleared by eliminating the cause of the error and performing the error read/clear operation from the CX-Programmer.

5-9 Function Block (FB) Functions

Encapsulate Programs in Ladder or ST Language

When the CX-Programmer Ver. 6.11 (and later versions) is used, frequently used processes can be encapsulated as function blocks (FBs). Function blocks allow complex programming units to be reused easily, with the I/O data treated as just a user interface to external applications.

The function block's internal programming can be written in either ladder programming language or in the structured text (ST) language. With ST language, it is easy to program mathematical processes that would be difficult to enter with ladder programming.

Function Block (FB) Functions

OMRON function blocks conform to the IEC 61131-3 function block standard.

Note The IEC 61131 standard was defined by the International Electrotechnical Commission (IEC) as an international programmable logic controller (PLC) standard. The standard is divided into 7 parts. Specifications related to PLC programming are defined in Part 3 Textual Languages (IEC 61131-3).

The user can create function blocks in the CX-Programmer and place these function blocks in regular programs. In addition, OMRON provides a library of standard function blocks in its FQM1 Smart FB Library, which can be copied and placed in regular programs. Function blocks have the following features:

- Function block algorithms can be written in the ladder programming language or in the structured text (ST) language. (See note.)

Note The ST language is an advanced language for industrial control (primarily Programmable Logic Controllers) that is described in IEC 61131-3. The ST language supported by the CX-Programmer conforms to the IEC 61131-1 standard.

- A single function block can be converted to a library function as a single file, making it easy to reuse function blocks for standard processing.
- Programs containing function blocks (ladder or ST language) can be downloaded and uploaded just like regular programs that do not contain function blocks. In contrast, tasks that contain function blocks cannot be downloaded in task units, although the tasks can be uploaded.
- One-dimensional array variables are supported, so data handling is easier for many applications.

Note Function blocks in CS/CJ Series Smart FB Library cannot be used in the FQM1, primarily because the instruction sets are different and the CS/CJ Series PLCs have an HR Area, while the FQM1 does not.

Function Block Usage and Procedures

For details on function block usage and procedures, refer to the *CX-Programmer Ver. 6.0 Operation Manual: Function Blocks (W447)*. Use the information listed in the following *ST Language Specifications* and *Function Block Specifications* to check for differences in specifications between the CS/CJ Series PLCs and FQM1 Controllers.

ST Language Specifications

In the FQM1, the ST language supports most of the functions for mathematical calculations. The following table lists the ST-language statements, operators, and functions that can be used in the FQM1.

Statements

Statement	Function	Example
End of statement	Ends the statement	;
Comment	All text between (* and *) is treated as a comment.	(*comment*)
Assignment	Substitutes the results of the expression, variable, or value on the right for the variable on the left.	A=B;
IF, THEN, ELSIF, ELSE, END_IF	Evaluates an expression when the condition for it is true.	IF (condition_1) THEN (expression 1); ELSIF (condition_2) THEN (expression 2); ELSE (expression 3); END_IF;
CASE, ELSE, END_CASE	Evaluates an express based on the value of a variable.	CASE (variable) OF 1: (expression 1); 2: (expression 2); 3: (expression 3); ELSE (expression 4); END_CASE;
FOR, TO, BY, DO, END_FOR	Repeatedly evaluates an expression according to the initial value, final value, and increment.	FOR (identifier) := (initial_value) TO (final_value) BY (increment) DO (expression); END_FOR;
WHILE, DO, END_WHILE	Repeatedly evaluates an expression as long as a condition is true.	WHILE (condition) DO (expression); END_WHILE;
REPEAT, UNTIL, END_REPEAT	Repeatedly evaluates an expression until a condition is true.	REPEAT (expression); UNTIL (condition) END_REPEAT;
EXIT	Stops repeated processing.	EXIT;
RETURN	Returns to the point in the program from which a function block was called.	RETURN;
Function block instance call	Calls another function block definition.	Variable name with FUNCTION BLOCK data type (called function block definition's input variable name := calling function block definition's variable name or constant, ..., called function block definition's output variable name or constant => calling function block definition's output variable name, ...);

Operators

Operation	Symbol	Data types supported by operator	Priority 1: Lowest 11: Highest
Parentheses and brackets	<i>(expression)</i> , <i>array[index]</i>		1
Function evaluation	<i>identifier</i>	Depends on the function. (Refer to the <i>Functions</i> table below.)	2
Exponential	**	REAL, LREAL	3
Complement	NOT	BOOL, WORD, DWORD, LWORD	4
Multiplication	*	INT, DINT, UINT, UDINT, ULINT, REAL, LREAL	5
Division	/	INT, DINT, LINT, UINT, UDINT, ULINT, REAL, LREAL	5
Addition	+	INT, DINT, LINT, UINT, UDINT, ULINT, REAL, LREAL	6
Subtraction	–	INT, DINT, LINT, UINT, UDINT, ULINT, REAL, LREAL	6
Comparisons	<, >, <=, >=	BOOL, INT, DINT, LINT, UINT, UDINT, ULINT, WORD, DWORD, LWORD, REAL, LREAL	7
Equality	=	BOOL, INT, DINT, LINT, UINT, UDINT, ULINT, WORD, DWORD, LWORD, REAL, LREAL	8
Non-equality	<>	BOOL, INT, DINT, LINT, UINT, UDINT, ULINT, WORD, DWORD, LWORD, REAL, LREAL	8
Boolean AND	&	BOOL, WORD, DWORD, LWORD	9
Boolean AND	AND	BOOL, WORD, DWORD, LWORD	9
Boolean exclusive OR	XOR	BOOL, WORD, DWORD, LWORD	10
Boolean OR	OR	BOOL, WORD, DWORD, LWORD	11

Functions

Function	Syntax
Numerical functions	Numerical processing functions such as absolute value and trigonometric functions.
Arithmetic functions	Exponential (EXPT)
Data Conversion functions	Source data type _TO_ Destination data type (variable name)

Numerical Functions

The following numerical functions can be used in structured text.

Numerical functions	Argument data type	Return value data type	Contents	Example
ABS (<i>argument</i>)	INT, DINT, LINT, UINT, UDINT, ULINT, REAL, LREAL	INT, DINT, LINT, UINT, UDINT, ULINT, REAL, LREAL	Absolute value [<i>argument</i>]	a: = ABS (b) (*absolute value of variable <i>b</i> stored in variable <i>a</i> *)
SQRT (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Square root: $\sqrt{\text{argument}}$	a: = SQRT (b) (*square root of variable <i>b</i> stored in variable <i>a</i> *)
LN (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Natural logarithm: LOG_e argument	a: = LN (b) (*natural logarithm of variable <i>b</i> stored in variable <i>a</i> *)
LOG (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Common logarithm: LOG_{10} argument	a: = LOG (b) (*common logarithm of variable <i>b</i> stored in variable <i>a</i> *)
EXP (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Natural exponential: e^{argument}	a: = EXP (b) (*natural exponential of variable <i>b</i> stored in variable <i>a</i> *)

Numerical functions	Argument data type	Return value data type	Contents	Example
SIN (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Sine: SIN argument	a: = SIN (b) (*sine of variable <i>b</i> stored in variable <i>a</i> *)
COS (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Cosine: COS argument	a: = COS (b) (*cosine of variable <i>b</i> stored in variable <i>a</i> *)
TAN (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Tangent: TAN argument	a: = TAN (b) (*tangent of variable <i>b</i> stored in variable <i>a</i> *)
ASIN (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Arc sine: SIN ⁻¹ argument	a: = ASIN (b) (*arc sine of variable <i>b</i> stored in variable <i>a</i> *)
ACOS (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Arc cosine: COS ⁻¹ argument	a: = ACOS (b) (*arc cosine of variable <i>b</i> stored in variable <i>a</i> *)
ATAN (<i>argument</i>)	REAL, LREAL	REAL, LREAL	Arc tangent: TAN ⁻¹ argument	a: = ATAN (b) (*arc tangent of variable <i>b</i> stored in variable <i>a</i> *)

Arithmetic Functions

The following general exponential function can be used in structured text.

Exponential function	Argument data type	Return value data type	Contents	Example
EXPT (<i>base, exponent</i>)	Base: REAL, LREAL Exponent: INT, DINT, LINT, UINT, UDINT, ULINT	REAL, LREAL	Exponential: Base ^{exponent}	a: = EXPT (b, c) (*Exponential with variable <i>b</i> as the base and variable <i>c</i> as the exponent is stored in variable <i>a</i> *)

Data Type Conversion Functions

The following data type conversion functions can be used in structured text (ST) language.

Syntax

Source data type _TO_ Destination data type (variable name)

Example: REAL_TO_INT (C)

This function changes the data type of variable C from REAL to INT.

Data Type Combinations

The following table shows the allowed source data (FROM) and destination data (TO) combinations.

FROM	TO											
	BOOL	INT	DINT	LINT	UINT	UDINT	ULINT	WORD	DWORD	LWORD	REAL	LREAL
BOOL	No	No	No	No	No	No	No	No	No	No	No	No
INT	No	No	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
DINT	No	YES	No	YES	YES	YES	YES	YES	YES	YES	YES	YES
LINT	No	YES	YES	No	YES	YES	YES	YES	YES	YES	YES	YES
UINT	No	YES	YES	YES	No	YES	YES	YES	YES	YES	YES	YES
UDINT	No	YES	YES	YES	YES	No	YES	YES	YES	YES	YES	YES
ULINT	No	YES	YES	YES	YES	YES	No	YES	YES	YES	YES	YES
WORD	No	YES	YES	YES	YES	YES	YES	No	YES	YES	No	No
DWORD	No	YES	YES	YES	YES	YES	YES	YES	No	YES	No	No
LWORD	No	YES	YES	YES	YES	YES	YES	YES	YES	No	No	No
REAL	No	YES	YES	YES	YES	YES	YES	No	No	No	No	YES
LREAL	No	YES	YES	YES	YES	YES	YES	No	No	No	YES	No

Function Block Specifications

The following items are the FQM1 function block specifications that are different from the CS/CJ Series.

Function Block Specifications

Item	Description
Number of function block definitions	128 max. per FQM1 (both Coordinator Module and Motion Control Modules)
Number of instances	256 max. per FQM1 (both Coordinator Module and Motion Control Modules)

Function Block Instance Areas

To use a function block, the system requires memory areas to store the instance's internal variables and I/O variables. These areas are known as the function block instance areas and the user must specify the first addresses and sizes of these areas. The first addresses and area sizes can be specified in 1-word units.

The following table shows the default FB instance area settings for the FQM1. These default settings are different from the CS/CJ Series settings and data cannot be allocated to a Holding Area (HR Area) in the FQM1. When the CX-Programmer compiles the function, it will output an error if there are any instructions in the ladder program that access words in these areas. Change the following settings when required.

FB Instance Area	Default value			Applicable memory areas
	Start address	End address	Size	
Non-retained	CIO 5000	CIO 5999	CIO 1000	CIO, WR, DM
Retained (See note.)	---	---	---	There is no retained area in the FQM1.
Timer	T206	T255	50	TIM
Counter	C206	C255	50	CNT

Note There is no Holding Area (HR Area) in the FQM1, so this setting is not supported.

- Function blocks in CS/CJ Series Smart FB Library cannot be used in the FQM1, primarily because the instruction sets are different and the CS/CJ Series PLCs have an HR Area, while the FQM1 does not. Use only FQM1 Smart FB Library functions.

SECTION 6

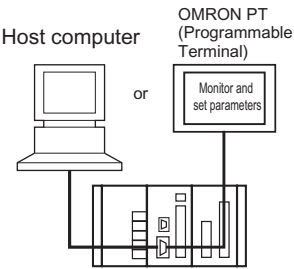
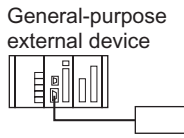
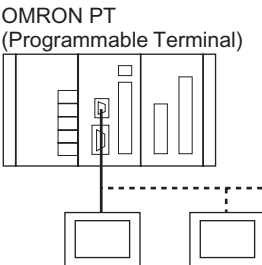
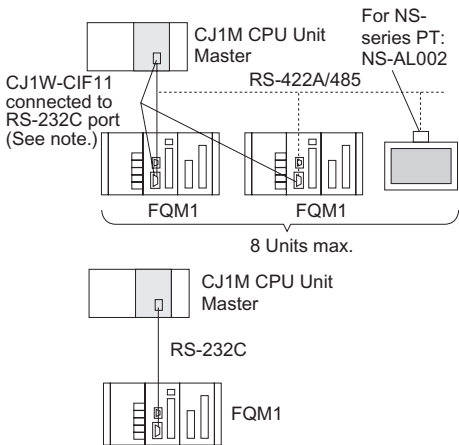
Coordinator Module Functions

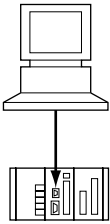
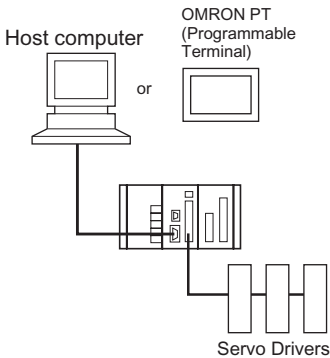
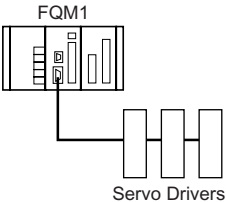
This section describes the serial communications functions, which are supported only by the Coordinator Module.

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6-1 Serial Communications

The FQM1 supports the following serial communications functions.

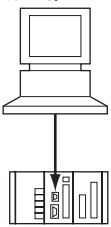

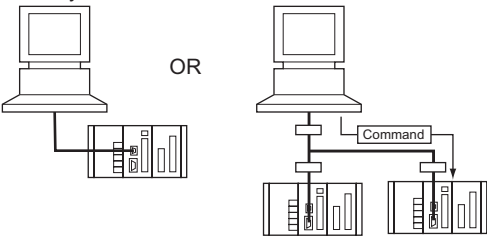
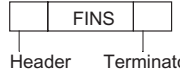
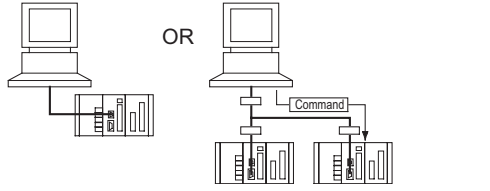
Protocol	Connections	Description	Ports		
			Peripheral	RS-232C	RS-422A
Host Link	Host computer or OMRON PT (Programmable Terminal) 	Various control commands, such as reading and writing I/O memory, changing the operating mode, and force-setting/resetting bits, can be executed by sending Host Link (C-mode) commands or FINS commands from the host computer to the Coordinator Module. Use Host Link communications to monitor data, such as status trace data, or to send data, such as operating conditions information, to the FQM1.	OK	OK	Not allowed
No-protocol	General-purpose external device 	Communicate with general-purpose devices connected to the RS-232C port without a command-response format. The TXD(236) and RXD(235) instructions are executed from the program to transmit data from the send port or read data at the receive port. The frame headers and end codes can be specified.	Not allowed	OK	Not allowed
1:N NT Link (The 1:N NT Link communications are used even for 1:1 connections.)	OMRON PT (Programmable Terminal) 	Data can be exchanged with PTs without using a communications program in the Coordinator Module.	OK	OK	Not allowed
Serial PLC Link Slave		Up to ten words per Module can be shared with up to eight Coordinator Modules as slaves using a CJM1 CPU Unit as the maser. An RS-422A Converter can be connected to the RS-232C port on each Coordinator Module to communicate via RS-422A/485, or one Coordinator Module can communicate via an RS-232C connection to the CJ1M master. The Serial PLC Links can also include PTs as slaves via NT Links (1:N) combined with Coordinator Modules.	Not allowed	OK	Not allowed

Protocol	Connections	Description	Ports		
			Peripheral	RS-232C	RS-422A
Peripheral Bus	<p>Programming Device (CX-Programmer)</p> 	<p>Provides high-speed communications with the CX-Programmer. (Remote programming through modems is not supported.)</p>	OK	OK	Not allowed
Serial Gateway	<p>Host computer or OMRON PT (Programmable Terminal)</p> 	<p>Communications are possible between a host computer or PT connected to the RS-232C port and Servo Drivers connected to the RS-422A port.</p>	Not allowed	Not allowed	OK
No-protocol	<p>FQM1</p> 	<p>TXD(236) and RXD(235) instructions in the Coordinator Module program can be used to send data to and receive data from Servo Drivers.</p>	Not allowed	Not allowed	OK

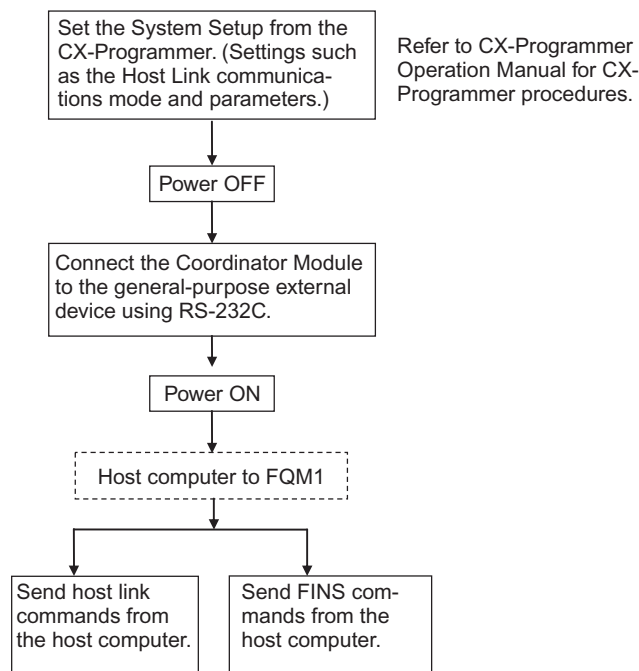
Note The CJ1W-CIF11 is not insulated and the total transmission distance is 50 meters max. If the total transmission distance is greater than 50 meters, use the insulated NT-AL001 and do not use the CJ1W-CIF11. If only the NT-AL001 is used, the total transmission distance is 500 meters max.

6-1-1 Host Link Communications

The following table shows the Host Link communication functions available in FQM1. Select the method that best suits your application.

Command flow	Command type	Communications method	Configuration	Application and remarks
Host computer to FQM1 	C-mode (Host Link) commands 	Create frame in the host computer and send command to the FQM1. Receive the response from the FQM1.	Directly connect the host computer in a 1:1 or 1:N system. 	Use this method when communicating primarily from the host computer to the FQM1. To use FINS commands, the host computer must send the commands using a Host Link header and terminator.
	FINS command (with Host Link header and terminator) 		Directly connect the host computer in a 1:1 or 1:N system. 	

Procedure



A list of Host Link commands is provided next. Refer to the *C-series Host Link Units System Manual (W143)* for details on Host Link and FINS commands.

Host Link Commands

The following table lists the Host Link commands. Refer to the *C-series Host Link Units System Manual (W143)* for details.

Type	Header code	Name	Function
Reading I/O memory	RR	CIO AREA READ	Reads the contents of the specified number of CIO Area words, starting from the specified word.
	RC	PV READ	Reads the contents of the specified number of timer/counter PVs (present values), starting from the specified timer/counter.
	RG	T/C STATUS READ	Reads the status of the Completion Flags of the specified number of timers/counters, starting from the specified timer/counter.
	RD	DM AREA READ	Reads the contents of the specified number of DM Area words, starting from the specified word.
	RJ	AR AREA READ	Reads the contents of the specified number of Auxiliary Area words, starting from the specified word.
Writing I/O memory	WR	CIO AREA WRITE	Writes the specified data (word units only) to the CIO Area, starting from the specified word.
	WC	PV WRITE	Writes the PVs (present values) of the specified number of timers/counters, starting from the specified timer/counter.
	WD	DM AREA WRITE	Writes the specified data (word units only) to the DM Area, starting from the specified word.
	WJ	AR AREA WRITE	Writes the specified data (word units only) to the Auxiliary Area, starting from the specified word.
Changing timer/counter set values	R#	SV READ 1	Reads the 4-digit BCD constant or word address in the SV of the specified timer/counter instruction.
	R\$	SV READ 2	Searches for the specified timer/counter instruction beginning at the specified program address and reads the 4-digit constant or word address of the SV.
	R%	SV READ 3	Searches for the specified timer/counter instruction beginning at the specified program address and reads the 4-digit BCD constant or word address of the SV.
Status commands	W#	SV CHANGE 1	Changes the 4-digit BCD constant or word address in the SV of the specified timer/counter instruction.
	W\$	SV CHANGE 2	Searches for the specified timer/counter instruction beginning at the specified program address and changes the 4-digit constant or word address of the SV.
	W%	SV CHANGE 3	Searches for the specified timer/counter instruction beginning at the specified program address and changes the 4-digit constant or word address of the SV.
	MS	STATUS READ	Reads the operating status of the Coordinator Module (operating mode, force-set/reset status, fatal error status).
	SC	STATUS CHANGE	Changes the Coordinator Module's operating mode.
	MF	ERROR READ	Reads errors in the Coordinator Module (non-fatal and fatal).
Force-set/reset commands	KS	FORCE SET	Force-sets the specified bit.
	KR	FORCE RESET	Force-resets the specified bit.
	FK	MULTIPLE FORCE SET/RESET	Force-sets, force-resets, or clears the forced status of the specified bits.
	KC	FORCE SET/RESET CANCEL	Cancels the forced status of all force-set and force-reset bits.
Reading model codes	MM	PLC MODEL READ	Reads the model type of the FQM1.
Test commands	TS	TEST	Returns, unaltered, one block of data transmitted from the host computer.

Type	Header code	Name	Function
Program area access commands	RP	PROGRAM READ	Reads the contents of the Coordinator Module's user program area in machine language (object code).
	WP	PROGRAM WRITE	Writes the machine language (object code) program transmitted from the host computer into the Coordinator Module's user program area.
Compound reading of I/O memory	QQMR	COMPOUND COMMAND	Registers the desired bits and words in a table.
	QQIR	COMPOUND READ	Reads the registered words and bits from I/O memory.
Processing Host Link communications	XZ	ABORT (command only)	Aborts the Host Link command that is currently being processed.
	**	INITIALIZE (command only)	Initializes the transmission control procedure of all Host Link Units connected to the host computer.
	IC	Undefined command (response only)	This response is returned if the header code of a command was not recognized.

FINS Commands

The following table lists the FINS commands. Refer to the *C-series Host Link Units System Manual (W143)* for details.

Type	Command code		Name	Function
I/O Memory Area Access	01	01	MEMORY AREA READ	Reads consecutive data from the I/O memory area.
	01	02	MEMORY AREA WRITE	Writes consecutive data to the I/O memory area.
	01	03	MEMORY AREA FILL	Fills the specified range of I/O memory with the same data.
	01	04	MULTIPLE MEMORY AREA READ	Reads non-consecutive data from the I/O memory area.
	01	05	MEMORY AREA TRANSFER	Copies and transfers consecutive data from one part of the I/O memory area to another.
Parameter Area Access	02	01	PARAMETER AREA READ	Reads consecutive data from the parameter area.
	02	02	PARAMETER AREA WRITE	Writes consecutive data to the parameter area.
	02	03	PARAMETER AREA FILL	Fills the specified range of the parameter area with the same data.
	02	20	CPU BUS UNIT SETTING READ	Reads CPU Bus Unit settings.
	02	21	CPU BUS UNIT SETTING WRITE	Writes CPU Bus Unit settings.
	02	25	ROUTING TABLE TRANSFER	Transfers the routing table.
	02	26	PRODUCTION INFORMATION READ	Reads the Module's production information.
02	27	PRODUCTION INFORMATION WRITE	Writes the Module's production information.	

Type	Command code		Name	Function
Program Area Access	03	04	PROGRAM AREA PROTECT START	Starts protection of the UM Area (user memory).
	03	05	PROGRAM AREA PROTECT CLEAR	Clears protection of the UM Area (user memory).
	03	06	PROGRAM AREA READ	Reads data from the user program area.
	03	07	PROGRAM AREA WRITE	Writes data to the user program area.
	03	08	PROGRAM AREA CLEAR	Clears the specified range of the user program area.
	03	20	STEP SPECIFICATION READ	Reads the step specification.
	03	21	PROGRAM INSERT/DELETE	Inserts or deletes programs.
	03	22	PROGRAM AREA INSTRUCTION SEARCH	Searches the UM Area (user memory) for an instruction.
	03	24	TIM/CNT SV READ	Reads a timer or counter SV.
	03	25	TIM/CNT SV WRITE	Changes a timer or counter SV.
	03	2A	PROGRAM AREA OPERAND SEARCH	Searches the UM Area (user memory) for an operand.
	03	30	PROGRAM PROPERTIES READ	Reads a program's property information.
	03	34	PROGRAM AREA DATA SEARCH	Searches the UM Area (user memory) for a fixed data.
Execution Control	04	01	RUN	Switches the Coordinator Module to RUN or MONITOR mode.
	04	02	STOP	Switches the Coordinator Module to PROGRAM mode.
Configuration Read	05	01	CONTROLLER DATA READ	Reads Coordinator Module information.
	05	02	CONNECTION DATA READ	Reads the model numbers of the specified Units.
Status Read	06	01	CONTROLLER STATUS READ	Reads the Coordinator Module's status information.
	06	20	CYCLE TIME READ	Reads the average, maximum, and minimum cycle times.
Communications Test	08	01	ECHOBACK TEST	Performs an echoback test.
Message Access	09	20	MESSAGE READ/CLEAR	Reads/clears messages and FAL(S) messages.
Access Right	0C	01	ACCESS RIGHT ACQUIRE	Acquires the access right if no other device holds it.
	0C	02	ACCESS RIGHT FORCED ACQUIRE	Acquires the access right even if another device currently holds it.
	0C	03	ACCESS RIGHT RELEASE	Releases the access right regardless of what device holds it.
	0C	10	POLLING PRIORITY REGISTER/CLEAR	Registers or clears the polling priority.
General commands	20	01	GENERAL-PURPOSE READ	Performs a general-purpose data read.
	20	02	GENERAL-PURPOSE WRITE	Performs a general-purpose data write.
Error Access	21	01	ERROR CLEAR	Clears errors and error messages.
	21	02	ERROR LOG READ	Reads the error log.
	21	03	ERROR LOG CLEAR	Clears the error log pointer to zero.
	21	24	HARDWARE TEST UNIT NUMBER SET	Sets the unit number used in hardware tests.
Programming Device	22	01	FILE NAME READ	Reads file memory data.
	22	02	SINGLE FILE READ	Reads a single file's contents.
	22	03	SINGLE FILE WRITE	Writes a single file's contents.
	22	04	FILE MEMORY FORMAT	Formats a file device.
	22	05	FILE DELETE	Deletes files.

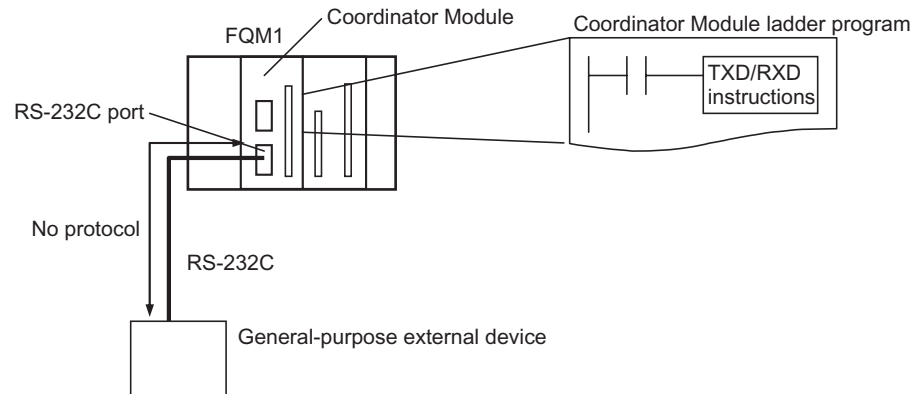
Type	Command code		Name	Function
Forced Status	23	01	FORCED SET/RESET	Force-sets, force-resets, or clears the forced status of the specified bits.
	23	02	FORCED SET/RESET CANCEL	Cancels the forced status of all force-set and force-reset bits.
	23	05	TRACE PARAMETERS SET	Sets the trace parameters.
	23	06	TRACE PARAMETERS READ	Reads the trace parameter settings.
	23	07	TRACE RUN	Executes a trace.
	23	0B	TRACE DATA READ	Reads trace data.
	23	11	DIFFERENTIAL MONITOR RUN	Executes differential monitoring.

6-1-2 No-protocol Communications (RS-232C Port)

No-protocol Mode is used to send and receive data using the communications port TXD(236) and RXD(235) I/O instructions in the Coordinator Module ladder program, without using retry processing, data conversion, branch processing based on received data, or other communications procedures and without converting the data.

No-protocol mode can be used with the RS-232C and RS-422A ports in the Coordinator Module. Data can be sent or received in one direction only between the Module and the general-purpose external device connected to the RS-232C or RS-422A port.

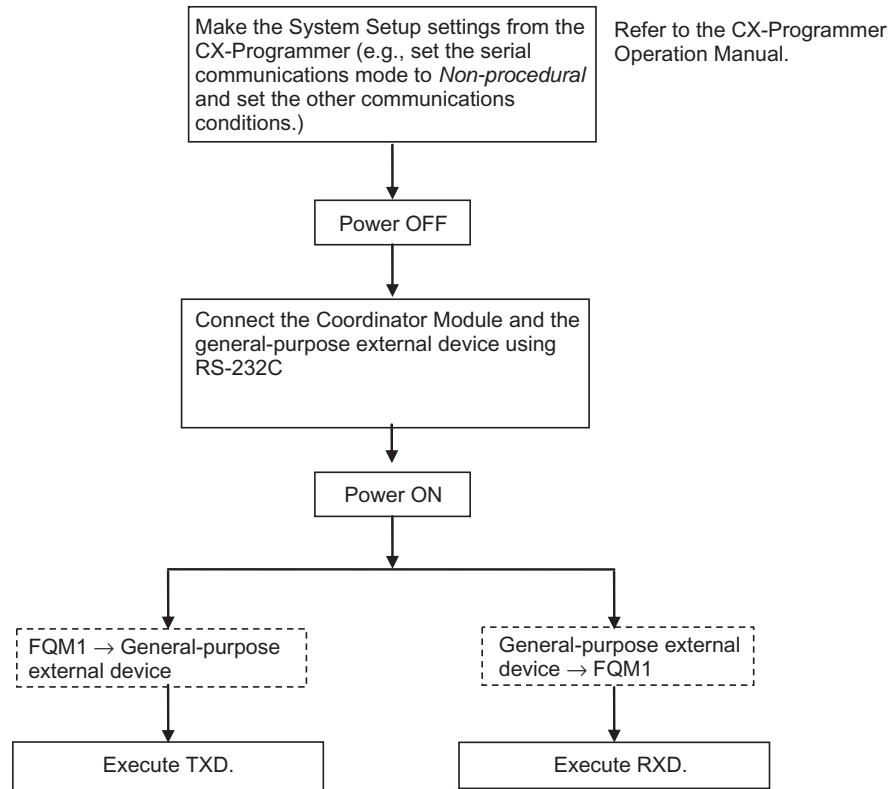
For example, data can be input from a bar code reader or output to a printer, or parameter data can be sent and received from a host controller.



The following table lists the no-protocol communications functions available for the FQM1.

Send/receive	Transfer direction	Method	Max. amount of data	Frame format		Other functions
				Start code	End code	
Sending data	FQM1 to General-purpose external device	Execute TXD(236) in the program	256 bytes	Yes: 00 to FF No: None	Yes: 00 to FF CR+LF None (Specify reception data size to between 1 and 256 bytes when set to none.)	<ul style="list-style-type: none"> Send delay time (delay between TXD(236) execution and sending data from specified port): 0 to 99,990 ms (unit: 10 ms) RS and ER signal ON/OFF
Receiving data	General-purpose external device to FQM1	Execute RXD(235) in the program	256 bytes			Monitoring of CS and DR signals

Procedure



Message Frame Formats

Data can be placed between a start code and end code for transmission by TXD(236) and frames with that same format can be received by RXD(235). When transmitting with TXD(236), just the data from I/O memory is transmitted, and when receiving with RXD(235), just the data itself is stored in specified area in I/O memory.

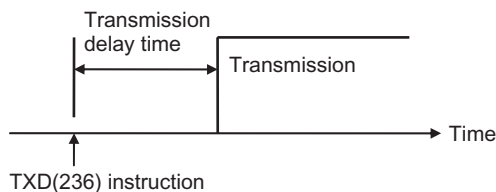
Up to 256 bytes (not including the start and end codes) can be transferred each time TXD(236) or RXD(235) are used. The start and end codes are specified in the System Setup.

Message Frame Formats for No-protocol Mode Transmission and Reception

Item		End code setting		
		No	Yes	CR+LF
Start code setting	No	<div style="border: 1px solid black; padding: 5px; display: inline-block;">Data</div> 256 bytes max.	<div style="border: 1px solid black; padding: 5px; display: inline-block;">Data</div> ED 256 bytes max.	<div style="border: 1px solid black; padding: 5px; display: inline-block;">Data</div> CR+LF 256 bytes max.
	Yes	ST <div style="border: 1px solid black; padding: 5px; display: inline-block;">Data</div> 256 bytes max.	ST <div style="border: 1px solid black; padding: 5px; display: inline-block;">Data</div> ED 256 bytes max.	ST <div style="border: 1px solid black; padding: 5px; display: inline-block;">Data</div> CR+LF 256 bytes max.

- When more than one start code is used, the first start code will be valid.
- When more than one end code is used, the first end code will be valid.
- If the data being transferred contains the end code, the data transfer will be stopped midway. In this case, change the end code to CR+LF.

Note The transmission of data after the execution of TXD(236) can be delayed by a specified transmission delay time, as shown in the following diagram.



Refer to the *Instructions Reference Manual* (Cat. No. O011) for more details on the TXD(236) and RXD(235) instructions.

System Setup

RS-232C Settings (Host Link Port Settings)

Item	Setting	Default	Enabled
Mode	RS-232C	Host Link	Each cycle
Delay	0 to 99,990 ms (unit: 10 ms)	0 ms	
End Code	00 to FF hex	00 hex	
Start Code	00 to FF hex	00 hex	
Received bytes	1 to 255 bytes	256 bytes	
Use of end code	Received bytes or CR+LF	Received bytes	
Use of start code	None	None	

Note The settings are made using CX-Programmer (Ver. 6.11 or higher) menus.

6-1-3 NT Link (1:N Mode)

With the FQM1, communications are possible with PTs (Programmable Terminals) using NT Links (1:N mode).

Note Communications are not possible using the 1:1-mode NT Link protocol. Also, the standard baud rate must be used.

The settings can be made using System Setup and the PT system menu.

System Setup

Communications port	Name	Settings contents	Default	Other conditions
Peripheral port	Mode	NT Link (1:N mode)	Host Link	Turn ON pin 2 on the Coordinator Module DIP switch.
	Baud	Standard NT Link	Standard NT Link	
	NT Link max.	0 to 7	0	
RS-232C port	Mode	NT Link (1:N mode)	Host Link	---
	Baud	Standard NT Link	Standard NT Link	
	NT Link max.	0 to 7	0	

PT System Menu

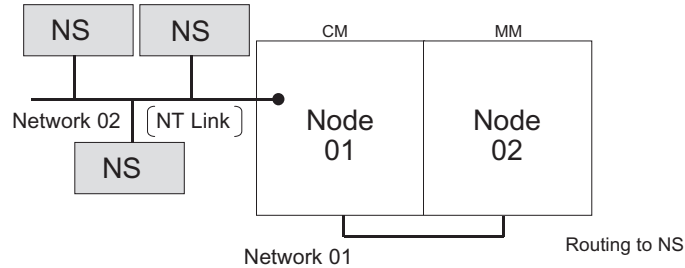
Set the PT as follows:

- 1,2,3...**
1. Select NT Link (1:N) from the Comm. A Method or Comm. B Method on the Memory Switch Menu in the System Menu on the PT.
 2. Press the SET Touch Switch to set the Comm. Speed to Standard. High-speed communications are not possible.

Data Exchange between Motion Control Modules and PTs

The following settings are not required if the PT is exchanging data with the Coordinator Module only. If the PT will be exchanging data with Motion Control Modules, routing table settings must be made for the PT.

The relationship between the 1:N NT Link and Motion Control Modules requires access across different networks, as shown in the following diagram. Routing table settings are required since the data is exchanged between networks. The routing table has the following default settings for communications between the Coordinator Module (CM) and Motion Control Modules (MM). Set routing tables (local network table and relay network table) in each PT to include this CM/MM routing table information.



In the example above, the PT is connected to the Coordinator Module’s RS-232C port.

Default Routing Tables in the FQM1

Routing tables for the Coordinator Module:

- Local network table

Local Network	Unit address	Explanation
01	FA	Network address for CM/MM network
02	FC	Network address for network connected to the RS-232C port
03	FD	Network address for network connected to peripheral port

- Relay network table
None

Routing tables for the Motion Control Modules:

- Local network table

Local Network	Unit address
01	FA

- Relay network table

Destination network	Relay network	Relay node
02	01	01
03	01	01

Routing Tables to set in the PT

The following routing table examples are for a connection to PT serial port A. The settings are the same in all PTs. Make these settings with the CX-Designer.

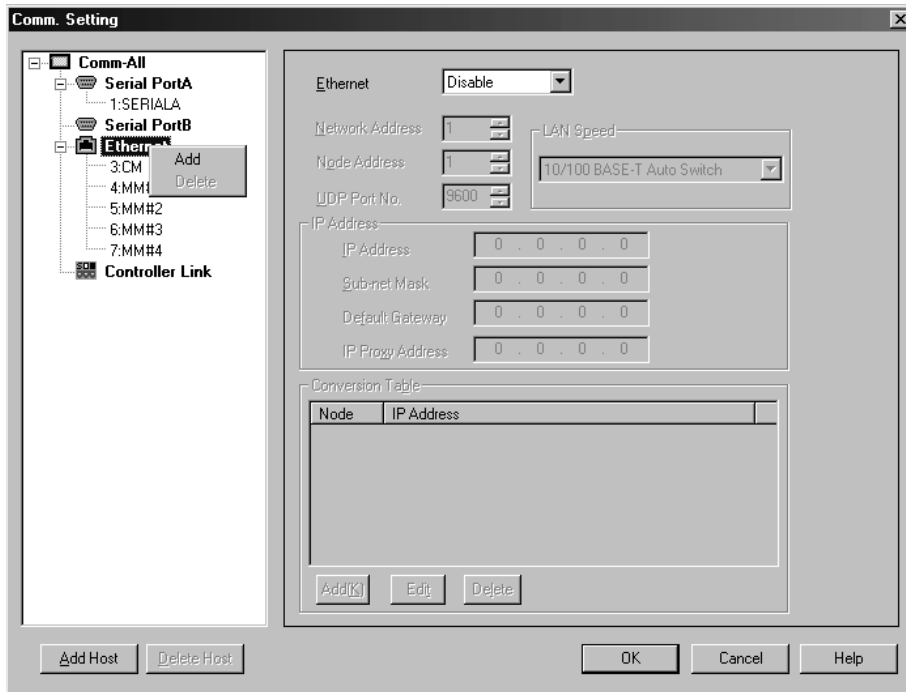
- Local network table

Local Network	Unit address
111	34

- Relay network table

Destination network	Relay network	Relay node
01	111	01

Note For details on the PT's routing tables, refer to the *CX-Designer Operation Manual*.



6-1-4 Serial PLC Links

Overview

The FQM1 can be connected to a Serial PLC Link by the Complete Link Method or Master Link Method.

With the Complete Link Method, both the CJ1M CPU and FQM1 can exchange data (without programming) with all other nodes.

With the Master Link Method, data can be exchanged (without programming) between the CJ1M CPU and FQM1 by connecting the CJ1M CPU Unit as the master and the FQM1 as the slave

The FQM1 connection is made to the RS-232C port on the Coordinator Module.

Words CIO 3100 to CIO 3189 in the Serial PLC Link Bit Area in the Coordinator Module are shared with the CJ1M master as shown below.

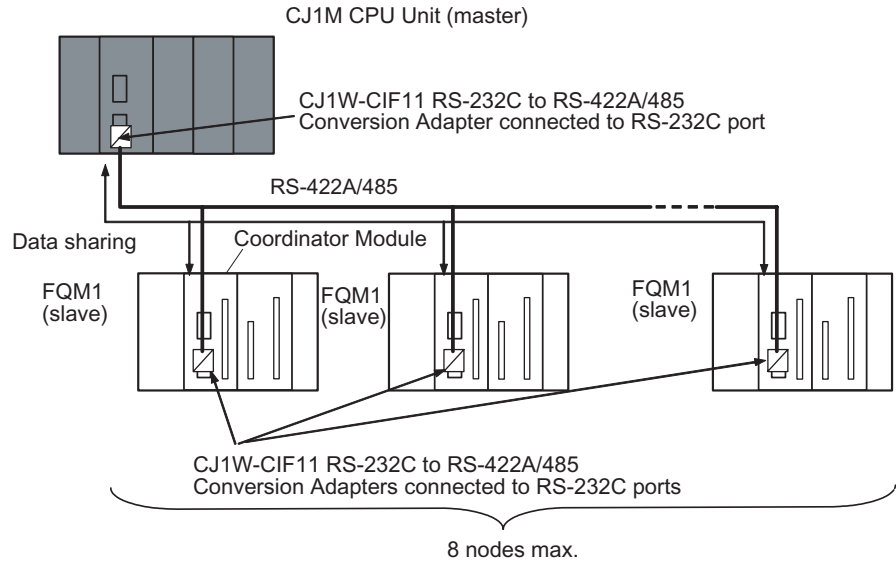
- CIO 3100 to CIO 3109: CJ1M master to FQM1 slave
- CIO 3110 to CIO 3189: FQM1 slave to CJ1M master

Note Use a CJ1W-CIF11 RS-232C to RS-422A/485 Conversion Adapter when connecting more than one FQM1 to the same CJ1M CPU Unit (1:N, where N = 8 max.).

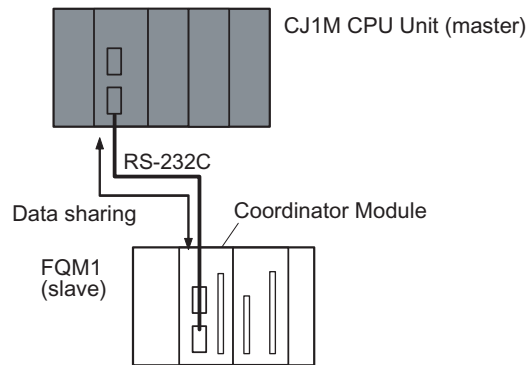
Up to 10 words can be sent by the CJM1 and FQM1. Fewer words can be sent by setting the number of link words, but the number of words will be the same for both the CJM1 and FQM1.

System Configuration

1:N Connection between CJ1M and FQM1 Controllers (8 Nodes Max.)



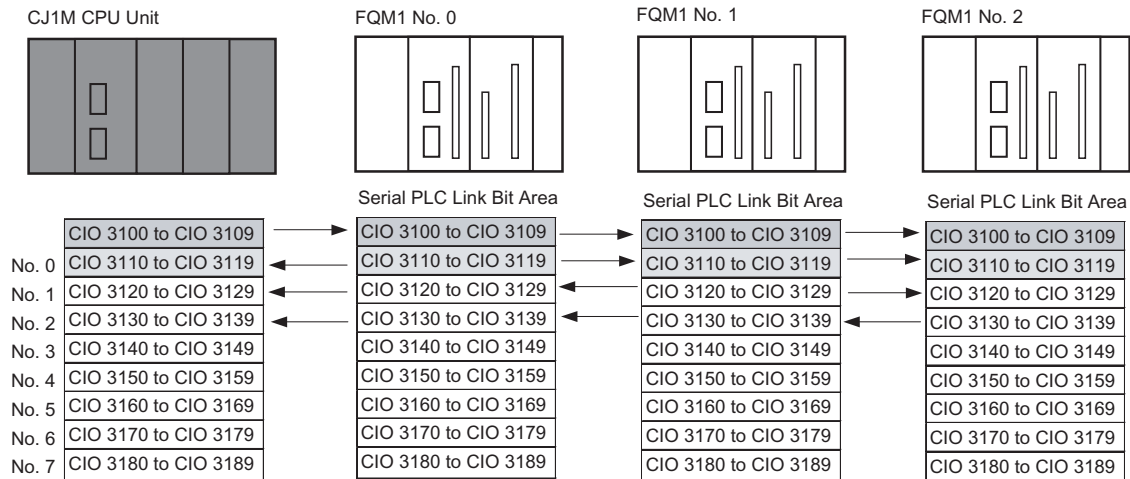
1:1 Connection between CJ1M and FQM1 Controller



Direction of Data Transfer

Complete Link Method

Example: Number of link words = 10 words (the maximum)



The CJ1M CPU Unit broadcasts the contents of words CIO 3100 to CIO 3109 from its I/O memory to words CIO 3100 to CIO 3109 in all of the FQM1 Controllers.

Source Words and Number of Link Words

Each FQM1 Controller transfers the contents of its 10 allocated words to the same 10 words in the CJ1M CPU Unit and the other FQM1 Controllers.

The words that will be sent depend on the number of link words as shown in the following table.

Send direction No. of link words	Send words				
	1 word	2 words	3 words	...	10 words
Master CJ1M to Slave FQM1s	(CIO 3100)	(CIO 3100 to CIO 3101)	(CIO 3100 to CIO 3102)	...	(CIO 3100 to CIO 3109)
FQM1 Slave 0 to CJ1M and other FQM1 Slaves	CIO 3110	CIO 3110 to CIO 3111	CIO 3110 to CIO 3112	...	CIO 3110 to CIO 3119
FQM1 Slave 1 to CJ1M and other FQM1 Slaves	CIO 3120	CIO 3120 to CIO 3121	CIO 3120 to CIO 3122	...	CIO 3120 to CIO 3129
FQM1 Slave 2 to CJ1M and other FQM1 Slaves	CIO 3130	CIO 3130 to CIO 3131	CIO 3130 to CIO 3132	...	CIO 3130 to CIO 3139
FQM1 Slave 3 to CJ1M and other FQM1 Slaves	CIO 3140	CIO 3140 to CIO 3141	CIO 3140 to CIO 3142	...	CIO 3140 to CIO 3149
FQM1 Slave 4 to CJ1M and other FQM1 Slaves	CIO 3150	CIO 3150 to CIO 3151	CIO 3150 to CIO 3152	...	CIO 3150 to CIO 3159
FQM1 Slave 5 to CJ1M and other FQM1 Slaves	CIO 3160	CIO 3160 to CIO 3161	CIO 3160 to CIO 3162	...	CIO 3160 to CIO 3169
FQM1 Slave 6 to CJ1M and other FQM1 Slaves	CIO 3170	CIO 3170 to CIO 3171	CIO 3170 to CIO 3172	...	CIO 3170 to CIO 3179
FQM1 Slave 7 to CJ1M and other FQM1 Slaves	CIO 3180	CIO 3180 to CIO 3181	CIO 3180 to CIO 3182	...	CIO 3180 to CIO 3189

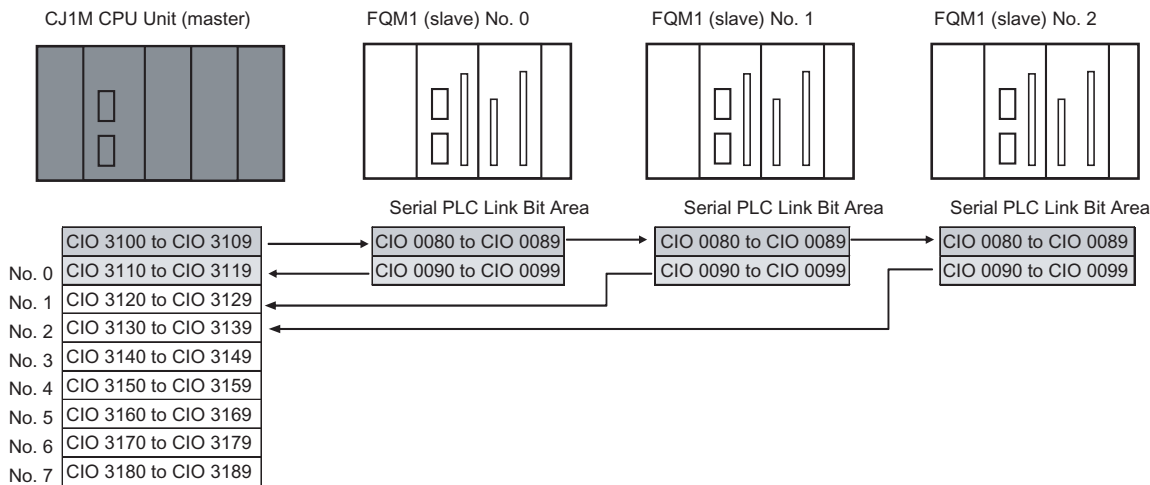
Note CJ1M CPU Unit I/O memory addresses are given in parentheses.

Master Link Method

Example: Number of link words = 10 words (the maximum)

The Master CJ1M CPU Unit broadcasts the contents of words CIO 3100 to CIO 3109 from its I/O memory to words CIO 3100 to CIO 3109 in all of the FQM1 Controllers.

Each FQM1 Controller transfers the contents of words CIO 3110 to CIO 3119 from its I/O memory to the 10 words allocated in the CJ1M CPU Unit's I/O memory (between CIO 3110 and CIO 3189).



Source Words and Number of Link Words

The words that will be sent depend on the number of link words as shown in the following table.

Send direction No. of link words	Send words				
	1 word	2 words	3 words	...	10 words
CJ1M (master) to (FQM1) slave	(CIO 3100)	(CIO 3100 to CIO 3101)	(CIO 3100 to CIO 3102)	...	(CIO 3100 to CIO 3109)
CJ1M to FQM1 No. 0	CIO 3110	CIO 3110 to CIO 3111	CIO 3110 to CIO 3112	...	CIO 3110 to CIO 3119
CJ1M to FQM1 No. 1					
CJ1M to FQM1 No. 2					
CJ1M to FQM1 No. 3					
CJ1M to FQM1 No. 4					
CJ1M to FQM1 No. 5					
CJ1M to FQM1 No. 6					
CJ1M to FQM1 No. 7					

Note CJ1M CPU Unit I/O memory addresses are given in parentheses.

Procedure

The Serial PLC Links operate according to the following settings in the PLC Setup and System Setup.

CJ1M (Master) Settings

- 1,2,3...**
1. Set the serial communications mode of the RS-232C communications port to Serial PLC Links (Polling Unit).
 2. Set the link method to the Polling Unit Link Method.
 3. Set the number of link words (1 to 10).
 4. Set the maximum unit number in the Serial PLC Links (0 to 7).

FQM1 (Slave) Settings

- 1,2,3...**
1. Set the serial communications mode of the RS-232C communications port to *PC Link (Slave)*.
 2. Set the unit number of the Serial PLC Link slave.

Settings

CJ1M (Master) PLC Setup

Item		Address		Set value	Default	Refresh timing
		Word	Bits			
RS-232C port setting	Serial communications mode	160	08 to 11	8 hex: Serial PLC Links Polling Unit	0 hex	Every cycle
	Port baud rate	161	00 to 07	00 to 09 hex: Standard (0A hex: High-speed cannot be used.)	00 hex	
	Link method	166	15	ON: Polling Unit links (OFF: Complete links cannot be used.)	0	
	Number of link words		04 to 07	1 to A hex	0 hex (See note 1.)	
	Highest unit number		00 to 03	0 to 7 hex	0 hex	

- Note**
- (1) Automatically allocates 10 words (A hex) when the default setting of 0 hex is used.
 - (2) Connection to the FQM1 is not possible at 115,200 bits/s.

FQM1 (Slave) System Setup

Item		Set value	Default	Refresh timing
RS-232C port settings	Mode	7 hex: PC Link (Slave)	Host Link	Every cycle
	Baud	00 to 09 hex: Standard (0A hex: High-speed cannot be used.)	Standard (38,400:1, 8, 1, 0)	
	PC Link Unit No.	0 to 7 hex	0 hex	

Note The settings are made using the CX-Programmer (Ver. 6.11 or later) menus.

6-1-5 Serial Gateway

Serial Gateway Function

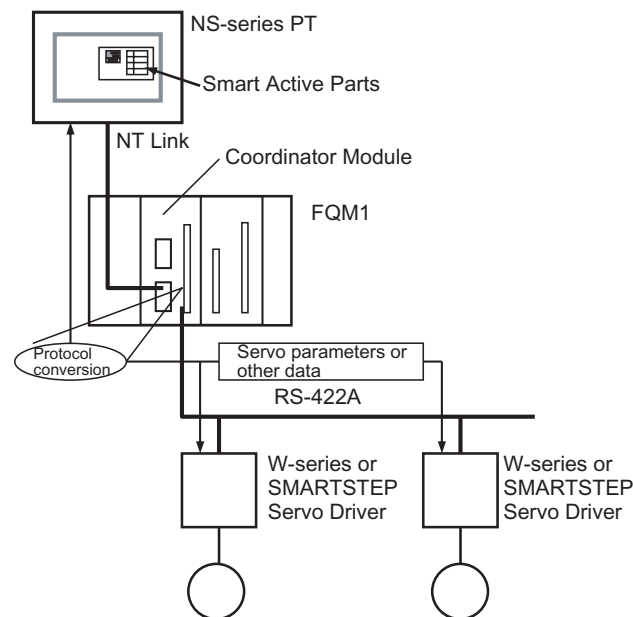
Servo parameters and other data can be read and written from NS-series PTs or personal computers (applications that operate on the CX-Server) to Servo Drivers that are connected to the FQM1 Coordinator Module's RS-422A port. This function can be executed by setting the FQM1 Coordinator Module's RS-422A serial communications mode to Serial Gateway.

RS-422A-compatible Servo Drivers

OMRON W-series and OMRON SMARTSTEP Servo Drivers.

System Configuration

Example: Accessing a W-series or SMARTSTEP Servo Driver from Smart Active Parts on a NS-series PT using an NT Link



Note When the Serial Gateway function is used, the FQM1 receives FINS commands (encapsulated W-series or SMARTSTEP commands) via the RS-422A port from NT-series PTs or personal computers and converts them to W-series or SMARTSTEP Servo Driver commands (removes the encapsulation) and transfers them to the W-series or SMARTSTEP Servo Drivers.

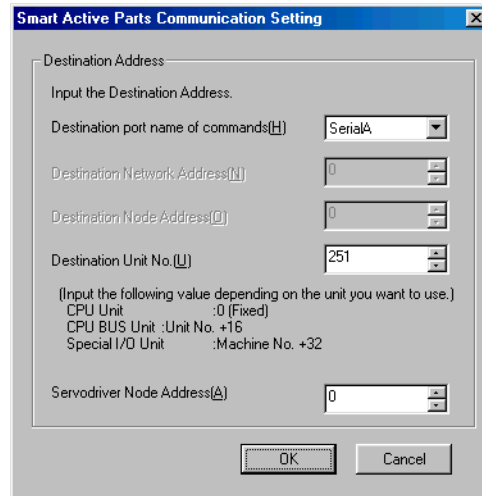
System Setup

Item		Settings	Default	Enabled
Drive Tab Page	Mode	Serial Gateway or Non-procedural (no-protocol)	Serial Gateway	Each cycle
	RS-422 Response Time-out of Command	0.1 to 25.5 s (unit: 0.1 s)	5 s	

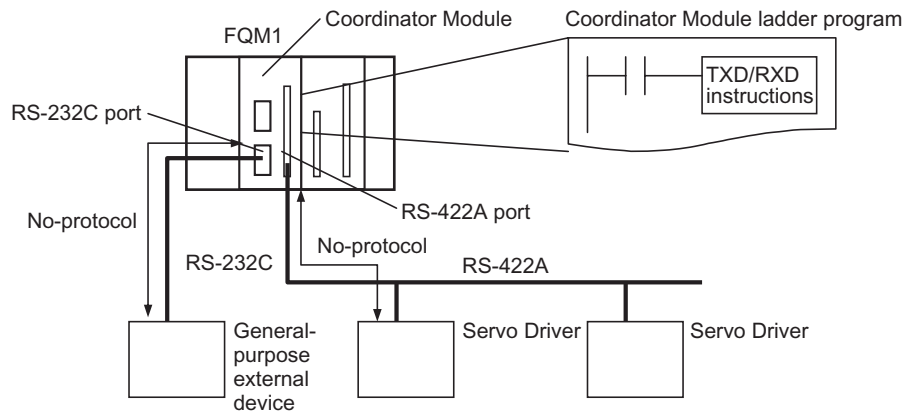
Note The settings are made using the CX-Programmer (Ver. 6.11 or later) menus.

Smart Active Parts Communications Settings

When using NS-series Smart Active Parts for Servo Drivers with the FQM1, set the Destination Unit No. (U) to 251 on the Smart Active Parts Communications Settings Screen. No. 251 indicates the RS-422A port for the FQM1.



6-1-6 No-protocol Communications (RS-422A Port)



RS-422A Settings

Item	Settings	Default	Enabled
Mode	No-protocol	Serial Gateway	Each cycle
Delay	0 to 99,990 ms (unit: 10 ms)	0 ms	
End code	00 to FF hex	00 hex	
Start code	00 to FF hex	00 hex	
Received bytes	01 to FF hex: 1 to 255 bytes	256 bytes	
Use of end code	Received bytes or CR+LF	Received bytes	
Use of start code	No	No	
	Yes		

Note The settings are made using the CX-Programmer (Ver. 6.11 or later) menus.

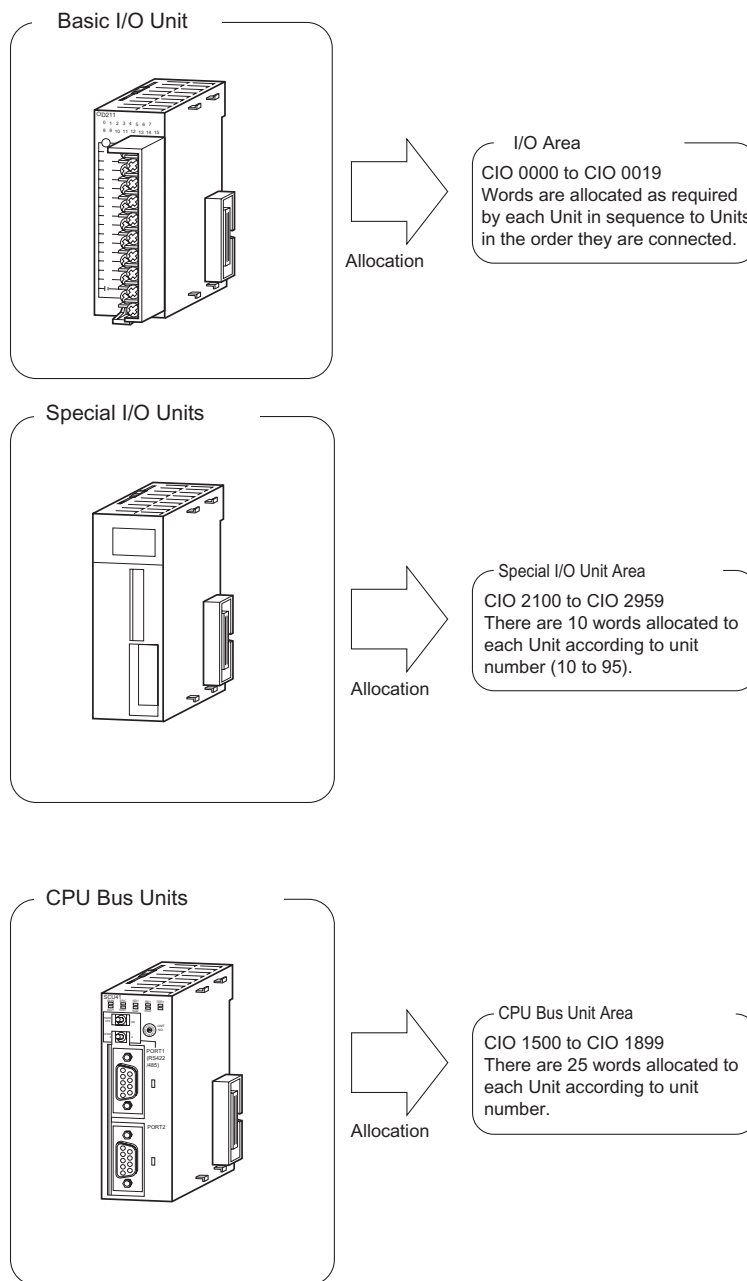
6-2 I/O Allocation to CJ-series Units

When the power is turned ON, the FQM1 Coordinator Module automatically allocates I/O words to the installed Basic I/O Units so that operation can start. Words will be allocated to Special I/O Units and CPU Bus Units according to the unit numbers set on the Units.

6-2-1 Types of CJ-series Units

There are 3 kinds of CJ-series Units (listed below) and memory is allocated differently to each kind of Unit.

- CJ-series Basic I/O Units
- CJ-series Special I/O Units
- CJ-series CPU Bus Units



**CJ-series Units
Compatible with the FQM1**

The following table lists the CJ-series Units that can be mounted. If any other CJ-series Unit is mounted, a fatal error will occur in the Coordinator Module.

Unit type	Supported models	Description
Basic I/O Units	All models except the CJ1W-INT01 Interrupt Unit and CJ1W-IDP01 Quick-response Input Unit	Provides 320 additional I/O points.
CPU Bus Units	CJ1W-SPU01 Data Collection Unit	Automatically collects specified data at high speed from the Coordinator Module.
	CJ1W-NCF71 MECHATROLINK II Position Control Unit	Connects multiple axes of Servos with communications capabilities.
Special I/O Units	CJ1W-SRM21 CompoBus/S Master Unit	Provides additional I/O points with reduced wiring.
Communications Units	CJ1W-DRM21 DeviceNet Unit	Can be used in Slave mode only. Provides high capacity data exchange with the host PLC.

- Note**
- (1) When an I/O Control Module is being used to connect CJ-series Units, always mount a CJ1W-TER01 End Cover on the right side of the Rack. If an FQM1-TER01 End Module is used, an I/O bus error will occur and the Coordinator Module will stop operating. Likewise, an I/O bus error will occur if only Motion Control Modules are being used, but a CJ-series End Cover is mounted.
 - (2) When a CJ1W-SPU01 Data Collection Unit is mounted, it takes about 20 seconds for the Coordinator Module to recognize the SPU Unit. Consequently, the Controller will be in standby status (CPU waiting) for a longer time when an SPU Unit is mounted.
 - (3) The CJ1W-NCF71 can control up to 16 axes of Servo Drivers, but too many axes may cause an excessive Coordinator Module cycle time because the I/O refreshing time will be longer and a longer program will be required to control the axes. Limit the number of controlled axes to maintain the required Coordinator Module performance.

6-2-2 I/O Allocation

Each time the power supply is turned ON, the FQM1 automatically allocates I/O words to the mounted Basic I/O Units and then starts operation.

**I/O Allocation to
Basic I/O Units**

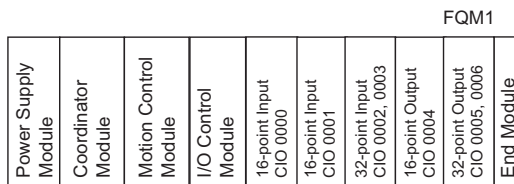
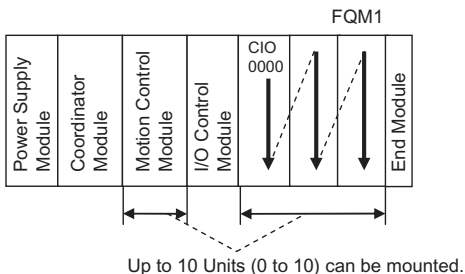
CJ-series Basic I/O Units are allocated words in the I/O Area (CIO 0000 to CIO 0019) and can be mounted to the FQM1 CPU Rack or Expansion Rack.

- Note** Refer to 2-5 *CJ-series Unit Tables* for details on the available Basic I/O Units.

Allocation Procedures**1. CPU Rack**

The Coordinator Module's built-in inputs are allocated to CIO 2960 and the built-in outputs are allocated to CIO 2961. Basic I/O Units in the CPU Rack are allocated words from left to right starting with CIO 0000 being allocated to the Unit closest to the CPU Unit, as shown in the following example. Each Unit is allocated as many words as it requires.

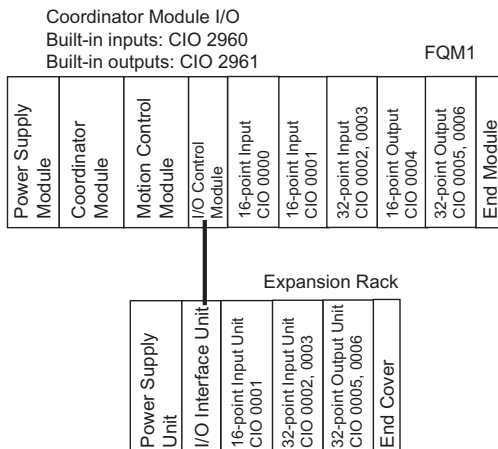
Note Units that have 1 to 16 I/O points are allocated 1 word (16 bits) and Units that have 17 to 32 I/O points are allocated 2 words (32 bits). For example, an 8-point Unit is allocated 16 bits (1 word) and bits 00 to 07 of that word are allocated to the Unit's 8 points.



Coordinator Module I/O
 Built-in inputs: CIO 2960
 Built-in outputs: CIO 2961

2. CJ-series Expansion Rack

I/O allocation to Basic I/O Units continues in order from the CPU Rack to the Expansion Rack, as shown in the following example. Words are allocated from left to right in 1-word (16-bit) units, just like Units in the CPU Rack.



Coordinator Module I/O
 Built-in inputs: CIO 2960
 Built-in outputs: CIO 2961

I/O Allocation to Special I/O Units

Each CJ-series Special I/O Unit is allocated ten words in the Special I/O Unit Area (CIO 2100 to CIO 2959) according the unit number set on the Unit. Special I/O Units can be mounted to the FQM1 CPU Rack or CJ-series Expansion Rack.

Note Refer to 2-5 *CJ-series Unit Tables* for details on the available Special I/O Units.

The following table shows which words in the Special I/O Unit Area are allocated to each Unit.

Unit number	Number of words allocated	Allocated words
10	10 words	CIO 2100 to CIO 2109
11	10 words	CIO 2110 to CIO 2119

Unit number	Number of words allocated	Allocated words
12	10 words	CIO 2120 to CIO 2129
:	:	:
25	10 words	CIO 2250 to CIO 2259
:	:	:
95	10 words	CIO 2950 to CIO 2959

- Note**
- (1) Unit numbers 0 to 9 (CIO 2000 to 2099) cannot be used.
 - (2) Special I/O Units are ignored during I/O allocation to Basic I/O Units and have no effect on Basic I/O Unit I/O allocation.

Example

Slot numbers: 0 1 2 3

Power Supply Module	Coordinator Module	Motion Control Module	I/O Control Module	16-point Input CIO 0000	Special I/O Unit CIO 2100 to 2109	16-point Output CIO 0001	End Module
---------------------	--------------------	-----------------------	--------------------	-------------------------	-----------------------------------	--------------------------	------------

Coordinator Module I/O
 Built-in inputs: CIO 2960
 Built-in outputs: CIO 2961

Slot	Unit	Number of words	Allocated words	Unit number	Unit type
0	CJ1W-ID211 16-point DC Input Unit	1 word	CIO 0000	---	Basic I/O Unit
1	CJ1W-SRM21 Compo-Bus/S Master Unit	10 words	CIO 2100 to CIO 2109	10	Special I/O Unit
2	CJ1W-OD211 16-point Transistor Output Unit	1 word	CIO 0001	---	Basic I/O Unit

I/O Allocation to CPU Bus Units

Each CJ-series CPU Bus Unit is allocated 25 words in the CPU Bus Unit Area (CIO 1500 to CIO 1899) according the unit number set on the Unit. CJ-series CPU Bus Units can be mounted to the FQM1 CPU Rack or CJ-series Expansion Rack.

- Note** Refer to 2-5 *CJ-series Unit Tables* for details on the available CPU Bus Units.

The following table shows which words in the CJ-series CPU Bus Unit Area are allocated to each Unit.

Unit number	Number of words allocated	Allocated words
0	25 words	CIO 1500 to CIO 1524
1	25 words	CIO 1525 to CIO 1549
2	25 words	CIO 1550 to CIO 1574
:	:	:
15	25 words	CIO 1875 to CIO 1899

- Note**
- (1) CPU Bus Units are ignored during I/O allocation to Basic I/O Units and have no effect on Basic I/O Unit I/O allocation.
 - (2) The same unit number can be set on more than one CPU Bus Unit.

Example

Slot numbers: 0 1 2 3

Power Supply Module	Coordinator Module	Motion Control Module	I/O Control Module	16-point Input CIO 0000	16-point Output CIO 0001	CPU Bus Unit CIO 1500 to 1524	End Module
---------------------	--------------------	-----------------------	--------------------	-------------------------	--------------------------	-------------------------------	------------

Coordinator Module I/O
 Built-in inputs: CIO 2960
 Built-in outputs: CIO 2961

Slot	Unit	Number of words	Allocated words	Unit number	Unit type
0	CJ1W-ID211 16-point DC Input Unit	1 word	CIO 0000	---	Basic I/O Unit
1	CJ1W-OD211 16-point Transistor Output Unit	1 word	CIO 0001	---	Basic I/O Unit
2	CJ1W-NCF71 Position Control Unit	25 words	CIO 1500 to CIO 1524	0	CPU Bus Unit

6-3 Data Exchange between Coordinator Module and Units

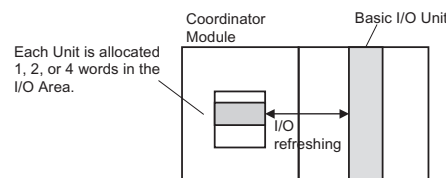
This section describes how data can be exchanged between the Coordinator Module and each kind of CJ-series Unit (Basic I/O Units, Special I/O Units, and CJ-series CPU Bus Units).

6-3-1 Basic I/O Units

I/O Refreshing

Data is exchanged each cycle during I/O refreshing of the Basic I/O Unit Area. Each Unit is automatically allocated the required number of words (1, 2, or 4 words) when the power is turned ON. Refer to the operation manuals for individual Basic I/O Units for details.

I/O Area for Basic I/O Units: CIO 0000 to CIO 0019



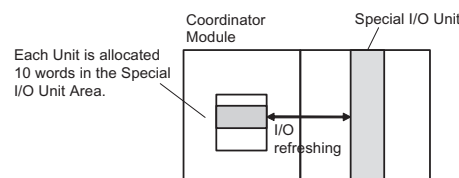
6-3-2 Special I/O Unit Area

I/O Refreshing

Data is exchanged each cycle during I/O refreshing of the Special I/O Unit Area. Basically, 10 words are allocated to each Special I/O Unit based on its unit number setting. Refer to the operation manuals for individual Special I/O Units for details.

Special I/O Unit Area: CIO 2100 to CIO 2959 (10 words x 86 unit numbers)

Do not use unit numbers 0 to 10 (CIO 2000 to CIO 2099).



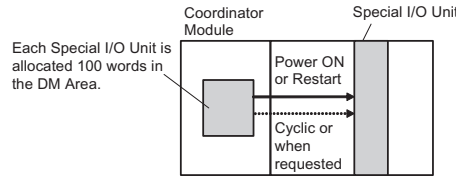
Transfer of Allocated DM Area Words

Each Special I/O Unit is allocated 100 DM Area words based on its unit number setting. There are three times that data may be transferred through these words, depending on the model of Special I/O Unit being used.

1. Data transfer when the PLC is turned ON or restarted
2. Data transfer each cycle
3. Data transfer when necessary

Special I/O Unit Words in DM: D21000 to D29599 (100 Words x 86 Units)

These 100 words are generally used to hold initial settings for the Special I/O Unit. When the contents of this area are changed from the program to reflect a change in the system, the Restart Bits (A502.00 to A507.15) for affected Units must be turned ON to restart the Units.



Special I/O Unit Initialization

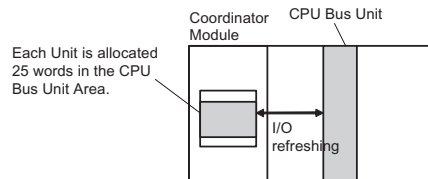
Special I/O Units can be used after being initialized when the PLC's power is turned ON or the Unit's Restart Bit (A502.00 to A507.15) is turned ON. The Unit's Special I/O Unit Initialization Flag (A330.00 to A335.15) will be ON while the Unit is initializing.

I/O refreshing (cyclic I/O refreshing) will not be performed with a Special I/O Unit while its Initialization Flag is ON.

6-3-3 CPU Bus Units

I/O Refreshing

Data is exchanged each cycle during I/O refreshing of the CPU Bus Unit Area. Each CPU Bus Unit is allocated 25 words based on its unit number setting. CPU Bus Unit Area: CIO 1500 to CIO 1899 (25 words x 16 unit numbers)



Transfer of Allocated DM Area Words

Each CPU Bus Unit is allocated 100 DM Area words based on its unit number setting.

Note Some CPU Bus Unit models do not use the allocated DM Area words.

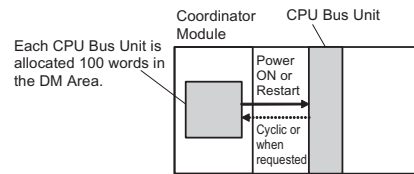
CPU Bus Unit Words in DM: D30000 to D31599 (100 Words x 16 Units)

There are three times that data may be transferred through these words, depending on the model of CPU Bus Unit being used.

1. Data transfer when the PLC is turned ON or restarted
2. Data transfer each cycle
3. Data transfer when necessary

Some models transfer data in both directions, from the DM Area to the Unit and from the Unit to the DM Area. See the CPU Bus Unit's Operation Manual for details on the direction and timing of data transfers.

These 100 words are generally used to hold initial settings for the CPU Bus Unit. When the contents of this area are changed from the program to reflect a change in the system, the Restart Bits (A501.00 to A501.15) for affected Units must be turned ON to restart the Units.



CPU Bus Unit Initialization

CPU Bus Units can be used after being initialized when the PLC’s power is turned ON or the Unit’s Restart Bit (A501.00 to A501.15) is turned ON. The Unit’s CPU Bus Unit Initialization Flag (A302.00 to A302.15) will be ON while the Unit is initializing.

Cyclic I/O refreshing will not be performed for a CPU Bus Unit while its CPU Bus Unit Initialization Flag is ON.

6-4 Automatic DM Data Backup Function

Automatic Storage of DM Data to Flash Memory

Part of the DM Area can be saved to flash memory.

DM data will be saved automatically when the retained area is overwritten from the CX-Programmer, a DM data transfer operation, or a PT. The DM data will not be saved when the retained area is overwritten by an instruction in the ladder program.

Retained Area

DM Area words D20000 to D32767 are backed up.

Related Auxiliary Area Flags

Name	Address	Function
Flash Memory Error Flag	A403.10	Turns ON when the flash memory fails.

Note The flash memory lifetime will be shortened if data is frequently written to the retained area. For example, do not write data from the PT to the retained area every cycle.

SECTION 7

Motion Control Module Functions

This section describes the various functions supported by the Motion Control Modules.

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7-1 Overview

The FQM1 Modules have the following functions.

Main function (Applicable Modules)	Sub-functions		
Basic interrupt functions (FQM1-MMP22/MMA22)	Input Interrupts (4 points) (Input Interrupt Mode or Counter Mode)		
	Interval Timer Interrupt (1 point) Setting range: 0.5 to 99,990 ms Unit: 0.1 ms	Scheduled Interrupts One-shot Interrupts	
	Constant Cycle Time Exceeded Error Clear Function		
High-speed Counters (FQM1-MMP22/MMA22)	High-speed Counter PVs (2 points) Phase differential, Increment/decrement, or Pulse + direction; 50 kHz or 500 kHz	No interrupts Target Value Comparison Interrupts (Count check interrupts) Range Comparison and Bit Pattern Outputs	
	High-speed Counter Movement Measurement Sampling time (1 to 9,999 ms) or cycle time		
	High-speed Counter Frequency Measurement Measured frequency: 0 to 500 kHz (1 point)		
	High-speed Counter Latch (2 latch inputs) (Latched high-speed counter PV can be read with PRV(881) instruction.)		
	Functions for Servo Drivers Compatible with Absolute Encoders (FQM1-MMP22/MMA22)		Absolute Number of Rotations PV
			Absolute PV
Absolute PV Preset Function			
Absolute Offset Preset Function			
Pulse Outputs (FQM1-MMP22 only)	Pulse Outputs (2 points) Pulse output without acceleration/deceleration, non-trapezoidal acceleration or deceleration, trapezoidal acceleration/deceleration, and electronic cam control		
	One-shot Pulse Output Pulse ON time: 0.01 to 9,999 ms		
	Pulse Counter (for time measurement) Measurement unit: Select 0.001 ms, 0.01 ms, 0.1 ms, or 1 ms. Measurement range: 0000 0000 to FFFF FFFF hex		
	These three interrupt/bit pattern output settings can be set for the Pulse Outputs, One-shot Pulse Outputs, and Pulse Counter Functions listed above.	No interrupts	
		Target Value Comparison Interrupts (Count check interrupts)	
		Range Comparison and Bit Pattern Outputs	
Virtual Pulse Outputs (FQM1-MMP22/MMA22)	The AXIS instruction generates trapezoidal acceleration/deceleration in a virtual axis.		
Analog Outputs (FQM1-MMA22 only)	Sloped Output by Instruction (2 points) 1 to 5 V, 0 to 5 V, 0 to 10 V, or -10 to 10 V		
	Immediate refreshing at instruction execution, analog output value hold function, offset/gain adjustment supported		
Analog Inputs (FQM1-MMA22 only)	Immediate Refreshing by Instruction (1 point) 1 to 5 V, 0 to 5 V, 0 to 10 V, -10 to 10 V, or 4 to 20 mA		
	Offset/Gain Adjustment of Analog Input Value		
	High-speed Analog Sampling The CTBL(882) instruction starts analog sampling when the high-speed counter 1 PV matches the preset target value.		
DM Data Storage Function (FQM1-MMP22/MMA22)	---		

7-2 Interrupt Functions

7-2-1 Overview

The Motion Control Modules support the following interrupts.

Executing Interrupt Programs in the FQM1

The programming routines that are executed for all of the following interrupts are programmed as interrupt tasks.

Input Interrupts

Inputs to the Motion Control Module's built-in contact inputs 0 to 3 can be set as interrupt inputs. If they are set as interrupt inputs, an interrupt will be generated when the input turns ON, OFF, or both. If they are set for Counter Mode, an interrupt will be generated when a specified counter value is reached.

Interval Timer Interrupts

An interrupt will be generated for an interval timer that can be set to a precision of 0.1 ms. Interval timer interrupts can also be used in the Coordinator Module.

High-speed Counter Interrupts

An interrupt will be generated when the PV of the counter equals a preset target value.

Pulse Output Interrupts

An interrupt will be generated when the PV of the pulse output (or the pulse counter's PV/measured time) equals a preset target value.

Note In addition to interrupts, bit patterns can be output internally when the PV is within a specified range in Range Comparison Mode. High-speed counter PVs, pulse output PVs, pulse counter timer PVs, and one-shot pulse elapsed times can be used as the PVs for bit pattern output.

7-2-2 Interrupt Priority

A specified interrupt task will be executed when an interrupt is generated. The priority of interrupts is shown below.

If an additional interrupt occurs while another interrupt is already being processed, the new interrupt will be executed after the first interrupt task has been completed.

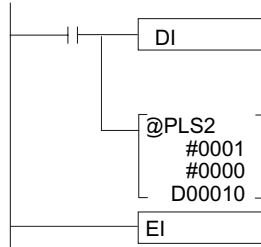
If two or more interrupts occur simultaneously, the higher-priority interrupt will be executed first. Interrupts have the following priority:

- Input interrupt 0 → Input interrupt 1 → Input interrupt 2 → Input interrupt 3
- Interval timer interrupt → Pulse output 1 interrupt → Pulse output 2 interrupt → High-speed counter 1 interrupt → High-speed counter 2 interrupt

An instruction controlling a port operation cannot be programmed in an interrupt task if an instruction in the main program is already controlling pulse I/O or a high-speed counter for the same port. If this is attempted, the ER Flag will turn ON. The following instructions are included: INI(880), PRV(881), CTBL(882), SPED(885), PULS(886), PLS2(887), ACC(888), and STIM(980).

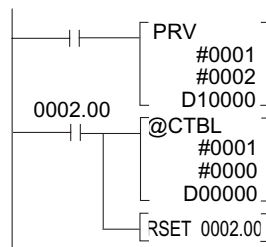
This situation can be avoided with the programming methods shown in the following diagram.

Method 1:
Disabling all interrupts
in the main program

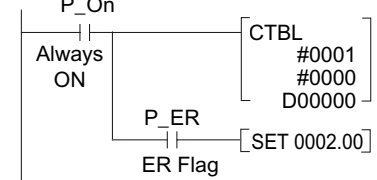


Method 2:
Executing the routine in the main program instead of
the interrupt task, where it could not be executed.

(Main program)



(Interrupt task)



Note Only one interrupt task number is recorded for pulse output and high-speed counter interrupts. When a pulse output or high-speed counter interrupt is on standby (because another interrupt is being executed or interrupts are disabled) and another interrupt occurs, the earlier interrupt task number is replaced with the most recent interrupt task number. Design the system to allow sufficient time between interrupts for the length of the interrupt tasks to prevent unwanted conflicts between interrupts.

7-2-3 Disabling and Enabling All Interrupts

All interrupts can be disabled using the DI(802) instruction, as shown below. The following interrupts are disabled and enabled by DI(802) and EI(694).

- Input interrupts
- Interval timer interrupts
- High-speed counter interrupts
- Pulse output interrupts

Observe the following precautions when using DI(802).

- DI(802) and EI(694) cannot be used within an interrupt task to disable or enable interrupts.
- Do not use DI(802) to disable all interrupts unless there is a specific need to do so.

Disabling All Interrupts

The DI(802) instruction will disable all interrupts.

```
— [ (@)DI ]
```

Note Interrupt processing will not be executed for an interrupt that occurs while interrupts are disabled, but the interrupt event will be recorded for each type of interrupt and interrupt processing will be executed when interrupts are enabled.

Enabling All Interrupts

The EI(694) instruction clears the prohibition on all interrupts that was set with the DI(802) instruction.

```
— [ (@)EI ]
```

Note Executing the EI(694) instruction merely returns the interrupts to the status they were in before all interrupts were prohibited (disabled by DI(802)). The EI(694) instruction does not enable all interrupts. If an interrupt was masked before all interrupts were disabled, that interrupt will still be masked after the prohibition on all interrupts is cleared.

Clearing Recorded Interrupts

The CLI(691) instruction clears the interrupt event information recorded while all interrupts were disabled by the DI(802) instruction.

7-3 Input Interrupts**7-3-1 Applicable Models**

Model number	Functions
FQM1-MMP22	Motion Control Module for Pulse I/O
FQM1-MMA22	Motion Control Module for Analog I/O

7-3-2 Overview of the Input Interrupt Function

Contact inputs 0 to 3 in the Motion Control Modules can be used for external interrupt inputs. These inputs correspond to CIO 2960.00 to CIO 2960.03. The interrupt tasks corresponding to these inputs are fixed and cannot be changed. Contact inputs 0 to 3 call interrupt tasks 000 to 003, respectively.

Note If the input interrupts are not being used, interrupt tasks 000 to 003 can be used as interrupt tasks for other interrupt functions.

7-3-3 Interrupt Modes

There are two modes that can be used for the input interrupts. Each of the four interrupt inputs can be set to either of these modes.

- Input Interrupt Mode:
An interrupt is generated when the external input turns ON, OFF, or both.
- Counter Mode:
External signals are counted, decrementing the PV from an SV, and an interrupt is generated when the PV equals 0.

The interrupt mode for each interrupt input is set using the MSKS(690) instruction.

7-3-4 Input Interrupt Specifications**Input Interrupt Mode**

Item	Specification
Interrupt condition	Contact inputs 0 to 3 (CIO 2960.00 to CIO 2960.03) turn ON, OFF, or both Note Set the interrupt condition in the System Setup.
Interrupt task numbers	CIO 2960.00 to CIO 2960.03: Interrupt tasks 000 to 003
Response time	0.1 ms for ON interrupt condition The response time is measured from when interrupt condition is met until interrupt task execution starts.
Signal pulse width	ON: 0.1 ms min., OFF: 0.2 ms min.

Counter Mode

Item	Specification
Interrupt condition	Counter decremented from SV each time input contacts 0 to 3 (CIO 2960.00 to CIO 2960.03) turn ON, OFF, or both and PV reaches 0. Note Set the interrupt condition in the System Setup.
Interrupt task numbers	CIO 2960.00 to CIO 2960.03: Interrupt tasks 000 to 003 (fixed)

Item	Specification
Counter operation	Decrementing pulse input
Input method	Single phase
Counting speed	2 kHz
Counter value	0000 to FFFF hex
Counter PV storage	Input interrupts 0 to 3 (CIO 2960.00 to CIO 2960.03): A536 to A539
Counter SV storage	Input interrupts 0 to 3 (CIO 2960.00 to CIO 2960.03): A532 to A535

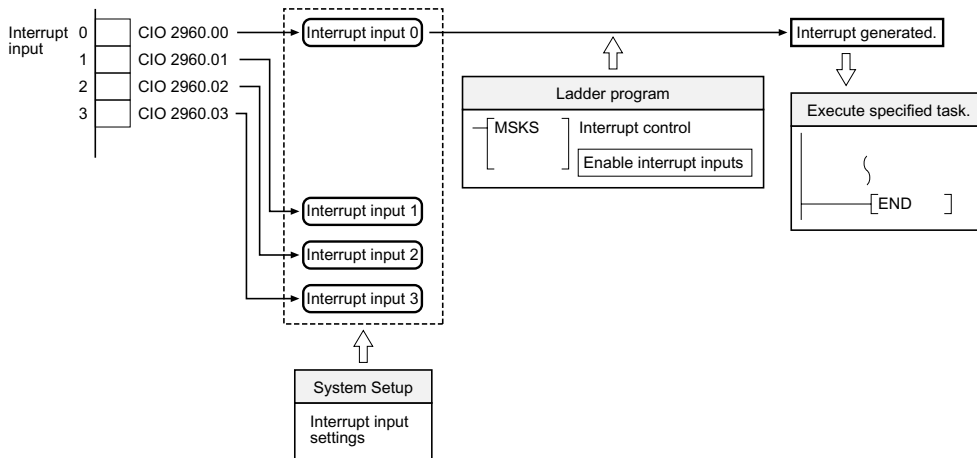
7-3-5 Using Input Interrupts

Input Interrupt Mode Procedure

- 1,2,3... 1. Determine which input interrupt number will be used.
2. Wire the input.

Input	Allocated input bit	Interrupt task number
External interrupt input 0	CIO 2960.00	000
External interrupt input 1	CIO 2960.01	001
External interrupt input 2	CIO 2960.02	002
External interrupt input 3	CIO 2960.03	003

3. Make the necessary System Setup settings.
- Set the Interrupt Input Settings (set whether an interrupt will be generated when the input turns ON, OFF, or both).
- Note** The default input setting is for a normal input.
4. Create the necessary ladder programming.
- Use the MSKS(690) instruction (SET INTERRUPT MASK) to enable the input as an interrupt input.
 - Create the interrupt task program.



Counter Mode Procedure

- 1,2,3... 1. Determine which input interrupt number will be used.
2. Determine the initial SV for the decrementing counter.

3. Wire the input.

Input	Allocated input bit	Interrupt task number
External interrupt input 0	CIO 2960.00	000
External interrupt input 1	CIO 2960.01	001
External interrupt input 2	CIO 2960.02	002
External interrupt input 3	CIO 2960.03	003

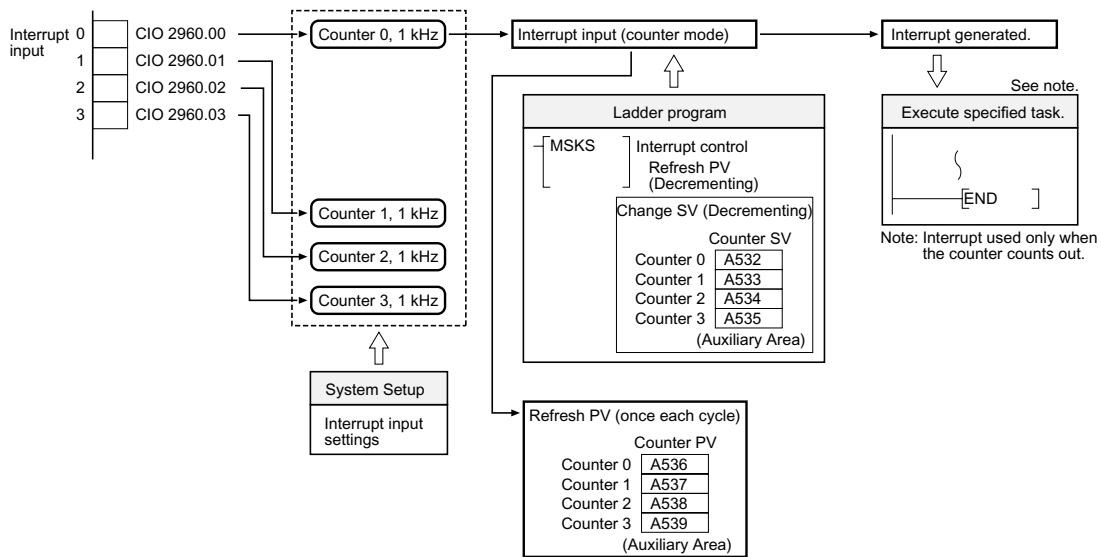
4. Make the necessary System Setup settings.

- Set the Interrupt Input Settings (set whether an interrupt will be generated when the input turns ON, OFF, or both).

Note The default input setting is for a normal input.

5. Create the necessary ladder programming.

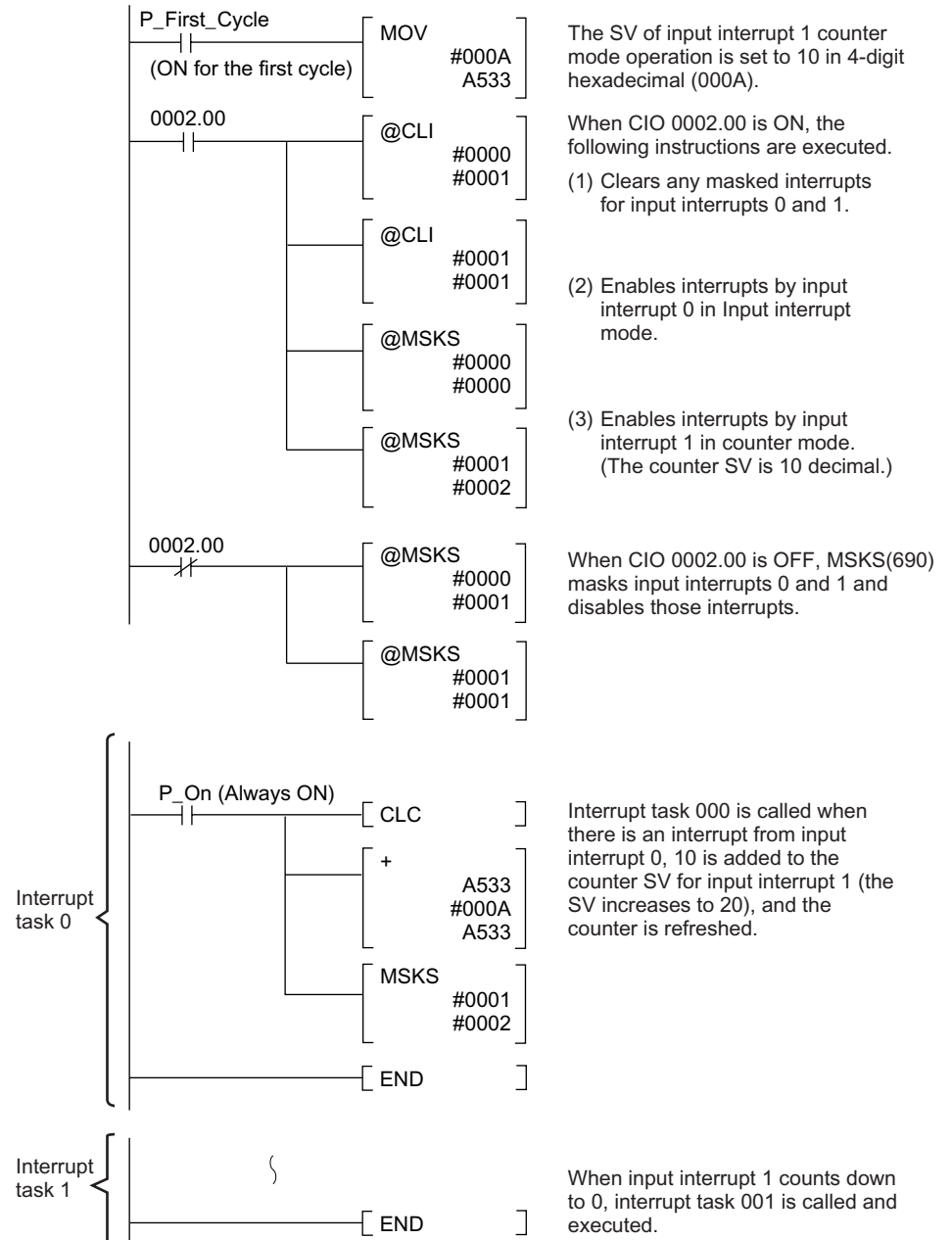
- Use the MSKS(690) instruction (SET INTERRUPT MASK) to refresh the counter's SV in counter mode.
- Create the interrupt task program.



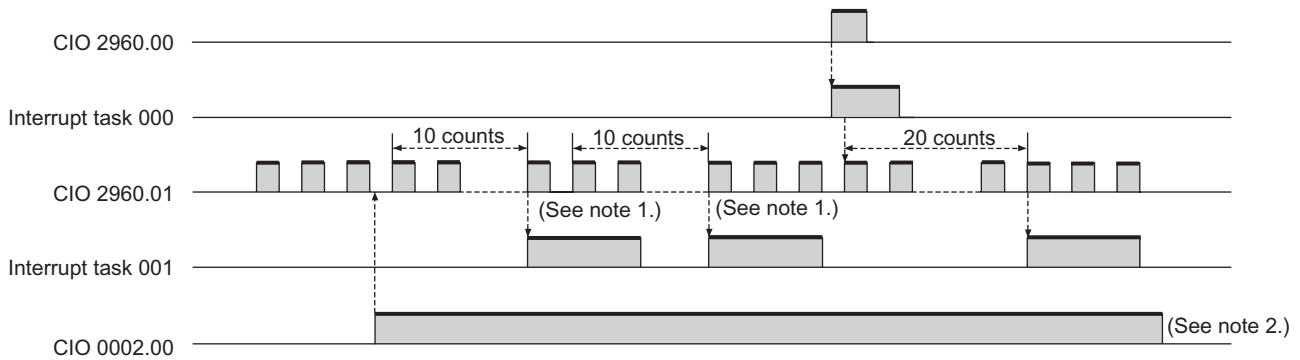
7-3-6 Application Example

This example shows input interrupt 0 and input interrupt 1 used in interrupt input mode and counter mode, respectively.

Before executing the program, verify that the following System Setup settings have been made: input 0 and input 1 both set to *Interruption (up)*. The other System Setup settings are set to their default settings.



The following timing chart shows the operation of the program as it is executed.



- Note**
- (1) Counting continues even while the interrupt task is being executed.
 - (2) The input interrupts are masked after this point.

7-4 Interval Timer Interrupts

7-4-1 Applicable Models

Model number	Functions
FQM1-CM002	Coordinator Module
FQM1-MMP22	Motion Control Module for Pulse I/O
FQM1-MMA22	Motion Control Module for Analog I/O

7-4-2 Overview

Interval timers can be used to perform high-speed, high-precision timer interrupt processing. The Motion Control Modules and Coordinator Module are equipped with one interval timer each.

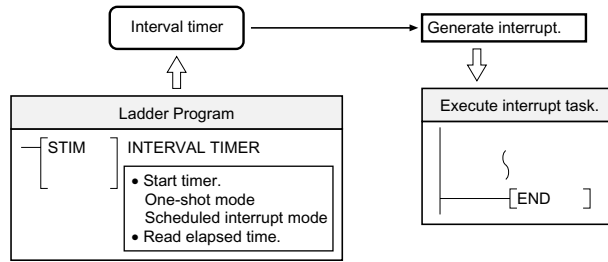
7-4-3 Interval Timer Interrupt Modes

There are two modes for interval timer operation.

- One-shot Mode
In one-shot mode, the interrupt is executed just once when the timer times out.
- Scheduled Interrupt Mode
In scheduled interrupt mode, the timer is reset to the SV each time it times out so the interrupt is repeated regularly at a fixed interval.

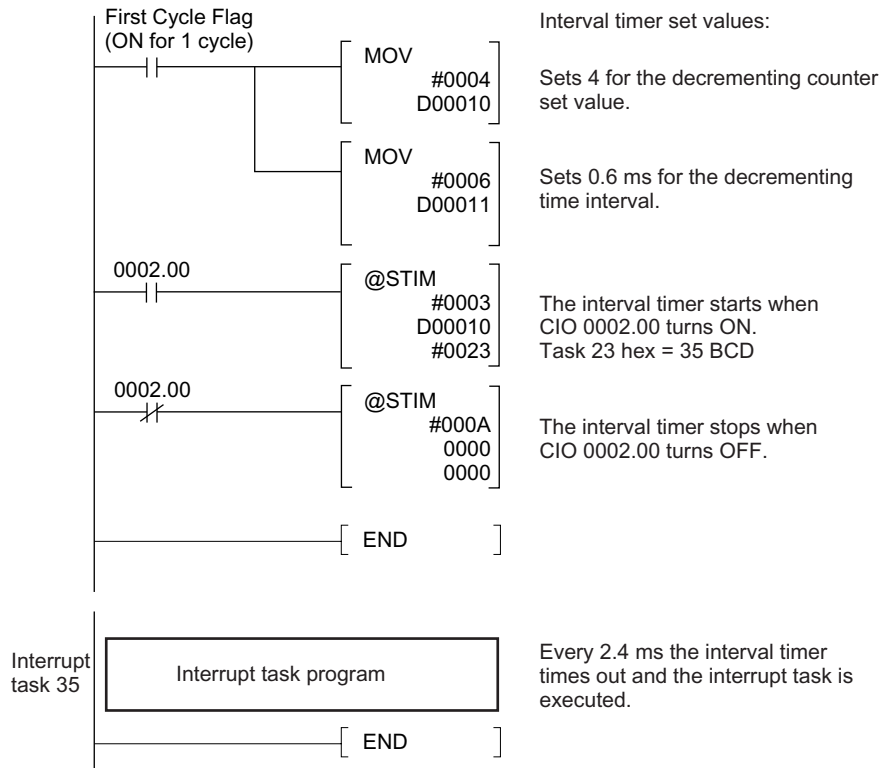
7-4-4 Using Interval Timer Interrupts

- 1,2,3...**
1. Interrupt Mode
 - Determine whether the timer will operate in one-shot mode or scheduled interrupt mode.
 2. Ladder Programming
 - Use the STIM(980) instruction to set the timer SV and start the timer in one-shot or scheduled interrupt mode.
 - Create the interrupt task program.

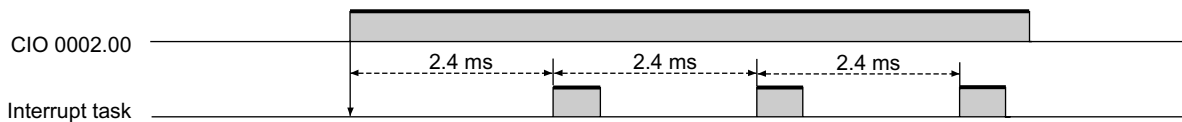


7-4-5 Application Example

In this example, the interval timer is used to generate an interrupt every 2.4 ms (0.6 ms × 4). The default System Setup settings are used. (Inputs are not refreshed for interrupt processing.)



When the program is being executed, the interrupt task will be executed every 2.4 ms while CIO 0002.00 is ON, as shown in the following diagram.



7-5 Pulse Inputs

7-5-1 Applicable Models

Model	Functions
FQM1-MMP22	Motion Control Module for Pulse I/O
FQM1-MMA22	Motion Control Module for Analog I/O

7-5-2 Outline

The FQM1-MMP22 and FQM1-MMA22 Motion Control Modules can receive pulse inputs. The following table shows the processes that can be performed by combining the pulse input function with the high-speed counters to count pulse signals from a rotary encoder or other device and perform processing based on the counter PV.

Process	Description
Target value comparison interrupts	An interrupt task is executed when the high-speed counter PV equals a preset target value.
Bit pattern outputs for range comparisons	When the high-speed counter PV is within a specified range, the user-set bit pattern specified in the comparison table is output internally.
Measurement modes 1 and 2	Movement in the high-speed counter or input pulse counting speed can be displayed while monitoring the high-speed counter PV.
High-speed counter PV latch	High-speed counters 1 and 2 each have a latch register. Two latch inputs can be used to capture the high-speed counter PVs at high speed.

Note Interrupts cannot be generated for range comparisons. Only bit patterns are output.

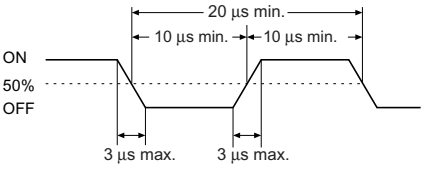
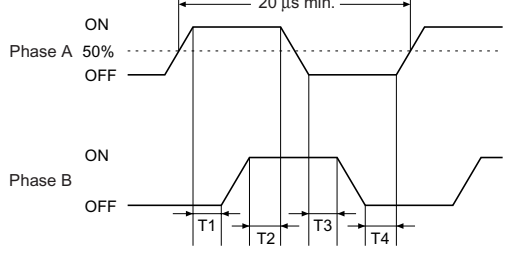
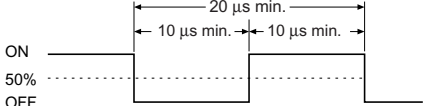
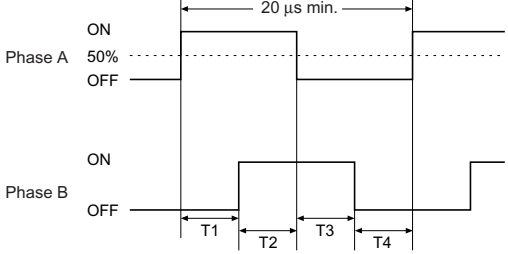
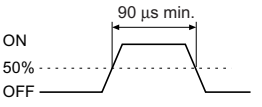
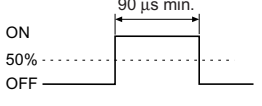
The high-speed counter PV movement during a fixed time interval (equivalent to the travel distance) and the high-speed counter's frequency can also be monitored as required.

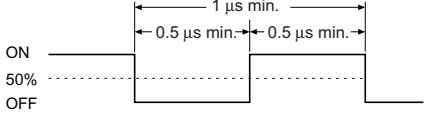
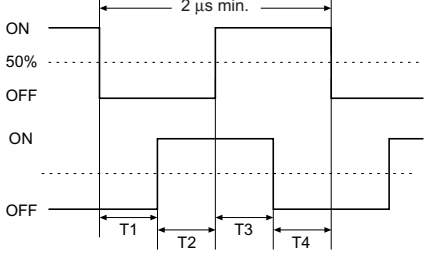
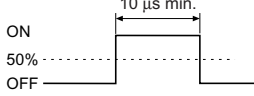
7-5-3 Specifications

Item			Specification		
Number of counters			2		
Pulse input operation mode (Set in System Setup.)			Phase differential	Increment/decrement	Pulse + direction
Input pin numbers	High-speed counter 1	High-speed counter 2			
	24 V: 1 (5) LD: 3 (5)	24 V: 2 (6) LD: 4 (6)	Phase A	Increment pulse	Pulse
	24 V: 7 (11) LD: 9 (11)	24 V: 8 (12) LD: 10 (12)	Phase B	Decrement pulse	Direction pulse
	24 V: 13 (17) LD: 15 (17)	24 V: 14 (18) LD: 16 (18)	Phase Z	Reset pulse	Reset pulse
Input method			Phase differential ×1, ×2, or ×4 (switchable)	Single-phase ×2	Single-phase + direction
			Set in the System Setup. (Set input for pulse input counter 1 and counter 2.)		
Counting speed (Set separately for each port in the System Setup.)			50 kHz (default) or 500 kHz (2 MHz when using phase differential ×4)		
Counter operation			Linear Counter or Circular Counter (Set in the System Setup.)		

Item		Specification
Counter values		Linear Counter: 8000 0000 to 7FFF FFFF hex Circular Counter: 0000 0000 to Circular maximum count (hex) (The circular maximum count is set in the System Setup between 0000 0001 and FFFF FFFF hex.)
High-speed counter PV storage locations		High-speed counter 1: A851 (upper bytes) and A850 (lower bytes) High-speed counter 2: A853 (upper bytes) and A852 (lower bytes) These values can be used for target-value comparison interrupts or range-comparison bit pattern outputs. Note The PVs are refreshed during the Motion Control Module's I/O refresh. The PVs can also be read with the PRV(881) instruction. Data storage format: 8-digit hexadecimal • Linear Counter: 8000 0000 to 7FFF FFFF hex • Circular Counter: 0000 0000 to Circular maximum count
Latch inputs		There are two latch inputs. One latch input can be for each high-speed counter or both latch inputs can be used for one high-speed counter. It is also possible for both high-speed counters to share one latch input. The latched PV can be read with the PRV(881) instruction.
Control method	Target value comparison	Register up to 48 target values and interrupt tasks.
	Range comparison	Register up to 16 upper limits, lower limits, and output bit patterns.
Counter reset		Phase Z Signal + Software Reset The counter is reset on the phase-Z signal if the Reset Bit is ON. Software Reset The counter is reset when the Reset Bit is turned ON. Note The counter reset method is set in System Setup. Reset Bits A860.01 is the Reset Bit for high-speed counter 1 and A861.01 is the Reset Bit for high-speed counter 2.
Measurement mode	Counter movements (mode 1)	Measures the change in the high-speed counter's PV for the set sampling time or each cycle. Sampling time: 1 to 9,999 ms Movement (absolute value): 0000 0000 to FFFF FFFF hex
	Counter frequency (mode 2)	The frequency is calculated from the PV between 0 and 500,000 Hz.
	Measurement storage location for above measurements	High-speed counter 1: A855 (upper bytes) and A854 (lower bytes) High-speed counter 2: A857 (upper bytes) and A856 (lower bytes) Note The high-speed counter value can also be read with the PRV(881) instruction. Stored Data Movement: 8-digit hexadecimal Frequency: 8-digit hexadecimal Note The data is refreshed during the Motion Control Module's I/O refresh period.
	<ul style="list-style-type: none"> • Select mode 1 or mode 2 in the System Setup. • Measurement starts when the Measurement Start Bit (A860.02 for high-speed counter 1 or A861.02 for high-speed counter 2) is turned ON. • The Measuring Flag (A858.06 for high-speed counter 1 or A859.06 for high-speed counter 2) will be ON during the measurement. 	

7-5-4 Pulse Input Specifications

Item	Specification				
Number of pulse inputs	2 inputs Note High-speed counter 1 can be an RS-422A line-driver input or an input with a voltage of 24 VDC. High-speed counter 2 can be an RS-422A line-driver input or an input with a voltage of 24 VDC, except for the FQM1-MMA22, which supports only line-driver inputs to high-speed counter 2.				
Signals	Encoder inputs A and B and pulse input Z				
Ports	High-speed counters 1 and 2		High-speed counters 1 and 2		
Input voltage	24 VDC \pm 10%		RS-422A line-driver (AM26LS31 equivalent)		
	Phases A and B	Phase Z	Phases A and B	Phase Z	
Input current	5 mA typical	8 mA typical	10 mA typical	13 mA typical	
ON voltage	19.6 V DC min.	18.6 V DC min.	---	---	
OFF voltage	4.0 V DC max.	4.0 V DC max.	---	---	
Minimum response pulse					
At 50 kHz	<p>Encoder Inputs A and B</p> <p>Waveform of Encoder Inputs A and B Signal rise and fall must be 3 μs max. 50-kHz pulse with 50% duty ratio</p>  <p>Relationship to Phase Differential Inputs A and B T1, T2, T3, and T4 must be 4.5 μs min. There must be 4.5 μs min. between phase-A and phase-B change points.</p> 		<p>Encoder Inputs A and B</p> <p>Encoder Inputs A and B Waveform Square waveform 50-kHz pulse with 50% duty ratio</p>  <p>Relationship to Phase Differential Inputs A and B T1, T2, T3, and T4 must be 4.5 μs min. There must be 4.5 μs min. between phase-A and phase-B change points.</p> 		
	<p>Encoder Input Z or Sensor Input</p> <p>Encoder Input Z Waveform The pulse width must be 90 μs min.</p> 		<p>Encoder Input Z or Sensor Input</p> <p>Encoder Input Z Waveform The pulse width must be 90 μs min.</p> 		

Item	Specification	
At 500 kHz	Operation may not be reliable above 50 kHz.	<p>Encoder Inputs A and B</p> <p>Encoder Inputs A and B Waveform Square waveform 1-MHz pulse with 50% duty ratio</p>  <p>ON 50% OFF</p> <p>Relationship with Phase Differential Inputs A and B T1, T2, T3, and T4 must be 0.5 μs min. There must be 0.5 μs min. between phase-A and phase-B change points.</p>  <p>ON 50% OFF</p> <p>Encoder Input Z or Sensor Input</p> <p>Encoder Input Z Waveform The pulse width must be 10 μs min.</p>  <p>ON 50% OFF</p>

7-5-5 Latch Input Specifications

Item	Specification
Number of inputs	2
Input voltage	20.4 to 26.4 V
Input response	ON response: 30 μs OFF response: 200 μs

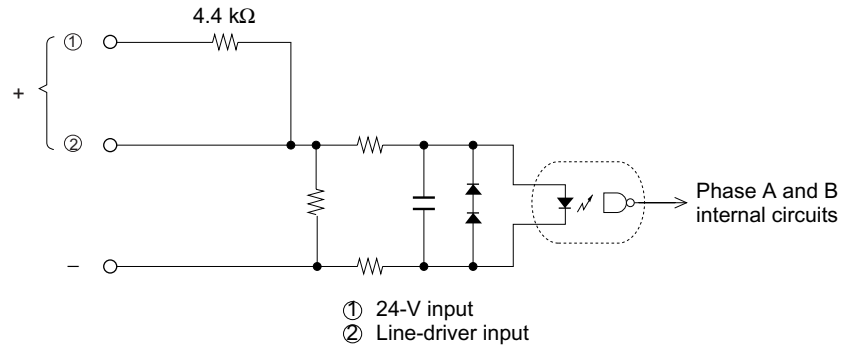
7-5-6 Applicable Instructions

Instruction	Control	Description
(@)CTBL(882)	Range comparison	One range comparison executed.
	Target value comparison table registration and starting comparison	Target value comparison table registered and comparison started.
	Target value comparison table registration	Target value comparison table registered.
(@)INI(880)	Starting comparison	Comparison started with previously registered target value comparison table.
	Stopping comparison	Target value comparison stopped.
	Changing PV	PV of high-speed counter changed.
	Changing circular value	Maximum circular value of high-speed counter changed.
(@)PRV(881)	Reading high-speed counter PV	PV of high-speed counter read.
	Reading high-speed counter movement or frequency	Movement or frequency of high-speed counter read.
	Reading the latched high-speed counter PV	Latched PV of high-speed counter read. (Reads the PV input to the latch register when the latch signal was input.)

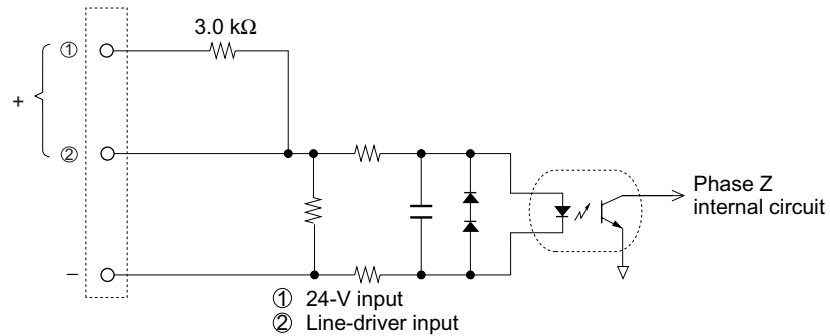
7-5-7 Internal Circuit Configurations

Pulse Inputs

Phases A and B



Phase Z



7-5-8 Pulse Input Function Description

The pulse input function uses the high-speed counters. The pulse input function can be used to monitor changes (movement) in the high-speed counter PV (mode 1) or changes in the high-speed counter frequency (mode 2).

High-speed Counter Function Description

Input Signal Type and Count Mode

High-speed counters 1 and 2 support the following inputs. The input method application depends on the signal type.

Phase Differential Inputs

This method uses the phase Z signal and the two phase signals (phase A and phase B) for a $\times 1$, $\times 2$, or $\times 4$ phase differential. The count is incremented or decremented according to the offset between the two phase signals.

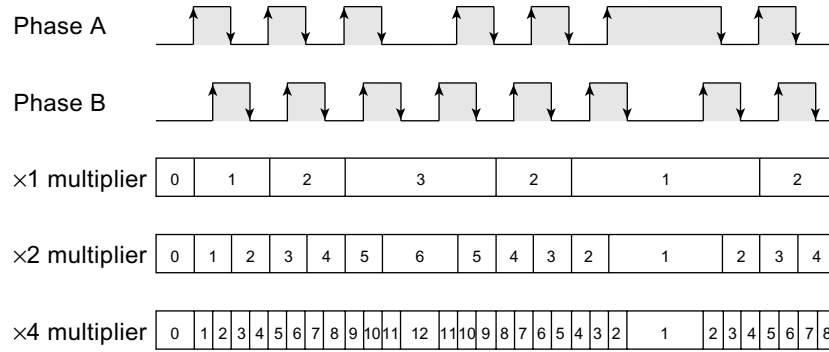
Increment/Decrement Pulse Inputs

The phase-A signal is the UP pulse and the phase-B signal is the DOWN pulse. The count is incremented or decremented by these pulses.

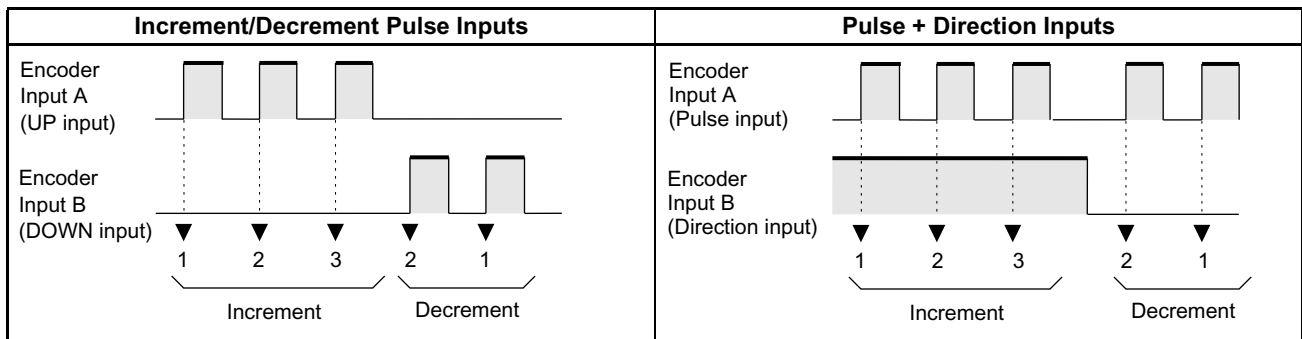
Pulse + Direction Inputs

The phase-A signal is the pulse signal and the phase-B signal is the direction signal. The count is incremented or decremented based on the ON/OFF status of the phase-B signal.

■ Phase Differential Input Operation



Phase A	Phase B	×1 multiplier	×2 multiplier	×4 multiplier
↑	L	Increment	Increment	Increment
H	↑	---	---	Increment
↓	H	---	Increment	Increment
L	↓	---	---	Increment
L	↑	---	---	Decrement
↑	H	---	Decrement	Decrement
H	↓	---	---	Decrement
↓	L	Decrement	Decrement	Decrement



Counter Operation (Numeric Ranges)

The following two counter operations are available for high-speed counters 1 and 2, with the specified counting ranges.

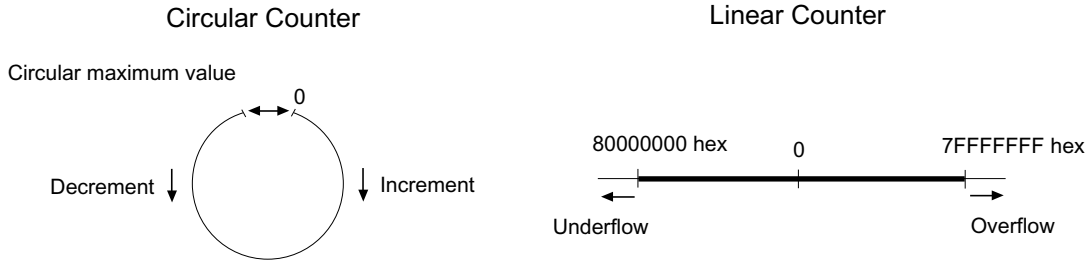
Circular Counter

With a Circular Counter, the circular maximum count can be set in the System Setup, and when the count is incremented beyond this maximum value, it returns to zero. The count never becomes negative. Similarly, if the count is decremented from 0, it returns to the maximum value.

The number of points on the circular is determined by setting the maximum value (i.e., the circular maximum value), which can be set between 1 and FFFF FFFF hex.

Linear Counter

With a Linear Counter, the count range is always 8000 0000 to 7FFF FFFF hex. If the count decrements below 8000 0000 hex, an underflow is generated, and if it increments above 7FFF FFFF hex, an overflow is generated.



If an overflow occurs, the PV of the count will remain at 7FFF FFFF hex, and if an underflow occurs, it will remain at 8000 0000 hex. In either case, counting will stop and the PV Overflow/Underflow Flag shown below will turn ON to indicate the underflow or overflow.

- High-speed counter 1: A858.01
- High-speed counter 2: A859.01

Note The high-speed counter PVs are refreshed during the Motion Control Module's I/O refresh.

When restarting the counting operation, toggle (turn OFF and then ON) the corresponding counter's Reset Bit. (A860.00 is the Reset Bit for high-speed counter 1 and A861.00 is the Reset Bit for high-speed counter 2.)

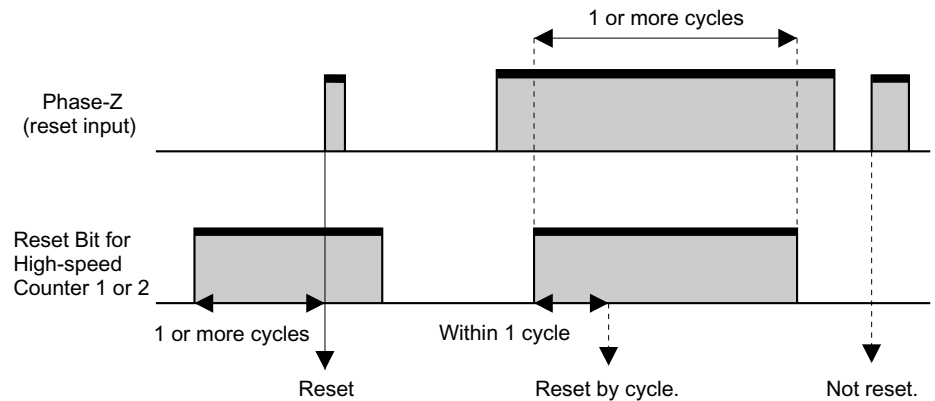
Reset Methods

The following two methods can be set to determine the timing at which the PV of the counter is reset (i.e., set to 0):

- Phase-Z signal and software reset
- Software reset

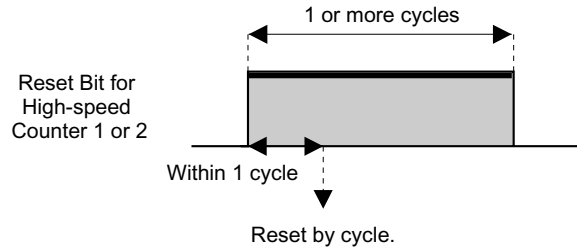
■ **Phase-Z Signal (Reset Input) and Software Reset**

The PV of the high-speed counter is reset on the first rising edge of the phase-Z signal after the corresponding High-speed Counter Reset Bit (see below) turns ON.



■ **Software Reset**

The PV is reset when the High-speed Counter Reset Bit turns ON. There are separate Reset Bits for high-speed counters 1 and 2.



The High-speed Counter Reset Bits are as follows:

- High-speed Counter 1 Reset Bit: A860.01
- High-speed Counter 2 Reset Bit: A861.01

The High-speed Counter Reset Bits are refreshed only once each cycle, so a Reset Bit must be ON for a minimum of 1 cycle to be read reliably.

Note The comparison table registration and comparison execution status will not be changed even if the PV is reset. If a comparison was being executed before the reset, it will continue.

Checking for High-speed Counter Interrupts

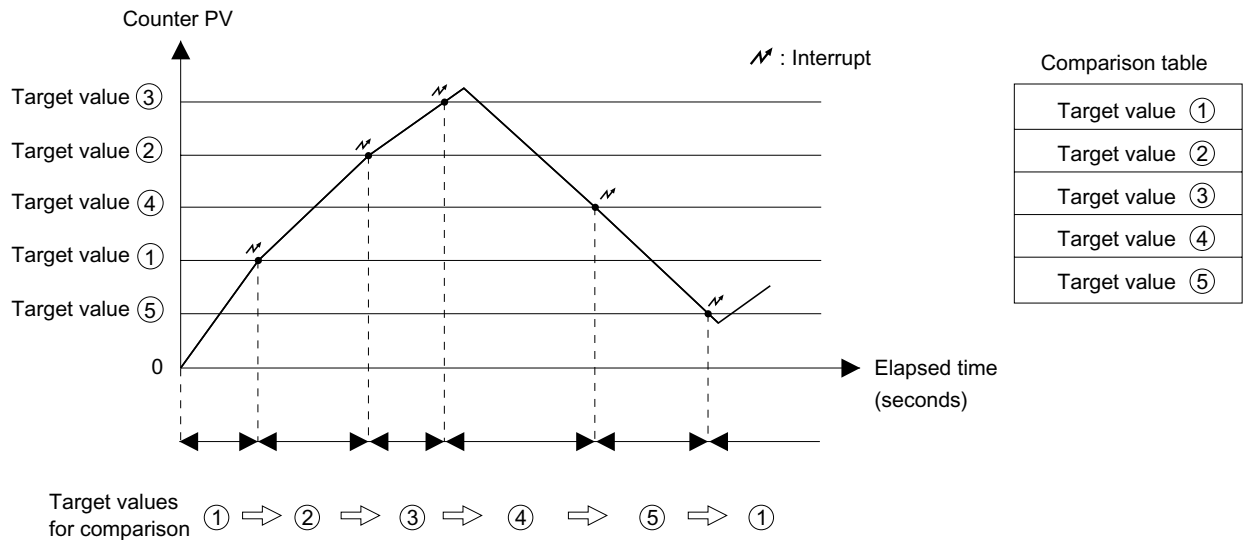
The following two methods are available to check the PV of high-speed counters 1 or 2.

- Target-value comparison method
- Range comparison method

■ Target-value Comparison Method

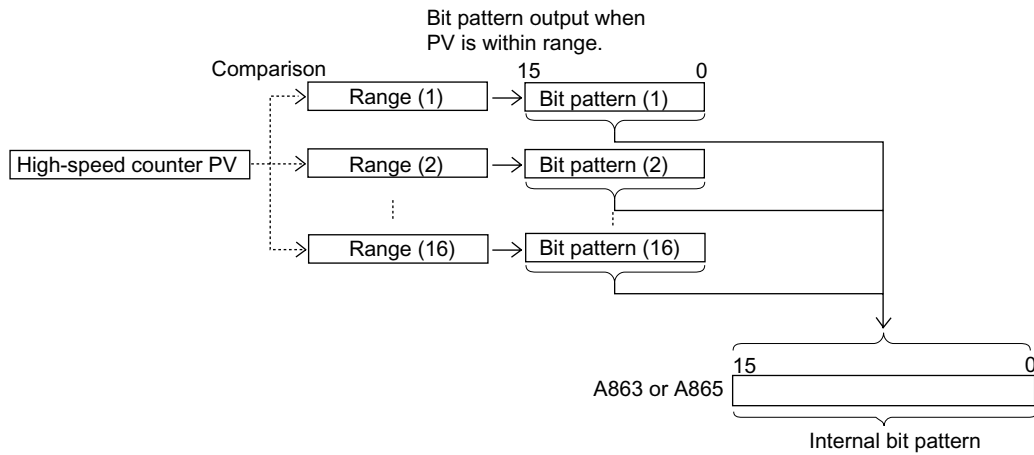
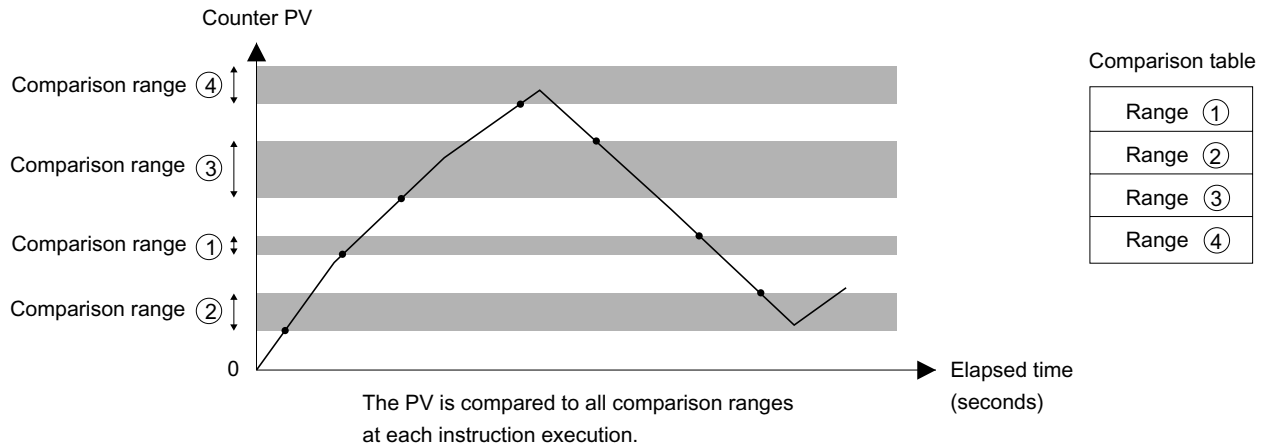
Up to 48 target values and corresponding interrupt task numbers can be registered in the comparison table. When the counter PV matches one of the 48 registered target values, the specified interrupt task will be executed.

Comparisons are made to each target value in the order that they appear in the comparison table until all values have been met, and then comparison will return to the first value in the table.



■ Range Comparison Method

Up to 16 comparison ranges (lower and upper limit values) and corresponding output bit patterns can be registered in the comparison table. When the PV of the counter first is within the upper and lower limits of one of the ranges for CTBL(882) execution, the corresponding bit pattern (1 to 16) will be output to A863 or A865.



Monitoring High-speed Counter Movement (Mode 1)

This function monitors the change in a high-speed counter's PV (travel distance) regularly at the preset sampling period. The sampling period can be set between 1 and 9,999 ms.

If the sampling time is set to 0, the change will be sampled once each cycle. The change in the high-speed counter PV (travel distance) is stored in A854 and A855 (high-speed counter 1) or A856 and A857 (high-speed counter 2). Status Flags A858.06 and A859.06 can be checked to determine whether or not change is being measured.

- Note**
- (1) The change (per sampling period) is refreshed during the Motion Control Module's I/O refreshing.
 - (2) The change in the high-speed counter PV's is output as an absolute value.

Word	Bits	Function	Details
A854 and A855	00 to 15	High-speed Counter 1 Monitor Data	Contains the change in high-speed counter 1. The change in the high-speed counter PV during the specified sampling period is stored in 8-digit hexadecimal (0000 0000 to FFFF FFFF).
A856 and A857	00 to 15	High-speed Counter 2 Monitor Data	Contains the change in high-speed counter 2. The change in the high-speed counter PV during the specified sampling period is stored in 8-digit hexadecimal (0000 0000 to FFFF FFFF).

Word	Bits	Function	Details
A858	06	High-speed Counter 1 Status Flag	Measuring Flag OFF: The high-speed counter movement measurement operation is stopped. ON: The high-speed counter movement is being measured.
A859	06	High-speed Counter 2 Status Flag	Measuring Flag OFF: The high-speed counter movement measurement operation is stopped. ON: The high-speed counter movement is being measured.

The pulse input's counter data display must be set to counter movements (mode 1) in the System Setup in advance. The sampling period must also be set in the System Setup.

Tab page	Function		Details
Pulse input	Counter 1	Counter data display	1 hex: Counter movements (mode 1)
		Sampling time (mode 1)	Set the sampling time when measuring counter movement. 0000: Cycle time 0001 to 270F hex: 1 to 9999 ms (unit: 1 ms)
	Counter 2	Counter data display	1 hex: Counter movements (mode 1)
		Sampling time (mode 1)	Set the sampling time when measuring counter movement. 0000: Cycle time 0001 to 270F hex: 1 to 9999 ms (unit: 1 ms)

High-speed Counter Movement (Mode 1) Specifications

Item	Specifications
Applicable pulse input	Either pulse 1 (high-speed counter 1) or pulse 2 (high-speed counter 2) can be used.
Displayable movement	0000 0000 to FFFF FFFF Note The software can generate the range of values shown above, but some hardware may not be able to display the full range due to input limitations.
Sampling time	Can be set to the cycle time or a fixed time between 1 and 9,999 ms.
Operating conditions	In the System Setup, set the pulse input's counter data display to counter movements (mode 1) and specify the sampling time.

- Note**
- (1) When using mode 1 with a circular counter, set the maximum circular value to 10 or higher.
 - (2) In mode 1, the Motion Control Module outputs the change as the difference in the count measured each sampling period. The output change varies, so determine how to manage the output value in the user program when the counter is reset or the INI(880) instruction is executed to change the PV during sampling.

Monitoring a High-speed Counter's Frequency (Mode 2)

Mode 2 is supported by high-speed counter 1 only.

This function monitors the input pulse's frequency from the high-speed counter movement value. The frequency is stored in A854 and A855. Status Flag A858.06 can be checked to determine whether or not the frequency is being measured.

- Note**
- (1) The frequency value stored in the Auxiliary Area is refreshed during the Motion Control Module's I/O refreshing.
 - (2) The frequency measurement can be performed only with high-speed counter 1. The frequency cannot be measured with high-speed counter 2.
 - (3) When measurement is started, the measurement direction (A860.03) must be specified to match the direction of the input pulses being measured.

Word	Bits	Function	Details
A854 and A855	00 to 15	High-speed Counter 1 Monitor Data	Contains the frequency measurement. The frequency calculated from the high-speed counter PV is stored in 8-digit hexadecimal (0000 0000 to 0007 A120 hex = 0 to 500 kHz).
A858	06	High-speed Counter 1 Status Flag	Measuring Flag OFF: The high-speed counter frequency measurement operation is stopped. ON: The high-speed counter frequency is being measured.

The pulse input's counter data display must be set to frequency measurement (mode 2) in the System Setup in advance.

System Setup	Function	Details
Pulse Input Tab Page Counter data display	Specifies the counter 1 measurement mode.	2 hex: Frequency (mode 2)

Frequency Measurement (Mode 2) Specifications

Item	Specifications
Applicable pulse input	Only pulse 1 (high-speed counter 1) can be used.
Measurable frequencies	0 to 500 kHz Note When no pulses have been input for 10 s, the measured value is set to 0 Hz (stopped). The previous output value is retained during this 10-second interval.
Measurement period	5 ms max. (input frequency 500 Hz min.) Note At input frequencies below 500 Hz, the measurement period is increased to accommodate the lower input frequencies and becomes 200 ms max. for input frequencies of 10 Hz min.
Operating conditions	In the System Setup, set the pulse input's counter data display to frequency measurement (mode 2).

Latching a High-speed Counter's PV

The present counter value can be latched at the rising edge of the latch signal input and stored as the latch register value. Each time the counter value is captured, the latch register value is overwritten with the new value and the old value is lost.

To use the latched counter value (latch register value) in the ladder program, read the latch register value with the PRV(881) instruction.

Word	Bit	Function	Details
A858	08	High-speed Counter 1 Status Flag	Count Latched Flag Indicates that a high-speed counter PV has been captured in the latch register by the latch signal input.
A859	08	High-speed Counter 2 Status Flag	Count Latched Flag (This flag has the same function as the flag for high-speed counter 1.)
A860	08	High-speed Counter 1 Command	Latch Input 1 Enable OFF: Disabled ON: Enabled
	09		Latch Input 2 Enable OFF: Disabled ON: Enabled
A861	08	High-speed Counter 2 Command	Latch Input 1 Enable OFF: Disabled ON: Enabled
	09		Latch Input 2 Enable OFF: Disabled ON: Enabled

There is one latch register provided for each counter.

Both latch input 1 and latch input 2 can be enabled for a single counter, but only latch input 1 will be effective when both inputs are enabled.

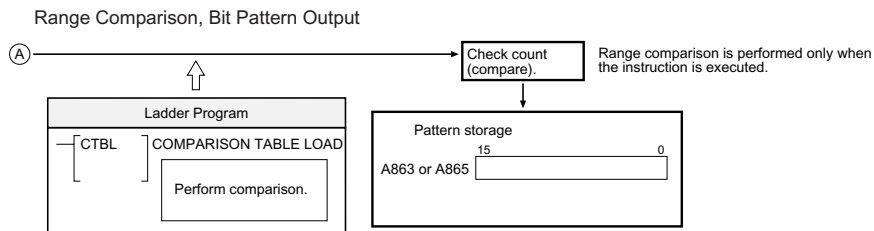
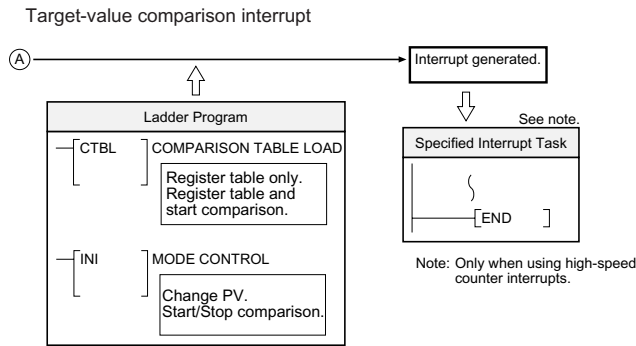
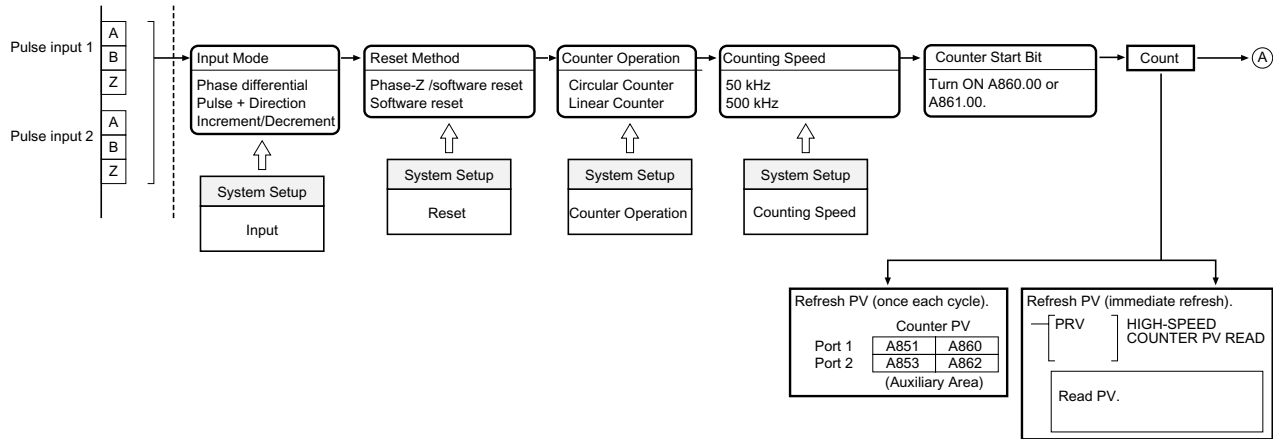
Two latch inputs can be used for a single counter by enabling/disabling latch input 1 and 2 from the ladder program to enable only the desired input when it is required. In this case, allow at least one Motion Control Module cycle between the use of the two inputs.

7-5-9 Pulse Input Function Procedures

High-speed Counter Procedure

- 1,2,3... 1. Determine the Input Mode, reset method, and Numeric Range.
 - Counting Speed: 50 kHz or 500 kHz
 - Input Mode: Phase Differential, Increment/Decrement, or Pulse + Direction
 - Reset method: Phase Z and software reset, or Software reset
 - Counter Operation: Circular Counter or Linear Counter
2. Wire the input.
3. Make the necessary System Setup settings.
 - Counting Speed: 50 kHz or 500 kHz
 - Input Mode: Phase Differential, Increment/Decrement, or Pulse + Direction
 - Reset: Phase Z and software reset, or Software reset
 - Counter Operation: Circular Counter or Linear Counter
 - Count Check Method: Target-value Comparison or Range Comparison
4. If the count check is being used, determine the count check (comparison) method.
5. Create the necessary ladder programming.

- Turn ON the High-speed Counter 1 or 2 Start Bit (A860.00 or A861.00) and start the high-speed counter.
- CTBL(882) instruction: Specifies the port, registers the comparison table, and starts comparison.
- INI(880) instruction: Specifies the port, changes the PV, and starts comparison.
- PRV(881) instruction: Specifies the port and reads the high-speed counter PV.



Mode 1 Procedure

- 1,2,3... 1. Determine the Counting Speed, Input Mode, Reset Method, and Counter Operation.
- Counting Speed: 50 kHz or 500 kHz
 - Input Mode: Phase Differential, Increment/Decrement, or Pulse + Direction
 - Reset method: Phase Z and software reset, or Software reset
 - Counter Operation: Circular Counter or Linear Counter

2. Wire the input.
3. Make the necessary System Setup settings.
 - Counter Data Display: Counter movements (mode 1)
4. Create the necessary ladder programming.
 - Turn ON the High-speed Counter 1 or 2 Start Bit (A860.00 or A861.00) and start the high-speed counter.
 - Turn ON the Measurement Start Bit (A860.02 or A861.02).
 - Monitor the high-speed counter movement value in A854 and A855 (high-speed counter 1) or A856 and A857 (high-speed counter 2).

Procedure

- 1,2,3...**
1. Set *Counter movements (mode 1)* in the System Settings (*Pulse Input, Counter data display*).
 2. Turn ON the Measurement Start Bit (A860.02 or A861.02).
 3. Monitor the high-speed counter movement value in A854 and A855 (high-speed counter 1) or A856 and A857 (high-speed counter 2).

Mode 2 Procedure

- 1,2,3...**
1. Determine the Counting Speed, Input Mode, Reset Method, and Counter Operation.
 - Counting Speed: 50 kHz or 500 kHz
 - Input Mode: Phase Differential, Increment/Decrement, or Pulse + Direction
 - Reset method: Phase Z and software reset, or Software reset
 - Counter Operation: Circular Counter or Linear Counter
 2. Wire the input.
 3. Make the necessary System Setup settings.
 - Counter Data Display: Frequency measurement (mode 2)
 4. Create the necessary ladder programming.
 - Turn ON the High-speed Counter 1 Start Bit (A860.00) and start the high-speed counter.
 - Specify the rotation direction in the Measurement Direction Bit (A860.03). OFF is forward, ON is reverse.
 - Turn ON the Measurement Start Bit (A860.02).
 - Monitor the high-speed counter's frequency in A854 and A855.

Procedure

- 1,2,3...**
1. Set *Frequency measurement (mode 2)* in the System Settings (*Pulse Input, Counter data display*).
 2. Specify the rotation direction in the Measurement Direction Bit (A860.03).
 3. Turn ON the Measurement Start Bit (A860.02).
 4. Monitor the high-speed counter's frequency in A854 and A855.

7-5-10 Pulse Input Function Example Application**Example 1:
High-speed Counter
Target Value
Comparison Interrupt**

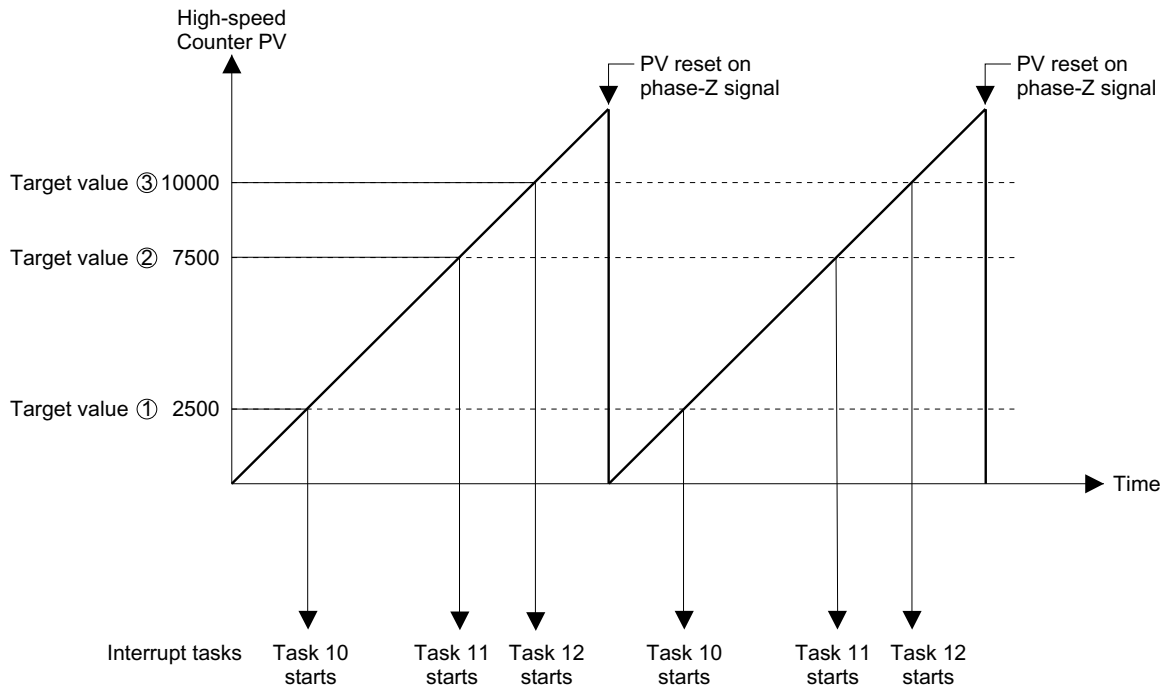
In this example, pulse input 1 operates a high-speed counter, the high-speed counter PV is compared in a target-value comparison, and corresponding interrupt tasks are executed when the target values are reached.

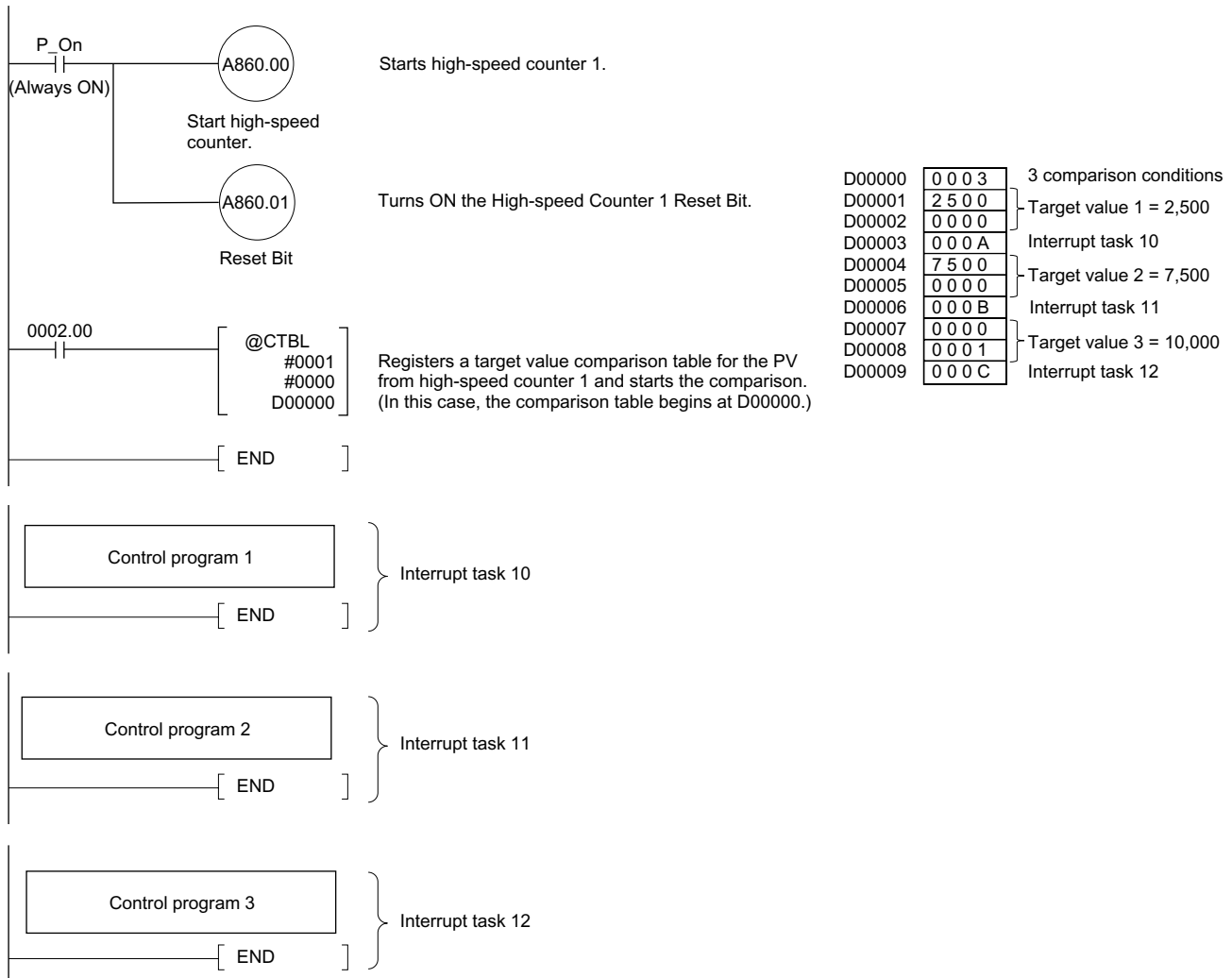
The Reset Bit is kept ON in the program and the PV of the counter is reset when the phase-Z signal is turned ON after the PV reaches its maximum value. Before running the program, make the following settings in the System Setup and restart the FQM1 to enable the new settings.

Counter 1:
Linear Counter, Counting speed = 50 kHz, Phase Z and software reset, and Increment/decrement pulse input

Example

When the PV reaches 2,500 hex, interrupt task 10 is started.
When the PV reaches 7,500 hex, interrupt task 11 is started.
When the PV reaches 10,000 hex, interrupt task 12 is started.





Example 2:
High-speed Counter
Range Comparison &
Bit Pattern Output

In this example, pulse input 1 operates a high-speed counter, the high-speed counter PV is compared in a range comparison, and corresponding bit pattern is output internally when the PV is within a specified range. The internal bit pattern value is output by a transfer to CIO 2961.

The Reset Bit is kept ON in the program and the counter PV is reset when the phase-Z signal turns ON after the PV reaches its maximum value. Before running the program, make the following settings in the System Setup and restart the FQM1 to enable the new settings.

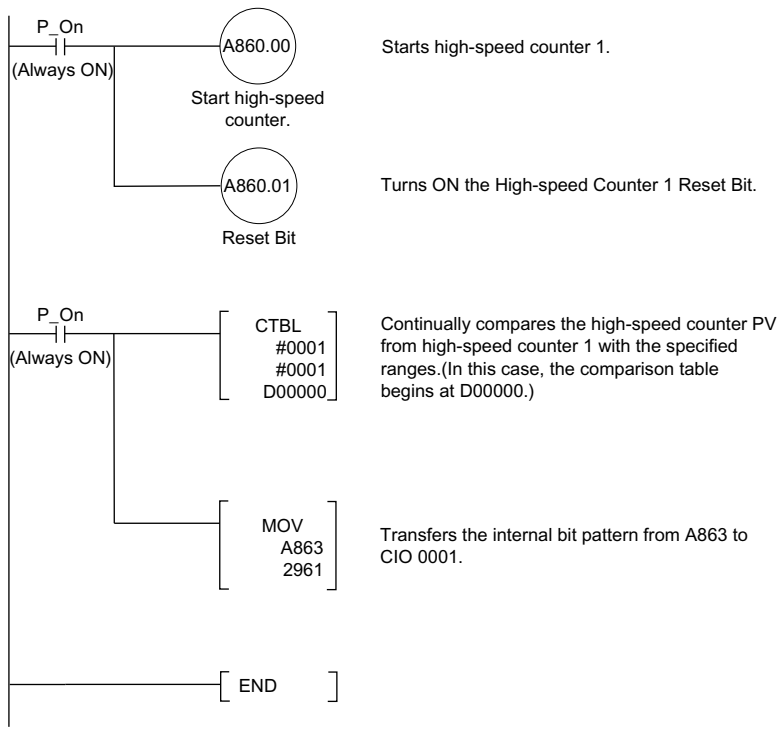
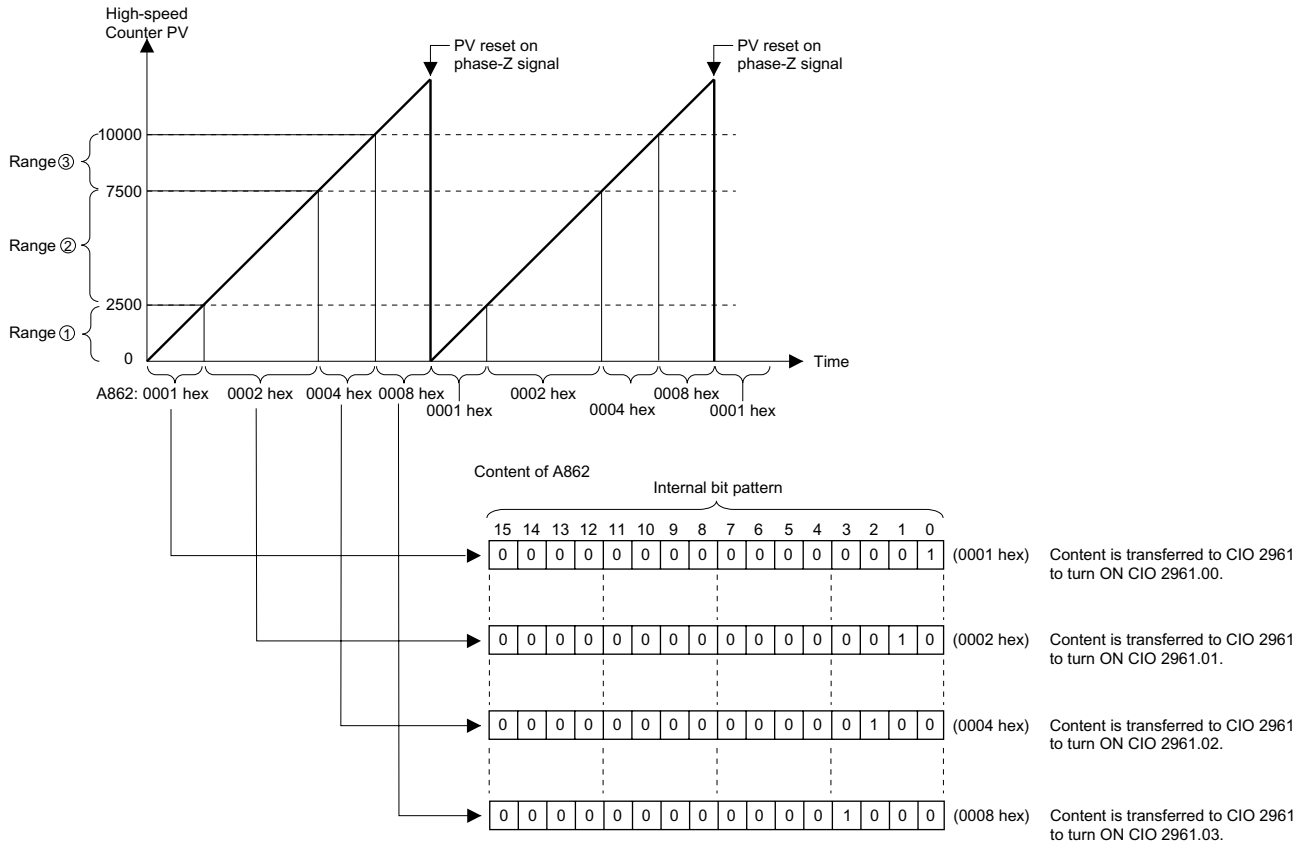
Counter 1:

Linear counter, Counting speed = 50 kHz, Phase Z and software reset, and Increment/decrement pulse input

The other System Setup settings are left at their default settings.

Example

When the PV is between 0 and 2,500 hex, CIO 2961.00 is ON.
 When the PV is between 2,501 and 7,500 hex, CIO 2961.01 is ON.
 When the PV is between 7,501 and 10,000 hex, CIO 2961.02 is ON.
 When the PV is 10,001 hex or higher, CIO 2961.03 is ON.



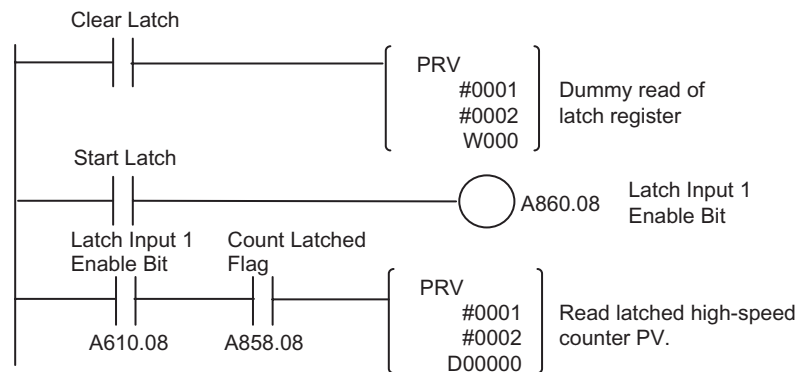
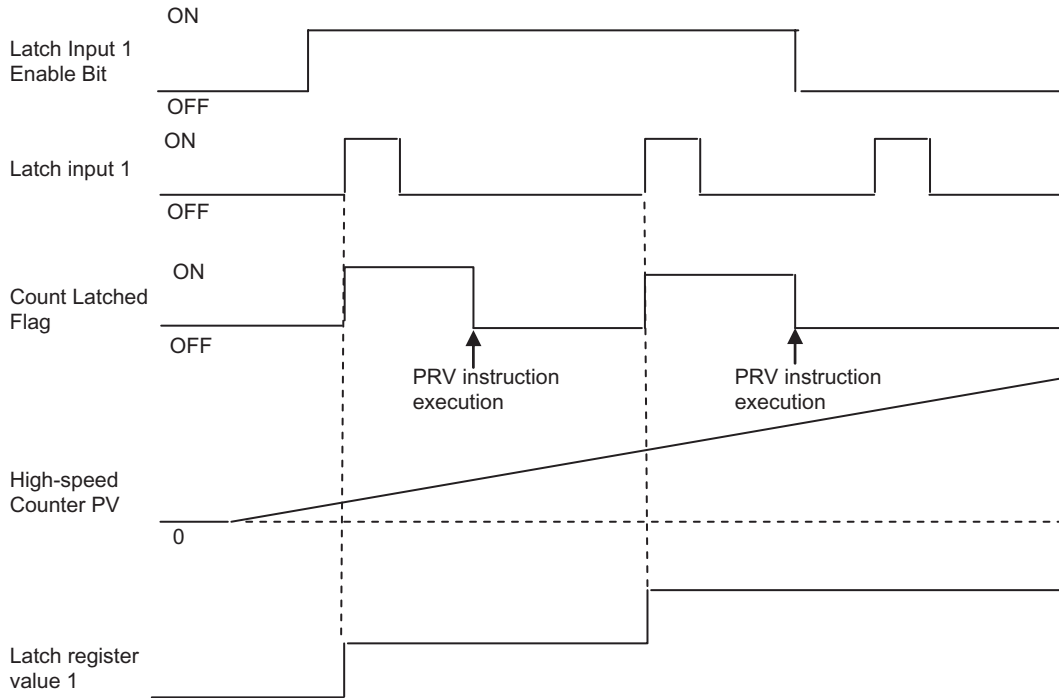
D00000	0 0 0 4	4 comparison conditions	
D00001	0 0 0 0	Lower limit ① 0	Range ①
D00002	0 0 0 0		
D00003	2 5 0 0	Upper limit ① 2500	
D00004	0 0 0 0		
D00005	0 0 0 1	Bit pattern	
D00006	2 5 0 1	Lower limit ② 2501	Range ②
D00007	0 0 0 0		
D00008	7 5 0 0	Upper limit ② 7500	
D00009	0 0 0 0		
D00010	0 0 0 2	Bit pattern	
D00011	7 5 0 1	Lower limit ③ 7501	Range ③
D00012	0 0 0 0		
D00013	0 0 0 0	Upper limit ③ 10000	
D00014	0 0 0 1		
D00015	0 0 0 4	Bit pattern	
D00016	0 0 0 1	Lower limit ④ 10001	Range ④
D00017	0 0 0 1		
D00018	F F F F	Upper limit ④ 7FFFFFFF	
D00019	7 F F F		
D00020	0 0 0 8	Bit pattern	

Example 3:
Latching High-speed Counter PV

In this example, pulse input 1 operates a high-speed counter, the high-speed counter PV is latched, and the captured high-speed counter PV is read. When the Latch Input 1 Enable Bit is ON and the latch input 1 is turned OFF→ON externally, the high-speed counter PV is captured to the latch register and the Count Latched Flag is turned ON during the next I/O refreshing.

The Count Latched Flag is used as a trigger for the PRV(881) instruction to read the captured high-speed counter PV and the Count Latched Flag is then turned OFF.

If latch input 1 is turned ON again while the Count Latched Flag is still ON (before the captured PV has been read by the PRV(881) instruction), the old captured PV will be refreshed with the new captured PV.



7-6 Pulse Outputs

7-6-1 Applicable Models

Model	Functions
FQM1-MMP22	Motion Control Module with Pulse I/O

7-6-2 Outline

The FQM1-MMP22 Motion Control Module provides 2 pulse outputs. The pulse outputs can be used for the following functions.

Note Set the pulse output operation mode for each output in System Setup (Pulse Output Tab Page).

Function	Description	Processing for PV
Pulse output operation mode	The pulse outputs can be used for positioning or speed control at a fixed duty ratio. Select one of five pulse output operation modes: Relative pulse output, linear absolute pulse output, circular absolute pulse output, electronic cam (linear), and electronic cam (circular).	It is possible to generate target-value interrupts (see note 2) or range-comparison bit pattern outputs based on the pulse output's PV. (See note 1.)
One-shot pulse outputs	Pulse output turned ON for only the specified interval (0.01 to 9,999 ms.)	None
Calculation (time measurement)	Enables use of the pulse output counter as a timer using the one-shot pulse output timer. Note Pulses are not output for this mode and the specified port cannot be used for pulse output.	It is possible to generate target-value interrupts or range-comparison bit pattern outputs based on the pulse counter's PV. (See note 1.)

Note (1) The processes listed in the following table can be performed for the PV of a pulse output, pulse output counter timer, or one-shot pulse output elapsed time.

Process	Description
Target value interrupts	An interrupt task can be executed when the high-speed counter PV equals a target value.
Bit pattern outputs for range comparisons	A user-set bit pattern is output internally when the high-speed counter PV is within a specified range.

(2) Cannot be combined with pulse output in independent mode.

7-6-3 Specifications

Item	Specification			
Acceleration/ deceleration	None		Yes	
Trapezoid	None		None (acceleration or deceleration)	Yes with separate acceleration and deceleration rates
Instructions for independent-mode positioning	PULS(886) + SPED(885)	PULS(886) (Electronic Cam Control)	PULS(886) + ACC(888)	PLS2(887)
Instructions for continuous-mode speed control	SPED(885)	---	ACC(888)	---
Output frequencies	Constant specified for SPED(885): 0 Hz to 1 MHz Word specified for SPED(885): 0 Hz to 1 MHz	0 Hz to 1 MHz	0 Hz to 1 MHz	
	<p>Although the above ranges can be set for the instructions, the output frequency range is ultimately controlled by the clock frequency. The output frequencies are obtained by dividing the clock pulse with an integer dividing ratio, meaning the actual output frequency can be different from the set frequency. (Refer to <i>Precautions when Using Pulse Outputs</i> on page 230 for details.)</p> <p>The settings in the System Setup (Clock) are as follows:</p> <p>20 MHz Pulse output frequency range: 400 Hz to 1 MHz 10 MHz Pulse output frequency range: 200 Hz to 200 kHz 5 MHz Pulse output frequency range: 100 Hz to 100 kHz 2.5 MHz Pulse output frequency range: 40 Hz to 50 kHz 1.25 MHz Pulse output frequency range: 20 Hz to 20 kHz</p>			
Frequency acceleration/deceleration rate	---		1 Hz to 9,999 Hz every 2 ms or 1 ms	
Duty ratio	50% (fixed)			
Pulse output operation modes	<p>One of the following can be set for each port in the System Setup.</p> <ol style="list-style-type: none"> 1) Relative pulse output: No. of output pulses = pulse output value 2) Absolute linear pulse output: No. of output pulses = |PV of pulse output – target pulse amount| 3) Absolute circular pulse output: As above. If the circular maximum count is exceeded, the count value returns to 0000 0000 hex. (Circular maximum count is set in System Setup.) 4) Electronic cam control (linear) (output with absolute position specification): The direction is automatically determined from the relation between the PV and target position (PV < Target = CW, PV > Target = CCW. No. of output pulses = |PV of pulse output – target pulse amount|) 5) One-shot pulse output: Pulse turned ON for specified time between 0.01 and 9,999 ms via STIM(980) instruction 6) Pulse counter timer: High-precision timer created using the one-shot pulse output function. Pulses are not output externally. 7) Electronic cam (circular) (output with absolute position specification): The direction is automatically determined from the relation between the PV and target position (PV < Target = CW, PV > Target = CCW). No. of output pulses = |PV of pulse output – target pulse amount|)			

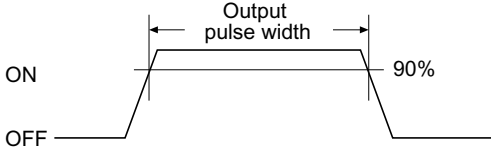
Item	Specification
Number of output pulses	1) Relative pulse output: 0000 0000 to FFFF FFFF hex 2) Absolute linear pulse output: 8000 0000 to 7FFF FFFF hex 3) Absolute circular pulse output: 0000 0000 to Circular maximum count hex 4) Electronic cam control (linear) (output with absolute position specification): 8000 0000 to 7FFF FFFF hex 5) Electronic cam control (circular) (output with absolute position specification): 0000 0000 to 7FFF FFFF hex Note The number of pulses is not set for a one-shot pulse output or pulse counter timer.
Storage location for pulse output PV	The PVs for pulse output operation modes 1 to 5, listed above, are stored in 8-digit hexadecimal in the following Auxiliary Area words: Pulse output 1: A871 (upper bytes) and A870 (lower bytes) Pulse output 2: A873 (upper bytes) and A872 (lower bytes) Target value comparison interrupts or bit pattern outputs for range comparisons can be performed on the PV. Note The contents of these above words are updated during I/O refreshing.

7-6-4 Pulse Output Specifications

All Pulse Outputs Except for One-shot Pulse Outputs

Item	Specification
Number of pulse outputs	2 outputs
Signals	Pulse output CW and CCW
Max. output frequency	1 MHz (but actual output frequencies are governed by clock frequency setting)
External power supply	5 VDC +10%/–15%, 120 mA max.
Line-driver output	Conforms to Am26LS31 and max. output current is 20 mA.

One-shot Pulse Outputs

Item	Specification
Number of pulse outputs	2 output
External power supply	24 VDC +10%/–15%, 30 mA max.
Max. switching capacity	NPN open-collector, 80 mA at 5 to 24 VDC ±10%
Min. switching capacity	NPN open-collector, 7 mA at 5 to 24 VDC ±10%
Leakage current	0.1 mA max.
Residual voltage	0.4 V max.
Output pulse width	(Set time) ± (1 μs or 0.1% of the set time, whichever is larger) 
	Note 1. The load during measurement is assumed to be a simple resistive load and the impedance of the cable connecting the load is not considered. 2. The actual pulse width might be smaller than the value given above due to pulse waveform distortion caused by impedance in the connecting cables.

7-6-5 Applicable Instructions

The following seven instructions can be used to control pulse outputs. The relationship between the instruction and the types of pulse output that is possible is also listed in the following table.

Instruction	Control	Positioning (Independent Mode)			Speed Control (Continuous Mode)	
		No acceleration/deceleration, single-phase output	Acceleration/deceleration, single-phase output		No acceleration/deceleration, single-phase output	Acceleration/deceleration, single-phase output
			No trapezoid, acceleration and deceleration	Trapezoid, separate acceleration and deceleration rates		
PULS(886)	Sets number of output pulses or absolute position.	OK	OK	No	No	No
SPED(885)	Controls pulse output without acceleration or deceleration (number of pulses set with PULS(886) for positioning).	OK	No	No	OK	No
ACC(888)	Controls pulse output with same acceleration and deceleration without trapezoid (number of pulses set with PULS(886) for positioning).	No	OK	No	No	OK
PULS(886) for Electronic Cam	Sets absolute position or frequency and outputs pulses.	OK	No	No	No	No
PLS2(887)	Controls pulse output with different acceleration and deceleration with trapezoid (number of pulses is also set using PLS2(887)).	No	No	OK	No	No
INI(880)	Stops pulse output.	OK	OK	OK	OK	OK
PRV(881)	Reads the current PV for pulse output.	OK	OK	OK	OK	OK

Instructions Ineffective during Pulse Output

Once pulse output has been started by an instruction, the output cannot always be changed with an instruction. Refer to 7-6-15 *Pulse Output Starting Conditions* for details on the allowed combinations of pulse output instructions.

7-6-6 Pulse Output Function Details

Overview

Pulses are output in independent mode or continuous mode. In independent mode, the number of output pulses is specified in advance. In continuous mode, the number of output pulses is not specified in advance.

Mode	Description
Independent mode	This mode is used for positioning. The pulse output stops automatically after the specified number of pulses has been output. With some instructions, the pulse output can be stopped (see note).
Continuous mode	This mode is used for speed control. The pulse output continues until it is stopped by an instruction (see note) or the Motion Control Module is switched to PRO-GRAM mode.

Note When pulses are being output by an SPED(885) or ACC(888) instruction, the pulse output can be stopped by executing the INI(880) instruction. The pulse output can also be stopped by executing SPED(885) or ACC(888) with a target frequency = 0.

When pulses are being output by the PULS(886) instruction (Electronic Cam Control), the pulse output can be stopped by executing the INI(880) instruction.

When using independent mode, select one of the four pulse output operation modes shown in the following table, depending on the method used to calculate the number of pulses and whether it is necessary to change the value during operation. Specify the pulse output operation mode in the System Setup (the operation mode setting in the Pulse Output Tab Page). In addition, if the PULS(886) instruction is being used, it is necessary to specify the Pulse Type in the second operand.

Pulse output operation mode (Only in Independent Mode)	Description	Compatible instructions
(1) Relative pulse output	Positions to a relative position from the present position. The number of output pulses (actual output amount) in the specified direction is the target number of pulses. <ul style="list-style-type: none"> • The frequency can be changed during pulse output. • The direction and the target number of pulses cannot be changed during pulse output. 	PULS(886) + SPED(885) or PULS(886) + ACC(888) (PULS(886) sets the number of pulses and SPED(885) or ACC(888) starts the pulse output.) PLS2(887) (Sets number of pulses and starts pulse output.)
(2) (3) Absolute pulse output	Positions to an absolute position from the origin. The number of output pulses is calculated automatically from the difference between the present position (pulse output PV) and target pulse amount. $\text{Number of output pulses (actual output amount)} = |\text{Present position} - \text{Target position}|$ <ul style="list-style-type: none"> • The frequency can be changed during pulse output. • The direction and the target number of pulses cannot be changed during pulse output. 	---
(2) Linear mode	Operates as linear counter with pulse output values ranging from 8000 0000 to 7FFF FFFF hex.	Same as for (1).
(3) Circular mode	Operates as circular counter with pulse output values ranging from 0000 0000 to the circular value. When the pulse output PV exceeds the circular value, it is automatically returned to 0000 0000. Conversely, when the pulse output PV is decremented from 0000 0000, it is automatically returned to the circular value.	PULS(886) + SPED(885) or PULS(886) + ACC(888) (PULS(886) sets the number of pulses and SPED(885) or ACC(888) starts the pulse output.)
(4) Electronic cam control (linear) (5) Electronic cam control (circular)	Positions to an absolute position from the origin. The difference between the present position (pulse output PV) and target pulse amount is calculated automatically. $\text{Number of output pulses (actual output quantity)} = |\text{Present pulse position} - \text{Target position}|$ <ul style="list-style-type: none"> • The direction is recognized automatically (CW direction when the present position < target position, and CCW direction when the present position > target position). • The frequency and target position can be changed during pulse output. The pulse output will stop if the direction is changed during pulse output. 	PULS(886) (Sets the number of pulses and starts the pulse output.) ACC(888) PLS2(887)

Pulse Output Operations

The following table shows the operations that can be performed with the pulse output function.

Mode	Frequency changes	Description	Procedure		Example
			Instruc-tions	Settings	
Continu-ous mode (Speed control)		The frequency is changed in steps (up or down) during pulse output.	SPED (885) ↓ SPED (885)	Port, CW/CCW, Continuous, Target frequency	Use when changing frequency in steps. (See page 244.)
		The frequency is accelerated or decelerated from the present frequency at a fixed rate.	ACC(888) or SPED (885) ↓ ACC(888)	Port, CW/CCW, Continuous, Acceleration/deceleration rate, Target frequency	Use when accelerating frequency at a fixed rate. (See page 244.)
Independ-ent mode (Positioning)		Pulse output starts at the specified frequency and stops when the specified number of pulses have been output. (The number of pulses cannot be changed during pulse output.)	PULS (886) ↓ SPED (885)	No. of pulses, Relative or absolute operation, Port, CW/CCW, Independent, Target frequency	Use when positioning with a single-phase output and no acceleration or deceleration. (See page 243.)
		The frequency accelerates or decelerates at a fixed rate and stops immediately when the specified number of pulses have been output. (The number of pulses cannot be changed during pulse output.)	PULS (886) ↓ ACC(888)	No. of pulses, Relative or absolute operation, Port, CW/CCW, Independent, Acceleration/deceleration rate, Target frequency	---

Mode	Frequency changes	Description	Procedure		Example
			Instruc-tions	Settings	
Independent mode (Positioning)	<p>Frequency</p> <p>Target frequency</p> <p>Present frequency</p> <p>Time</p> <p>PULS executed. Stops at specified position.</p>	<p>Pulse output starts at the specified frequency and stops immediately when the specified position is reached.</p> <p>(The target position can be changed during positioning (pulse output).)</p>	PULS (886) (Electronic Cam Control)	Port, Target frequency, Absolute positioning	Use for absolute positioning (electronic cam control) with a single-phase output, no acceleration or deceleration, and target position changes in a fixed time interval. (See page 245.)
	<p>Frequency</p> <p>Target frequency</p> <p>Starting frequency</p> <p>Time</p> <p>Output starts</p> <p>Target reached</p> <p>Deceleration point</p> <p>Output stops</p> <p>Stopping frequency</p> <p>Acceleration rate</p> <p>Deceleration rate</p> <p>Specified number of pulses</p>	<p>The frequency accelerates at a fixed rate, decelerates at a fixed rate, and stops when the specified number of pulses have been output.</p> <p>(The number of pulses cannot be changed during positioning (pulse output).)</p>	PLS2 (887)	Port, CW/CCW, Acceleration rate, Deceleration rate, Target frequency, Starting frequency, No. of pulses	Use for trapezoidal acceleration/ deceleration within a set time (the dwell time) and then a repeat of the operation in the opposite direction. (See page 247.)
Stop	<p>Frequency</p> <p>Present frequency</p> <p>Time</p> <p>INI executed.</p>	<p>Stops the pulse output immediately.</p>	SPED (885) or ACC(888) or PULS (886) (Electronic Cam Control) ↓ INI(880)	Stop pulse output	---
	<p>Frequency</p> <p>Present frequency</p> <p>Time</p> <p>SPED executed.</p>	<p>Stops the pulse output immediately.</p>	SPED (885) or ACC(888) ↓ SPED (885)	Port, Continuous, Target frequency = 0	---
	<p>Frequency</p> <p>Present frequency</p> <p>Target frequency = 0</p> <p>Time</p> <p>ACC executed.</p> <p>Acceleration/ deceleration rate</p>	<p>Decelerates the pulse output to a stop.</p>	SPED (885) or ACC(888) ↓ ACC(888)	Port, Continuous, Acceleration/ deceleration rate, Target frequency = 0	---

Note With ACC(888) and PLS2(887), the acceleration/deceleration rate's speed-change cycle can be set to 2ms or 1 ms. Also, the acceleration/deceleration rate can be set between 1 Hz and 9.999 kHz. Refer to 7-6-11 *Acceleration/Deceleration Rates in ACC(888) and PLS2(887)* for more details.

Precautions when Using Pulse Outputs

Pulses are output according to the clock frequency (20 MHz, 10 MHz, 5 MHz, 2.5 MHz, or 1.25 MHz) specified in the System Setup (Pulse Output/Clock). The clock signal is divided by an integer dividing ratio to create and output the output pulse frequency. This means that the actual frequency may not be the same as the target frequency. Refer to the following information to calculate the actual frequency.

The following information is used to calculate the output frequency.

Target frequency:

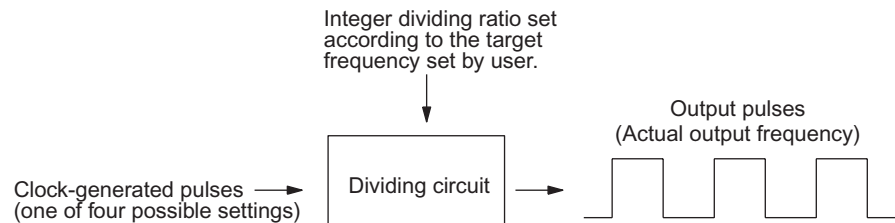
Set by user.

Dividing ratio:

An integer set in the dividing circuit used to generate the output pulses at the target frequency.

Actual frequency:

The actual frequency that is output as generated by the dividing circuit.



Formula:

Actual frequency = Clock frequency ÷ INT (clock frequency/target frequency)

Note INT (clock frequency/target frequency) is the dividing ratio.

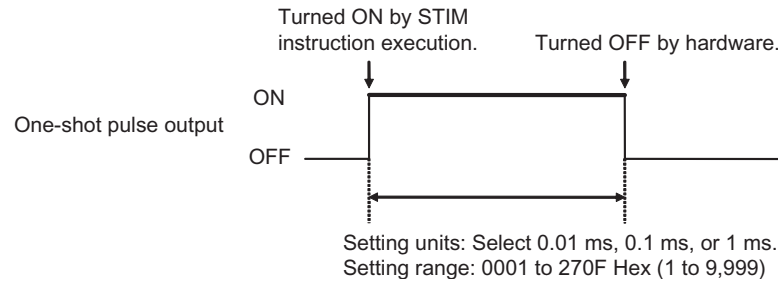
The difference between the target frequency and the actual frequency increases at higher frequencies. The following tables shows examples for a clock frequency of 20 MHz.

Target frequency (Hz)	Actual output frequency
952,382 to 1,000,000	1,000,000
909,092 to 952,381	952,381
869,566 to 909,091	909,091
·	·
·	·
·	·
487,806 to 500,000	500,000
476,191 to 487,805	487,805
465,117 to 476,190	476,190
·	·
·	·
·	·
198,021 to 200,000	100,806
196,079 to 198,020	198,020
194,176 to 196,078	196,078
·	·
·	·
·	·
49,876 to 50,000	50,000

Target frequency (Hz)	Actual output frequency
49,752 to 49,875	49,875
4,929 to 49,751	49,751
.	.
.	.
.	.
402	402
401	401
400	400

7-6-7 One-shot Pulse Output Function

The one-shot pulse output function turns ON the output only for a specified time between 0.01 and 9,999 ms. Use the STIM(980) instruction to start the pulse output (turn the output from OFF to ON). After the time specified in STIM(980) has elapsed, the pulse output is automatically turned OFF (in the hardware).



Set the pulse output operation mode to *1 shot* in advance in the System Setup, as shown in the following table.

Tab page	Function	Setting
Pulse Output	Pulse Output 1 – Operation mode	1 shot (one-shot pulse output)
	Pulse Output 2 – Operation mode	1 shot (one-shot pulse output)

Note A pulse output port that is being used for one-shot pulse outputs cannot be used for any other pulse output functions.

The elapsed time of the one-shot pulse output is stored in 8-digit hexadecimal in words A871 and A870 (pulse output 1) or A873 and A872 (pulse output 2). When the one-shot pulse output is turned ON, the content of the corresponding words is set to 0000 0000 hex and the content is incremented as time passes. The final value is retained when the one-shot output is turned OFF.

Word	Bits	Function	Contents	
A870	00 to 15	Elapsed time of One-shot pulse output 1	Lower 4 digits	Contains the elapsed time of the one-shot pulse output in 8-digit hexadecimal. The content can range from 0000 0000 to 0000 270F hex, and the units are set to 0.01 ms, 0.1 ms, or 1 ms with the STIM(980) instruction. Note These words are refreshed during the Motion Control Module's I/O refreshing.
A871	00 to 15		Upper 4 digits	
A872	00 to 15	Elapsed time of One-shot pulse output 2	Lower 4 digits	These words function just like the words for pulse output 1, described above.
A873	00 to 15		Upper 4 digits	

One-shot Pulse Output Specifications

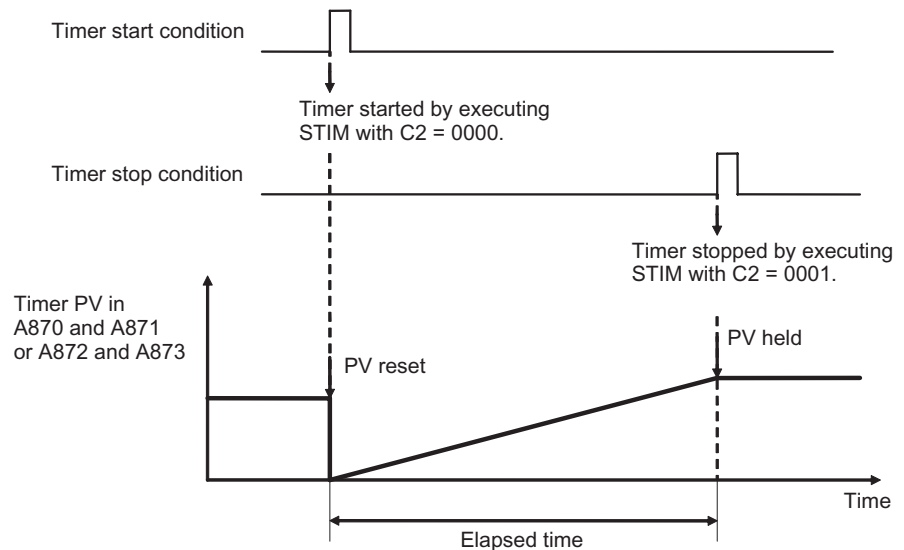
Item	Specification
Pulse ON time	0.01 to 9,999 ms (Can be set with the STIM(980) instruction.)
Operating conditions	1. Set the pulse output operation mode to <i>1 shot</i> in the System Setup. 2. Execute the STIM(980) instruction with operand C1 = #0001 or #0002.
Response time	Response time when the STIM(980) instruction is executed at the beginning of an interrupt task: 0.2 ms max. from the generation of the interrupt until the one-shot pulse output goes ON

7-6-8 Time Measurement with the Pulse Counter

The one-shot pulse output function can be used to create a high-precision pulse counter timer.

To measure time with high-precision, start the timer by executing the STIM(980) instruction with C1 = 000B or 000C and C2 = 0000, and stop the timer by executing STIM(980) with C1 = 000B or 000C and C2 = 0001.

Counting mode
(Time measurement)



The timer's elapsed time is stored in 8-digit hexadecimal in words A871 and A870 (pulse output 1) or A873 and A872 (pulse output 2). When the timer starts, the corresponding words are initialized to 0000 0000 hex and the content is incremented as time passes. The final value is retained when the timer stops.

Word	Bits	Function	Contents	
A870	00 to 15	Pulse time measurement 1	Lower 4 digits	Contains the pulse counter's time measurement in 8-digit hexadecimal. The content can range from 0000 0000 to FFFF FFFF hex. Note These words are refreshed during the Motion Control Module's I/O refreshing.
A871	00 to 15		Upper 4 digits	

Word	Bits	Function	Contents	
A872	00 to 15	Pulse time measurement 2	Lower 4 digits	These words function just like the words for pulse time measurement 1, described above.
A873	00 to 15		Upper 4 digits	

Set the pulse output operation mode to *Calculation (time measurement)* in advance in the System Setup, as shown in the following table.

Tab page	Function	Details
Pulse Output	Pulse output 1 – Operation mode	Calculation (time measurement)
	Pulse output 2 – Operation mode	

- Note**
- (1) The external pulse output from the port is disabled when this mode is selected.
 - (2) A pulse output port that is being used as a pulse counter timer cannot be used for any other pulse output functions.
 - (3) If the STIM(980) instruction is executed again to restart an operating timer, the timer value will be reset to 0 and the timer will restart.

Pulse Counter Timer Specifications

Item	Specification
Timer measurement range	0000 0000 to FFFF FFFF hex The time units can be set to 0.01 ms, 0.1 ms, or 1 ms with the STIM(980) instruction.
Operating conditions	<ol style="list-style-type: none"> 1. Set the pulse output operation mode to <i>Calculation (time measurement)</i> in the System Setup. 2. To start or stop the timer, execute the STIM(980) instruction with operand C1 = #000B or #000C and one of the following C2 values: To start the timer, execute STIM(980) with operand C2 = #0000. To stop the timer, execute STIM(980) with operand C2 = #0001.

7-6-9 Target-value Comparison Interrupts from Pulse Output PVs

An interrupt task can be executed when the pulse output PV reaches a target value, although this function cannot be used in independent mode (positioning), one-shot pulse output operation mode, or electronic cam control because the pulse output stops.

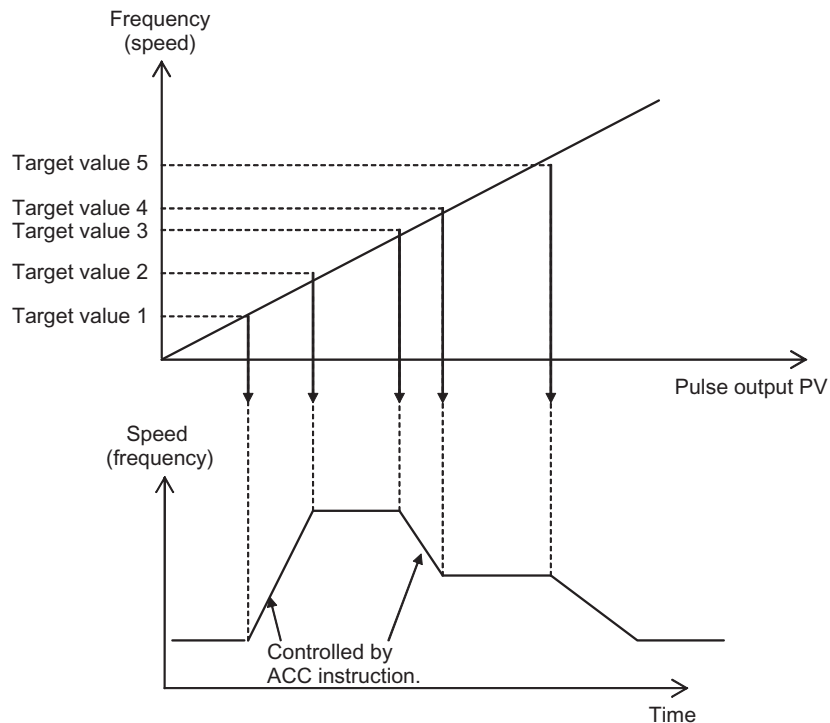
When the pulse output operation mode is set to linear mode, this function can be used for speed control (frequency changes) based on the present position.

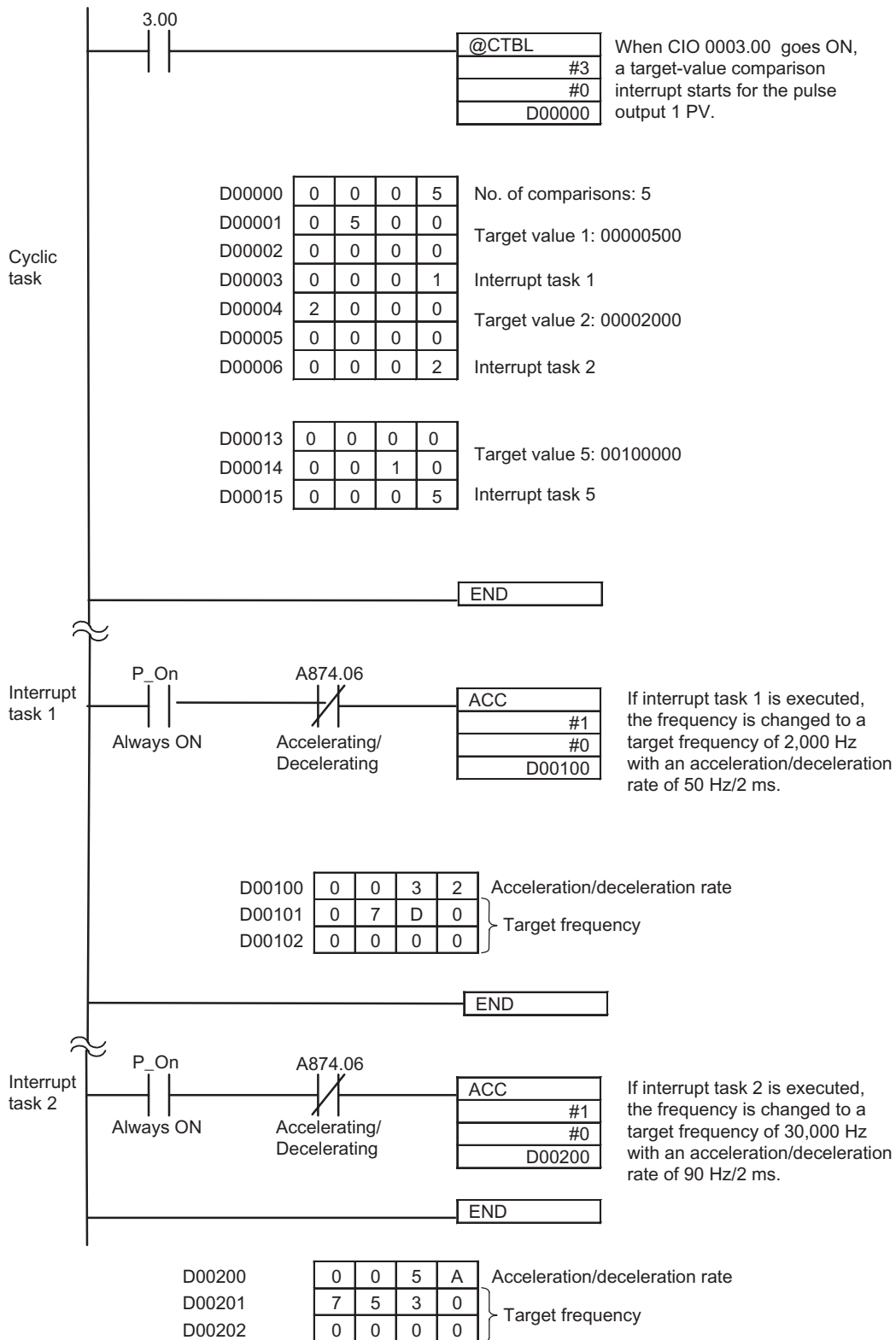
When the pulse output operation mode is set to circular mode, this function can be used for continuous speed control to control a series of repetitive operations at specific positions by repeating speed control patterns.

The processing of the target-value comparison interrupts for pulse output PVs is the same as the processing for high-speed counter PVs, so refer to *Checking for High-speed Counter Interrupts* under *High-speed Counter Function Description* in 7-5-8 *Pulse Input Function Description* for details.

**Linear Mode
Operation**

A target value can be set at a desired pulse output PV to execute an interrupt task when the target value is reached. An ACC(888) or SPED(885) instruction can be programmed in the interrupt task to perform speed control at that target value.



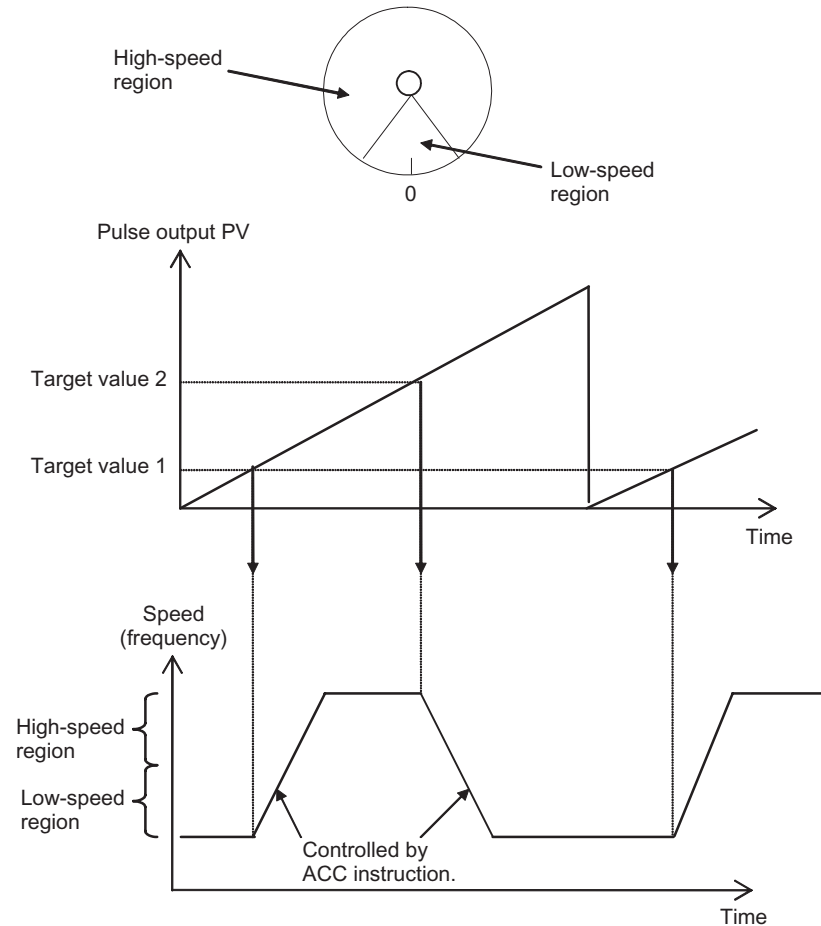


(Interrupt tasks 3, 4, and 5 are entered in the same way.)

Circular Mode Operation

A speed control pattern can be repeated in continuous speed control to control a series of repetitive operations at specific positions. For example, the following diagram shows an axis that repeatedly switches to low-speed operation at one position and switches to high-speed operation at another position. Since the speed control pattern must repeat in these applications, a counter cannot be used if it is reversible.

Single-rotation speed control pattern



7-6-10 Range Comparison Bit Pattern Outputs from Pulse Output PVs

Bit patterns can be output internally in the Auxiliary Area when the pulse output PV is within a specified range.

The processing of the range-comparison bit pattern outputs for pulse output PVs is the same as the processing for high-speed counter PVs, so refer to *Checking for High-speed Counter Interrupts* under *High-speed Counter Function Description* in 7-5-8 *Pulse Input Function Description* for details.

7-6-11 Acceleration/Deceleration Rates in ACC(888) and PLS2(887)

The acceleration/deceleration rate's speed-change cycle can be set to either 1 ms or 2 ms for the ACC(888) and PLS2(887) instructions. The same speed-change cycle setting applies to both pulse outputs 1 and 2 and both the ACC(888) and PLS2(887) instructions. Therefore, the speed-change cycle will be ignored in any instructions that are execute while pulse output is in progress on either port.

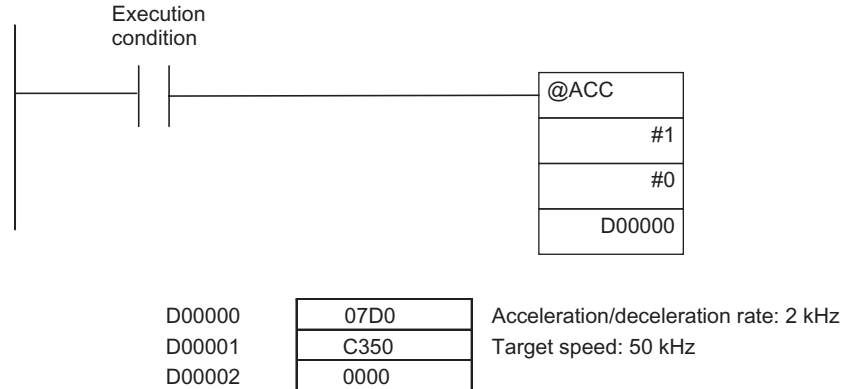
Do not change the speed-change cycle during pulse output on either port. Doing so may result in malfunction. Change the speed-change cycle only when pulse output is not in progress for both ports.

Setting the Speed-change Cycle

The speed change cycle for the ACC(888) and PLS2(887) instructions is specified by setting the ON/OFF bit status of A878.07 before executing the ACC(888) or PLS2(887) instruction.

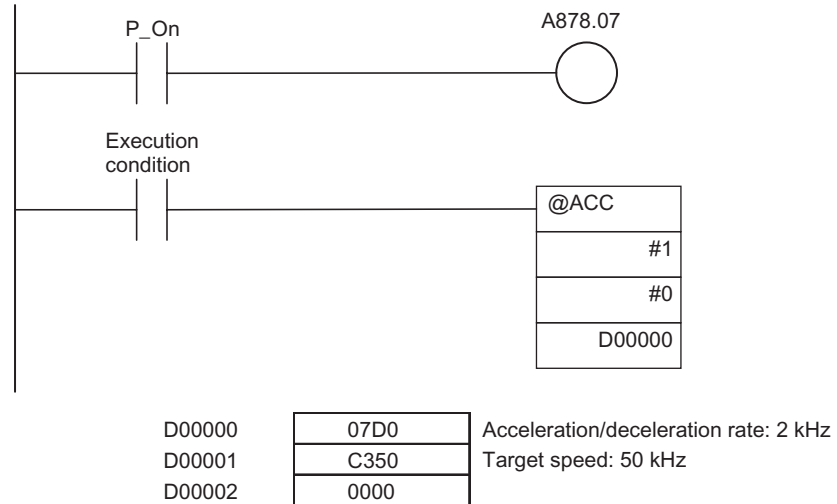
2-ms Cycle

Execute ACC(888) or PLS2(887) with A878.07 OFF.



1-ms Cycle

Execute ACC(888) or PLS2(887) with A878.07 ON.



7-6-12 PLS2(887) Pulse Output Direction Priority Mode

The direction of pulses output by the PLS2(887) instruction can be determined manually based on a user-set operand (pulse output direction priority mode) or automatically based on the absolute position (absolute position priority mode).

Pulse Output Direction Priority Mode

The user determines the pulse output direction with an operand setting. Pulses will be output only when the output direction specified in the PLS2(887) instruction matches the direction determined from the absolute position.

Absolute Position Priority Mode

The pulse output direction is determined automatically from the absolute position.

The Motion Control Module ignores the pulse output direction specified by the PLS2(887) operand setting. This mode allows positioning to be based on the absolute position only, so it is not necessary for the user to specify the direction.

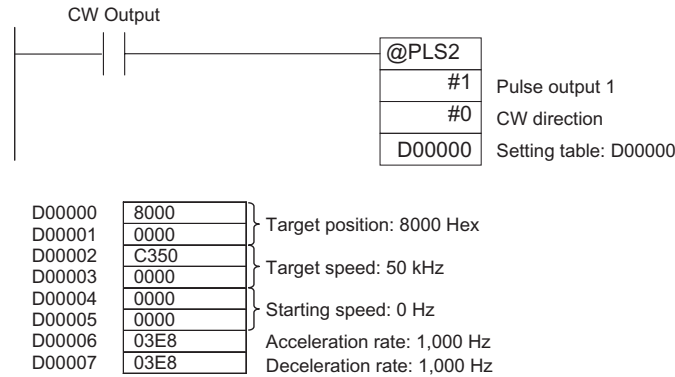
Setting the Pulse Output Direction Priority Mode

The pulse output direction priority mode for the PLS2(887) instruction is specified by setting the ON/OFF bit status of A878.14 before executing the PLS2(887) instruction.

Note The priority mode setting in A878.14 applies to both pulse output 1 and 2.

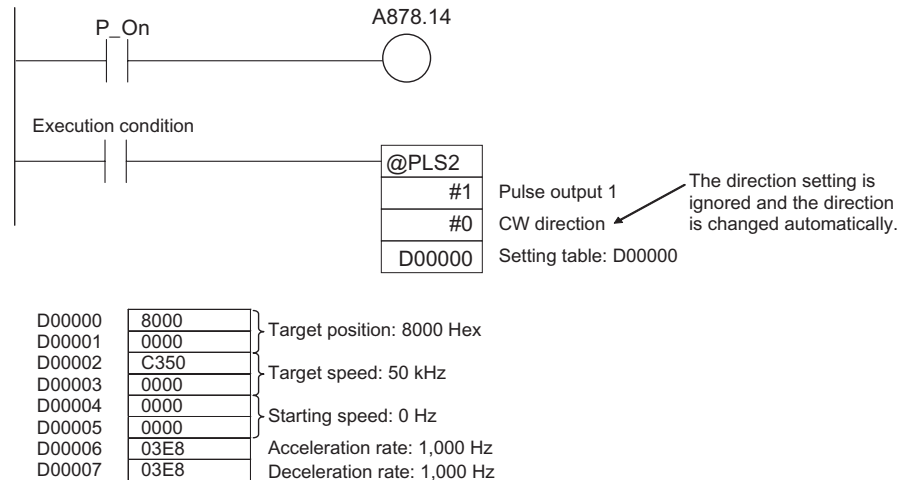
Pulse Output Direction Priority Mode

Execute PLS2(887) with A878.14 OFF.



Absolute Position Priority Mode

Execute PLS2(887) with A878.14 ON.



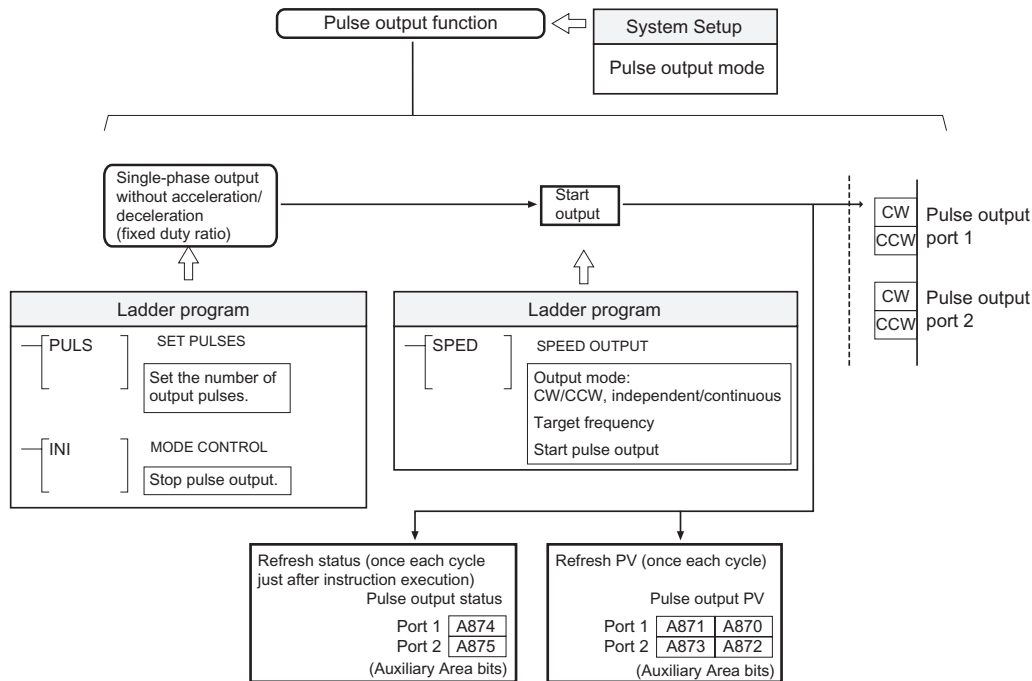
7-6-13 Pulse Output Function Procedures

Pulse Outputs without Acceleration/Deceleration (PULS(886) + SPED(885))

This procedure shows how to use PULS(886) and SPED(885) to generate a single-phase pulse output without acceleration or deceleration. The number of output pulses **cannot** be changed during positioning.

- 1,2,3...
1. Determine pulse output port.
 - Select pulse output 1 or 2.
 2. Wire the output.
 - Output: CW and CCW
 - Output power supply: 5 V DC

3. Make the necessary System Setup settings (Pulse Output Tab Page – Operation Mode).
 - Set the pulse output operation mode (in the Pulse Output Tab Page – Operation Mode) to relative pulse output, absolute linear pulse output, or absolute circular pulse output.
 - Set the clock speed for pulse outputs 1 and 2.
4. Create the necessary ladder programming.
 - Use PULS(886) to set number of output pulses for the specified port.
 - Use SPED(885) to start pulse output control without acceleration/deceleration from the specified port.
 - Use INI(880) to stop pulse output from the specified port.
 - Use PRV(881) to read the pulse output PV of the specified port.

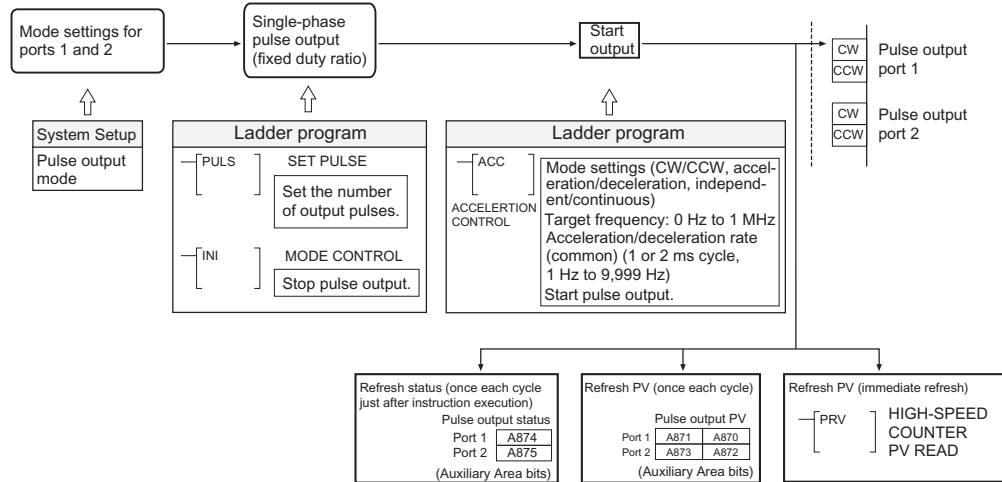


Pulse Outputs with Acceleration/Deceleration

This procedure shows how to use PULS(886) and ACC(888) to generate a pulse output with acceleration or deceleration. The number of output pulses **cannot** be changed during positioning.

- 1,2,3...**
1. Determine pulse output port.
 - Select pulse output 1 or 2.
 2. Wire the output.
 - Output: CW and CCW
 - Output power supply: 5 V DC
 3. Make the necessary System Setup settings (Pulse Output Tab Page – Operation Mode).
 - Set the pulse output operation mode (in the Pulse Output Tab Page – Operation Mode) to relative pulse output, absolute linear pulse output, or absolute circular pulse output.
 - Set the clock speed for pulse outputs 1 and 2.
 4. Create the necessary ladder programming.

- Use PULS(886) to set number of output pulses for the specified port.
- Use ACC(888) to start pulse output control with acceleration or deceleration from the specified port (acceleration and deceleration are specified separately).
- Use INI(880) to stop pulse output from the specified port.
- Use PRV(881) to read the pulse output PV of the specified port.



Pulse Outputs without Acceleration/Deceleration (PULS(886): Electronic Cam Control)

This procedure shows how to use the PULS(886) instruction’s electronic cam control function to generate a single-phase pulse output without acceleration or deceleration. The number of output pulses **can** be changed during positioning.

Procedure

- 1,2,3...**
1. Determine pulse output port.
 - Select pulse output 1 or 2.
 2. Wire the output.
 - Output: CW and CCW
 - Output power supply: 5 V DC
 3. Make the necessary System Setup settings (Pulse Output Tab Page – Operation Mode).
 - Set the pulse output operation mode (in the Pulse Output Tab Page – Operation Mode) to absolute linear pulse output (electronic cam control) or absolute circular pulse output (electronic cam control).
 - Set the clock speed for pulse outputs 1 and 2.
 4. Create the necessary ladder programming.
 - Use PULS(886) to set the absolute position, output frequency, and pulse output (automatic determination of pulse output direction) for the specified port.
 - Use INI(880) to stop pulse output from the specified port.
 - Use PRV(881) to read the pulse output PV of the specified port.

Electronic Cam Control Functions

The electronic cam control supports the following functions.

- The pulse output direction is determined automatically by comparing the present position (pulse output PV) and target position.

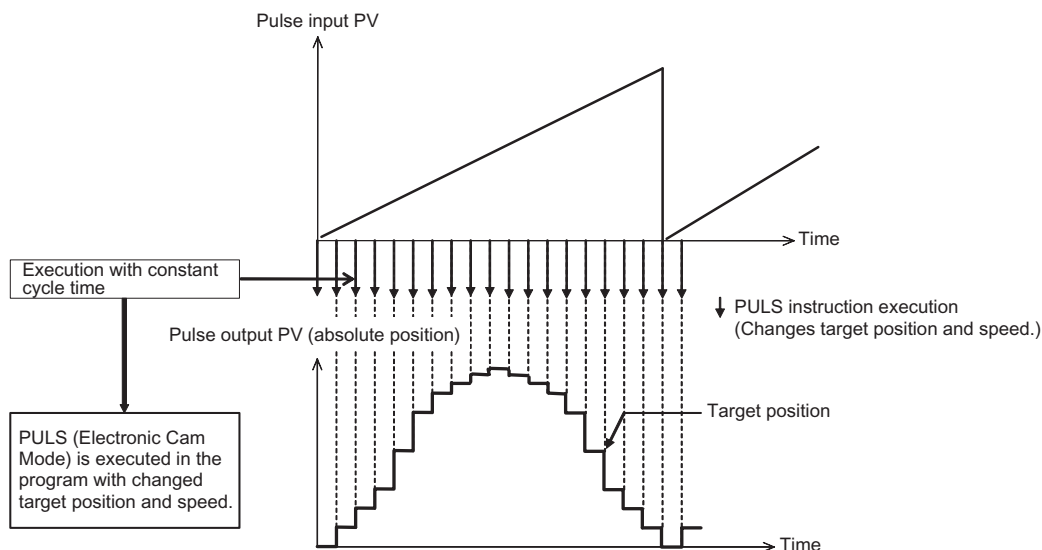
- The PULS(886) instruction can be executed during pulse output to change the absolute position setting and pulse frequency.
- Applications of Electronic Cam Operation:

The PULS(886) instruction (Electronic Cam Control) can be used to immediately change the pulse output value for absolute positioning or the pulse output frequency for speed control in response to the high-speed counter PV (e.g., for a rotational angle). This feature allows the Motion Control Module to perform electronic cam operation using simple linear approximation of a curve (for position or speed control based on the cam angle).

By setting a constant cycle time, the high-speed counter PV is read at regular intervals. The PULS(886) (Electronic Cam Control) instruction is executed immediately after reading the high-speed counter PV in order to determine the new target position for that cycle.

With the PULS(886) instruction (Electronic Cam Control), the target position or pulse output frequency (speed) can be changed by executing another instruction to change the target position or output frequency while the PULS(886) instruction is being executed. Consequently, position and speed control can be performed while outputting pulses, which is not possible with the PULS(886) + SPED(885) and PULS(886) + ACC(888) instruction combinations. This capability allows the target position or pulse output frequency (speed) to be changed in steps at high-speed in response to changes in the pulse input PV. In addition, the pulse input PV can be processed with operations such as basic arithmetic operations and the result can be used for the target position or pulse output frequency (speed).

Note The pulse output direction is selected automatically based on the relationship between the present position (pulse output PV) and target position.

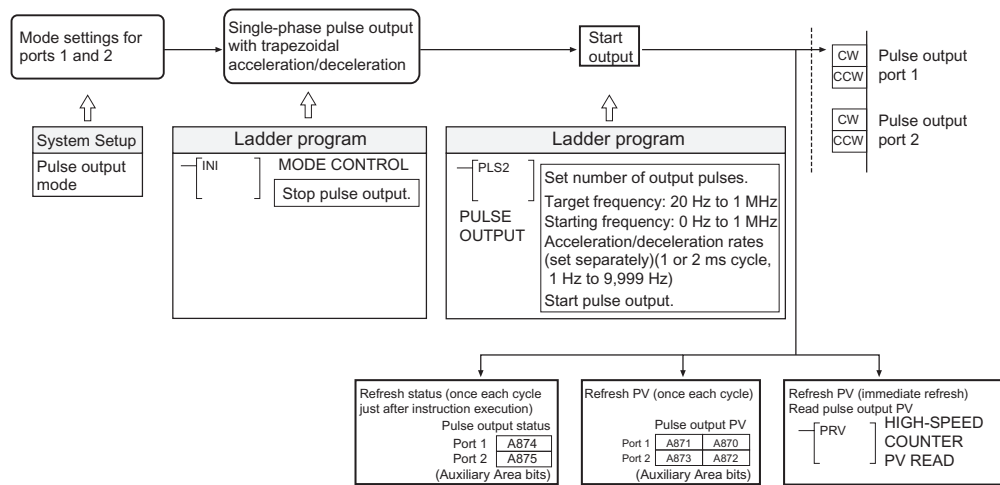


Note Speed control can be performed on a virtual axis by generating a virtual axis position (internal pulse count) with the AXIS instruction, processing that value with arithmetic operations or the APR instruction, and changing the target position or speed with the PULS(886) instruction. Refer to 7-8-4 Application Example for details.

Trapezoidal Pulse Output with Acceleration/Deceleration (PLS2(887))

This procedure shows how to use PLS2(887) to generate a pulse output with trapezoidal acceleration and deceleration. The number of output pulses **cannot** be changed during positioning.

- 1,2,3...
1. Determine pulse output port.
 - Select pulse output 1 or 2.
 2. Wire the output.
 - Output: CW and CCW
 - Output power supply: 5 V DC
 3. Make the necessary System Setup settings (Pulse Output Tab Page – Operation Mode).
 - Set the pulse output operation mode (in the Pulse Output Tab Page – Operation Mode) to relative pulse output or absolute linear pulse output.
 - Set the clock speed for pulse outputs 1 and 2.
 4. Create the necessary ladder programming.
 - Use PLS2(887) to start pulse output control with trapezoidal acceleration/ deceleration from the specified port (acceleration and deceleration are specified separately).
 - Use INI(880) to stop pulse output from the specified port.
 - Use PRV(881) to read the pulse output PV of the specified port.



One-shot Pulse Output (STIM(980))

- 1,2,3...
1. Determine pulse output port.
 - Select pulse output 1 or 2.
 2. Wire the output.
 3. Make the necessary System Setup settings.
 - Set the pulse output operation/dec mode (in the Pulse Output Tab Page – Operation Mode) to *1 shot*.
 4. Create the necessary ladder programming.
 - Use STIM(980) (with C1 = #0001 or #0002) to turn ON the one-shot pulse output.

Note The STIM(980) one-shot pulse output function can be used at the same time as an STIM(980) timer interrupt function (one-shot timer or scheduled timer).

Pulse Counter Timer Function (STIM(980))

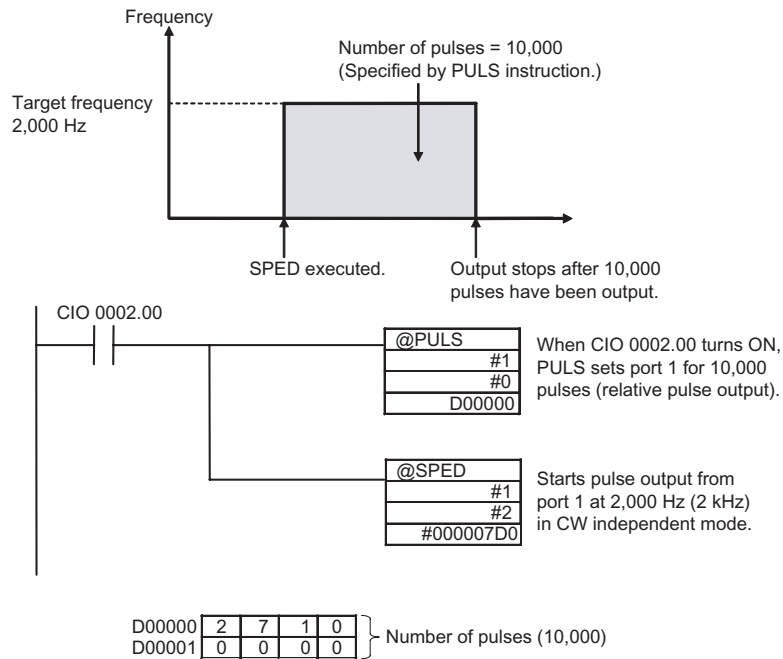
- 1,2,3...
1. Determine pulse output port.
 - Select pulse output 1 or 2.
 2. Make the necessary System Setup settings.
 - Set the pulse output operation mode (in the Pulse Output Tab Page – Operation Mode) to *Calculation (time measurement)*.
 3. Create the necessary ladder programming.
 - a. Use STIM(980) with C1 = #000B or #000C and C2 = #0000 to start measurement.
 - b. Use STIM(980) with C1 = #000B or #000C and C2 = #0001 to stop measurement.

Note The STIM(980) pulse counter timer function used at the same time as an STIM(980) timer interrupt function (one-shot timer or scheduled timer).

7-6-14 Pulse Output Function Examples

Positioning using Pulse Outputs without Acceleration/Deceleration

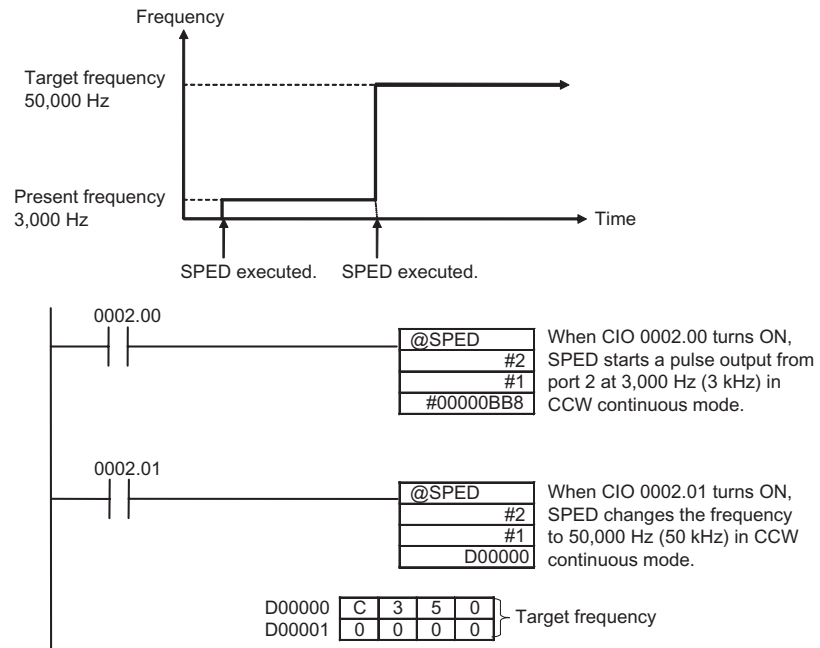
In the following positioning example, the PULS(886) and SPED(885) instructions are used to control a relative pulse output from port 1 (CW independent mode positioning). The number of pulses specified in PULS(886) (10,000) are output at the frequency specified in SPED(885) (2,000 Hz).



Caution Be sure that the pulse frequency is within the motor's self-starting frequency range when starting and stopping the motor.

Changing the Frequency in Steps

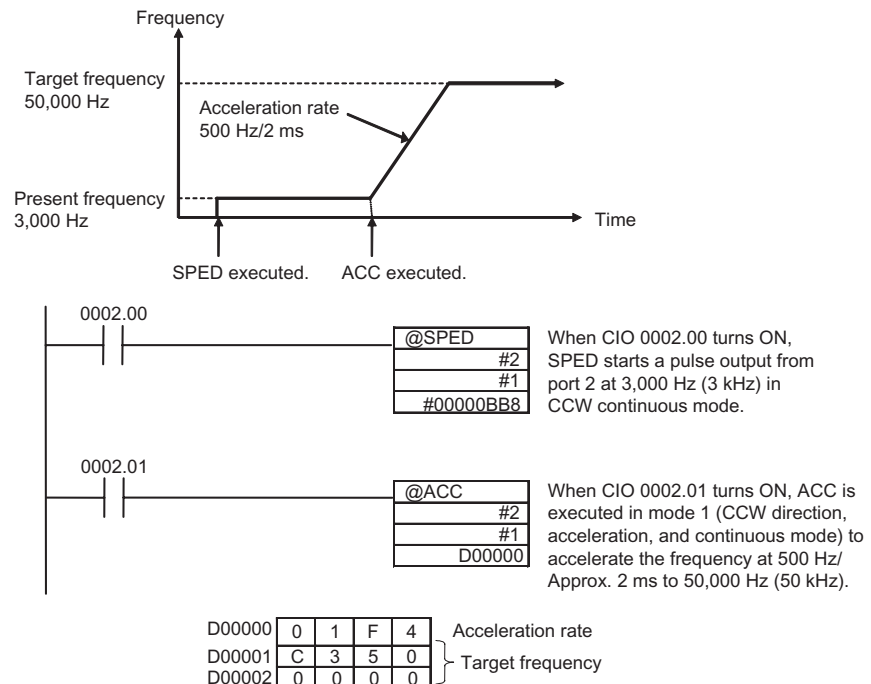
In this example, the SPED(885) instruction is used to change the speed of a pulse output from port 2 from a frequency of 3,000 Hz to 50,000 Hz. In this case, the pulse output is a CCW continuous mode output.



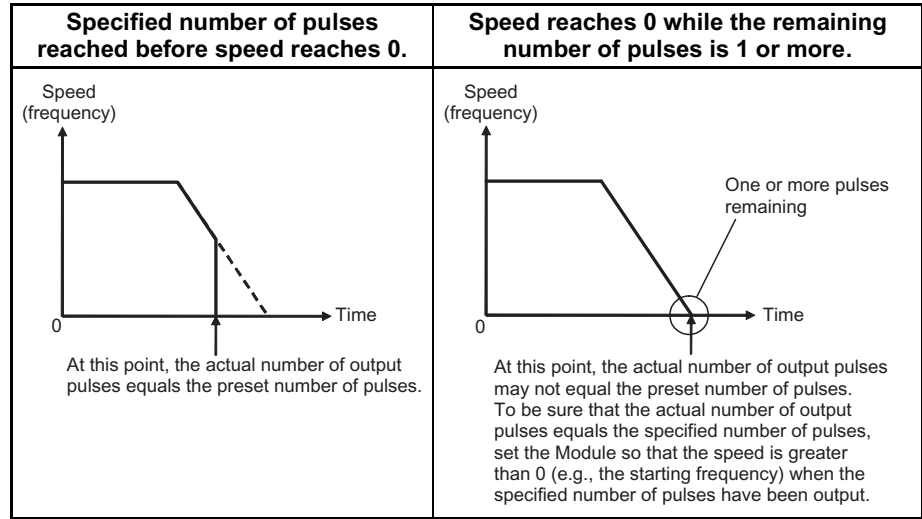
Note Speed control timing will be accurate when frequency changes are executed by SPED(885) instructions in interrupt tasks called by input interrupts.

Accelerating the Frequency at a Fixed Rate

In this example, the ACC(888) instruction is used to accelerate the pulse output from port 2 from a frequency of 3,000 Hz to 50,000 Hz at an acceleration rate of 500 Hz/2 ms.



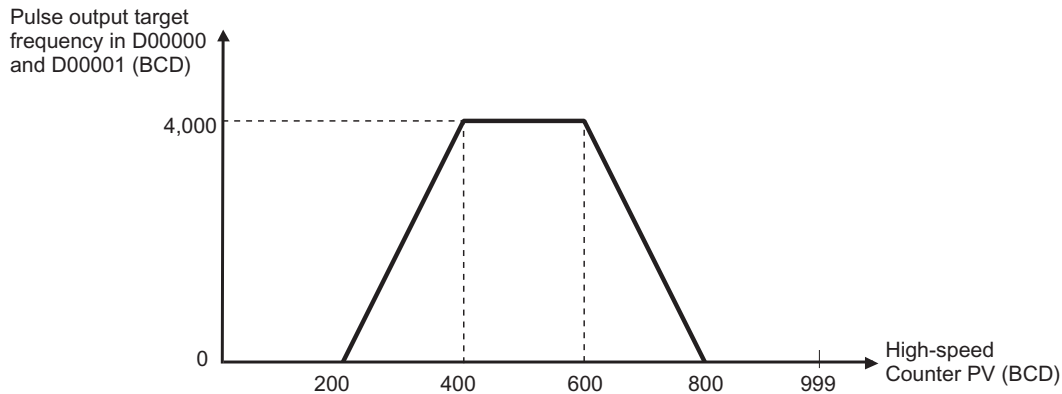
Note The pulse output can be stopped by executing ACC(888) with a deceleration target frequency of 0. However, since the pulse output cannot be stopped at the correct number of pulses, the deceleration target frequency should not be set to 0 if it is necessary to output a precise number of pulses.



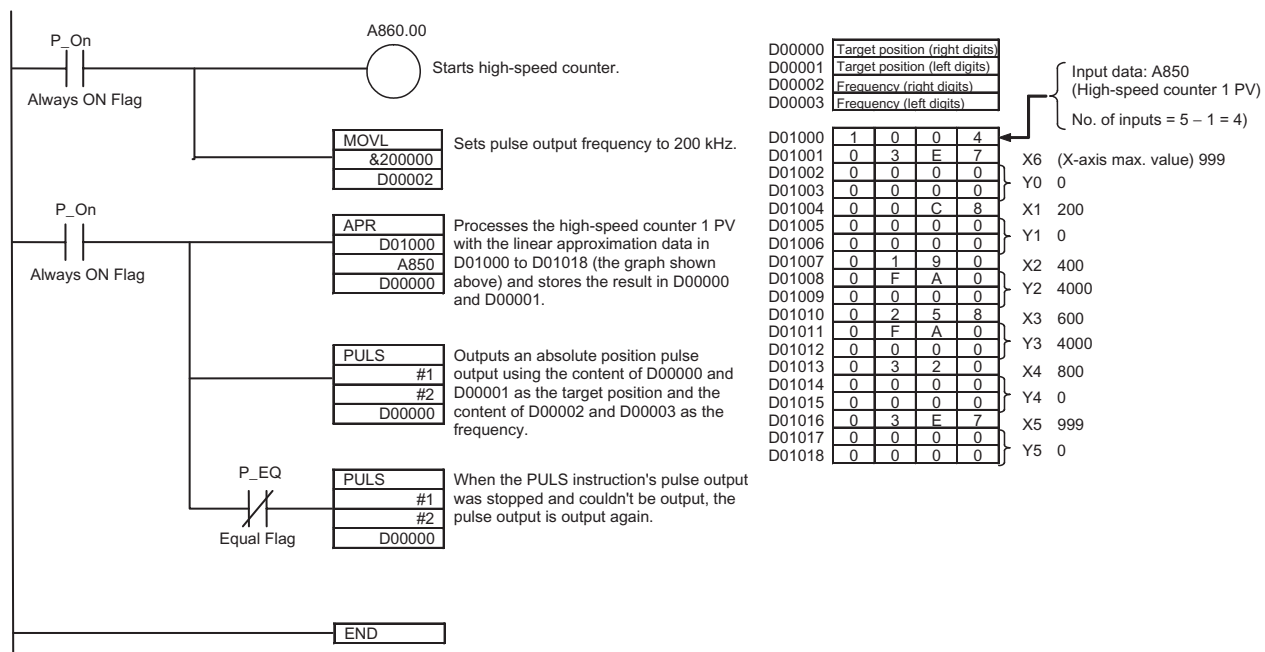
Absolute Positioning with Continually Changing Target Position

This example performs absolute positioning (Electronic Cam Control) using a single-phase pulse output without acceleration/deceleration, and the target position is updated every cycle. This function relies on a constant cycle time, in which the ladder program is executed every 2 ms, and positioning is performed using a target value that is changed every cycle according to the high-speed counter PV.

The pulse output is controlled by the target position, which is calculated repeatedly from the high-speed counter PV. The target position is calculated, so the APR instruction can be used for linear approximation.



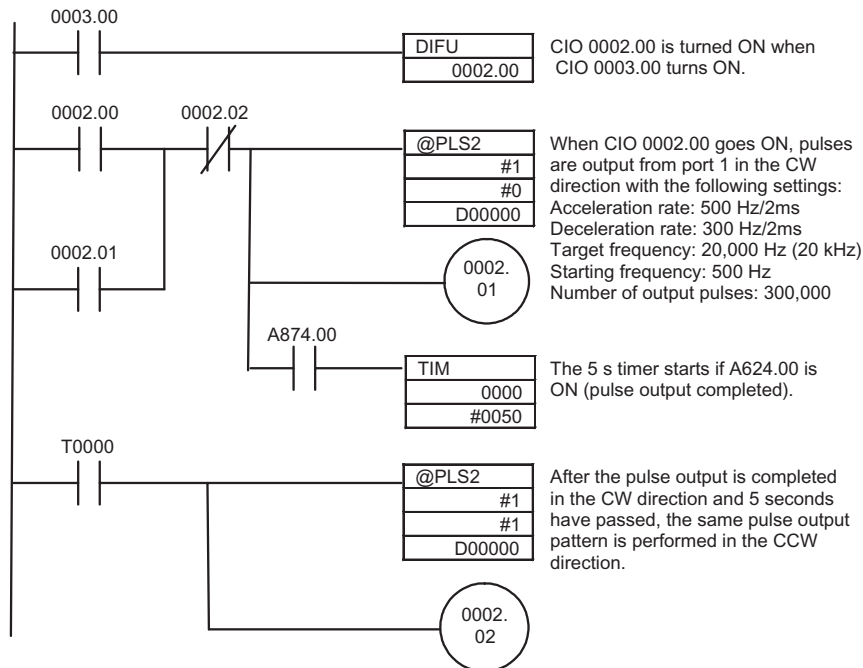
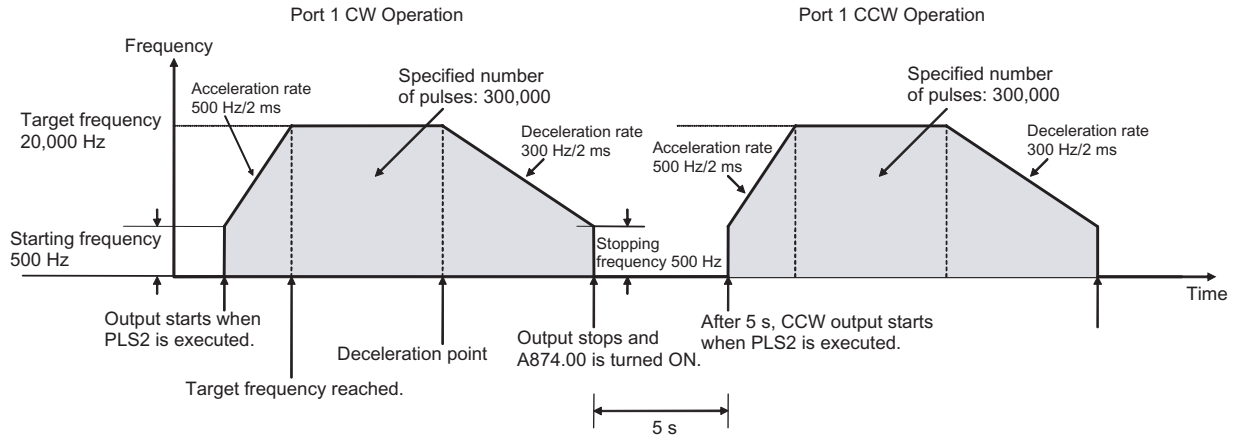
The high-speed counter is set for circular operation with a circular value of 999 BCD.



Using PLS2(887) for Trapezoidal Acceleration/Deceleration

In this example, the axis is accelerated in the CW direction at 500 Hz/2 ms, the acceleration/deceleration rate is reduced to 300 Hz/2 ms, and the pulse output is stopped after 300,000 pulses have been output.

After 5 s, the same trapezoidal acceleration/deceleration operation is performed in the CCW direction.



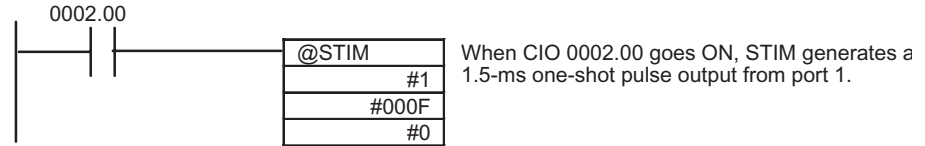
T	D00000	9	3	E	0	} Number of output pulses
T+1	D00001	0	0	0	4	
T+2	D00002	4	E	2	0	} Target frequency
T+3	D00003	0	0	0	0	
T+4	D00004	0	1	F	4	} Starting frequency
T+5	D00005	0	0	0	0	
T+6	D00006	0	1	F	4	} Acceleration rate
T+7	D00007	0	1	2	C		} Deceleration rate

Note When PLS2(887) cannot perform trapezoidal positioning with the trapezoidal acceleration/deceleration settings, it will perform triangular positioning with the same acceleration/deceleration settings. In this case, the PLS2(887) Tar-

get Frequency Not Reached Flag (A874.02 or A875.02) will turn ON at the peak of the triangular pattern and turn OFF when deceleration is completed.

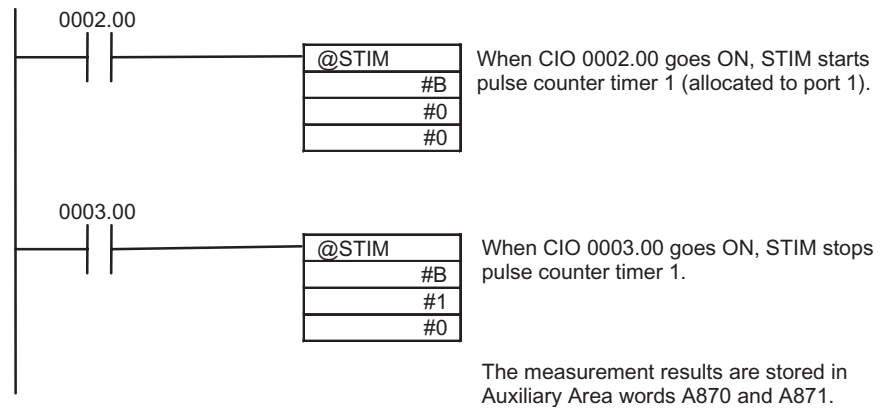
One-shot Pulse Output Function Example

In this example, STIM(980) is used to generate a 1.5-ms one-shot pulse output from pulse output 1.



Pulse Counter Time Measurement (Timer) Example

In this example, a pulse counter timer is allocated to pulse output 1.



7-6-15 Pulse Output Starting Conditions

Pulse Output Operation Modes Supported by Instruction

Pulse output operation mode	Starting instruction							
	SPED(885)	PULS(886) (with output)	ACC(888)	PLS2(887)	STIM(980) (One-shot)	STIM(980) (Timer)	INI(880) (Change PV)	INI(880) (Stop pulse output)
Relative pulse output	OK	No	OK	OK	No	No	OK (note 1)	OK
Absolute pulse output (linear)	OK	No	OK	OK	No	No	OK	OK
Absolute pulse output (circular)	OK	No	OK	No	No	No	OK	OK
Electronic Cam Control (linear)	No	OK	OK (note 2)	OK (note 3)	No	No	OK	OK
One-shot pulse mode	No	No	No	No	OK	No	OK (note 1)	No
Pulse counter timer	No	No	No	No	No	OK	OK (note 1)	No
Electronic Cam Control (circular)	No	OK	OK (note 2)	OK (note 3)	No	No	OK	OK

- Note**
- (1) Even if the PV is changed, it will start from 0 at startup.
 - (2) Supports continuous mode only.

(3) Use this function for positioning.

Allowed Startup Conditions for Pulse Output Operations (with Output Stopped)

The following table shows when an independent mode pulse output (SPED(885) independent mode, ACC(888) independent acceleration mode, or ACC(888) independent deceleration mode) can be started when pulses are not being output.

Startup conditions and status		Startup mode and conditions					
		Relative pulse output CW	Relative pulse output CCW	Absolute linear CW	Absolute linear CCW	Absolute circular CW	Absolute circular CCW
Relative		OK	OK	---	---	---	---
Absolute linear	Target position > Present position	---	---	OK	OK with SPED(885), ACC(888) Disabled with PLS2(887)	---	---
	Target position < Present position	---	---	OK with SPED(885), ACC(888) Disabled with PLS2(887)		---	---
	Target position = Present position	---	---	No	No	---	---
Absolute circular	Target position > Present position	---	---	---	---	OK	OK
	Target position < Present position	---	---	---	---	OK	OK
	Target position = Present position	---	---	---	---	OK	OK

The following table shows when a continuous mode pulse output (SPED(885) continuous mode, ACC(888) continuous acceleration mode, or ACC(888) continuous deceleration mode) can be started when pulses are not being output..

Startup conditions and status		Startup mode and conditions					
		Relative pulse output CW	Relative pulse output CCW	Absolute linear CW	Absolute linear CCW	Absolute circular CW	Absolute circular CCW
Relative		OK	OK	---	---	---	---
Absolute linear	Target position = Maximum value	---	---	OK	OK	---	---
	Target position = Minimum value	---	---	OK	OK	---	---
Absolute circular	Target position = Maximum value	---	---	---	---	OK	OK
	Target position = Minimum value	---	---	---	---	OK	OK

PULS(886) Absolute Pulse Output in Progress

Pulse Output Operation Mode (Absolute Linear) Limitations **PLS2(887)**

Startup conditions and status		Startup mode and conditions					
		Relative CW	Relative CCW	Pulse output direction priority mode (A878.14 = 0)		Absolute position priority mode (A878.14 = 1)	
				Absolute linear CW	Absolute linear CCW	Absolute linear CW	Absolute linear CCW
Relative		OK	OK	---	---	---	---
Absolute linear	Target position > Present position	---	---	OK	No	OK	OK
	Target position = Present position	---	---	No	No	No	No
	Target position < Present position	---	---	No	OK	OK	OK

Startup Conditions when other Instructions are being Executed

Operating instruction		Starting instruction										
		SPED (885) independent	SPED (885) continuous	PULS (886) relative, without output	PULS (886) absolute without output	PULS (886) absolute with output	ACC (888) acceleration, continuous	ACC (888) deceleration, continuous	ACC (888) acceleration, independent	ACC (888) deceleration, independent	PLS2 (887)	
SPED (885)	Independent	OK	No	No	No	No	No	No	OK	OK	No	
SPED (885)	Continuous	OK (See note 2.)	OK	OK	OK	No	OK	OK	OK (See note 2)	OK (See note 2)	No	
PULS (886)	No relative output	OK	OK	OK	---	No	OK (See note 5)	OK (See note 5)	OK (See note 5)	OK (See note 5)	(See note 1)	
PULS (886)	No absolute output	OK	OK	---	OK	No	OK (See note 5)	OK (See note 5)	OK (See note 5)	OK (See note 5)	(See note 1)	
PULS (886)	Relative output	No	No	No	No	OK	No	No	No	No	No	
ACC (888)	Acceleration + continuous	Accelerating	OK (See note 2)	OK	OK	OK	No	OK (See note 3)	OK (See note 3)	OK (See notes 2 and 4)	OK (See notes 2 and 4)	No
		Steady speed	OK (See note 2)	OK	OK	OK	No	OK	OK	OK (See note 2)	OK (See note 2)	No
ACC (888)	Deceleration + continuous	Decelerating	OK (See note 2)	OK	OK	OK	No	OK (See note 3)	OK (See note 3)	OK (See notes 2 and 4)	OK (See notes 2 and 4)	No
		Steady speed	OK (See note 2)	OK	OK	OK	No	OK	OK	OK (See note 2)	OK (See note 2)	No
ACC (888)	Acceleration + independent	Accelerating	OK	No	No	No	No	No	No	OK (See note 4)	OK (See note 4)	No
		Steady speed	OK	No	No	No	No	No	No	OK	OK	No
ACC (888)	Deceleration + independent	Decelerating	OK	No	No	No	No	No	No	OK (See note 4)	OK (See note 4)	No
		Steady speed	OK	No	No	No	No	No	No	OK	OK	No
PLS2 (887)		No	No	No	No	No	No	No	No	No	No	

- Note**
- (1) Cancel the number of output pulses set with PULS(886) and then execute PLS2(887).
 - (2) Execution is OK when the number of output pulses has been set.
 - (3) Set the ACC(888) instruction's mode specifier operand to #0008 (continuous mode speed change).
 - (4) Set the ACC(888) instruction's mode specifier operand to #0009 (independent mode speed change).
 - (5) Can be executed only when pulses are being output by an ACC(888) instruction executed with the mode specifier operand set to #0008 or #0009.

Allowed Startup Conditions for Pulse Output Operations (with Output in Progress)

Operating instruction		Starting instruction										
		SPED (885) independent	SPED (885) continuous	PULS (886) relative, without output	PULS (886) absolute without output	PULS (886) absolute with output	ACC (888) acceleration, continuous	ACC (888) deceleration, continuous	ACC (888) acceleration, independent	ACC (888) deceleration, independent	PLS2 (887)	
SPED (885)	Independent	Case (1)	No	No	No	No	No	No	Case (8)	Case (11)	No	
SPED (885)	Continuous	Case (2)	Case (4)	Yes	Yes	No	Case (6)	Case (7)	Case (9)	Case (12)	No	
PULS (886)	No relative output	Yes	Yes	Yes	---	No	Yes	Yes	Yes	Yes	(See note.)	
PULS (886)	No absolute output	Yes	Yes	---	Yes	No	Yes	Yes	Yes	Yes	(See note.)	
PULS (886)	Absolute output	No	No	No	No	Case (5)	No	No	No	No	No	
ACC (888)	Acceleration + continuous	Accelerating	Case (2)	Case (4)	Yes	Yes	No	Case (14)	Case (14)	Case (15)	Case (15)	No
		Steady speed	Case (2)	Case (4)	Yes	Yes	No	Case (6)	Case (7)	Case (9)	Case (12)	No
ACC (888)	Deceleration + continuous	Decelerating	Case (2)	Case (4)	Yes	Yes	No	Case (14)	Case (14)	Case (15)	Case (15)	No
		Steady speed	Case (2)	Case (4)	Yes	Yes	No	Case (6)	Case (7)	Case (9)	Case (12)	No
ACC (888)	Acceleration + independent	Accelerating	Case (3)	No	No	No	No	No	No	Case (15)	Case (15)	No
		Steady speed	Case (3)	No	No	No	No	No	No	Case (10)	Case (13)	No
ACC (888)	Deceleration + independent	Decelerating	Case (3)	No	No	No	No	No	No	Case (15)	Case (15)	No
		Steady speed	Case (3)	No	No	No	No	No	No	Case (10)	Case (13)	No
PLS2 (887)		No	No	No	No	No	No	No	No	No	No	

Note Cancel the number of output pulses set with PULS(886) and then execute PLS2(887).

Startup Conditions for Deceleration Stop (Pulses being Output)

When an ACC(888) instruction is executed with the mode specifier operand set to #0008 (continuous mode speed change) or #0009 (independent mode speed change) and a target frequency of 0 Hz, the instruction effectively operates as a deceleration stop command.

Operating instruction		Starting instruction	
		ACC(888) with mode = #0008 (continuous mode speed change) and target frequency = 0 Hz	ACC(888) with mode = #0009 (independent mode speed change) and target frequency = 0 Hz
SPED(885)	Independent	Yes (See note 1.)	Yes
SPED(885)	Continuous	Yes	Yes (See note 2.)
PULS(886)	Absolute output	No	No
ACC(888)	Acceleration/deceleration + continuous	Yes	Yes (See note 2.)
ACC(888)	Acceleration/deceleration + independent	Yes (See note 1.)	Yes
PLS2(887)	---	Yes (See note 1.)	Yes

Note (1) Decelerates in independent mode. The output will stop when the target number of output pulses is reached during deceleration.
 (2) Allowed when the number of output pulses has been set.

Cases (1), (2), and (3)

Output status		Starting instruction and conditions			
		SPED(885), independent, relative		SPED(885), independent, absolute (linear or circular)	
		CW	CCW	CW	CCW
Relative	CW output	Yes	No	---	---
	CCW output	No	Yes	---	---
Absolute linear or circular	CW output	---	---	Yes	No
	CCW output	---	---	No	Yes

Case (4)

Output status		Starting instruction and conditions					
		SPED(885), continuous, relative		SPED(885), continuous, absolute linear		SPED(885), continuous, absolute circular	
		CW	CCW	CW	CCW	CW	CCW
Relative	CW output	Yes	No	---	---	---	---
	CCW output	No	Yes	---	---	---	---
Absolute linear	CW output	---	---	Yes	No	---	---
	CCW output	---	---	No	Yes	---	---
Absolute circular	CW output	---	---	---	---	Yes	No
	CCW output	---	---	---	---	No	Yes

Case (5)

Output status		Starting instruction and conditions	
		PULS(886) absolute linear output in progress Target position > Present position	PULS(886) absolute linear output in progress Target position < Present position
Absolute linear	CW output	Yes	Yes (See note.)
	CCW output	Yes (See note.)	Yes

Note The pulse output will stop. After the axis stops, it must be restarted.

Cases (6), (8), (9), and (10)

• Starting instruction: ACC(888) (continuous or independent), acceleration, relative

Output status		Direction and starting conditions			
		CW		CCW	
		Target position > Present position	Target position < Present position	Target position > Present position	Target position < Present position
Relative	CW output	Yes	No	No	No
	CCW output	No	No	Yes	No

- Starting instruction: ACC(888) (continuous or independent), acceleration, absolute linear

Output status		Direction and starting conditions			
		CW		CCW	
		Target position > Present position	Target position < Present position	Target position > Present position	Target position < Present position
Absolute linear	CW output	Yes	No	No	No
	CCW output	No	No	Yes	No

- Starting instruction: ACC(888) (continuous or independent), acceleration, absolute circular

Output status		Direction and starting conditions			
		CW		CCW	
		Target position > Present position	Target position < Present position	Target position > Present position	Target position < Present position
Absolute circular	CW output	Yes	No	No	No
	CCW output	No	No	Yes	No

Cases (7), (11), (12), (13)

- Starting instruction: ACC(888) (continuous or independent), deceleration, relative

Output status		Direction and starting conditions			
		CW		CCW	
		Target position > Present position	Target position < Present position	Target position > Present position	Target position < Present position
Relative	CW output	No	Yes	No	No
	CCW output	No	No	No	Yes

- Starting instruction: ACC(888) (continuous or independent), deceleration, absolute linear

Output status		Direction and starting conditions			
		CW		CCW	
		Target position > Present position	Target position < Present position	Target position > Present position	Target position < Present position
Absolute linear	CW output	No	Yes	No	No
	CCW output	No	No	No	Yes

- Starting instruction: ACC(888) (continuous or independent), deceleration, absolute circular

Output status		Direction and starting conditions			
		CW		CCW	
		Target position > Present position	Target position < Present position	Target position > Present position	Target position < Present position
Absolute circular	CW output	No	Yes	No	No
	CCW output	No	No	No	Yes

Case (14)

Set the ACC(888) instruction's mode specifier operand to #0008 (continuous mode speed change). When the mode is set to #0008, the CW/CCW direction and acceleration/deceleration direction is determined automatically

Case (15)

Set the ACC(888) instruction's mode specifier operand to #0009 (independent mode speed change). When the mode is set to #0009, the CW/CCW direction and acceleration/deceleration direction is determined automatically

Note ACC(888) modes #0008 (continuous mode speed change) and #0009 (independent mode speed change) are different from modes #0001 to #0007 because it isn't necessary to specify the pulse output direction and acceleration/deceleration in the ladder program, so the ladder program can be simplified when modes #0008 and #0009 are used.

7-7 Functions for Servo Drivers Compatible with Absolute Encoders

7-7-1 Applicable Models

Model	Functions
FQM1-MMP22	Motion Control Module for Pulse I/O
FQM1-MMA22	Motion Control Module for Analog I/O

The examples in this section demonstrate the functions with high-speed counter 1 only. When using high-speed counter 2, replace the Auxiliary Area addresses with the appropriate addresses for high-speed counter 2.

7-7-2 Overview

Either of the following types of pulse input signals can be input to the unit:

- Pulse trains from normal incremental encoders, etc.
- Encoder output data (e.g., OMRON's W Series) of Servo Drivers compatible with absolute encoders (multi-turns absolute encoders)

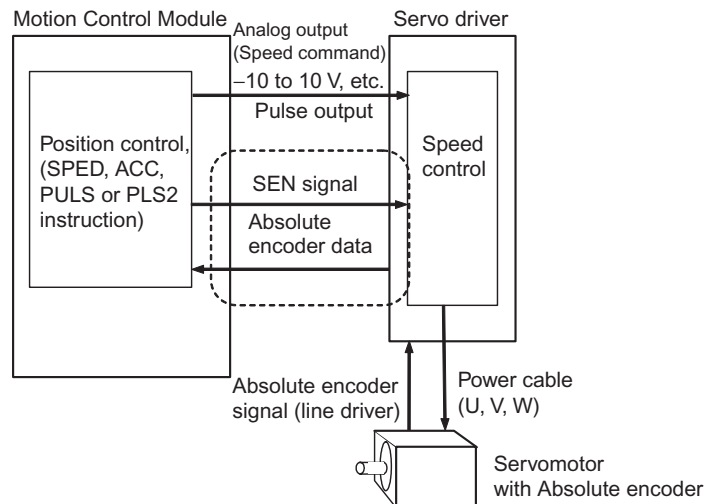
The following explains the functions that are compatible with the latter, Servo Drivers compatible with absolute encoders.

Note Refer to 7-5 *Pulse Inputs* for details on pulse train inputs from devices such as normal incremental encoders

To input the encoder output data from a Servo Driver compatible with an absolute encoder, the SEN output signal from the Motion Control Module has to be connected to the Servo Driver. When starting an operation, the number of multi-turns (to phase A as serial data) and the initial incremental pulse (to phase A/B as pulse) are input once as the absolute position information.

After that, the position data during operations are input with the phase differential input (using normal counter functions).

Using a Servo Driver compatible with an absolute encoder enables the controlled operation to be started from the position at turning on the power without performing any origin searches.



7-7-3 Data Format of Absolute Encoder Output

The format of data from a Servo Driver compatible with an absolute encoder supported by the Motion Control Module is as follows:

Serial Data Specification

The number of digits for rotation data	5 digits
Data transmitting method	Asynchronous
Baud rate	9,600 bits/s
Start bit	1 bit
Stop bit	1 bit
Parity	Even numbers
Character code	ASCII 7 bits
Data format	8 characters

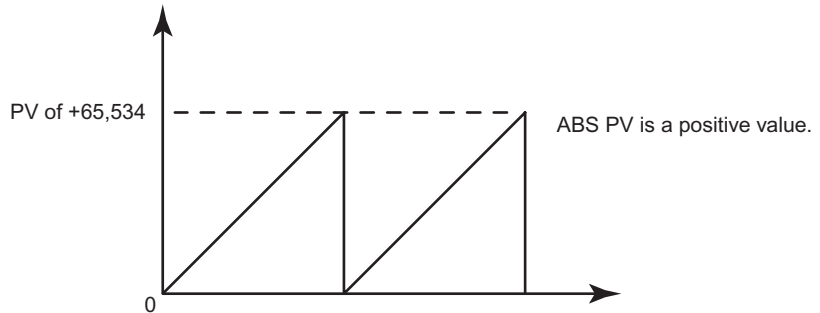
Data Format

Byte	+0	+1	+2	+3	+4	+5	+6	+7
	P (See note 1.)	Rotation data						CR
		Sign (+ or -)	Integer (5-digit decimal)					

- Note**
- (1) The "P" is in ASCII. It is 50 hex in hexadecimal.
 - (2) The range of No. of rotations that can be received by the Motion Control Module is between +65,535 to -65,535.
 - (3) For details of the data on the number of multi-turns received from a Servo Driver, please check the manual of the Servo Driver in use.
 - (4) Set the System Setup's Counter 1 Counter operation to either an absolute linear (CW-) or absolute linear (CW+) counter corresponding to the setting of reverse rotation mode on the Servo Driver in use.
 - (5) When the mode where the data on the number of rotations is output only in the + direction is set in the absolute encoder multi-turn limit setting, the data received by the Motion Control Module is handled as described below according to the setting of Counter 1 Counter operation in the System Setup.

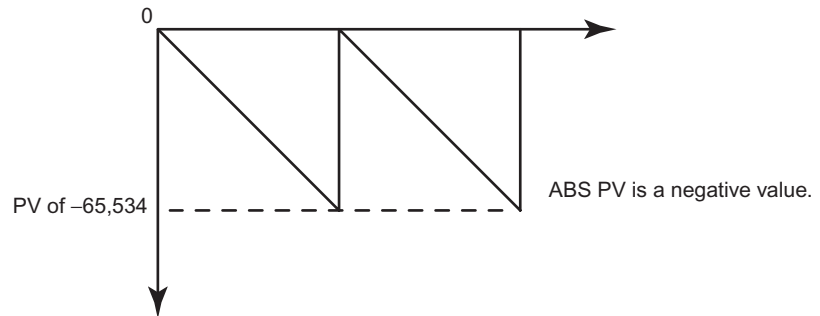
• Example 1

A value between 0 and 65,534 is set in the Servo Driver, the System Setup's Counter 1 Counter operation is set to an absolute linear (CW-) counter, and the Servo Driver's reverse rotation mode setting (Pn000.0) is set to 0 (+ command for rotation in CCW direction).



• Example 2

The System Setup's Counter 1 Counter operation is set to an absolute linear (CW+) counter and the Servo Driver's reverse rotation mode setting (Pn000.0) is set to 1 (+ command for rotation in CW direction).



Note The phase-B phase can be inverted with an FQM1-series Servo Relay Unit so that the Servo Driver's operation matches the pulse output operation.

7-7-4 Counter Operation

Counting Operation

The counting operations performed in the absolute linear (CW-), absolute linear (CW+), and absolute circular counters are the same as the pulse input function's linear and circular counters. However, the normal linear counter does not have the function that receives the rotation data stored in a Servo Driver compatible with an absolute encoder.

Counter Operation Details

Absolute Linear (CW-) Counter (CCW Rotation for + Count)

When an absolute encoder rotates in reverse, the pulse information is counted with a linear counter. Use this mode when the Servo Driver's reverse rotation mode parameter has been set to positive (+) command for CCW rotation.

Absolute Linear (CW+) Counter (CW Rotation for + Count)

When an absolute encoder rotates forward, the pulse information is counted with a linear counter. Use this mode when the Servo Driver's reverse rotation mode parameter has been set to positive (+) command for CW rotation.

Absolute Circular Counter

The absolute encoder's pulse information is counted using a circular counter. (Only the initial incremental pulse (angle) reading is used as the absolute value.)

Settings for Various Combinations of FQM1, Servo Drivers, and Servo Relay Units

Set the FQM1's counter operation mode (System Setup setting) and Servo Driver's reverse rotation mode parameter to combination 1 or 4, shown in the following table. If you want the servo operation and pulse output operation to match, an FQM1-series Servo Relay Unit can be used to invert the phase of the phase B signal. In this case, combinations 2 and 3 in the following table can be used.

The correct absolute PV cannot be generated with combinations 5 to 8, so these combinations must not be used.

No.	FQM1 pulse input count operation mode	Servo Driver's Reverse Rotation Mode setting (Pn000.0)	Servo Relay Unit's Servomotor phase B conversion switch	Increasing counter direction, viewed from motor axis	Status of present position when power is turned ON again after more than 1 revolution
1	ABS linear (CW+)	CW for + reference	INC	CW direction	Yes
2	ABS linear (CW+)	CCW for + reference	ABS-CW	CW direction	Yes
3	ABS linear (CW-)	CW for + reference	ABS-CW	CCW direction	Yes
4	ABS linear (CW-)	CCW for + reference	INC	CCW direction	Yes
5	ABS linear (CW+)	CW for + reference	ABS-CW	CCW direction	No (cannot be used)
6	ABS linear (CW+)	CCW for + reference	INC	CCW direction	No (cannot be used)
7	ABS linear (CW-)	CW for + reference	INC	CW direction	No (cannot be used)
8	ABS linear (CW-)	CCW for + reference	ABS-CW	CW direction	No (cannot be used)

7-7-5 Absolute Number of Rotations PV (Counter 1: A854 and A855)

The multi-turn data (a present value read from an encoder) is input to the Motion Control Module after the SEN signal is input to a Servo Driver. The data is stored as the absolute number of rotations present value. The stored value is determined by the following conversion formulae:

$$\text{Absolute number of rotations PV (A854 and A855)} = R \times M$$

$$\text{Number of initial incremental pulses (A850 and A851)} = P_0$$

M: Multi-turn data (meaning how many times the axis of a rotary encoder rotated)

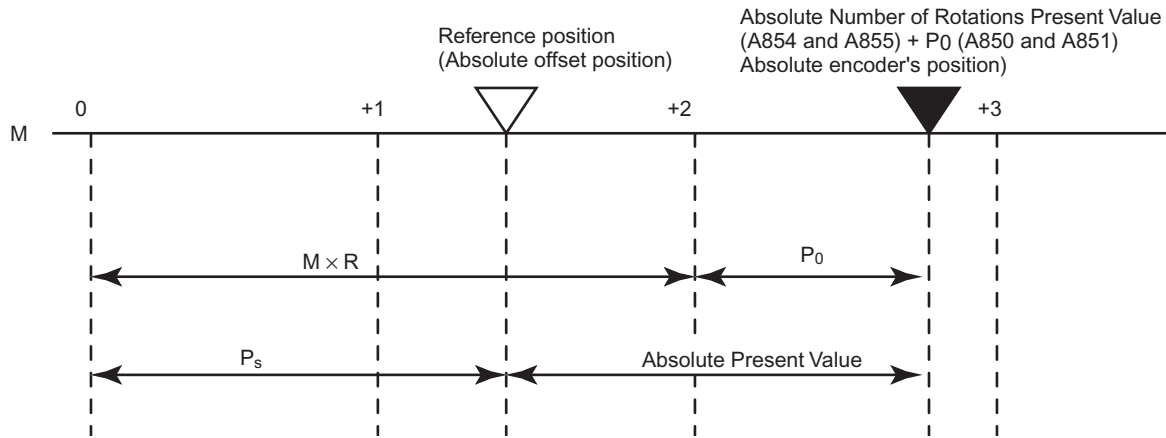
R (System Setup: ABS encoder resolution): The number of pulses for encoder's one revolution

(Absolute encoder's resolution set on Servo Driver x phase differential input multiplication of the Motion Control Module (System Setup: Counter 1 Input))

P₀: The number of initial incremental pulses

P_s: Absolute offset

When the absolute number of rotations value is read, the number of initial incremental pulses portion is stored in A850 and A851.



Note The Absolute Number of Rotations Read Bits (A860.07 and A861.07) cannot be used at the same time as high-speed counters 1 and 2.

7-7-6 Absolute Present Value

The absolute present value is calculated by subtracting an absolute offset from the absolute encoder's state (position) when the SEN signal was turned ON.

The value is calculated using the following formulae and is used for the absolute present value preset function. It is not stored in the memory as data.

Absolute Linear Counter

$$\text{Absolute PV} = \text{Absolute number of rotations PV (A854 and A855)} + \text{Number of initial incremental pulses (A850 and A851)} - P_s$$

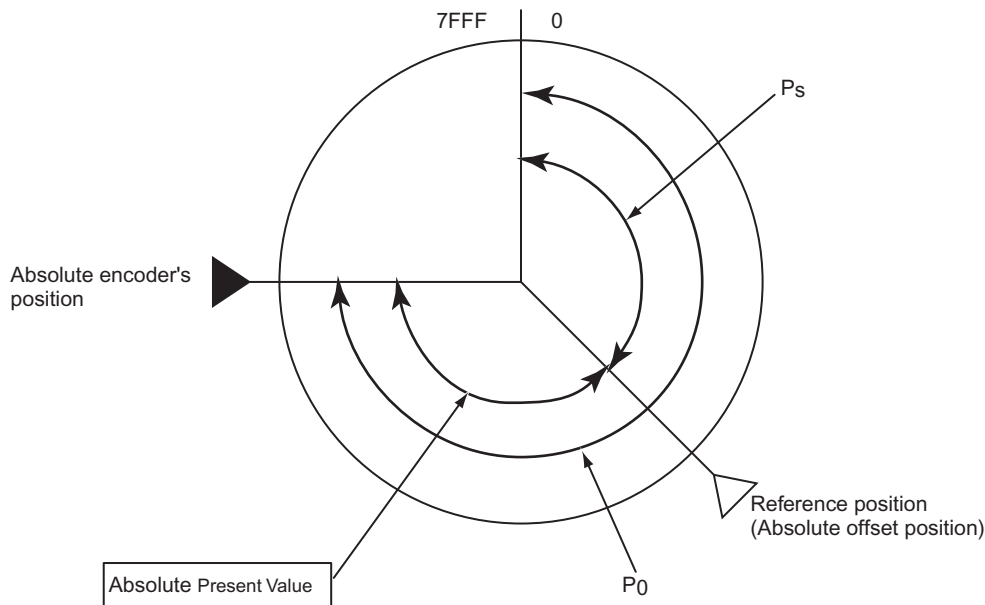
P_s : Absolute offset

Absolute Circular Counter

$$\text{Absolute PV} = P_0 - P_s$$

P_0 : The number of initial incremental pulses

P_s : Absolute offset



Note With an absolute circular counter, the absolute number of rotations present value (A854/A855) is not used; only the initial incremental pulses are used.

The initial incremental pulses are the data of an amount treated as the angle from an origin.

7-7-7 Absolute Present Value Preset

The absolute encoder's state (absolute number of rotations PV (in A854 and A855) and the number of initial incremental pulses (in A850 and A851)) can be reflected in high-speed counter present value 1 (A850 and A851). This function is enabled by turning ON the Absolute Present Value Preset Bit (A860.06). The absolute present value is stored in High-speed Counter Present Value 1 (A850 and A851). Additionally, absolute present values vary depending on the counter operation. See *7-7-6 Absolute Present Value* for details.

7-7-8 Absolute Offset Preset

The present value to be defined as an origin is obtained from the absolute number of rotations present value (A854 and A855) at the time and the number of initial incremental pulses. The value can be stored in the absolute offset (System Setup parameter). The value read from an absolute encoder at the time is defined as a machine (application) origin. This function is executed by turning ON the Absolute Offset Preset Bit (A860.05).

7-7-9 Related Areas

System Setup

Tab page	Function		Details	Time when setting becomes effective
Pulse Input	Counter 1	Pulse input mode	0 hex: Phase differential x1 1 hex: Phase differential x2 2 hex: Phase differential x4 3 hex: Increment/decrement pulse input 4 hex: Pulse + direction	At power ON
		Counter reset method	0 hex: Software reset 1 hex: Phase Z and software reset	
		Counting Speed	0 hex: 50 kHz 1 hex: 500 kHz	
		Counter operation	0 hex: Linear counter 1 hex: Circular counter 2 hex: Absolute linear (CW-) 3 hex: Absolute circular 4 hex: Absolute linear (CW+)	
		Counter data display	0 hex: Do not monitor 1 hex: Counter movements (mode 1) 2 hex: Frequency measurement (mode 2) Note Frequency measurement can be set for counter 1 only.	
		Sampling time (for mode 1)	Sets the sampling time when the high-speed counter PV is being measured (mode 1). 0000 hex: Cycle time 0001 to 270F hex: 1 to 9,999 ms (1-ms units) Note This setting is used only when the Counter Data Display parameter is set to 1 hex (mode 1).	
	Counter 2	Pulse input mode	The counter 2 parameters have the same functions as the parameters for counter 1, above. Note The Counter Data Display parameter cannot be set to frequency measurement (2 hex).	
		Counter reset method		
		Counting Speed		
		Counter operation		
		Counter data display		
		Sampling time (for mode 1)		

Tab page	Function		Details	Time when setting becomes effective
Pulse input	Counter 1	Max. circular value	When the counter operation is set to circular counter, this parameter sets the maximum value in the circular counter. Setting range: 0000 0001 to FFFF FFFF hex	At power ON
		Absolute encoder resolution (Number of input pulses per encoder revolution)	0000 0001 to 0000 FFFF hex Note Set the resolution considering the Servo Driver's encoder dividing rate and the Motion Control Module's pulse input multiplier setting. Example: Set the resolution to FA0 (4,000) when the Servo Driver's rate is 1,000 and the Motion Control Module's multiplier is ×4.	
	Counter 2	Max. circular value	The counter 2 parameters have the same functions as the parameters for counter 1, above.	
		Absolute encoder resolution (Number of input pulses per encoder revolution)		
Counter 1	Absolute offset	Setting range: 8000 0000 to 7FFF FFFF hex This is the origin of the application when using an absolute encoder.	Always	
Counter 2	Absolute offset	The counter 2 offset has the same function as the counter 1 offset, above.		

Auxiliary Area

Word	Bits	Function		Details	Controlled by
A850	00 to 15	High-speed Counter 1 PV		Counter range: 8000 0000 to 7FFF FFFF hex (8 digits hexadecimal) Note In Linear Counter Mode, high-speed counter PVs are checked for overflow and underflow errors when the PVs are read (at built-in I/O refresh for the Module).	Motion Control Module
A851	00 to 15				
A852	00 to 15	High-speed Counter 2 PV			
A853	00 to 15				
A854 and A855	00 to 15	High-speed Counter 1	Counter operation • Absolute linear (CW-) • Absolute circular • Absolute linear (CW+)	Absolute No. of rotations PV Multi-turn data (PV read from encoder) input to the Motion Control Module is stored here when SEN signal is input to Servo Driver. 8000 0000 to 7FFF FFFF hex (8-digit hexadecimal)	Motion Control Module

Word	Bits	Function			Details	Controlled by
A856 and A857	00 to 15	High-speed Counter 2	Counter operation • Absolute linear (CW-) • Absolute circular • Absolute linear (CW+)	Absolute No. of rotations PV	The same as for high-speed counter 1, except that the high-speed counter frequency measurement cannot be performed.	Motion Control Module
A858	04	High-speed Counter 1 Status	Absolute No. of Rotations Read Error Flag		OFF: No error ON: Error occurred	Motion Control Module
	05		Absolute No. of Rotations Read Completed Flag		OFF: Not reading or reading ON: Reading completed (This is set at the completion of receiving serial data on No. of rotations.)	
	12		Absolute Offset Preset Error Flag		An error occurred when storing the absolute offset in the System Setup parameter area.	
A859	04	High-speed Counter 2 Status	Absolute No. of rotations read error		These flags have the same functions as the ones for High-speed Counter 1 Status, above.	Motion Control Module
	05		Absolute No. of rotations read completed			
	12		Absolute offset preset error			
A860	05	High-speed Counter 1 Command	Absolute offset preset		OFF: No preset OFF to ON: Offset obtained from multi-turn data from Servo Driver and the No. of initial incremental pulses are stored as the absolute offset. When defining machine origin, difference between machine and encoder's origins is preset as the absolute offset.	Motion Control Module
	06		Absolute PV preset		OFF: Absolute PV preset invalid OFF to ON: At this point, the absolute PV is stored in high-speed counter PV 1 (A850 and A851). Note Refer to 7-7-6 <i>Absolute Present Value</i> for details on the absolute PV.	
	07		Absolute No. of rotations read		OFF: No. of rotations data read from Servo Driver invalid ON: At the rising edge of the signal, SEN is output to Servo Driver, and multi-turn data is received from the phase A input.	
A861	05	High-speed Counter 2 Command	Absolute Offset Preset		These control bits have the same functions as the ones for High-speed Counter 1 Command, above.	Motion Control Module
	06		Absolute PV Preset			
	07		Absolute No. of Rotations Read			

7-7-10 Overview of Absolute Encoder Output Data Acquire

Behavior of the Servo Driver Compatible with an Absolute Encoder

The SEN signal being turned ON, the Servo Driver behaves in the following manner:

- 1,2,3...
1. The Servo Driver transmits the state of the absolute encoder when the SEN signal is turned ON.
The operation proceeds in the following order:
 - a. Transmits the multi-turn data (how many revolutions the axis of the rotary encoder made) with the serial communications.
 - b. Transmits the initial incremental pulse (difference between present position and origin) with phase differential pulse output.
 2. After transmitting the absolute value data, transmits the pulse train corresponding to the rotational displacement. (Transmits the same pulse as an incremental encoder)

Absolute Encoder Output Data Acquiring Method

Use the following procedure to read the absolute encoder output data from a Servo Driver to the Motion Control Module:

Step 1 (Required): Setting

Setting the Pulse Input Method

Set the pulse input method in the System Setup. Select one of the following 5 methods:

Phase differential $\times 1$, $\times 2$, or $\times 4$, increment/decrement pulse input, or pulse + direction. Set the pulse input method to a phase differential input.

Setting the Input Pulse Counting Speed

Set the input pulse counting speed to 500 kHz. To do so, set the input pulse counting speed to 500 kHz in the System Setup.

Setting the Counter Operation

Set the Counter 1 Counter operation in the System Setup. Select one of the following three counter operations for counting the encoder output.

- Absolute linear (CW-) counter
- Absolute linear (CW+) counter
- Absolute circular counter

Be sure to set the System Setup's Counter 1 Counter operation so that it agrees with the Servo Driver's reverse rotation mode setting.

Setting the Absolute Encoder Resolution

Set absolute encoder resolution, which is the number of pulses received from the Servo Driver for each revolution of the encoder.

Consider both the Servo Driver's encoder dividing rate setting and the Motion Control Module's pulse input multiplier setting (with the System Setup's pulse input method setting). For example, set the resolution to FA0 (4,000) when the Servo Driver's rate is 1,000 and the Motion Control Module's multiplier is $\times 4$.

Step 2 (Required): Acquiring the Encoder Status when the SEN Signal is Turned ON

Turn ON the Absolute Number of Rotations Read Bit (A860.07) from the ladder program. At this point, the SEN signal will go ON (high level). Leave the SEN signal ON during operation, just like the RUN signal.

After a short time has passed to allow the Servo Driver's output to stabilize, turn ON the High-speed Counter Start Bit (A860.00) from the ladder program. The encoder's status (multi-turn data), which was acquired when the SEN signal was turned ON, is received as serial data. After the multi-turn data has been received through serial communications, the Absolute Number of Rotations Read Completed Flag (A858.05) will go ON. If a reception error occurs at this point, the Absolute Number of Rotations Read Completed Flag (A858.05) and Absolute Number of Rotations Read Error Flag (A858.04) will go ON and the received data will be discarded.

Step 3 (as Needed): Origin Compensation (Absolute Offset Preset)

When necessary, the absolute offset preset function can be used to set encoder's present position as the origin.

Use the absolute offset preset function to store the present value that will be defined as an origin as the absolute offset; the present value is computed from the Absolute Number of Rotations PV (A854 and A855) and the Number of Initial Incremental Pulses (A850 and A851).

To use the absolute offset preset function, turn ON the Absolute Offset Preset Bit (A860.05).

Note When performing origin compensation, set the absolute offset to 0 before starting the origin compensation operation. Use the CX-Programmer's System Setup to set the absolute offset to 0.

To use the absolute offset preset function, wait 30 to 62.5 ms after the Absolute Number of Rotations Read Completed Flag (A858.05) is turned ON and then toggle (turn ON and then OFF) the Absolute Offset Preset Bit (A860.05).

Note Be sure to perform the absolute offset preset operation before starting normal Servo Driver pulse outputs. The Absolute Offset Preset Bit's ON timing depends on encoder's resolution, etc. Adjust as needed corresponding to the system.

Step 4 (Required): Absolute Present Value Preset

Use the absolute present value preset function to store the absolute present value in high-speed counter PV 1 (A850 and A851).

To use the absolute present value preset function, toggle (turn ON and then OFF) the Absolute PV Preset Bit (A860.06).

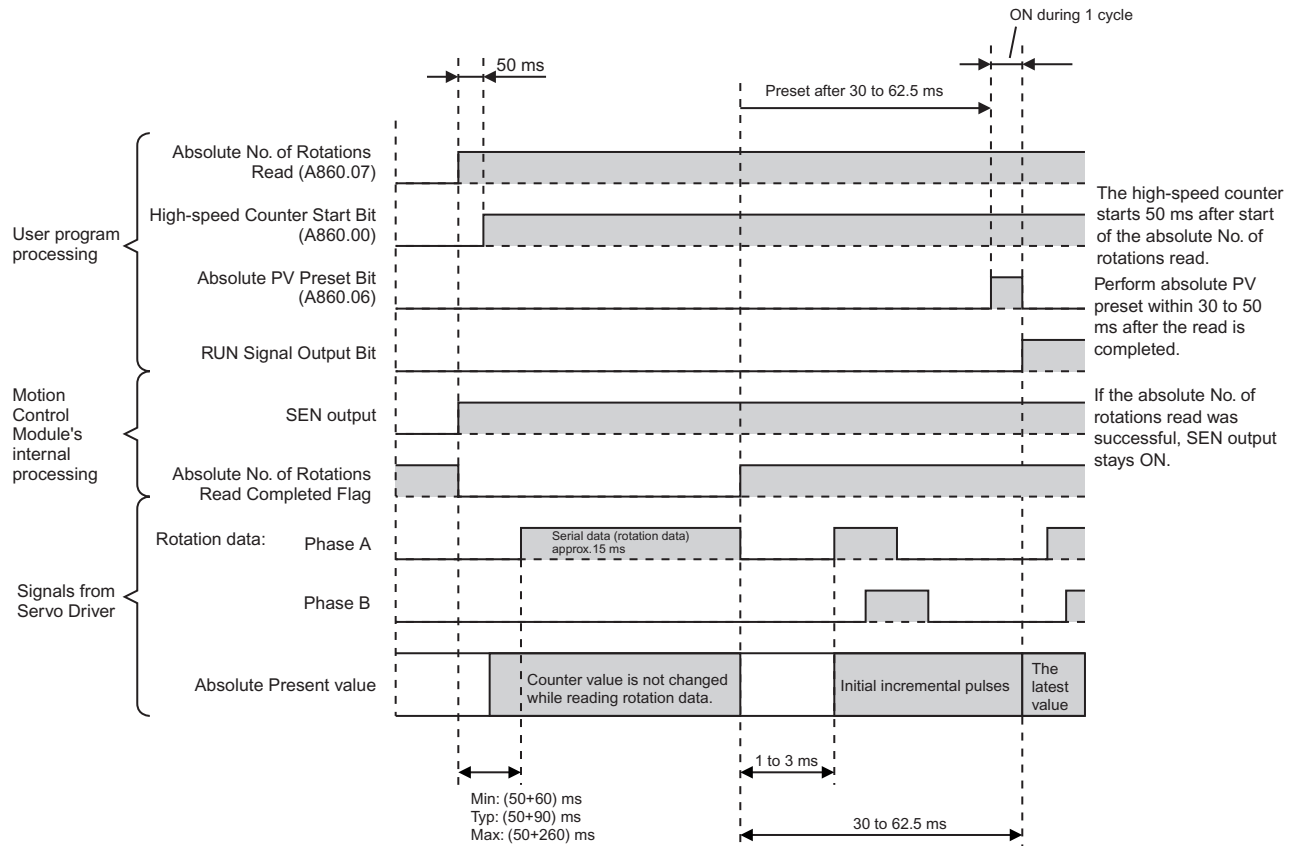
Step 5 (Required): Operating Command to Servo Driver

Turn ON the RUN Signal Output Bit (Servo Lock). Doing so will cause the Servo Driver to start operating. At the same time, the Motion Control Module will start receiving pulse trains and counting the number of pulses corresponding to Servo Driver's rotational displacement.

Step 6 (Required): Stopping Servo Driver

Turn OFF the RUN Signal Output Bit (Servo Lock). Doing so will stop the Servo Driver. In addition, turn OFF the Absolute Number of Rotations Read Bit (A860.07) and High-speed Counter Start Bit (A860.00). When these bits are OFF, the Motion Control Module will stop counting the pulse trains.

7-7-11 Timing Chart for Servo Drivers Compatible with Absolute Encoders

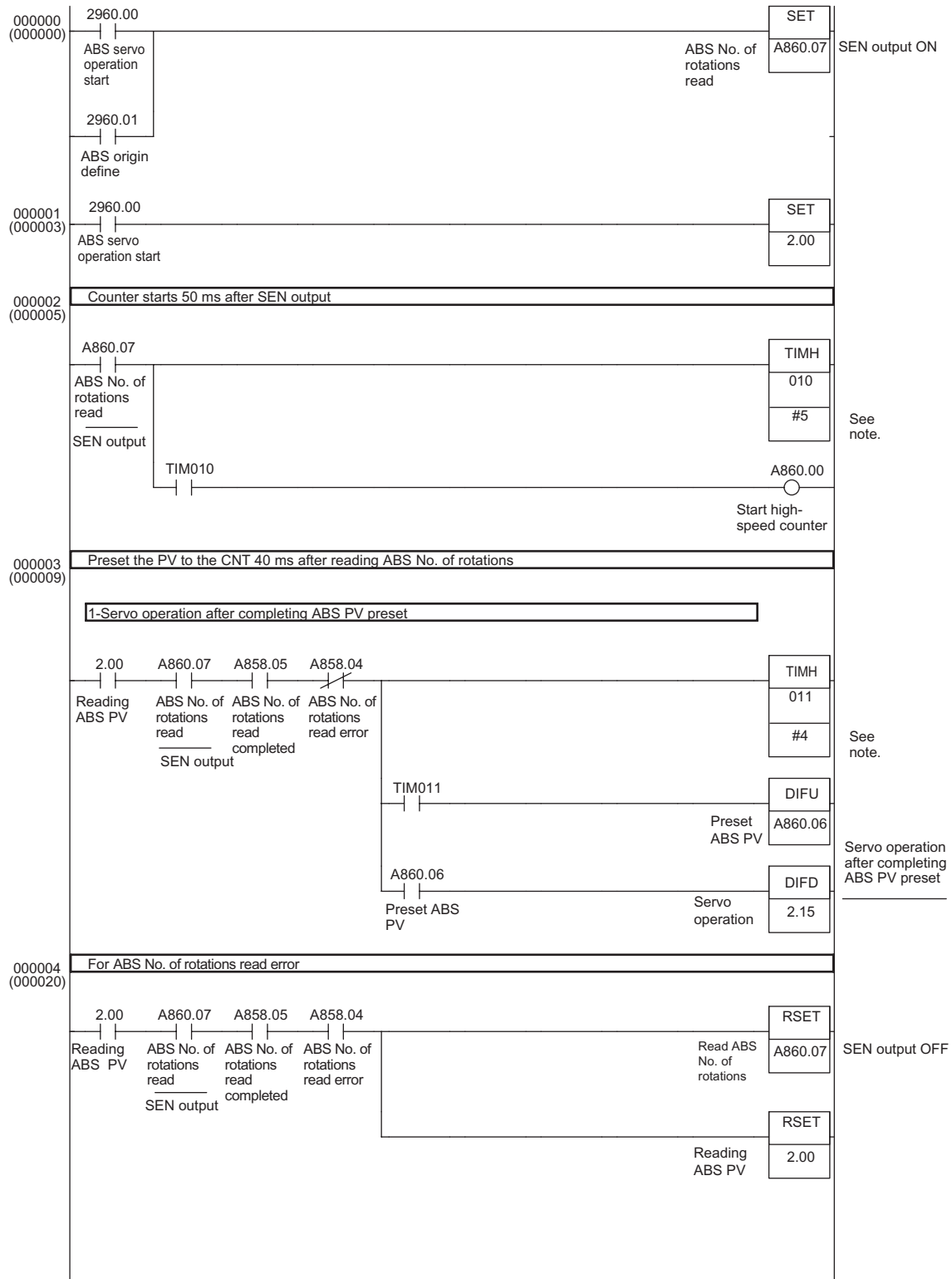


Note Do not leave the Absolute Number of Rotations Read Bit ON when the Servo Driver's power supply is turned OFF. If the bit is left ON, the absolute encoder's battery will discharge very quickly.

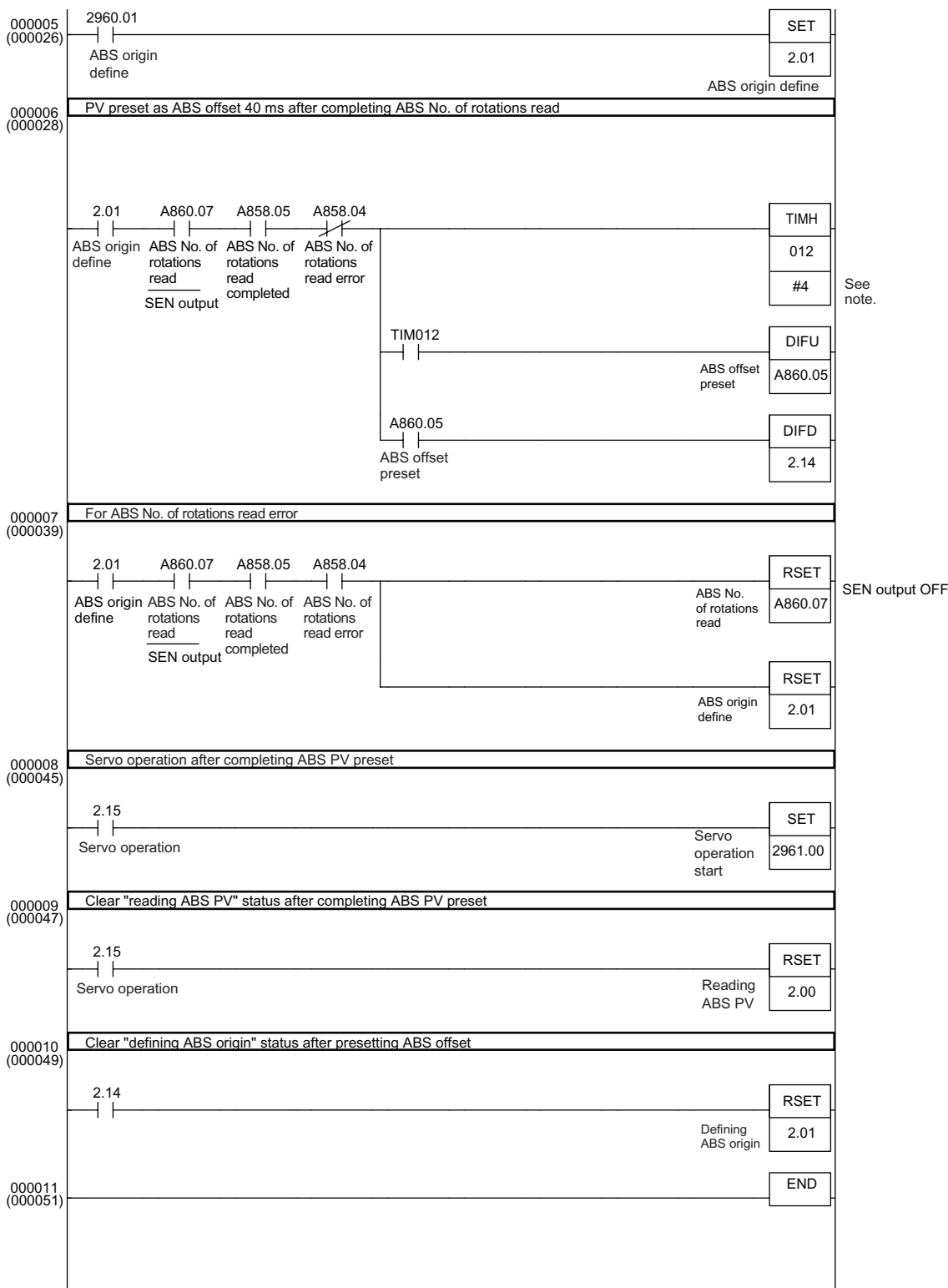
7-7-12 Sample Programs (Connecting an OMRON W-series Servo Driver)

Program Description

- 1,2,3... 1. With the Motion Control Module set to MONITOR mode, turning ON CIO 2960.01 (absolute origin define) presets the absolute origin as the absolute offset.
2. With the Motion Control Module set to MONITOR mode, turning ON CIO 2960.00 (absolute servo operation start) presets the absolute present value in A850 and A851.



Note Adjust the timer value of TIMH(15) instruction (10 ms timer) to match to the system requirements (such as the absolute encoder's resolution setting). When more precision is required, use the TMHH(540) instruction (1 ms timer).



- Note**
- (1) Adjust the timer value of TIMH(15) instruction (10 ms timer) to match the system requirements (such as the absolute encoder's resolution setting). When more precision is required, use TMHH(540) instruction (1 ms timer).
 - (2) Always turn ON the Absolute Offset Preset Bit (A860.05 or A861.05) before turning ON the Absolute PV Preset Bit (A860.06 or A861.06). The

offset value is calculated (just after the absolute encoder status is read when the SEN signal goes ON) by adding the number of incremental pulses contained in A850 (or A852) and the absolute number of rotations PV contained in A854 (or A856) and the result is stored as the absolute offset value in the System Setup.

The absolute offset value will not be correct if the Absolute Offset Preset Bit is turned ON and A850 (or A852) is changed to the high-speed counter PV (ABS PV) after the Absolute PV Preset Bit (A860.06 or A861.06) turned ON.

- (3) The Servo Driver must be unlocked in order to read the absolute encoder status by turning ON the SEN signal. The Absolute Offset Preset can be executed at a servo-locked position, by unlocking the servo, turning ON the Absolute Origin Define Bit (CIO 2960.01), and then setting the absolute offset value at that position.

7-8 Virtual Pulse Output Function

7-8-1 Applicable Models

Model	Functions
FQM1-MMP22	Motion Control Module for Pulse I/O
FQM1-MMA22	Motion Control Module for Analog I/O
FQM1-CM002	Coordinator Module

7-8-2 Overview

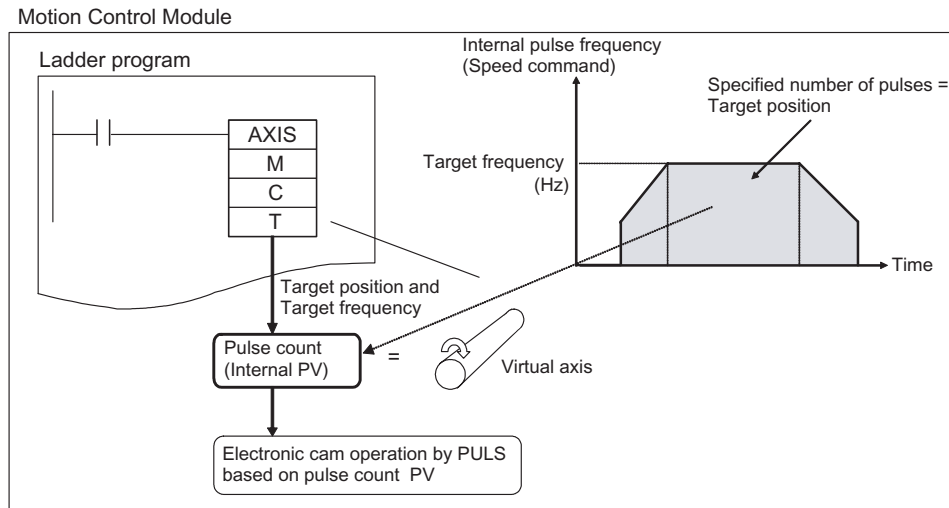
The AXIS instruction allows the execution of virtual pulse output with trapezoidal acceleration/deceleration.

The AXIS instruction executes the pulse output with trapezoidal acceleration/deceleration internally. At the same time, AXIS internally integrates (counts) the number of pulses (area) in the trapezoid.

With this function, the internal pulse count can be used in various applications as a virtual axis position.

Example 1: Position/Speed Control Using a Virtual Axis (Electronic Cam Operation)

The internal pulse count can be treated as a virtual axis in order to perform electronic cam operation (position and speed control based on the virtual axis angle) with curve approximation on the real axis operation using the positions of the virtual axis as reference.



Example 2: Locus Control Using a Virtual Axis (2-axis Synchronous Control)

If internal pulse counts are treated as virtual reference axes, a synchronous control operation such as elliptical locus control can be performed by executing synchronous output control (electronic cam operation) simultaneously on two pulse outputs using the position and speed of the virtual axis.

Example 3: Semi-closed Loop Position Control with an Analog-input Servo Driver

Semi-closed loop positioning can be performed with an analog-input Servo Driver by creating a ladder program routine that controls an error counter based on the internal pulse count and the feedback signal from the Servo Driver.

7-8-3 AXIS Instruction (For Virtual Pulse Outputs)

Overview

The AXIS instruction is used to generate a virtual pulse output with trapezoidal acceleration/deceleration.

The operands for the AXIS instruction are a target position specified in pulses or as an absolute position, and a target speed specified in pulses/s (Hz). While the AXIS instruction’s input condition is ON, it internally generates the specified number of pulses and integrates (counts) the number of pulses (area) in the trapezoid.

Operands

AXIS	
M	M: Mode specifier
C	C: Calculation cycle
T	T: First word of setting table

M (Mode Specifier)

Sets the output mode.

- #0000: Relative mode
- #0001: Absolute mode

C (Calculation Cycle)

Sets the calculation cycle.

- #0000: 2 ms calculation cycle
- #0001: 1 ms calculation cycle
- #0002: 0.5 ms calculation cycle

T (First Word of Setting Table)

Address		Name	Description	Setting range	Set/ monitored
T		Internal pulse count (8-digit hexadecimal)	The present value of internal pulse counter is stored here.	Relative mode: 0000 0000 to FFFF FFFF	Monitored (Read)
T+1				Absolute mode: 8000 0000 to 7FFF FFFF	
T+2	Bit 15	Virtual pulse output status	Indicates whether or not the virtual pulse output has started.	OFF: Pulse output stopped ON: Pulse being output	
	Bit 08		Indicates the direction of virtual pulse currently being output.	OFF: CW ON: CCW	
	Bit 07		Indicates whether or not the virtual pulse output is being counted.	OFF: Pulse being counted ON: Target position reached (Counting stopped)	
	Bit 00		Indicates whether or not the virtual pulse output is accelerating/ decelerating.	OFF: Constant speed ON: Accelerating/decelerating	
T+3 to T+4		Present speed (8-digit hexadecimal)	The frequency of the virtual pulse output is stored here.	0000 0000 to 000F 4240 hex (0 to 1 MHz in 1-Hz units)	
T+5 to T+6		Target position (8-digit hexadecimal)	Set the number of virtual output pulses here.	Relative mode: 0000 0000 to FFFF FFFF Absolute mode: 8000 0000 to 7FFF FFFF	Set (Read/ Write)
T+7 to T+8		Target frequency (8-digit hexadecimal)	Set the target frequency of virtual pulses here.	0000 0001 to 000F 4240 hex (0 to 1 MHz in 1-Hz units)	
T+9 to T+10		Starting frequency (8-digit hexadecimal)	Set the starting frequency of virtual pulses here.	0000 0000 to 000F 4240 hex (0 to 1 MHz in 1-Hz units)	
T+11		Acceleration rate (4-digit hexadecimal)	Set the acceleration rate of virtual pulses here.	0001 to 270F (1 to 9,999 Hz, in 1-Hz units)	
T+12		Deceleration rate (4-digit hexadecimal)	Set the deceleration rate of virtual pulses here.	0001 to 270F (1 to 9,999 Hz, in 1-Hz units)	
T+13 to T+26		Work area	Used by the system.		---

Description

- Use the AXIS instruction with an input condition that is ON for one cycle. AXIS cannot be used as a differentiated instruction (the @ prefix is not supported).
- AXIS is executed at the rising edge of the input condition. If the input remains ON, the virtual pulse output continues until the target position is reached. Once the target position is reached, the virtual pulse output is stopped. If the input condition goes OFF during the virtual pulse output, the output stops at that point.
- The AXIS instruction's mode specifier operand (M) specifies whether the virtual pulse output operates in relative or absolute mode.
 - In relative mode, the internal pulse counter initializes the internal pulse count to 0 when AXIS is executed and starts incrementing from 0.
 - In absolute mode, the internal pulse counter retains the internal pulse count when AXIS is executed and starts incrementing or decrementing from that existing pulse count.
- The internal pulse counts are refreshed every cycle at the interval specified in the calculation cycle (2 ms, 1 ms, or 0.5 ms) on the condition that the cycle time is constant. If the specified calculation cycle time does not match the execution cycle time, the time difference between the cycles can cause an error in the count. If highly accurate pulse counts are required, use the constant cycle time function and match the execution

cycle time and calculation cycle time. (Set the constant cycle time in the System Setup's Cycle Time Tab Page.)

- When trapezoidal control cannot be performed with the specified target position, target frequency, and acceleration/deceleration, AXIS will automatically compensate as follows:

The acceleration and deceleration rates will be set to the same rate (symmetrical trapezoidal control).

OR

When one-half of the specified target pulses have been output, AXIS will start decelerating the operating axis at the same rate as acceleration (symmetrical triangular control).

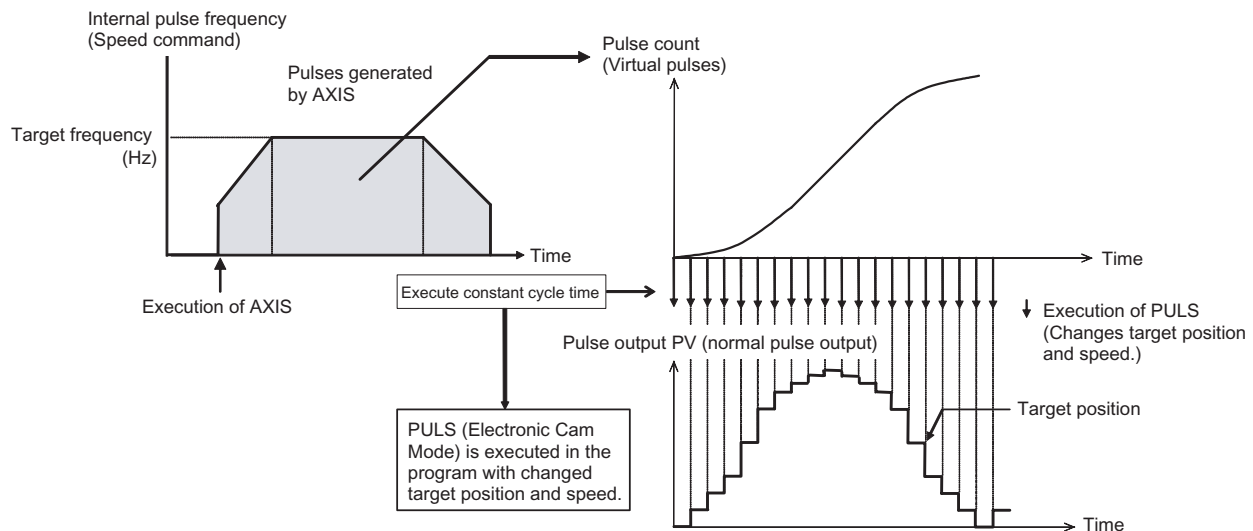
Note When the AXIS instruction's input condition is OFF, the contents of setting table words T+2, T+3, and T+4 will be initialized to 0.

7-8-4 Application Example

Positioning or Speed Control Using a Virtual Axis

The internal pulse count can be treated as a virtual axis position in order to perform electronic cam operation on the real axis operation with simple curve approximation.

First, the AXIS instruction is executed to generate an internal pulse count. The internal pulse count is read at every cycle, that pulse count is processed with basic arithmetic operations or the APR instruction, and the result is used as a target position or target speed in the PULS(886) instruction. The PULS(886) instruction (in electronic cam control) is executed immediately after the target position or speed is calculated.



Simple locus control can be performed by executing electronic cam control simultaneously on both pulse outputs 1 and 2 using the same virtual axis as above.

7-9 Analog Input Functions

7-9-1 Applicable Models

Model	Functions
FQM1-MMA22	Motion Control Module for Analog I/O

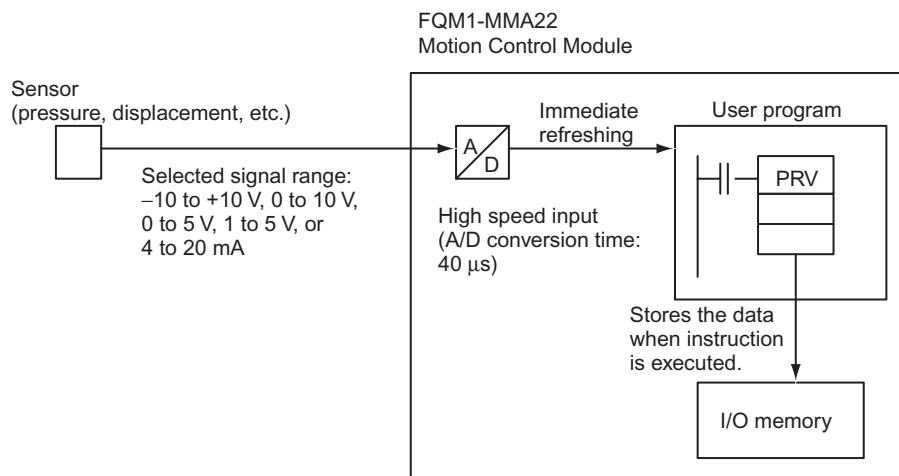
7-9-2 Overview

The FQM1-MMA22 Motion Control Module can input analog input signals at high-speed (A/D conversion time: 40 μs).

One of five signal types for analog inputs can be selected: -10 to +10 V, 0 to 10 V, 0 to 5 V, 1 to 5 V, and 4 to 20 mA.

Analog input values are stored in the Motion Control Module's Auxiliary Area in A800. The stored input value is the analog input value read at END refreshing. It is also possible to adjust the analog input values.

The PRV(881) instruction can also be used to read the latest analog input value through immediate refreshing. Analog signals can be input from pressure sensors, position meters, or sensors that require high-speed input processing such as a displacement sensors/end-measuring sensors. Consequently, this function allows simple, low-cost pressure control, tension control, or other control applications requiring high-speed mechanical measurement (distortion/thickness/length).

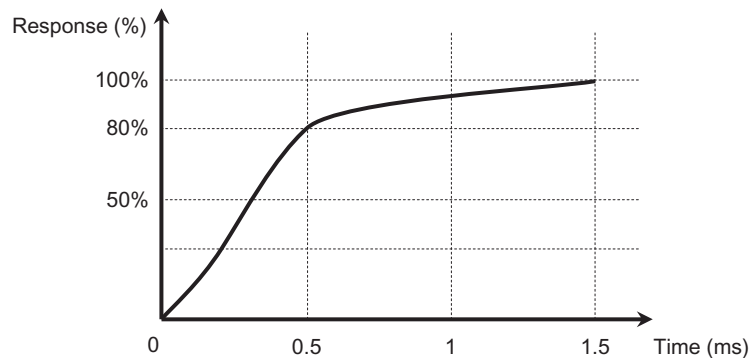


Note The analog input responsiveness has been set relatively high to increase the processing speed. The high responsiveness may result in input signal distortion by external noise or interference. Take steps to suppress noise if the Motion Control Module is being used in an environment with a lot of noise. When the Motion Control Module's analog input value is being used, additional noise countermeasures can be added to the program such as using END refreshing and filtering the input values with AVG instructions.

7-9-3 Analog Input Function Specifications

Item		Specification						
Input signals		Voltage inputs, current inputs						
No. of analog inputs		1 input						
Input signal ranges		Select one of the following input ranges in the System Setup (<i>Analog Input/Output Tab Page – Input Setting</i>): –10 to +10 V, 0 to 10 V, 0 to 5 V, 1 to 5 V, or 4 to 20 mA.						
A/D conversion time		40 μ s						
Input response time		1.5 ms or less (See note.)						
Resolution		–10 to +10 V: 1/16,000 (14 bits) 0 to 10 V: 1/8,000 (13 bits) 0 to 5 V: 1/4,000 (12 bits) 1 to 5 V: 1/4,000 (12 bits) 4 to 20 mA: 1/4,000 (12 bits)						
Analog input refresh method		Analog input value can be acquired by either of the following methods: <ul style="list-style-type: none"> • END Refresh Read the data from A550 in the Motion Control Module's Auxiliary Area. (Data is stored in A800 during END refreshing after execution of END instruction) • Immediate Refresh Read the present analog input value immediately by executing the PRV(881) instruction. 						
Analog input value storage area		A800 of Motion Control Module's Auxiliary Area With the immediate refresh, the present analog input value can be acquired by executing the PRV(881) instruction.						
Overall accuracy		<table border="1"> <thead> <tr> <th>Voltage input:</th> <th>Current input:</th> </tr> </thead> <tbody> <tr> <td>$\pm 0.2\%$ (23 $\pm 2^\circ\text{C}$)</td> <td>$\pm 0.4\%$ (23 $\pm 2^\circ\text{C}$)</td> </tr> <tr> <td>$\pm 0.4\%$ (0 to 55$^\circ\text{C}$)</td> <td>$\pm 0.6\%$ (0 to 55$^\circ\text{C}$)</td> </tr> </tbody> </table>	Voltage input:	Current input:	$\pm 0.2\%$ (23 $\pm 2^\circ\text{C}$)	$\pm 0.4\%$ (23 $\pm 2^\circ\text{C}$)	$\pm 0.4\%$ (0 to 55 $^\circ\text{C}$)	$\pm 0.6\%$ (0 to 55 $^\circ\text{C}$)
Voltage input:	Current input:							
$\pm 0.2\%$ (23 $\pm 2^\circ\text{C}$)	$\pm 0.4\%$ (23 $\pm 2^\circ\text{C}$)							
$\pm 0.4\%$ (0 to 55 $^\circ\text{C}$)	$\pm 0.6\%$ (0 to 55 $^\circ\text{C}$)							
Function	Offset/gain adjustment	Input values can be adjusted to correct inputs suitable for the connected devices. In PROGRAM mode, specify an offset or gain value, input the analog value from the device (the value that will be corrected with the offset or gain value), and use the CX-Programmer to monitor the adjustment value in the Adjustment Value Monitor Area (A822 and A823). It is also possible to monitor averaged offset or gain values. If averaging is required, set the number of average value samples in A824.						

Note The following diagram is provided as a reference example. This example shows the input response (step response) characteristics of an input when the external input signal is changed in a step pattern. In this case, the input range is –10 to +10 V.



7-9-4 Related Areas and Settings

System Setup

Tab page	Function		Settings	Time when setting becomes effective
Analog Input/ Output	Both inputs and outputs	Input method	0 hex: END refresh 1 hex: Immediate refresh (Refresh with PRV(881).)	At power ON and start of operation
		Output method	0 hex: END refresh (Content of A810 and A811 is output as analog output after execution of END instruction.) 1 hex: Immediate refresh (Analog output when SPED(885) or ACC(888) is executed. A810 and A811 used for monitoring.)	At power ON and start of operation
	Inputs	Input range	00 hex: -10 to 10 V 01 hex: 0 to 10 V 02 hex: 1 to 5 V (4 to 20 mA) 03 hex: 0 to 5 V	At power ON
	Outputs	Output range	00 hex: -10 to 10 V 01 hex: 0 to 10 V 02 hex: 1 to 5 V 03 hex: 0 to 5 V 5A hex: Disable outputs (See note.) Note Outputs can be disabled to shorten the I/O refreshing time or reduce the Motion Control Module's power consumption.	At power ON
		Output stop function	0 hex: Clear outputs 1 hex: Hold outputs 2 hex: Maximum value	
	Outputs	Output range	These parameters have the same settings as output 1, above.	
Output stop function				

Auxiliary Area

Word	Bits	Function		Settings		Controlled by
A800	00 to 15	Analog Input PV		Contains the value input from the analog input port (using either the END refresh or immediate refresh) in 4-digit hexadecimal. The PV range depends on the input range: • 0 to 10 V: FE70 to 20D0 hex • 0 to 5 V or 1 to 5 V: FF38 to 1068 hex • -10 to 10 V: DDA0 to 2260 hex		Motion Control Module
A802	00	Analog Input Status	Analog Input	User Adjustment Completed	OFF: Not adjusted ON: Adjustment completed	
	01 to 06			Reserved		
	07			Analog Sampling Started	OFF: Not started ON: Started	
	08			Factory Adjustment Data Error	OFF: No Error ON: Error (Checked at startup.)	
	09			User Adjustment Data Error	OFF: No Error ON: Error (Checked at startup.)	
	10 to 14	Reserved				
	15	Analog Input Status	Analog Input	Analog Sampling Overlap	OFF: Normal sampling ON: The next sampling operation occurred before the present sampling operation completed.	Motion Control Module
A809	01 to 15	Analog Input Status	Analog Input	Number of Samples	Indicates the number of data samples actually input since sampling started.	Motion Control Module
A810	00 to 15	Analog Output 1 Output Value	When an END refresh is selected, the 4-digit hexadecimal value set here by the user is output from analog output port 1. When immediate refreshing is selected, the 4-digit hexadecimal value being output from analog output port 1 is stored here for monitoring. The output value range depends on the output range, as shown below. • 0 to 10 V, 0 to 5 V or 1 to 5 V: FF38 to 1068 hex • -10 to 10 V: EA84 to 157C hex Note 1. Set the analog output method (END or immediate refreshing) with the System Setup's output method setting. A setting of 0 hex specifies an END refresh. This setting applies to both analog output 1 and 2. 2. Specify the output range with the output 1 setting.		With immediate refresh: Motion Control Module With END refresh: User	
A811	00 to 15	Analog Output 2 Output Value	This word has the same settings as the analog output 1 output value (A560), above. (When an END refresh is selected, set the value to output from analog output port 2. When an immediate refresh is selected, the output value is stored here for monitoring.) Note 1. Set the analog output method (END or immediate refresh) with the System Setup's output method setting. A setting of 0 hex specifies an END refresh. This setting applies to both analog output 1 and 2. 2. Specify the output range with the output 2 setting.			

Word	Bits	Function	Settings	Controlled by	
A812	00	Analog Output 1 Flags	User Adjustment Completed	Initial value is 0. Set to 1 if user performs offset/gain adjustment and Returns to factory default setting of 0 if adjustment value is cleared.	Motion Control Module
	01 to 03		Reserved	---	
	04		Operating	ON: ON while the analog output is being changed by ACC(888). OFF: Turned OFF when target value is reached.	Motion Control Module
	05 to 07		Reserved	---	
	08		Output SV Error	ON: ON when the output SV setting is outside of the allowed setting range. OFF: OFF when the output SV is within range. Note Only in End refresh mode	Motion Control Module
	09 to 11		Reserved	---	
	12		Factory Adjustment Value Error	ON: ON when the factory-set data stored in flash memory is invalid. OFF: OFF when the factory-set data stored in flash memory is normal.	Motion Control Module
	13		Reserved	---	
	14		User Adjustment Value Error	ON: ON when the user-set adjustment value stored in flash memory is invalid. OFF: OFF when the user-set adjustment value stored in flash memory is normal.	Motion Control Module
	15		Reserved	---	
A813	00	Analog Output 2 Flags	User Adjustment Completed	These flags have the same functions as the Analog Output 1 Flags, above.	Motion Control Module
	01 to 03		Reserved		
	04		Operating		
	05 to 07		Reserved		
	08		Output SV Error		
	09 to 11		Reserved		
	12		Factory Adjustment Value Error		
	13		Reserved		
	14		User Adjustment Value Error		
	15		Reserved		

Word	Bits	Function	Settings	Controlled by		
A820	00	Adjustment Mode Command Bits (Effective only when A825 is 5A5A hex.)	Adjustment Enable	Analog Input	OFF: Adjustment disabled. ON: Adjustment enabled. When this bit is turned from OFF to ON, the default value (offset or gain value) corresponding to the selected I/O signal range is transferred to Adjustment Value Monitor Area (A822 and A823).	User
	01			Reserved		
	02			Analog Output 1		
	03			Analog Output 2		
	04 to 06		Reserved			
	07		Adjustment Mode Specifier	OFF: Offset adjustment ON: Gain adjustment	User	
	08 to 11		Reserved			
	12		Adjustment Value Increment	While this bit is ON, the offset or gain value will be incremented by one resolution unit each 0.5 s.	Motion Control Module	
	13		Adjustment Value Decrement	While this bit is ON, the offset or gain value will be decremented by one resolution unit each 0.5 s.		
	14		Adjustment Value Clear	OFF to ON: Clears the adjustment data to the factory defaults.		
15		Adjustment Value Set	OFF to ON: Reads the present value in the Adjustment Value Monitor Area (A822 and A823) and saves this value to flash memory. This adjustment value will be used for the next normal mode operation.			
A821	00	Adjustment Mode Status	Adjustment Operation Error	ON when an operational error has been made, such as turning ON both the Analog Input and Analog Output 2 Adjustment Enable Bits at the same time.	Motion Control Module	
	01 to 14		Reserved			
	15		Adjustment Mode Started	ON during adjustment mode operation (when A825 contains 5A5A hex).		
A822	00 to 15	Adjustment Mode Monitor (Effective only when A825 is 5A5A hex.)	Used for Analog Input and Analog Outputs 1/2	Setting Offset Monitor	The values in these words can be overwritten directly, without using the Adjustment Value Increment/Decrement Bits.	Motion Control Module or User
A823	00 to 15			Gain Value Monitor		
A824	00 to 15			Analog Inputs	Number of Average Value Samples in Adjustment Mode		Indicates the number of values to be averaged to obtain the Offset/Gain Value Monitor values in adjustment mode. The number of samples can be set between 0000 and 0040 hex (0 to 64). Set this parameter before turning ON the Adjustment Enable Bit.	User
A825	00 to 15	Adjustment Mode Password		5A5A hex: Adjustment mode enabled. Other value: Adjustment mode disabled.	User	

7-9-5 Applicable Instructions

With END Refreshing

Read the analog input PV (A800) using an instruction such as the MOV instruction.

With Immediate Refreshing

The data is acquired immediately with the PRV(881) instruction.

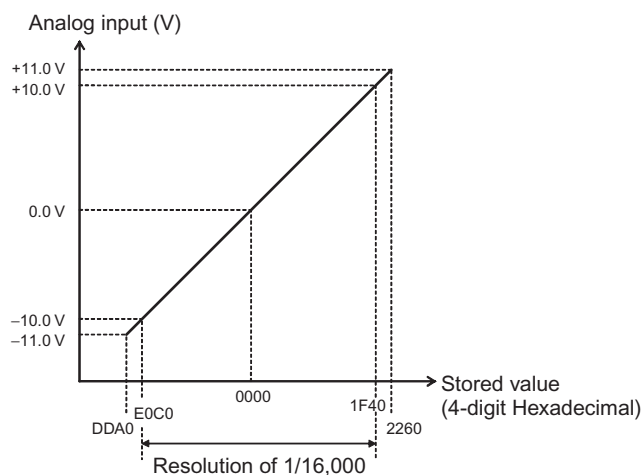
(@) PRV	
P	P: Output port (#0003: Analog input)
C	C: Control specification (#0000: Present value read)
D	D: Present value storage first word

7-9-6 A/D Conversion Value

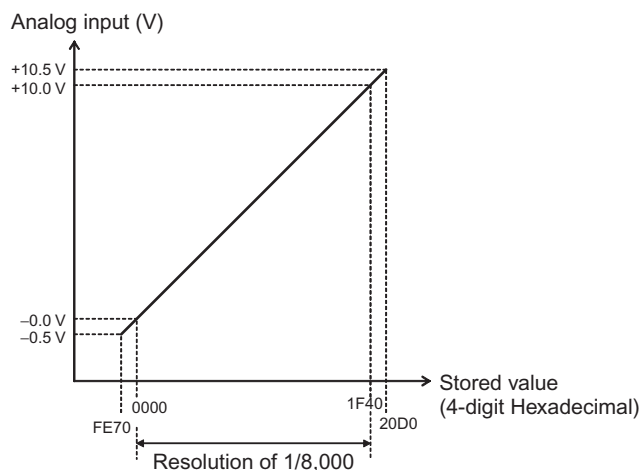
When a signal is input that exceeds the allowed ranges indicated below, the conversion value will be processed as it is. However, inputting out-of-range signals may result in hardware failure or system malfunction, so do not input out-of-range signals.

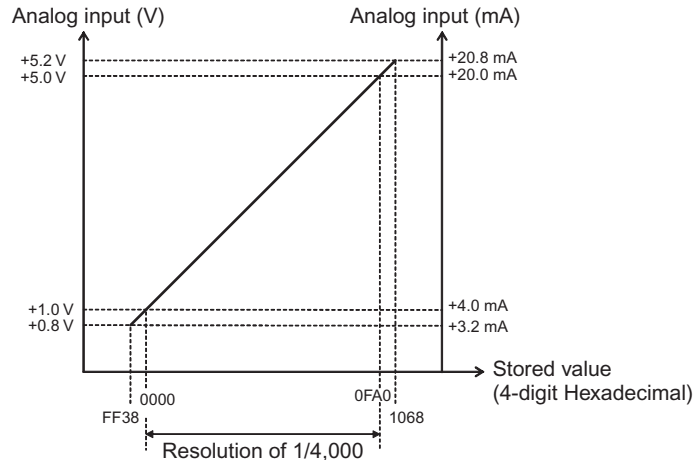
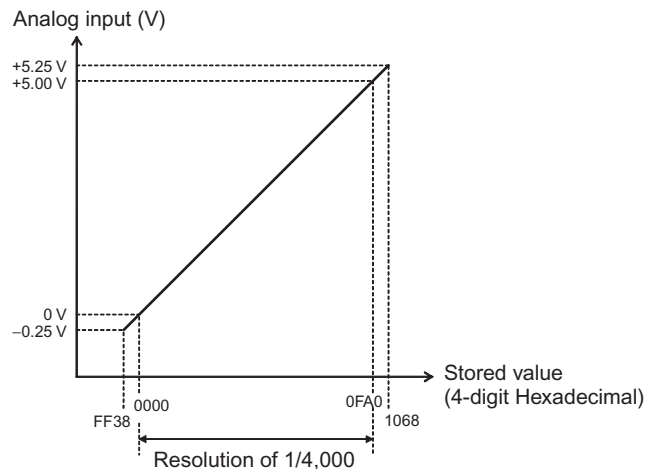
Note If a voltage exceeding the input voltage limits is input, the conversion value will be either the upper or lower limit value.

Signal Range: -10 to 10 V



Signal Range: 0 to 10 V



Signal Range: 1 to 5 V and 4 to 20 mA**Signal Range: 0 to 5 V****7-9-7 High-speed Analog Sampling (FQM1-MMA22 Only)****Overview**

When an FQM1-MMA22 Motion Control Module is being used, the Motion Control Module can be synchronized with pulse inputs from the encoder to collect analog data.

This sampling method checks measurements in synchronization with the position, an operation which could not be performed with scheduled interrupts in earlier controllers.

When the CTBL(882) instruction is used as a high-speed analog sampling function, the Motion Control Module can start sampling analog input data at high speed when a preset counter PV is reached, and store the specified number of samples automatically in the DM Area.

This function can be used with high-speed counter 1 only.

CTBL(882) Instruction Operation

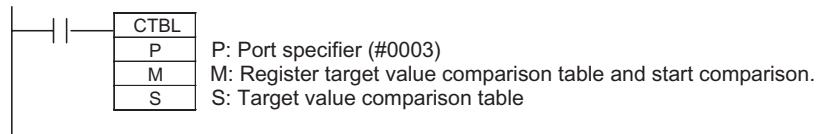
The CTBL(882) instruction starts a specified interrupt task when the high-speed counter PV of pulse input 1 matches a specified target value.

If the CTBL(882) instruction is executed in an interrupt task to perform high-speed analog sampling, pulses on pulse input 1 will be counted using the ring counter size specified with INI(880) and the Motion Control Module will sample analog values at each target value specified with the CTBL(882) instruction.

Once the sampling of analog input values starts, the number of values specified with the circular value (up to 32,767 samples) are stored in the DM Area beginning at the specified DM address. The sampling operation will be completed when the specified number of samples are all stored in the DM Area.

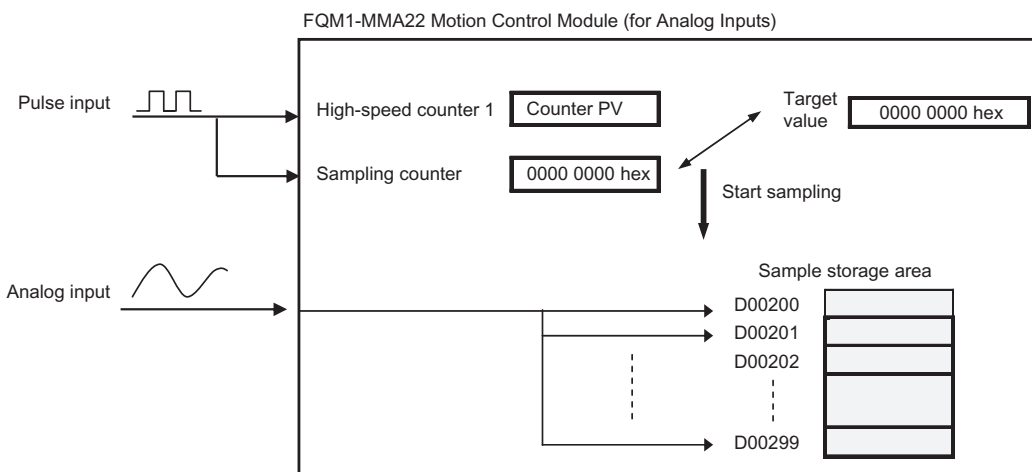
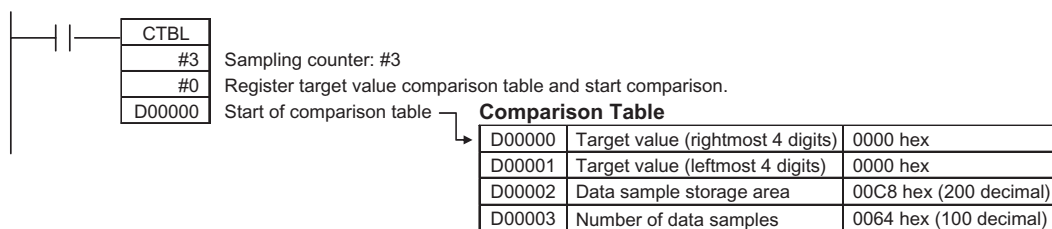
The sampling counter always counts with a multiplier of 1x (fixed).

CTBL(882) with High-speed Analog Sampling Function



S	Target value	8-digit hex
S+1		
S+2	First word of data sample storage area (DM Area address)	0000 to 7FFF hex
S+3	Number of data samples	0001 to 8000 hex

Example



Application Example

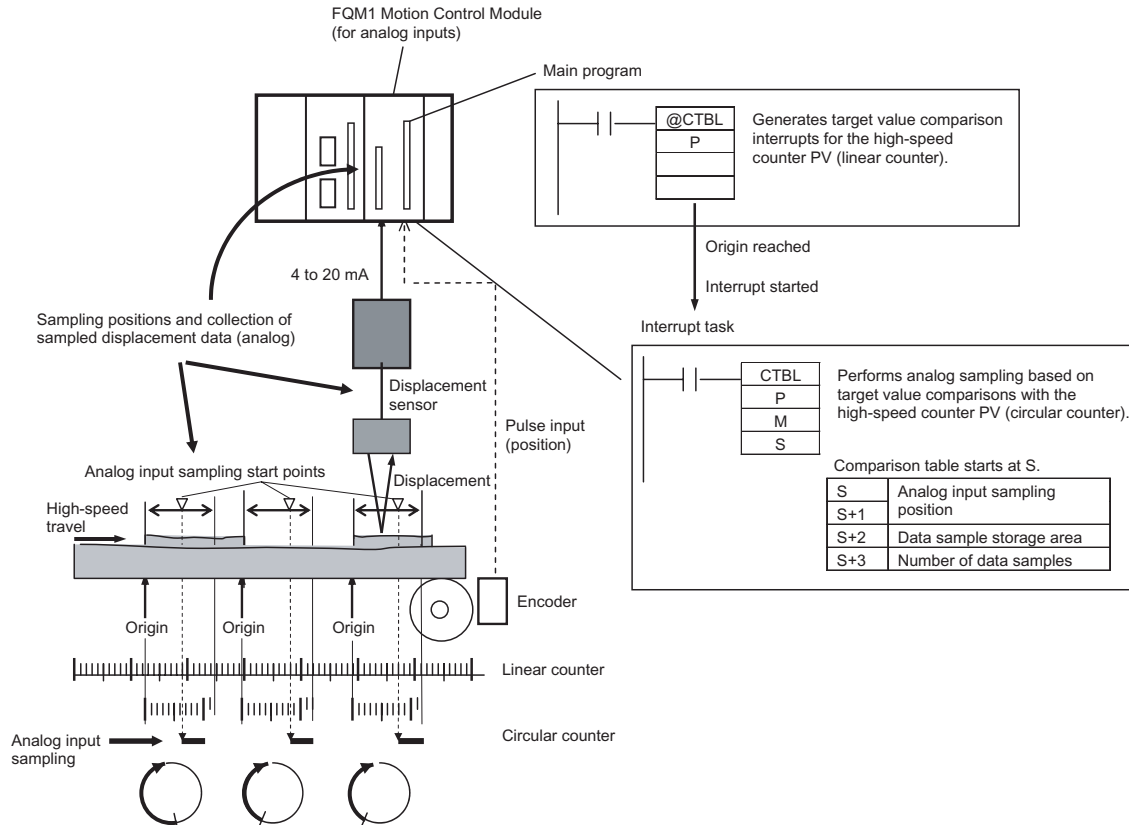
Creating Displacement Data from a Particular Workpiece Position

In this example, operation is synchronized to the measurement position of a workpiece (such as a sheet of glass) and the Motion Control Module collects displacement data from an analog output sensor. Displacement is measured at several measurement points.

- 1,2,3... 1. When the workpiece has reached the measurement point, the CTBL(882) instruction is executed and an interrupt will be generated for the high-speed counter PV (linear counter).

2. Another CTBL(882) instruction (using the CTBL(882) instruction's high-speed analog sampling function) is executed in that interrupt task. When the High-speed counter PV (circular counter) reaches the preset value, the Motion Control Module collects the specified number of high-speed analog input data samples from a displacement sensor.
3. The high-speed analog sampling function stops when the specified number of high-speed analog input data samples have been collected.

The following diagram shows how this method can be used to collect displacement data from a particular workpiece position.



The sampled data can be processed to calculate and store the average, maximum, and minimum values in multiple ranges specified. A judgement output can also be generated.

7-10 Analog Outputs

7-10-1 Applicable Models

Model	Functions
FQM1-MMA22	Motion Control Module for Analog I/O

7-10-2 Outline

The FQM1-MMA22 Motion Control Module can generate analog output signals for two ports. Each output can be set independently to one of four signal types: -10 to +10 V, 0 to 10 V, 0 to 5 V, or 1 to 5 V.

Normally, the analog values stored in A810 and A811 are output cyclically during END refreshing, but the outputs values can also be immediately refreshed with the SPED(885) instruction for step-pattern outputs or the ACC(888) instruction for sloped outputs.

7-10-3 Analog Output Function Specifications

Analog Outputs

Item	Specification			
Output signals	Voltage outputs			
Number of analog outputs	2 outputs			
Output ranges	Select each output's signal range in the System Setup (Analog Input/Output Tab Page, Output 1 Setting and Output 2 Setting): –10 to 10 V, 0 to 10 V, 0 to 5 V, or 1 to 5 V			
D/A conversion time	40 μ s/output			
Resolution	–10 to 10 V: 1/10,000 (14-bit value between EC78 and 1388 hex) 0 to 10 V, 0 to 5 V, or 1 to 5 V: 1/4,000 (12-bit value between 0000 and 0FA0 hex)			
Analog output refresh method	Set the refresh timing of analog output values in the System Setup (<i>Analog Input/Output Tab Page – Output</i>):			
	<ul style="list-style-type: none"> • END refresh • Immediate refresh (executing SPED(885) or ACC(888)) 			
	<table border="1"> <tr> <td>END refreshing</td> <td>The values in A810 and A811 are output.</td> </tr> <tr> <td>Immediate refreshing by instructions</td> <td>The specified analog value is output when SPED(885) or ACC(888) is executed in the program. <ul style="list-style-type: none"> • SPED(885): Changes analog output value in a step pattern. • ACC(888): Changes analog output value with a slope. (Value changes every 2 ms.) <p>Note</p> <ol style="list-style-type: none"> 1. Analog output values can also be controlled from interrupt subroutines. 2. The setting in the analog output stop function determines the analog output value from startup until execution of an instruction that controls the analog output. </td> </tr> </table>	END refreshing	The values in A810 and A811 are output.	Immediate refreshing by instructions
END refreshing	The values in A810 and A811 are output.			
Immediate refreshing by instructions	The specified analog value is output when SPED(885) or ACC(888) is executed in the program. <ul style="list-style-type: none"> • SPED(885): Changes analog output value in a step pattern. • ACC(888): Changes analog output value with a slope. (Value changes every 2 ms.) <p>Note</p> <ol style="list-style-type: none"> 1. Analog output values can also be controlled from interrupt subroutines. 2. The setting in the analog output stop function determines the analog output value from startup until execution of an instruction that controls the analog output. 			
Analog output values	<ul style="list-style-type: none"> • With END refreshing, the analog output values are specified in A810 and A811. • With immediate refreshing by instructions, the analog output values are specified in the instruction's operands. <p>–10 to 10 V EC78 to 1388 hex (–5,000 to 5,000 decimal) (resolution: 10,000) corresponding to 0% to 100% voltage (–10 to 10 V) The possible setting range is actually EA84 to 157C hex (–5,500 to 5,500 decimal) corresponding to –5% to 105% voltage (–11 to 11 V)</p> <p>0 to 10 V, 0 to 5 V, or 1 to 5 V: 0000 to 0FA0 hex (0 to 4,000 decimal) (resolution: 4,000) corresponding to 0% to 100% of the FS range. (Actually, the setting range is FF38 to 1068 (–200 to 4,200 decimal) corresponding to –5% to 105% voltage (–0.5 to 10.5 V, –0.25 to 5.25 V, or 0.8 to 5.2 V).)</p>			
Analog output value storage locations	<p>Analog output 1: A810; Analog output 2: A811</p> <ul style="list-style-type: none"> • With END refreshing, the contents of these words can be changed to change the analog output values that are output externally. (The actual output value may be different from the stored value if the output stop function is being used to clear the output or output the maximum value.) • With immediate refreshing by instructions, the value being output by SPED(885) or ACC(888) is stored in these words for monitoring when SPED(885) or ACC(888) is executed. If the hold function is being used, the values output by the hold function are stored for monitoring. 			
Max. external output current	2.4 mA			

Item		Specification
Overall accuracy (See note 1.)	23 ±2°C	±0.3% of FS
	0 to 55°C	±0.5% of FS
Functions	Slope	The ACC(888) instruction can be used to change the analog output value at the following rates: -10 to 10 V: 0000 to 2AF8 hex (0 to 11,000 decimal) 0 to 10 V, 0 to 5 V, or 1 to 5 V: 0000 to 1130 hex (0 to 4,400 decimal)
	Output hold	The output stop function will clear the output, hold it at the peak value, or hold it at the current value in the following cases. <ul style="list-style-type: none"> • One of the Analog Output SV Error Flags is ON. (A812.08 is the flag for output 1 and A813.08 is the flag for output 2.) (Only when end refresh is selected.) • A fatal error (other than a Motion Control Module WDT error or flash memory adjustment data error) occurred in the Motion Control Module. (See note 2.) • The other analog output is being adjusted in adjustment mode.
	Offset/gain adjustment	The output values can be offset as required for the connected device. In adjustment mode, the offset or gain can be changed by turning ON the Adjustment Enable Bit (A820.00 for the analog input, A820.01 for analog output 1, or A820.02 for analog output 2), specifying the offset or gain value, and turning ON the Increment or Decrement Bit from the CX-Programmer. <ul style="list-style-type: none"> • Offsets: -10 to 10 V: FE0C to 01F4 hex 0 to 10 V, 0 to 5 V, or 1 to 5 V: FF38 to 00C8 hex • Gain values: -10 to 10 V: 1194 to 157C hex 0 to 10 V, 0 to 5 V, or 1 to 5 V: 0ED8 to 1068 hex

Note

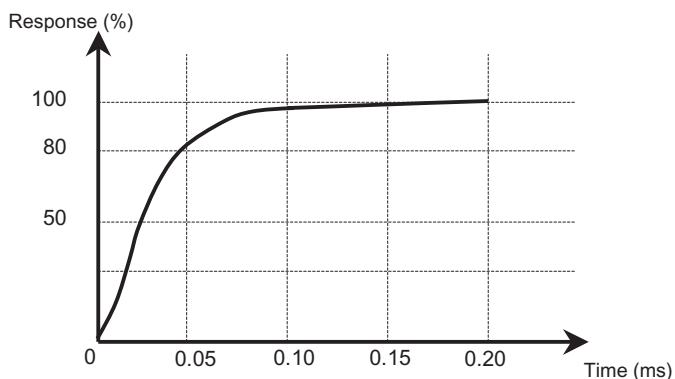
- (1) The overall accuracy is the ratio of accuracy to the full scale.
- (2) The following table shows the status of the analog outputs if there is a fatal error in the Motion Control Module or the Coordinator Module is in CPU standby status.

Condition	Analog output
WDT error in Motion Control Module	Output near 0 V (0 V output without offset adjustment).
<ul style="list-style-type: none"> • Flash memory adjustment data error in Motion Control Module (flash memory error or adjustment data error indicated in Auxiliary Area) • CPU standby error in Coordinator Module 	
Another fatal error in the Motion Control Module (such as flash memory errors not listed above, FALS, etc.)	The output status specified by the hold function (clear, peak, or hold) will be output.

If there is an error in the System Setup settings for the analog output function (Analog Input/Output), the following settings will be used.

Output range: - 10 to 10 V
 Output stop function: Clear
 Refreshing method: END refresh

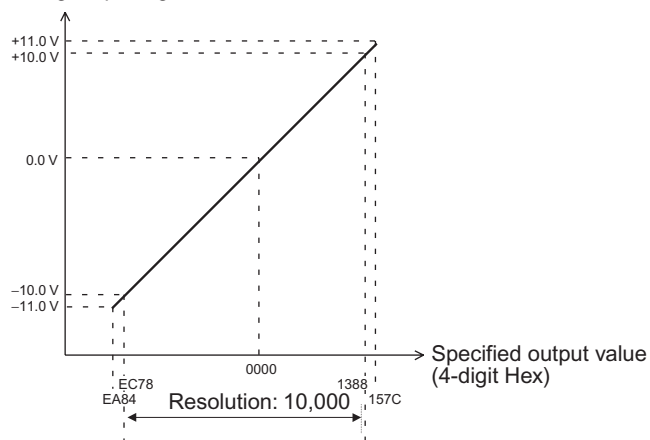
Note The step response output characteristic for stepping the output signal in the $\pm 10\text{-V}$ range is shown below as reference.



Specified Output Values and Analog Output Signals

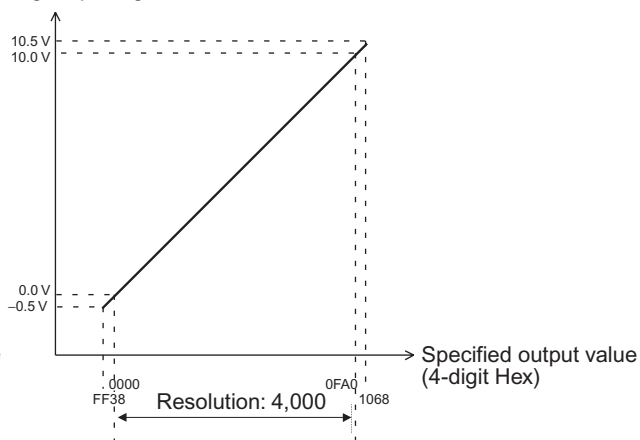
-10 to 10 V

Analog output signal



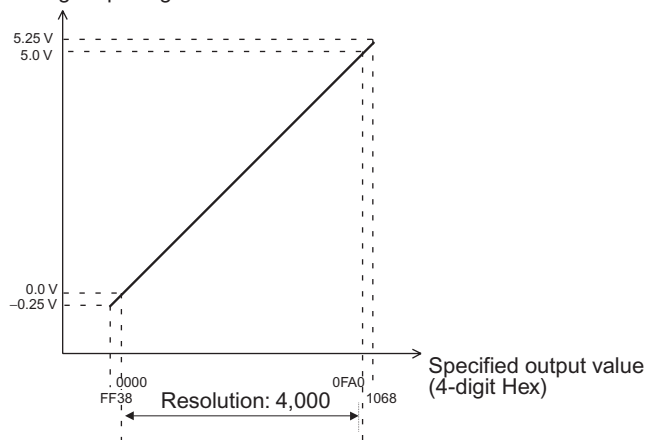
0 to 10 V

Analog output signal



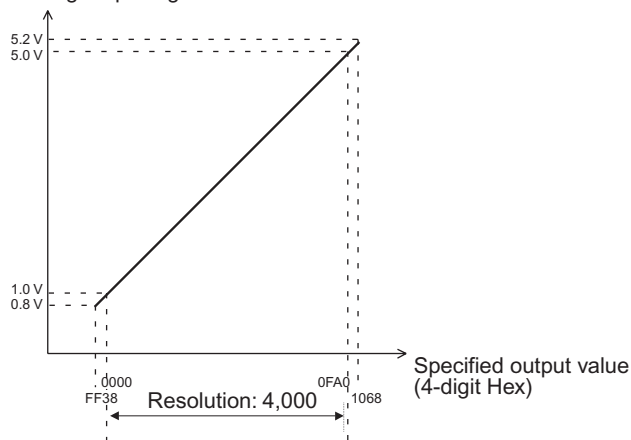
0 to 5 V

Analog output signal



1 to 5 V

Analog output signal



7-10-4 Applicable Instructions

END Refreshing

Set the analog output values in A810 and A811 using an instruction such as the MOV instruction.

With Immediate Refreshing

Outputs can be controlled with SPED(885) and ACC(888) as outlined below. SPED(885) can be used to change the output value in steps.

(@) SPED	
P	P: Port specifier (#0001 for analog output 1 or #0002 for analog output 2)
#0000	M: Always #0000
F	F: Analog output value

F: Analog output value

Specifies the target analog output value as a 4-digit hexadecimal value.

- 10 to 10 V	EA84 to 157C hex (-5,500 to 5,500 decimal, resolution: 11,000)
0 to 10 V, 0 to 5 V, 1 to 5 V	FF38 to 1068 hex (-200 to 4,200 decimal, resolution: 4,400)

Note The specified analog output value must be within the allowed range listed above. If an out-of-range output value is specified, an error will occur and it will be necessary to switch to PROGRAM mode in order to output the analog output again.

ACC(888) can be used to generate a rising or falling analog output value

(@) ACC	
P	P: Port specifier (#0001 for analog output 1 or #0002 for analog output 2)
#0000	M: Always #0000
T	

T = Rate of change, T+1 = Analog output target value

T = Rate of Change (4-digit hexadecimal)

T contains the rate of change (slope) per 2 ms.

-10 to 10 V	0000 to 2AF8 hex (0 to 11,000 decimal)
0 to 10 V, 0 to 5 V or 1 to 5 V	0000 to 1130 hex (0 to 4,400 decimal)

T+1 = Analog Output Target Value

T+1 is set to the target analog output value as a 4-digit hexadecimal value.

-10 to 10 V	EA84 to 157C hex (-5,500 to 5,500 decimal, resolution: 11,000)
0 to 10 V, 0 to 5 V or 1 to 5 V	FF38 to 1068 hex (-200 to 4,200 decimal, resolution: 4,400)

Note ACC(888) and SPED(885) can also be used to change the analog output value while ACC(888) is generating a sloped output.

7-10-5 Procedure

- 1,2,3... 1. Determine the analog output range, number of outputs, refreshing method, and instructions that will be used.
2. Wire the analog output.
3. Make the necessary System Setup settings (output method).
 - Set the analog output range (-10 to +10 V, 0 to 10 V, 0 to 5 V, or 1 to 5 V).
 - Set the output stop function (clear, peak value, or hold).
 - Set the analog output refreshing method (END refresh or immediate refresh).
4. Create the necessary ladder programming.

- Set the output value in A810 or A811 with an instruction such as MOV.
- Execute SPED(885) or ACC(888).

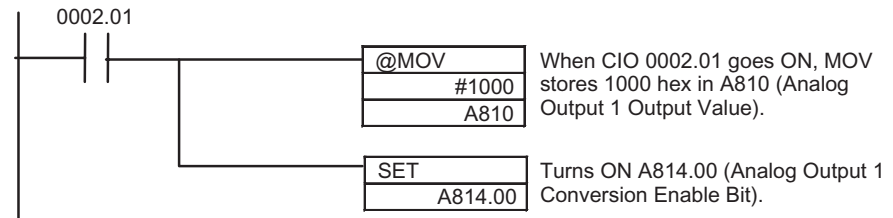
7-10-6 Application Example

Outputting the Analog Output Value Stored in the Auxiliary Area

In this example, the Motion Control Module outputs the analog output value stored in A810 from analog output 1.

Set the following System Setup settings:

- Analog Input/Output Tab Page – Output 1: Set the output range of analog output 1 to “1 to 5 V.”
- Analog Input/Output Tab Page – Output: Set the analog output refreshing method to END refresh.

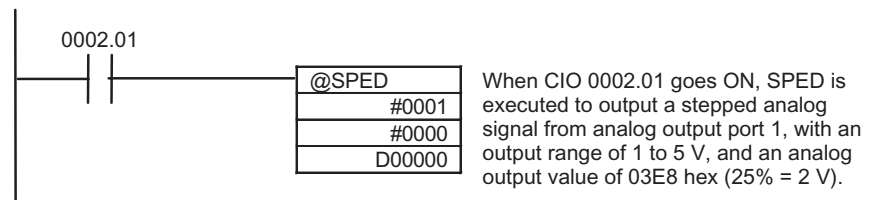


Outputting a Stepped Analog Output

In this example, the Motion Control Module outputs a step-pattern analog output using a particular input signal as the trigger.

Set the following System Setup settings:

- Analog Input/Output Tab Page – Output 1: Set the output range of analog output 1 to “1 to 5 V.”
- Analog Input/Output Tab Page – Output: Set the analog output refreshing method to immediate refresh.



D00000

0	3	E	8
---	---	---	---

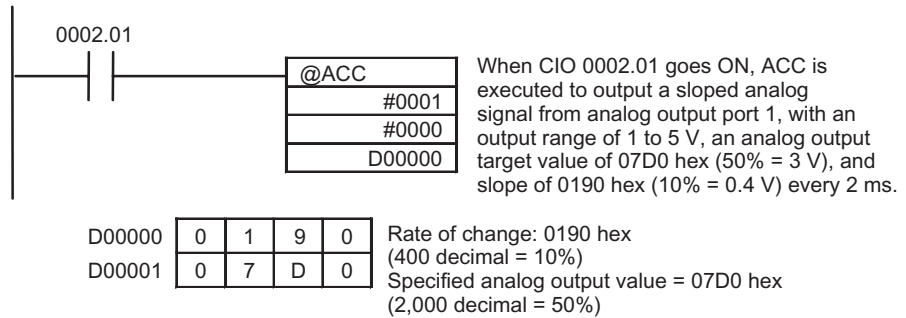
 Specified analog output value = 03E8 hex (1,000 decimal = 25%)

Outputting a Sloped Analog Output

In this example, the Motion Control Module outputs a sloped analog output using a particular input signal as the trigger.

Set the following System Setup settings:

- Analog Input/Output Tab Page – Output 1: Set the output range of analog output 1 to “1 to 5 V.”
- Analog Input/Output Tab Page – Output: Set the analog output refreshing method to immediate refresh.



7-11 DM Data Storage Function

Storing DM Data to Flash Memory

Part of the DM Area can be saved to flash memory.

The System Setup can be set to automatically save DM data when the power is turned ON. This storage function can be executed in PROGRAM mode only.

Retained Area

DM Area words D00000 to D29999 are backed up.

Storing Data to Flash Memory

Use the following Auxiliary Area control bit and word to save DM data to flash memory.

Address	Name	Function	Status when switching to RUN mode	Status at startup
A751.15	DM Save Start Bit	Turn ON to start DM data save operation.	Retained	Cleared
A752	DM Save Password	Write A5A5 hex to this word and turn ON the DM Save Start Bit (A751.15) to transfer DM data to flash memory.	Retained	Cleared

Note

The status of the DM Save Start Bit is retained when the mode is switched. When the bit has gone ON in MONITOR mode or RUN mode and the mode is later switched to PROGRAM mode, the rising edge of the bit won't be detected and the save operation won't be executed.

Checking for Saved Data

The following Auxiliary Area flag indicates whether DM data has been saved in flash memory.

Address	Name	Function	Status when switching to RUN mode	Status at startup
A345.04	DM Data in Flash Memory Flag	This flag will be ON when System Setup setting +82 (Read DM Data at Startup) is set to 1 and the DM data in flash memory is valid.	Retained	Cleared

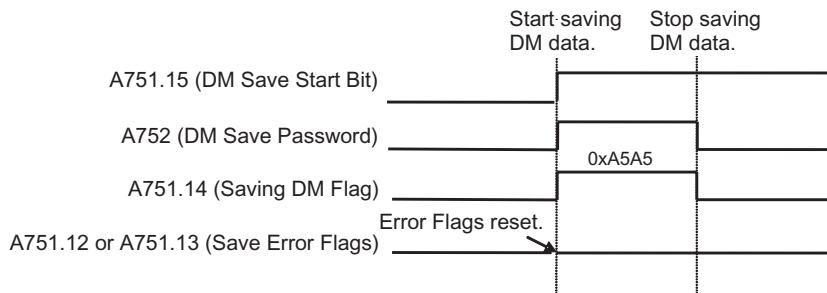
Operating Mode

This function can be executed in PROGRAM mode only. The signal will be ignored if the control bit is turned ON in MONITOR mode or RUN mode.

Notification that Data is being Saved

The following Auxiliary Area flag indicates that DM data is being saved in flash memory.

Address	Name	Function	Status when switching to RUN mode	Status at startup
A751.14	Saving DM Flag	This flag will be ON when DM data is being saved.	Retained	Cleared



Flash Memory Save Failures

The DM data save may fail if the flash memory has passed its usable lifetime or become damaged. The following Auxiliary Area flags indicate that a DM data save has failed.

Address	Name	Function	Status when switching to RUN mode	Status at startup
A751.12	Invalid DM Save Password Flag	This flag will be ON if A752 contained the wrong password when DM data was being saved to flash memory.	Retained	Cleared
A751.13	DM Backup Error Flag	This flag will be ON if the DM data save operation failed.	Retained	Cleared

Reading DM Data from Flash Memory

DM data is read from flash memory only when the power is turned ON.

Read DM Data at Startup Setting

The following PLC Setup setting determines whether the FQM1 will read DM data at startup.

Address	Bit	Name	Description	Timing
+82	15	Read DM Data at Startup	When the Coordinator Module's Startup Mode setting is disabled in the System Settings, the default operation for this setting is to not read DM Data.	At startup (power ON)

Invalid DM Data in Flash Memory

The following Auxiliary Area flag will be turned ON if the DM data in flash memory is invalid because the data could not be saved properly. One possible cause of invalid data is a power interruption during the save operation.

In this case, the data will not be read from flash memory and the DM data will be cleared to zeroes.

Address	Name	Function	Status when switching to RUN mode	Status at startup
A751.11	Saved DM Data Invalid Flag	This flag will be ON if the DM data in flash memory was invalid when it was read.	Retained	Cleared

SECTION 8

Connecting the CX-Programmer

This section explains how to connect a personal computer running the CX-Programmer to the FQM1.


8-1	CX-Programmer	290
8-2	Connecting the CX-Programmer	291
8-2-1	System Configuration	291
8-2-2	CX-Programmer Connecting Cables	294

8-1 CX-Programmer

The CX-Programmer Ver. 6.11 (WS02-CXPC1-E-V60) is required to create the ladder program, make System Setup settings, and monitor or debug operation in the FQM1-CM002, FQM1-MMP22, and FQM1-MMA22. To connect the FQM1 and a personal computer, use the cables shown in the following table.

Name	Model	Specifications
Programming Device Connecting Cables (for peripheral port)	CS1W-CN118	Connects a personal computer (Microsoft Windows OS). D-Sub 9-pin receptacle (converts between RS-232C and peripheral communications) (Length: 0.1 m)
	CS1W-CN226	Connects a personal computer (Microsoft Windows OS). D-Sub 9-pin (Length: 2.0 m)
	CS1W-CN626	Connects a personal computer (Microsoft Windows OS). D-Sub 9-pin (Length: 6.0 m)
Programming Device Connecting Cables (for RS-232C port)	XW2Z-200S-CV	Connects a personal computer (Microsoft Windows OS). D-Sub 9-pin (Length: 2.0 m), Static-resistant connector used.
	XW2Z-500S-CV	Connects a personal computer (Microsoft Windows OS). D-Sub 9-pin (Length: 5.0 m), Static-resistant connector used.
	XW2Z-200S-V	Connects a personal computer (Microsoft Windows OS). D-Sub 9-pin (Length: 2.0 m) (see note)
	XW2Z-500S-V	Connects a personal computer (Microsoft Windows OS). D-Sub 9-pin (Length: 5.0 m) (see note)
USB-Serial Conversion Cable	CS1W-CIF31	USB to D-Sub 9-pin conversion cable (Length: 0.5 m)

Note These RS-232C Connecting Cables cannot be used to connect to the CX-Programmer with Peripheral Bus communications. Connect to the CX-Programmer with Host Link (SYSMAC WAY) communications.

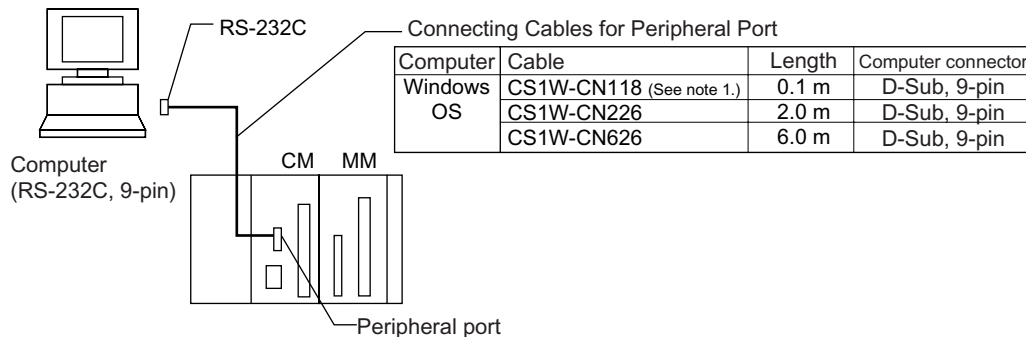
 **Caution** Never connect a PLC Programming Console (such as the C200H-PRO27) to the Coordinator Module's peripheral port. The FQM1 may malfunction if a PLC Programming Console is connected.

8-2 Connecting the CX-Programmer

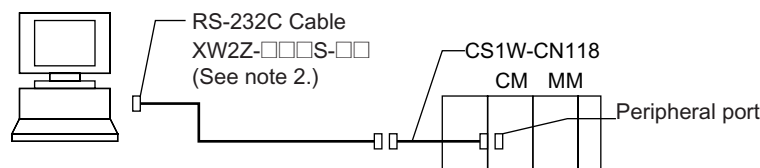
8-2-1 System Configuration

Connecting a Personal Computer Running Support Software

Connecting to the Peripheral Port

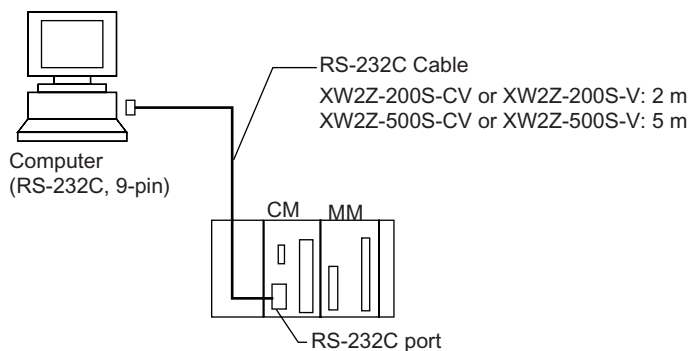


Note 1. The CS1W-CN118 Cable is used with an RS-232C cable to connect to the peripheral port on the Coordinator Module as shown below. Peripheral bus communications cannot be used if the CS1W-CN118 Cable is combined with an RS-232C Cable that has a model number ending in -V. In this case, Host Link (SYSMAC WAY) communications must be used.



2. Host Link (SYSMAC WAY) communications cannot be used. Use peripheral bus communications.

Connecting to the RS-232C Port



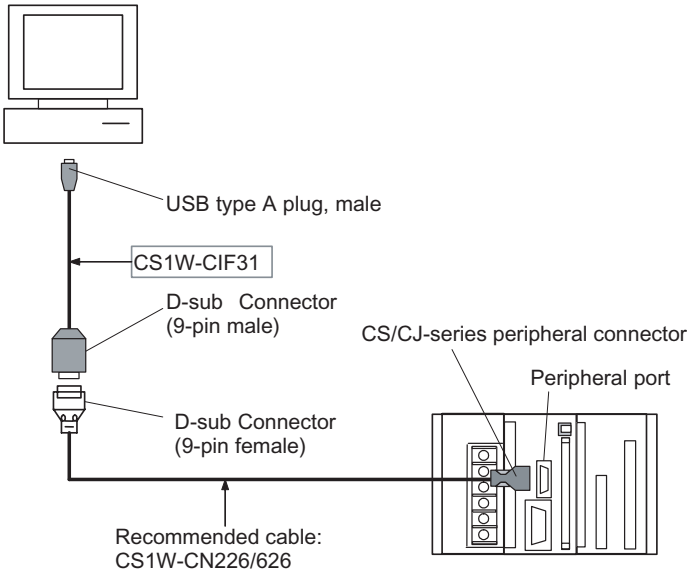
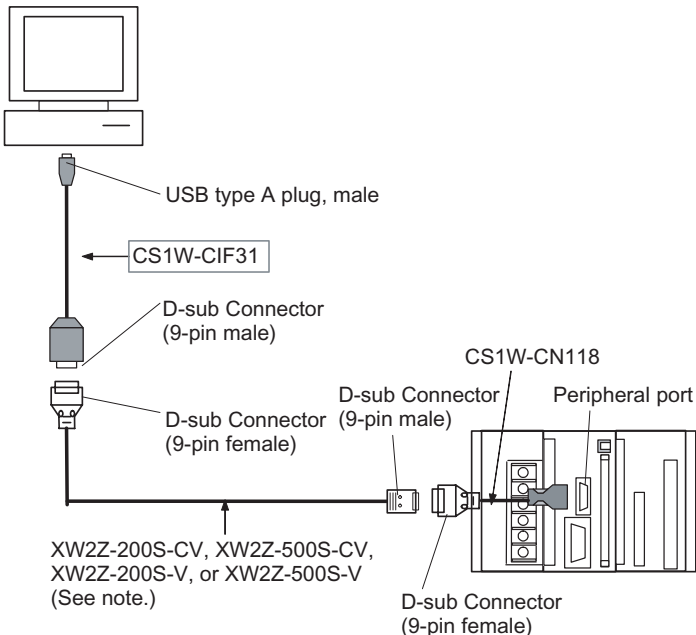
Note The XW2Z-200S-CV and XW2Z-500S-CV use static-resistant connectors and can be connected through peripheral bus or Host Link communications. The XW2Z-200S-V and XW2Z-500S-V, however, can only be connected through Host Link, not through peripheral bus.

Programming Software

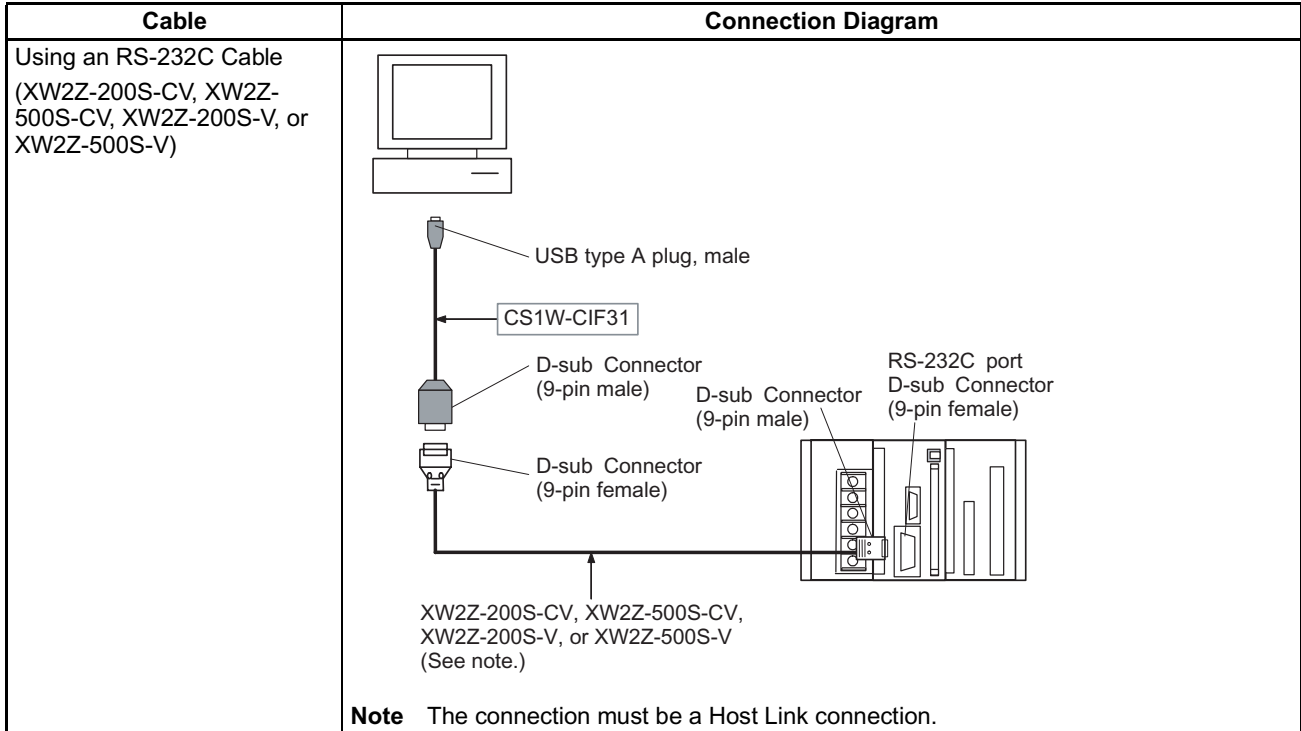
OS	Name	
Microsoft Windows	CX-Programmer Version 6.11 or higher only	CD-ROM

Connecting through the USB port with a USB-Serial Conversion Cable

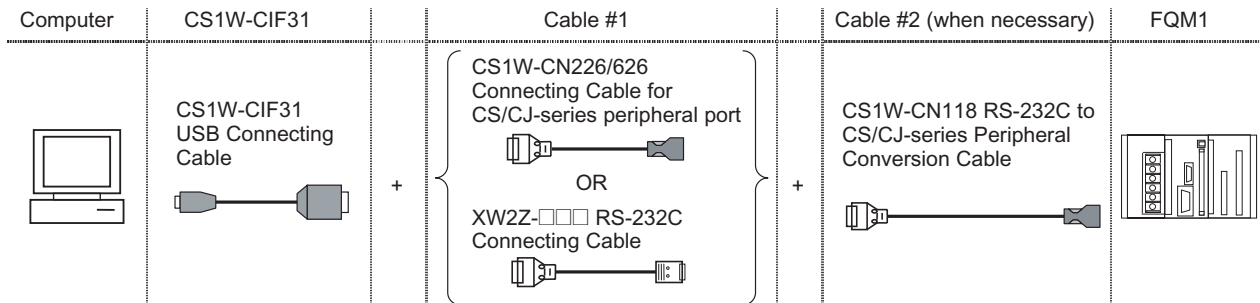
Connecting to the Peripheral Port

Cable	Connection Diagram
Using a CS1W-CN226/626 Cable	 <p>USB type A plug, male</p> <p>CS1W-CIF31</p> <p>D-sub Connector (9-pin male)</p> <p>D-sub Connector (9-pin female)</p> <p>CS/CJ-series peripheral connector</p> <p>Peripheral port</p> <p>Recommended cable: CS1W-CN226/626</p>
Using an RS-232C Cable (XW2Z-200S-CV, XW2Z-500S-CV, XW2Z-200S-V, or XW2Z-500S-V)	 <p>USB type A plug, male</p> <p>CS1W-CIF31</p> <p>D-sub Connector (9-pin male)</p> <p>D-sub Connector (9-pin female)</p> <p>CS1W-CN118</p> <p>D-sub Connector (9-pin male)</p> <p>Peripheral port</p> <p>D-sub Connector (9-pin female)</p> <p>XW2Z-200S-CV, XW2Z-500S-CV, XW2Z-200S-V, or XW2Z-500S-V (See note.)</p> <p>Note The connection must be a Host Link connection.</p>

Connecting to the RS-232C Port



Connection Methods (Using a USB-Serial Conversion Cable)




USB Connecting Cable	Cable 1			Cable 2			Port	Communications mode
	Connector	Model	Connector	Connector	Model	Connector		
CS1W-CIF31	D-Sub 9-pin female	CS1W-CN226/626 (2 or 6 m)	CS/CJ peripheral	Unnecessary			Coordinator Module peripheral	Peripheral bus (Tool bus) or Host Link
	D-Sub 9-pin female	XW2Z-200S-CV/500S-CV (2 or 5 m)	D-Sub 9-pin male	D-Sub 9-pin female	CS1W-CN118 (0.1 m)	CS/CJ peripheral		Peripheral bus (Tool bus) or Host Link
	D-Sub 9-pin female	XW2Z-200S-V/500S-V (2 or 5 m)	D-Sub 9-pin male	D-Sub 9-pin female	CS1W-CN118 (0.1 m)	CS/CJ peripheral		Host link
	D-Sub 9-pin female	XW2Z-200S-CV/500S-CV (2 or 5 m)	RS-232C D-Sub 9-pin male	Unnecessary			RS-232C D-Sub 9-pin female	Peripheral bus (Tool bus) or Host Link
	D-Sub 9-pin female	XW2Z-200S-V/500S-V (2 or 5 m)	RS-232C D-Sub 9-pin male	Unnecessary				Host link

8-2-2 CX-Programmer Connecting Cables

Port on Module	Computer	Port on computer	Communications mode (Network type)	Model	Length	Remarks
Built-in peripheral port	Windows OS	D-Sub 9-pin male	Peripheral bus (Tool bus) or Host Link (SYSMAC WAY)	CS1W-CN226	2.0 m	---
				CS1W-CN626	6.0 m	
Built-in RS-232C port (D-Sub 9-pin female)	Windows OS	D-Sub 9-pin male	Peripheral bus (Tool bus) or Host Link (SYSMAC WAY)	XW2Z-200S-CV	2 m	Uses static-resistant connectors
				XW2Z-500S-CV	5 m	

Note When connecting one of these cables to the Coordinator Module's RS-232C port, always touch a grounded metal object to discharge any electrostatic charge from the body before touching the cable connector. The XW2Z-□□□S-CV Cables are equipped with static-resistant XM2S-0911-E Connector Hoods to improve static resistance, but we recommend discharging static build-up before touching these connectors as well.

 **Caution** The OMRON Cables listed above can be used for connecting cables or an appropriate cable can be assembled. The external device or Coordinator Module itself may be damaged if a standard computer RS-232C cable is used as a connecting cable.

Connecting an RS-232C Cable to the Peripheral Port

The following connection configurations can be used when connecting an RS-232C cable to the Coordinator Module's peripheral port.

Port on Module	Computer	Port on computer	Communications mode (Network type)	Model	Length	Remarks
Built-in peripheral port	Windows OS	D-Sub 9-pin male	Peripheral bus (Tool bus) or Host Link (SYSMAC WAY)	CS1W-CN118 + XW2Z-200S-CV/ 500S-CV	0.1 m + (2 m or 5 m)	The XW2Z-□□□S-CV Cables have static-resistant connectors.
			Host link (SYSMAC WAY)	CS1W-CN118 + XW2Z-200S-V/ 500S-V		---

Connecting an RS-232C Cable to the RS-232C Port

The following connection configuration can be used to connect a personal computer to the Coordinator Module's RS-232C port with an RS-232C cable.

Port on Module	Computer	Port on computer	Communications mode (Network type)	Model	Length	Remarks
Built-in RS-232C port D-sub 9-pin female	Windows OS	D-Sub 9-pin male	Host link (SYSMAC WAY)	XW2Z-200S-V	2 m	---
				XW2Z-500S-V	5 m	

Note Either one of the following two serial communications modes can be used when connecting the CX-Programmer to the FQM1.

Serial communications mode	Features
Peripheral bus (Tool bus)	<p>Supports high-speed communications, so this communications mode is normally used to connect to the CX-Programmer.</p> <ul style="list-style-type: none"> • Supports only a 1:1 connection. • When the FQM1 is connected, the CX-Programmer can recognize the baud rate and make the connection automatically.
Host link (SYS-MAC WAY)	<p>This communications mode is generally used to connect to a host computer. Both 1:1 and 1:N connections are supported.</p> <ul style="list-style-type: none"> • Host link communications are relatively slow compared to the peripheral bus mode. • The Host Link mode supports connections through modems or optical adapters, long-distance connections using RS-422A or RS-485 communications, and 1:N connections.

The following table lists the Programming Devices other than the CX-Programmer that can be used with CJ-series Units.

Programming Device	Description	Connection
CX-Designer NS-Designer	These are Programming Devices for HMI devices. Can be connected through the Coordinator Module's communications port or directly connected to PT.	Supported
CX-Motion-NCF	The CX-Motion-NCF can be used to set CJ1W-NCF71 Position Control Units and connected Servo Drivers. Connect through the Coordinator Module's communications port.	Supported

Programming Device	Description	Connection
CX-Integrator	The CX-Integrator is network configuration support software, which cannot be used through the Coordinator Module's communications port. DeviceNet settings for DeviceNet Slave Units in the FQM1 can be made through the DeviceNet Master Unit mounted to the host PLC. The Configurator can be connected to the Coordinator Module's communications port.	Not supported
CX-Drive	Use the CX-Motion-NCF to change parameters in Servo Drivers connected to a CJ1W-NCF71 Position Control Unit.	Not supported
SPU-Console	The SPU-Console can be used to set and operate SYSMAC SPU Units. Connect this Programming Device directly to the SPU Unit.	Supported

SECTION 9

Error Processing

This section provides information on identifying and correcting errors that occur during FQM1 operation.

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9-1 Error Log

Each time that an error occurs in the FQM1, the error information is stored in the Error Log Area starting at A100. The error information includes the error code (same code stored in A400) and error contents. Up to 20 records can be stored in the Error Log.

Errors Generated by FAL(006)/FALS(007)

In addition to system errors generated by the Coordinator Module and Motion Control Module, the FQM1 records user-defined errors generated by the FAL and FALS instructions in the ladder program. These instructions make it easier to track the operating status of the system.

A user-defined error is generated when FAL or FALS is executed in the program. The input conditions of these instructions constitute the user-defined error conditions.

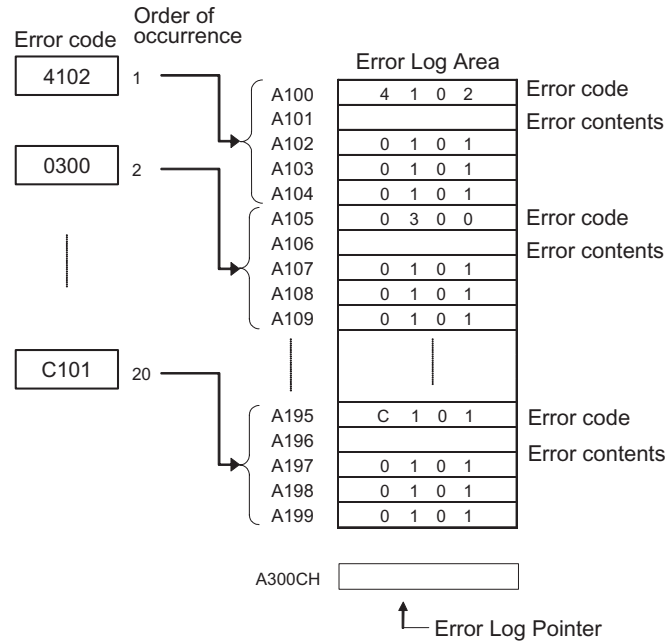
The following table shows the error codes for FAL and FALS, which are stored in A400 and the first word of the error record when the instruction is executed.

Instruction	FAL numbers	Error codes
FAL	#0001 to #01FF (1 to 511 decimal)	4101 to 42FF
FALS	#0001 to #01FF (1 to 511 decimal)	C101 to C2FF

Note FAL generates a non-fatal error (the Coordinator and Motion Control Module continue operating). FALS generates a fatal error that stops operation.

Error Log Structure

When more than 20 errors occur, the oldest error data (in A100 to A104) is deleted and the newest record is stored in A195 to A199.



Note The Error Log Pointer can be reset by turning ON the Error Log Pointer Reset Bit (A500.14), effectively clearing the error log display in the CX-Programmer. The contents of the Error Log Area (A100 to A199) will not be cleared by resetting the pointer.

9-2 Error Processing

9-2-1 Error Categories

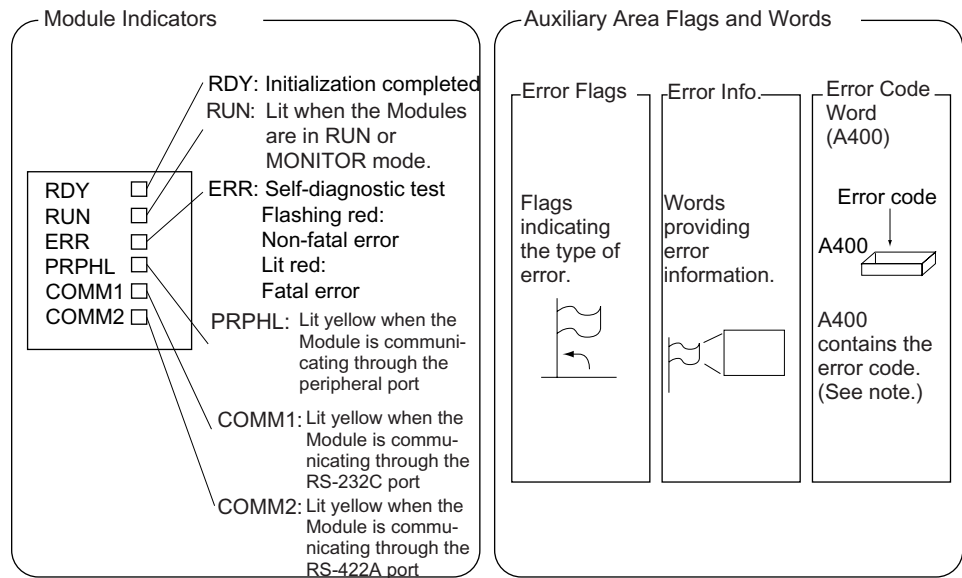
Errors in the FQM1 can be broadly divided into the following three categories.

Category	Result	Indicators			Comments
		RDY	RUN	ERR	
Standby	The FQM1 will not start operation in RUN or MONITOR mode.	OFF	OFF	OFF	This status occurs when a faulty Motion Control Module is connected.
Non-fatal Errors (including FAL)	The FQM1 will continue operating in RUN or MONITOR mode.	ON (Green)	ON (Green)	Flashing (Red)	This status indicates a non-fatal error other than a communications error.
Fatal Errors (including FALS)	The FQM1 will stop operating in RUN or MONITOR mode.	ON (Green)	OFF	ON (Red)	This status indicates a fatal error other than a power interruption. (The indicators will all be OFF when there is a power interruption.)

9-2-2 Error Information

There are basically four sources of information on errors that have occurred:

- The LED indicators on the front of the Coordinator and Motion Control Modules
- The Auxiliary Area Error Flags
- The Auxiliary Area Error Contents Words
- The Auxiliary Area Error Code Word



Note When two or more errors occur at the same time, the highest (most serious) error code will be stored in A400.

Indicator Status and Error Conditions

The following table shows the status of the FQM1's indicators for errors that have occurred in RUN or MONITOR Mode.

Indicator	CPU error	CPU reset	CPU standby	Fatal error	Non-fatal error	Communications error		
						Peripheral	RS-232C	RS-422A
RDY	OFF	OFF	OFF	ON	ON	ON	ON	ON
RUN	OFF	OFF	OFF	OFF	ON	---	---	---

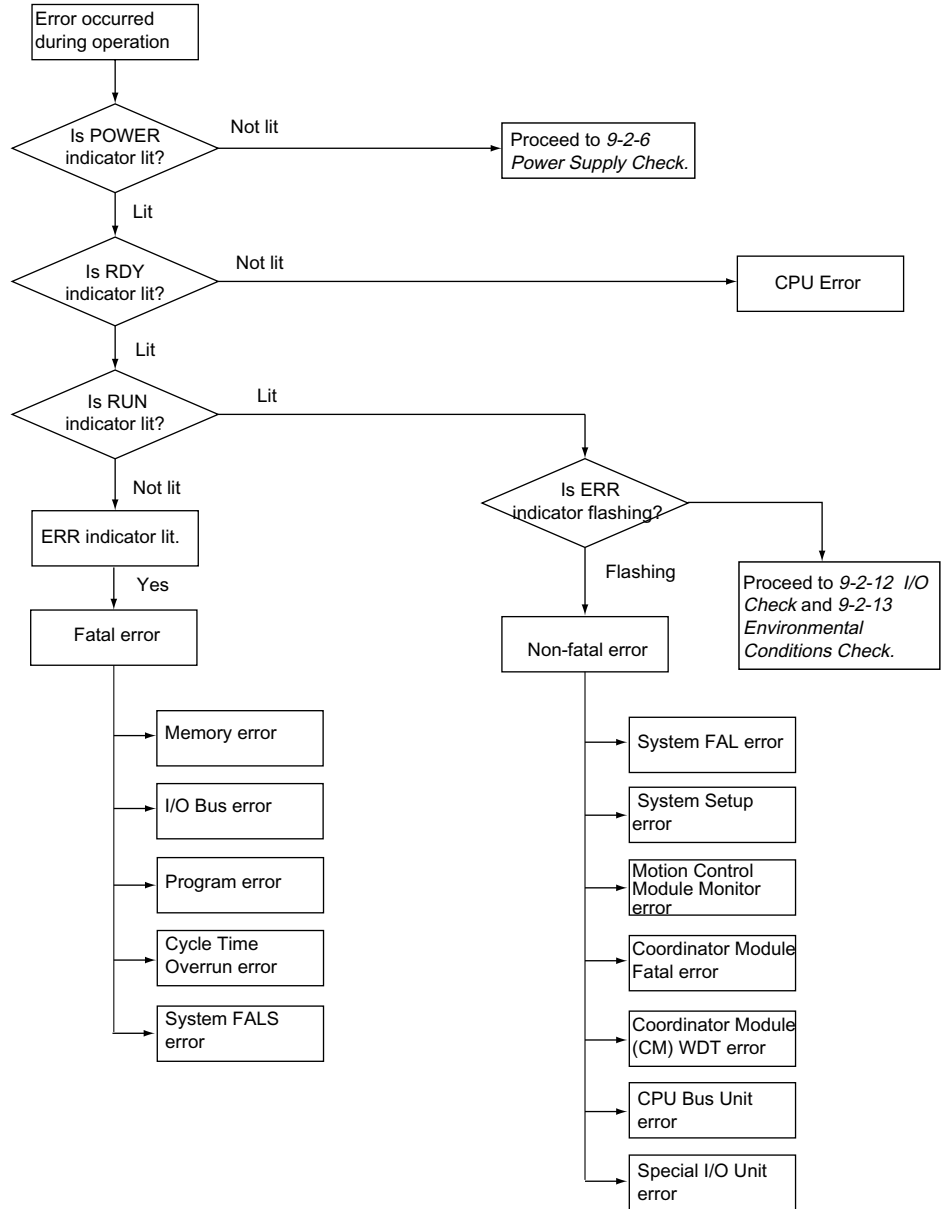
Indicator	CPU error	CPU reset	CPU standby	Fatal error	Non-fatal error	Communications error		
						Peripheral	RS-232C	RS-422A
ERR	ON	OFF	OFF	ON	Flashing	---	---	---
PRPHL	---	---	---	---	---	OFF	---	---
COMM1	---	---	---	---	---	---	OFF	---
COMM2	---	---	---	---	---	---	---	OFF

9-2-3 Error Codes

Classification	Error code	Error name	Page
Fatal system errors	80F1	Memory error	304
	80C0	I/O bus error	304
	80CF	Bus error (location undetermined)	304
	80CE	No End Cover	304
	80CD	Synchronous bus error	304
	80E0	I/O setting error	305
	80F0	Program error	305
	80E9	Duplicated number error	305
	80E1	Too many I/O points error	305
	809F	Cycle time overrun error	306
Non-fatal system errors	009B	System Setup setting error	306
	0200 to 020F	CPU Bus Unit error	306
	030A to 035F	Special I/O Unit error	307
	0001	Coordinator Module WDT error	307
	0006	Coordinator Module error	307
	0300	Motion Control Module WDT error	307
User-defined non-fatal errors	4101 to 42FF	FAL error (4101 to 42FF are stored for FAL numbers 001 to 511)	306
User-defined fatal errors	C101 to C2FF	FALS error (C101 to C2FF are stored for FALS numbers 001 to 511)	306

9-2-4 Error Processing Flowchart

Use the following flowchart as a guide for error processing with the CX-Programmer.



9-2-5 Error Tables

The following tables show the errors which can occur in the FQM1 and indicate the probable cause of the errors.

Note Always confirm the safety of connected equipment before turning the power supply OFF or ON.

CPU Errors

If the following LED indicator condition appears during operation (in RUN or MONITOR mode), it indicates that a CPU error has occurred. The CX-Programmer cannot be connected if a CPU error has occurred.

If a fatal error occurs, the RDY and ERR indicators will be lit and the RUN indicator will be OFF, but a CX-Programmer can be connected. This difference can be used to distinguish between a CPU error and other fatal errors.

Power Supply Module Indicators	Module Indicators (Coordinator Module and Motion Control Modules)					
POWER	RDY	RUN	ERR	PRPHL	COMM1	COMM2
Lit	OFF	OFF	Lit	---	---	---

Operating status	Error name	Error flags in Auxiliary Area	Error code (in A400)	Error contents	Probable cause	Remedy
Stopped	CPU error	None	None	None	A WDT (watchdog timer) error occurred in a Module. (This error does not normally occur)	Turn the power OFF and restart. The Module may be damaged. Contact your OMRON representative.

CPU Reset

The following indicator status shows that the CPU Unit has been reset (not a CPU error). A Programming Device cannot be connected in this condition.

Power Supply Module Indicators	Module Indicators (Coordinator Module and Motion Control Modules)					
POWER	RDY	RUN	ERR	PRPHL	COMM1	COMM2
Lit	OFF	OFF	OFF	---	---	---

Operating status	Error name	Error flags in Auxiliary Area	Error code (in A400)	Error contents	Probable cause	Remedy
Stopped	CPU reset	None	None	None	Power is not being supplied to the Expansion Rack.	Supply power to the Expansion Rack.
					I/O Control Module is not connected correctly, e.g., more than one is connected or one is connected to an Expansion Rack.	Turn OFF the power supply, correct the connections, and turn the power supply back ON.
					The I/O Connecting cable is not connected correctly, e.g., the connections to the input and output connectors on the I/O Interface Unit are reversed.	Turn OFF the power supply, correct the connections, and turn the power supply back ON.

Note When the power supply to an Expansion Rack is interrupted, the Coordinator Module will stop running and perform the same power interruption procedure that is performed when the power supply is interrupted to the Coordinator Module itself.

CPU Standby

If the following LED indicator condition appears when the power is turned ON, it indicates that the FQM1 is in CPU standby status.

When the FQM1 is turned ON, cyclic servicing starts after the Coordinator Module recognizes all of the connected Motion Control Modules and CJ-series Units. Operation can be started at that point.

If the startup mode is RUN or MONITOR mode, the FQM1 will remain in standby status until all of the Motion Control Modules have been recognized.

Power Supply Module Indicators	Module Indicators (Coordinator Module and Motion Control Modules)					
POWER	RDY	RUN	ERR	PRPHL	COMM1	COMM2
Lit	OFF	OFF	OFF	---	---	---

Operating status	Error name	Error flags in Auxiliary Area	Error code (in A400)	Error contents	Probable cause	Remedy
Stopped	CPU standby	None	None	None	A Motion Control Module or CJ-series Unit did not start up properly.	Replace the Motion Control Module or CJ-series Unit.

The FQM1 will go into CPU standby when a Too many I/O points error, unit number error, duplicated number error, or I/O setting error is detected when the power is turned ON. The ERR Indicator will be lit in this case. Eliminate the cause of the error and turn the power ON again.

Note When a CJ1W-SPU01 SPU Unit is mounted, it takes the Coordinator Module about 20 seconds to recognize the SPU Unit, so the CPU standby time will be longer than usual.

Fatal Errors

If the following LED indicator condition appears during operation (in RUN or MONITOR mode), it indicates that a fatal error has occurred.

Power Supply Unit Indicators	Module Indicators					
POWER	RDY	RUN	ERR	PRPHL	COMM1	COMM2
Lit	Lit	OFF	Lit	---	---	---

The fatal error's error contents will be displayed in the Error Tab in the CX-Programmer's Error Window. Determine the cause of the error from the error message and related Auxiliary Area flags/words and correct the cause of the error.

Errors are listed in order of importance. When two or more errors occur at the same time, the more serious error's error code will be recorded in A400.

The I/O memory will be cleared when a fatal error other than FALS occurs. (The I/O memory will not be cleared when FALS is executed to generate a fatal error.)

When operation is stopped, all outputs will be turned OFF. The Servo Driver that is in Servo ON state for outputs from the FQM1 will switch to Servo OFF state.

Fatal Errors

Error	Error code (in A400)	Auxiliary Area flag and word data	Probable cause	Possible remedy
Memory error	80F1	A401.15: Memory Error Flag A403: Memory Error Location	An error has occurred in memory. A bit in A403 will turn ON to show the location of the error as listed below.	See below.
			A403.00 ON: A checksum error has occurred in the user program memory. An illegal instruction was detected.	Check the program and correct the error.
			A403.04 ON: A checksum error has occurred in the System Setup.	Transfer the System Setup settings again.
			A403.10 ON: An error occurred in flash memory (backup memory).	Module hardware is faulty. Replace the Module.
			A403.13 ON: There is an error in the analog offset/gain data.	Check the data and set again.
			A403.14 ON: A checksum error has occurred in the DM data stored in flash memory.	Save the DM data in flash memory again. If the error cannot be cleared, replace the Module.
I/O Bus error	80C0 80C1 80CD 80CE 80CF	A401.14: I/O Bus Error Flag	<p>Error has occurred in the data transfer between connected Modules or the End Cover is not connected to the right side of the FQM1.</p> <p>Note A404.00 to A404.07 contain the error slot number (00 to 09) in binary. A404.08 to A404.15 contain the error rack number (00 to 01) in binary. Both of these bytes will contain 0D if a synchronous bus error occurred. The code 0F hex indicates that the slot cannot be determined. The code 0E hex indicates an End Cover is not connected.</p>	<p>Try turning the power OFF and ON again.</p> <p>If the error persists, turn the power OFF and check connections between the Modules and the End Cover.</p> <p>Check for damage to the Modules. After correcting the problem, turn the FQM1's power OFF and then ON again.</p>

Error	Error code (in A400)	Auxiliary Area flag and word data	Probable cause	Possible remedy
Program error	80F0	A401.09: Program Error Flag A295: Program error information	The program is incorrect. A bit in A405 will turn ON to show the error details as listed below.	Check A405 to determine the type of error that occurred. Correct the program and then clear the error.
			A295.11: No END error	Be sure that there is an END instruction at the end of the program.
			A295.15: UM overflow error The last address in UM (user program memory) has been exceeded.	Use the CX-Programmer to transfer the program again to FQM1.
			A295.13: Differentiation overflow error Too many differentiated instructions have been inserted or deleted during online editing.	After writing any changes to the program, switch to PROGRAM mode and then return to MONITOR mode to continue editing the program.
			A295.12: Task error A task error has occurred. The task specified in the MSKS instruction doesn't exist.	Check that all of the task numbers specified in the MSKS instructions have corresponding tasks. Use MSKS to mask any input interrupt task or other interrupt tasks that are not being used and that do not have programs set for them.
		A295.14: Illegal instruction error The program contains an instruction that cannot be executed.	Check and correct the program.	
I/O Table Setting error	80E0	A401.10: I/O Setting Error Flag	More than 5 Motion Control Modules are connected.	Check whether the number of Modules is incorrect. If the number of Modules is incorrect, turn OFF the power supply and correctly connect the Modules.
			An unsupported CJ-series Unit has been mounted.	Remove the unsupported CJ-series Unit and turn the power ON again.
Duplicated Number error	80E9	A410: CPU Bus Unit Duplicate Number Flags	The same unit number has been allocated to more than one CPU Bus Unit. Note A410.00 to A410.15 correspond to unit numbers 0 to F.	Check the CPU Bus Unit unit numbers, eliminate the duplications, and turn the Rack's power supply OFF and then ON again.
		A411 to A416: Special I/O Unit Duplicate Number Flags	The same unit number has been allocated to more than one Special I/O Unit. Note A411.00 to A416.15 correspond to unit numbers 0 to 95.	Check the Special I/O Unit unit numbers, eliminate the duplications, and turn the Rack's power supply OFF and then ON again.
		A Special I/O Unit has a unit number setting between 0 and 9.	Set all Special I/O Unit unit numbers to 10 or higher.	
Too Many I/O Points error	80E1	A401.11: Too Many I/O Points Flag A407: Too Many I/O Points, Details	The probable causes are listed below. The 3-bit binary value (000 to 101) in A407.13 to A407.15 indicates the cause of the error. The value of these 3 bits is also output to A407.00 to A407.12. <ol style="list-style-type: none"> 1. The total number of I/O points allocated to Basic I/O Units exceeds the maximum allowed (320 I/O points). (bits: 000) 2. The number of Expansion Racks exceeds the maximum (bits: 101). 3. More than 10 I/O Units are connected to one Rack (bits: 111). 	Correct the problem and then turn the power supply OFF and back ON.

Error	Error code (in A400)	Auxiliary Area flag and word data	Probable cause	Possible remedy
Cycle Time Overrun error	809F	A401.08: Cycle Time Too Long Flag	The cycle time has exceeded the maximum cycle time (watch cycle time) set in the System Setup.	Change the program to reduce the cycle time or change the System Setup's maximum cycle time setting. One way to reduce the cycle time is by jumping parts of the program that aren't being used.
System FALS error	C101 to C2FF	A401.06: FALS Error Flag	FALS has been executed in the program. The error code in A400 will indicate the FAL number. The leftmost digit of the code will be C and the rightmost 3 digits of the code will be from 101 to 2FF hex, which correspond to FAL numbers 001 to 511.	Remove the cause of the user-defined error indicated by the FAL number.

Non-fatal Errors

If the following LED indicator condition appears during operation (in RUN or MONITOR mode), it indicates that a non-fatal error has occurred.

Power Supply Unit Indicators	Module Indicators					
POWER	RDY	RUN	ERR	PRPHL	COMM1	COMM2
Lit	Lit	Lit	Flashing	---	---	---

The non-fatal error's error contents will be displayed in the Error Tab in the CX-Programmer's Error Window. Determine the cause of the error from the error message and related Auxiliary Area flags/words and correct the cause of the error.

Errors are listed in order of importance. When two or more errors occur at the same time, the more serious error's error code will be recorded in A400.

Non-fatal Errors

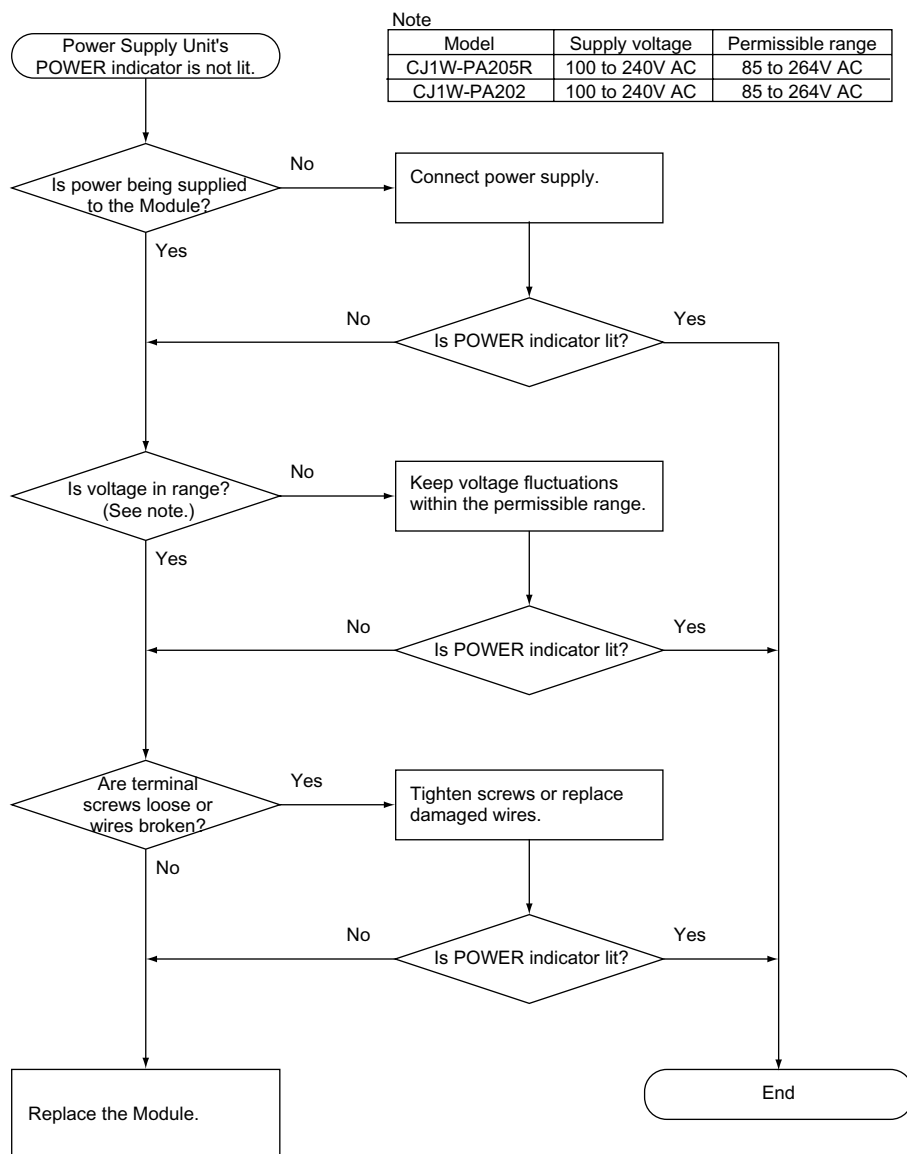
Error	Error code (in A400)	Flag and word data	Probable cause	Possible remedy
System FAL error	4101 to 42FF	A402.15: FAL Error Flag	FAL has been executed in program. The error code in A400 will indicate the FAL number. The leftmost digit of the code will be 4 and the rightmost 3 digits of the code will be from 101 to 2FF hex, which correspond to FAL numbers 001 to 511.	Remove the cause of the user-defined error indicated by the FAL number.
System Setup error	009B	A402.10: System Setup Error Flag A406: System Setup Error Location	There is a setting error in the System Setup. The location of the error is written to A406.	Set the correct value in the System Setup.
CPU Bus Unit error	0200 to 020F	A402.07: CPU Bus Unit Error Flag A417: CPU Bus Unit Error, Unit Number Flags	An error occurred in a data exchange between the CPU Unit and a CPU Bus Unit. Note The corresponding flag in A417 is turned ON to indicate the problem Unit. A417.00 to A417.15 correspond to unit numbers 0 to F.	Check the Unit indicated in A417. Refer to the Unit's operation manual to find and correct the cause of the error. Restart the Unit by toggling its Restart Bit or turn the power OFF and ON again. Replace the Unit if it won't restart.

Error	Error code (in A400)	Flag and word data	Probable cause	Possible remedy
Special I/O Unit error	030A to 035F	A402.06: Special I/O Unit Error Flag A418 to A423: Special I/O Unit Error, Unit Number Flags	An error occurred in a data exchange between the CPU Unit and a Special I/O Unit. The corresponding flag in A418 to A423 is turned ON to indicate the problem Unit. A418.00 to A423.15 correspond to unit numbers 0 to 95.	Check the Unit indicated in A418 to A423. Refer to the Unit's operation manual to find and correct the cause of the error. Restart the Unit by toggling its Restart Bit or turn the power OFF and ON again. Replace the Unit if it won't restart.
Motion Control Module Monitoring error	0300	A402.05: Motion Control Module Monitoring Error Flag	An error occurred during cyclic refreshing with the Motion Control Module.	Turn the power OFF and ON again.
Coordinator Module Fatal error	0006	A402.14: Coordinator Module Fatal Error Flag	A fatal error occurred in the Coordinator Module.	Remove the cause of the error in the Coordinator Module and then clear the error.
Coordinator Module WDT error	0001	A402.08: Coordinator Module WDT Error Flag	A watchdog timer error occurred in the Coordinator Module.	Turn the power OFF and ON again.

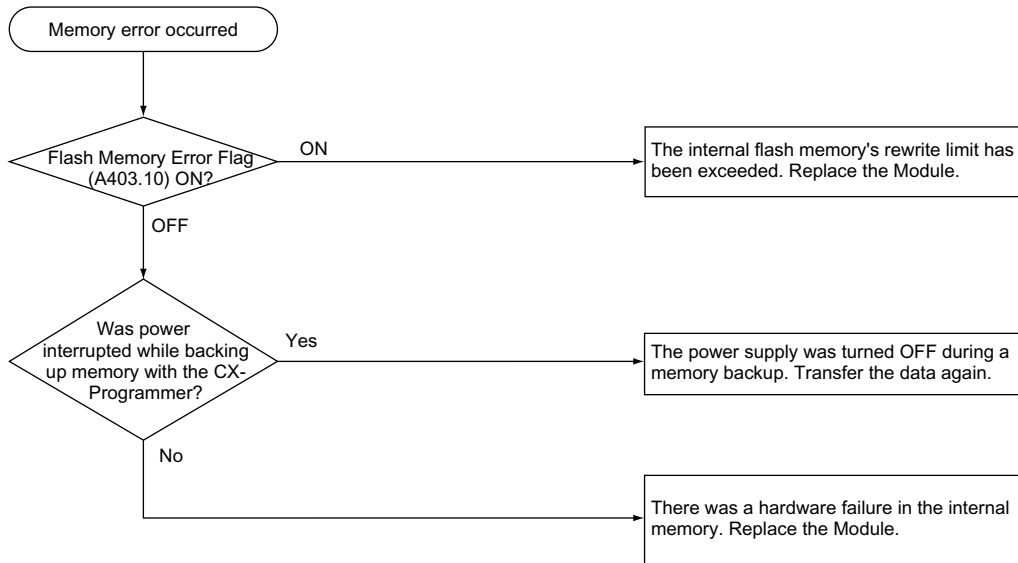
Other Errors

LED indicator status	Error	Error code (A400)	Flag and word data	Probable cause	Possible remedy																	
<table border="1"> <tr> <td>Power Supply Unit</td> <td>POWER</td> <td>Lit</td> </tr> <tr> <td rowspan="5">Coordinator Module</td> <td>RDY</td> <td>Lit</td> </tr> <tr> <td>RUN</td> <td>Lit</td> </tr> <tr> <td>ERR</td> <td>---</td> </tr> <tr> <td>PRPHL</td> <td>OFF</td> </tr> <tr> <td>COMM1</td> <td>---</td> </tr> <tr> <td></td> <td>COMM2</td> <td>---</td> </tr> </table>	Power Supply Unit	POWER	Lit	Coordinator Module	RDY	Lit	RUN	Lit	ERR	---	PRPHL	OFF	COMM1	---		COMM2	---	Communications error	None	None	A communications error occurred between the peripheral port and the connected device.	Check the cables. Also, check the setting of DIP Switch pin 2 and the communications settings for the peripheral port in the System Setup and correct any mistakes.
Power Supply Unit	POWER	Lit																				
Coordinator Module	RDY	Lit																				
	RUN	Lit																				
	ERR	---																				
	PRPHL	OFF																				
	COMM1	---																				
	COMM2	---																				
<table border="1"> <tr> <td>Power Supply Unit</td> <td>POWER</td> <td>Lit</td> </tr> <tr> <td rowspan="5">Coordinator Module</td> <td>RDY</td> <td>Lit</td> </tr> <tr> <td>RUN</td> <td>Lit</td> </tr> <tr> <td>ERR</td> <td>---</td> </tr> <tr> <td>PRPHL</td> <td>---</td> </tr> <tr> <td>COMM1</td> <td>OFF</td> </tr> <tr> <td></td> <td>COMM2</td> <td>OFF</td> </tr> </table>	Power Supply Unit	POWER	Lit	Coordinator Module	RDY	Lit	RUN	Lit	ERR	---	PRPHL	---	COMM1	OFF		COMM2	OFF	Communications error	None	None	A communications error occurred between the RS-232C port and the connected device.	Check the host link port settings in the System Setup. Check the cable wiring. If a host computer is connected, check the host computer's serial port settings and the program.
Power Supply Unit	POWER	Lit																				
Coordinator Module	RDY	Lit																				
	RUN	Lit																				
	ERR	---																				
	PRPHL	---																				
	COMM1	OFF																				
	COMM2	OFF																				
<table border="1"> <tr> <td>Power Supply Unit</td> <td>POWER</td> <td>Lit</td> </tr> <tr> <td rowspan="5">Coordinator Module</td> <td>RDY</td> <td>Lit</td> </tr> <tr> <td>RUN</td> <td>Lit</td> </tr> <tr> <td>ERR</td> <td>---</td> </tr> <tr> <td>PRPHL</td> <td>---</td> </tr> <tr> <td>COMM1</td> <td>---</td> </tr> <tr> <td></td> <td>COMM2</td> <td>OFF</td> </tr> </table>	Power Supply Unit	POWER	Lit	Coordinator Module	RDY	Lit	RUN	Lit	ERR	---	PRPHL	---	COMM1	---		COMM2	OFF	Communications error	None	None	A communications error occurred between the RS-422A port and the connected device.	Check whether the servo driver settings in the System Setup are correct. Check the cable wiring. Check the operating status of the connected servo driver.
Power Supply Unit	POWER	Lit																				
Coordinator Module	RDY	Lit																				
	RUN	Lit																				
	ERR	---																				
	PRPHL	---																				
	COMM1	---																				
	COMM2	OFF																				

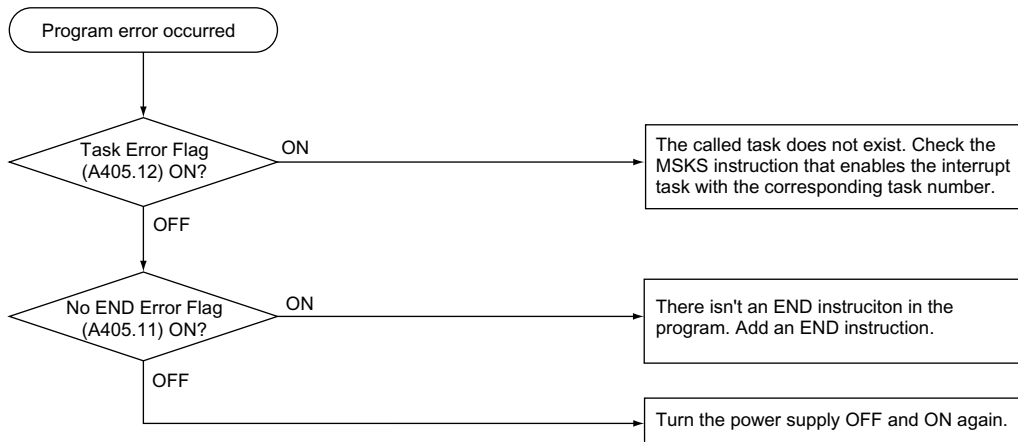
9-2-6 Power Supply Check



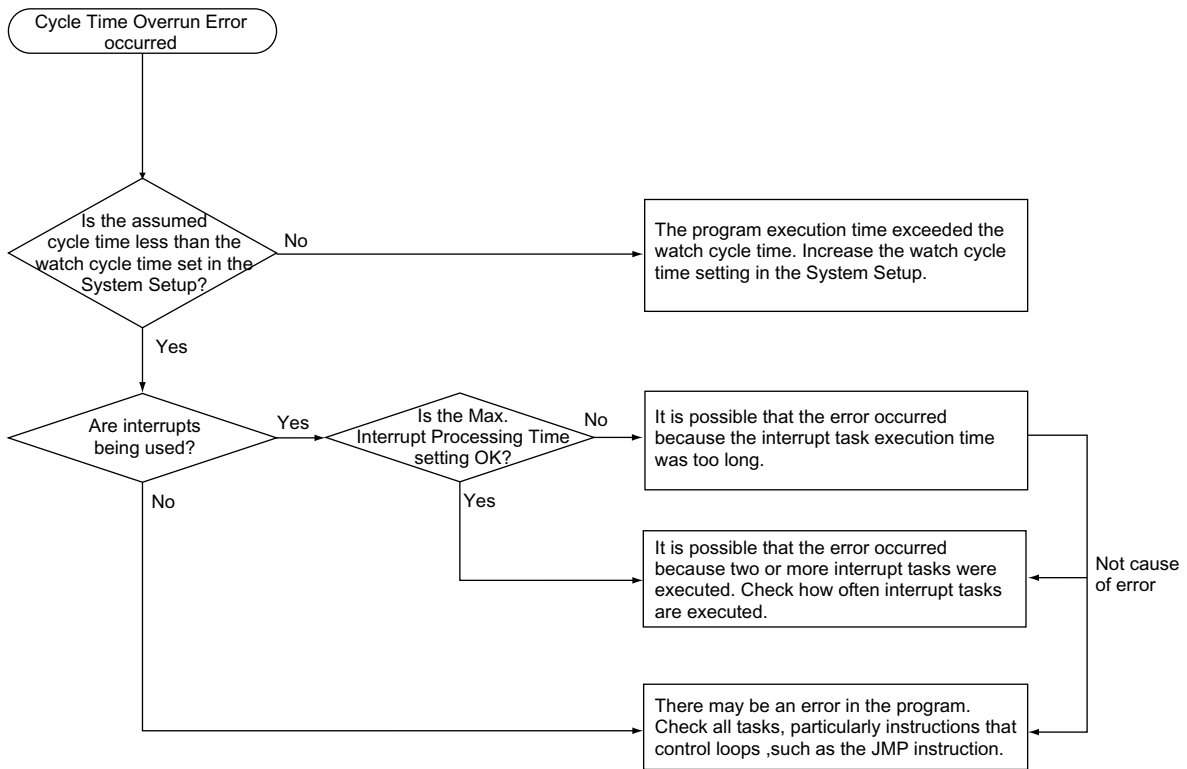
9-2-7 Memory Error Check



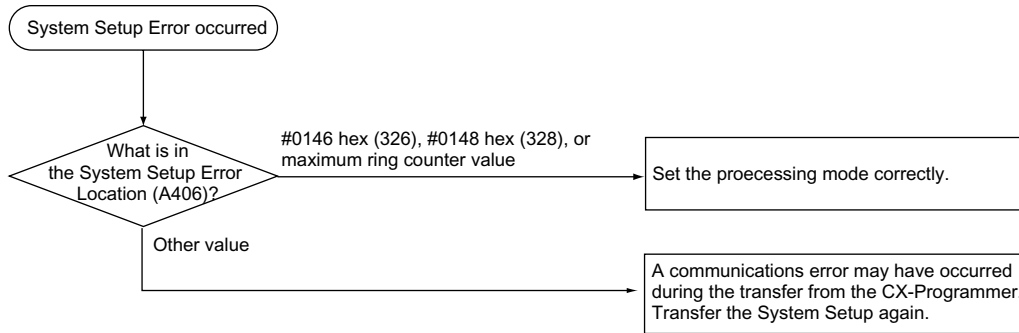
9-2-8 Program Error Check



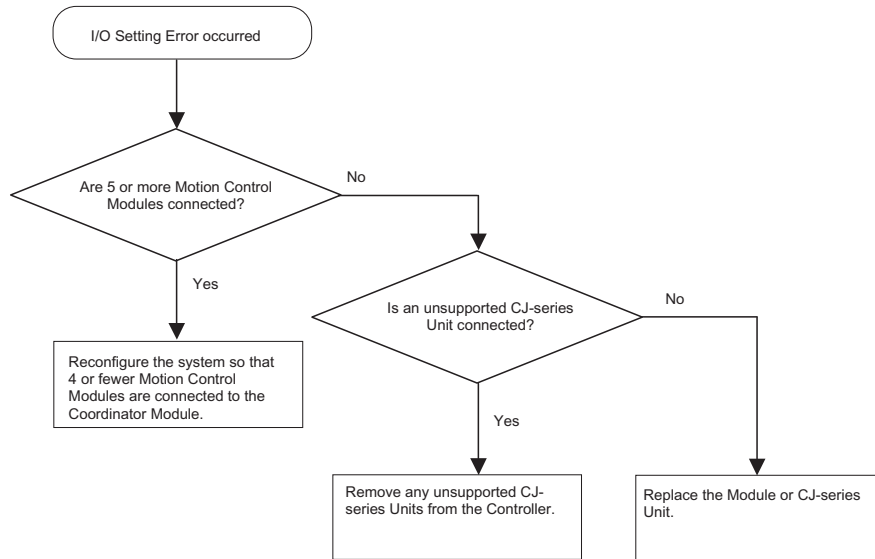
9-2-9 Cycle Time Overrun Error Check



9-2-10 System Setup Error Check

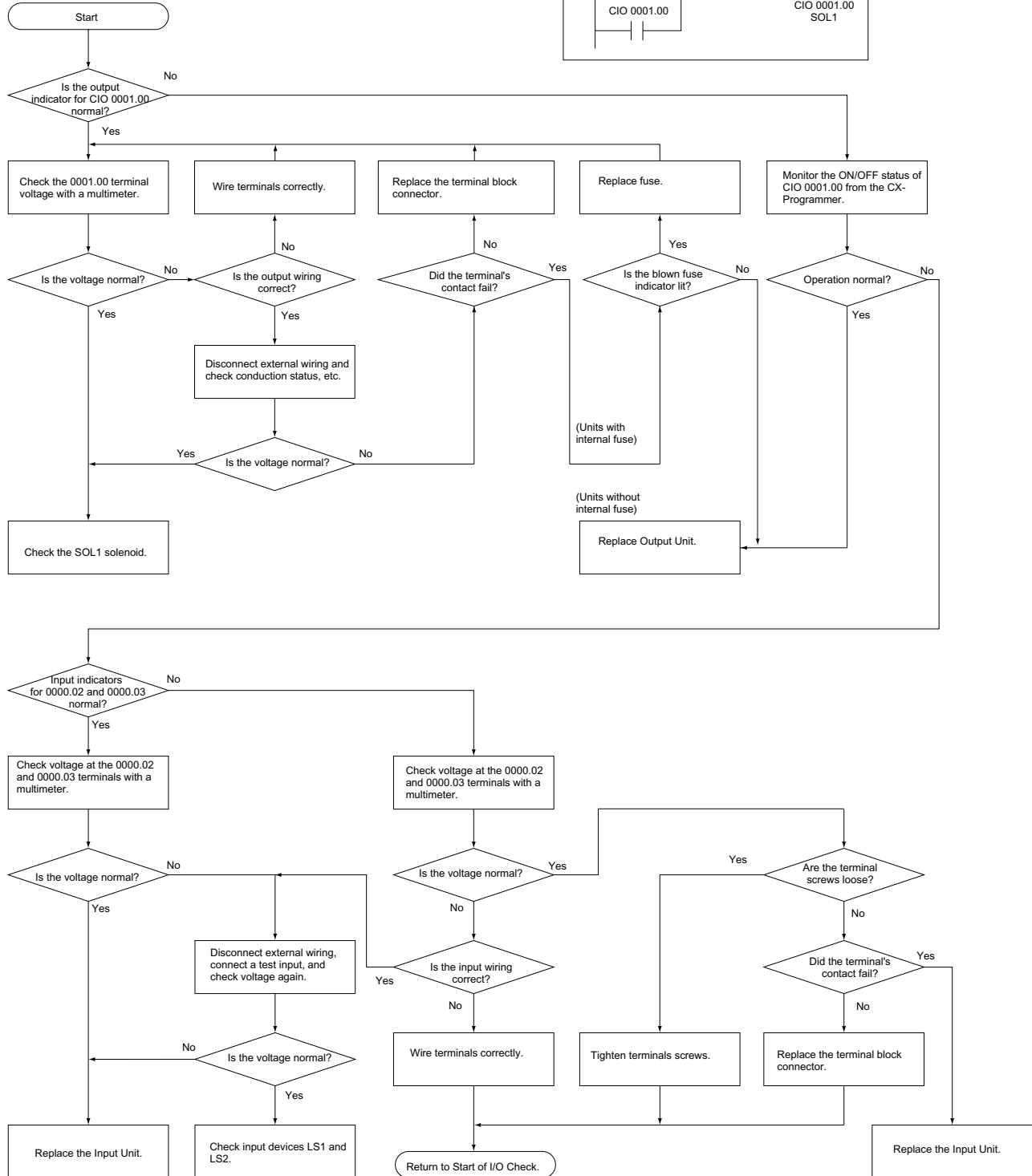
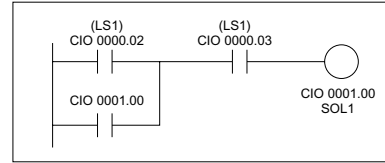


9-2-11 I/O Setting Error Check

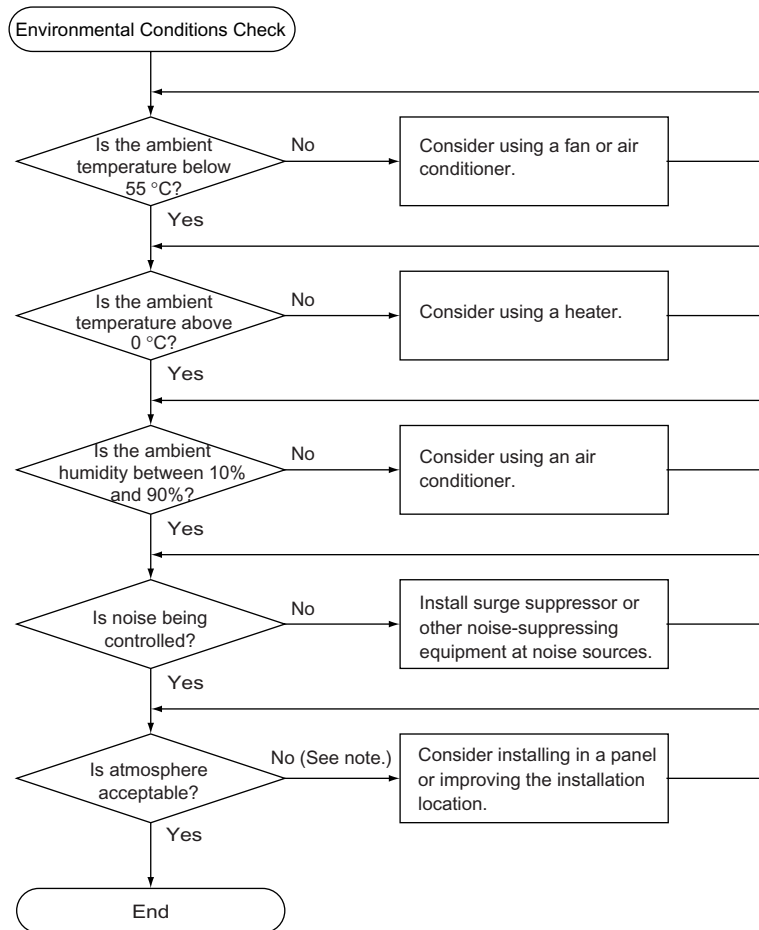


9-2-12 I/O Check

The I/O check flowchart is based on the following ladder diagram section, assuming that the problem is SOL1 does not turn ON.



9-2-13 Environmental Conditions Check



Note Prevent exposure to corrosive gases, flammable gases, dust, dirt, salts, metal dust, direct sunlight, water, oils, and chemicals.

9-3 Troubleshooting Problems in Modules

Coordinator Module Errors

Error condition	Probable cause	Remedy
The Power Supply Unit's POWER indicator is not lit.	PCB short-circuited or damaged.	Replace the Power Supply Unit.
The RDY indicators on the Modules do not go ON.	The power supply line is faulty	Replace the Power Supply Unit.
The Coordinator Module's RUN indicator does not go ON.	An error in program is causing a fatal error	Correct program
The Power Supply Unit's RUN output* does not turn ON. The Coordinator Module's RUN indicator is lit. (*CJ1W-PA205R Power Supply Unit only)	Internal circuitry of Power Supply Unit is faulty.	Replace the Power Supply Unit.

Error condition	Probable cause	Remedy
A Motion Control Module, Special I/O Unit, or CPU Bus Unit does not operate or does not operate properly.	1. The I/O bus is faulty. 2. The I/O Connecting Cable is faulty.	Replace the Motion Control Module.
A particular I/O point does not operate.		Replace the CS/CJ Series I/O Connecting Cable
Error occurs in 8-point or 16-point units.		Replace the I/O Control Module.
A particular I/O point stays ON.		Replace the I/O Interface Unit.
None of the I/O points will go ON in a particular Module or CJ-series Unit.		

Motion Control Module Errors

Error condition	Probable cause	Remedy
The Motion Control Module's RUN indicator does not go ON.	An error in program is causing a fatal error	Correct program.
Motion Control Module does not operate or does not operate properly.	The I/O bus is faulty.	Replace the Motion Control Module.
A particular I/O point does not operate.		
Error occurs in 8-point or 16-point units.		
A particular I/O point stays ON.		
None of a particular Module's I/O points will go ON.		

Input Errors

Error condition	Probable cause	Remedy
None of inputs turn ON. (Indicators are not lit.)	(1) External input power supply is not being supplied.	Connect a proper external input power supply.
	(2) The external input power supply voltage is too low.	Adjust supply voltage to within proper range.
	(3) Terminal block screws are loose.	Tighten screws.
	(4) Terminal block connector is not making good contact.	Replace terminal block connector.
None of inputs turn ON. (Indicators are lit.)	Input circuit is faulty.	Replace the Module.
None of inputs turn OFF.	Input circuit is faulty.	Replace the Module.
A particular input does not turn ON.	(1) Input device is faulty.	Replace the input device.
	(2) Input wiring disconnected.	Check input wiring.
	(3) Terminal block screws are loose.	Tighten screws.
	(4) Terminal block connector is not making good contact.	Replace terminal block connector.
	(5) External input's ON time is too short.	Adjust input device
	(6) Faulty input circuit	Replace the Module.
	(7) An input bit address is used in an output instruction.	Correct program.
A particular input does not turn OFF.	(1) Input circuit is faulty.	Replace the Module or Input Unit.
	(2) An input bit address is used in an output instruction.	Correct program.

Error condition	Probable cause	Remedy
Input turns ON/OFF irregularly.	(1) External input voltage is low or unstable.	Adjust external input voltage to within the proper range.
	(2) Malfunction due to noise.	Take protective measures against noise, such as: (1) Install surge suppressor. (2) Install isolating transformer. (3) Install shielded cables between the inputs and loads.
	(3) Terminal block screws are loose.	Tighten screws.
	(4) Faulty terminal block connector contact.	Replace terminal block connector.
Errors occur in 8-point or 16-point blocks, i.e., for the same common.	(1) Common terminal screw is loose.	Tighten screw.
	(2) Faulty terminal block connector contact.	Replace terminal block connector.
	(3) Faulty data bus	Replace the Module or Input Unit.
	(4) Faulty CPU	Replace the Coordinator Module.
Input indicator does not light, but input operates normally.	Faulty indicator or indicator circuit.	Replace the Module or Input Unit.

Output Errors

Error condition	Probable cause	Remedy
None of the outputs will go ON.	(1) The load power is not being supplied.	Supply power.
	(2) Load power supply voltage is too low.	Adjust voltage to within the allowed range.
	(3) Terminal block screws are loose.	Tighten screws.
	(4) Faulty terminal block connector contact.	Replace terminal block connector.
	(5) An overcurrent (possibly caused by a short at the load) resulted in a blown fuse in the Output Unit. (Some Output Units provide an indicator for blown fuses.)	Replace fuse.
	(6) Faulty I/O bus connector contact.	Replace the Module or Output Unit.
	(7) Output circuit is faulty.	Replace the Module or Output Unit.
None of the outputs will go OFF.	Output circuit is faulty.	Replace the Module or Output Unit.
A specific bit address' output does not turn ON. (Indicator is not lit.)	(1) Output ON time too short because of a program error.	Correct program to increase the time that the output is ON.
	(2) The bit's status is controlled by multiple output instructions.	Correct program so that each output bit is controlled by only one instruction.
	(3) Faulty output circuit.	Replace the Module or Output Unit.

Error condition	Probable cause	Remedy
A specific bit address' output does not turn ON. (Indicator is lit).	(1) Faulty output device.	Replace output device.
	(2) Break in output wiring.	Check output wiring.
	(3) Terminal block screws are loose.	Tighten screws.
	(4) Faulty terminal block connector.	Replace terminal block connector.
	(5) Faulty relay (Relay Output Unit only)	Replace relay.
	(6) Faulty output circuit.	Replace Unit.
A specific bit address' output does not turn OFF. (Indicator is not lit.)	(1) Faulty relay (Relay Output Unit only)	Replace relay.
	(2) Output does not turn OFF due to leakage current or residual voltage.	Replace external load or add dummy resistor.
Output of a specific bit number does not turn OFF. (Indicator lit.)	(1) The bit's status is controlled by multiple output instructions.	Correct program.
	(2) Faulty output circuit.	Replace the Module or Output Unit.
Output turns ON/OFF irregularly.	(1) Low or unstable load voltage.	Adjust load voltage to within proper range
	(2) The bit's status is controlled by multiple output instructions.	Correct program so that each output bit is controlled by only one instruction.
	(3) Malfunction due to noise.	Take protective measures against noise, such as: (1) Install surge suppressor. (2) Install isolating transformer. (3) Install shielded cables between the outputs and loads.
	(4) Terminal block screws are loose.	Tighten screws.
	(5) Faulty terminal block connector contact.	Replace terminal block connector.
Errors occur in 8-point or 16-point blocks, i.e., for the same common.	(1) Common terminal screw is loose.	Tighten screw.
	(2) Faulty terminal block connector contact.	Replace terminal block connector.
	(3) An overcurrent (possibly caused by a short at the load) resulted in a blown fuse in the Output Unit.	Replace fuse.
	(4) Faulty data bus	Replace the Module or Output Unit.
	(5) Faulty CPU	Replace the Coordinator Module.
Output indicator does not light, but output operates normally.	Faulty indicator or indicator circuit.	Replace the Module or Output Unit.

SECTION 10

Inspection and Maintenance

This section provides inspection and maintenance information.

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10-1-1	Inspection Points.....	318
10-1-2	Module Replacement Precautions	319

10-1 Inspections

Daily or periodic inspections are required in order to maintain the FQM1 in peak operating condition.

10-1-1 Inspection Points

Although the major components in the FQM1 have an extremely long life time, they can deteriorate under improper environmental conditions. Periodic inspections are thus required to ensure that the required condition is being maintained.

Inspection is recommended at least once every six months to a year, but more frequent inspections will be necessary in adverse environments.

Take immediate steps to correct the situation if any of the conditions in the following table are not met.

Inspection Points for Periodic Inspections

No.	Item	Inspection	Criteria	Action
1	Source Power Supply	Check for voltage fluctuations at the power supply terminals.	The voltage must be within the allowable voltage fluctuation range. (See note.)	Use a voltage tester to check the power supply at the terminals. Take necessary steps to bring voltage fluctuations within limits.
2	I/O Power Supply	Check for voltage fluctuations at the I/O terminals.	Voltages must be within specifications for each Module.	Use a voltage tester to check the power supply at the terminals. Take necessary steps to bring voltage fluctuations within limits.
3	Ambient environment	Check the ambient temperature. (Inside the control panel if the FQM1 is in a control panel.)	0 to 55°C	Use a thermometer to check the temperature and ensure that the ambient temperature remains within the allowed range of 0 to 55°C.
		Check the ambient humidity. (Inside the control panel if the FQM1 is in a control panel.)	Relative humidity must be 10% to 90% with no condensation.	Use a hygrometer to check the humidity and ensure that the ambient humidity remains within the allowed range. In particular, verify that there is no condensation or icing caused by sudden temperature changes.
		Check that the FQM1 is not in direct sunlight.	Not in direct sunlight	Protect the FQM1 if necessary.
		Check for accumulation of dirt, dust, salt, metal filings, etc.	No accumulation	Clean and protect the FQM1 if necessary.
		Check for water, oil, or chemical sprays hitting the FQM1.	No spray on the FQM1	Clean and protect the FQM1 if necessary.
		Check for corrosive or flammable gases in the area of the FQM1.	No corrosive or flammable gases	Check by smell or use a sensor.
		Check the level of vibration or shock.	Vibration and shock must be within specifications.	Install cushioning or shock absorbing equipment if necessary.
		Check for noise sources near the FQM1	No significant noise sources	Either separate the FQM1 and noise source or protect the FQM1.

No.	Item	Inspection	Criteria	Action
4	Installation and wiring	Check that each Module and CJ-series Unit is connected and locked to the next Module securely.	No looseness	Press the connectors together completely and lock them with the sliding latches.
		Check that cable connectors are fully inserted and locked.	No looseness	Correct any improperly installed connectors.
		Check for loose screws in external wiring.	No looseness	Tighten loose screws with a Phillips-head screwdriver.
		Check crimp connectors in external wiring.	Adequate spacing between connectors	Check visually and adjust if necessary.
		Check for damaged external wiring cables.	No damage	Check visually and replace cables if necessary.

Note The following table shows the allowable voltage fluctuation ranges for source power supplies.

Supply voltage	Allowable voltage range
100 to 240 V AC	85 to 264 V AC

Tools Required for Inspections

Required Tools

- Phillips-head screwdriver
- Voltage tester or digital multimeter
- Industrial alcohol and clean cotton cloth

Tools Required Occasionally

- Synchroscope
- Oscilloscope with pen plotter
- Thermometer and hygrometer (humidity meter)

10-1-2 Module Replacement Precautions

Check the following after replacing any faulty Module.

- Do not replace a Module or CJ-series Unit until the power is turned OFF.
- Check the new Module to make sure that there are no errors.
- If a faulty Module is being returned for repair, describe the problem in as much detail as possible, enclose this description with the Module, and return the Module to your OMRON representative.
- For poor contact, take a clean cotton cloth, soak the cloth in industrial alcohol, and carefully wipe the contacts clean. Be sure to remove any lint prior to remounting the Module.

Note

- (1) When replacing a Coordinator Module or Motion Control Module, be sure that not only the user program but also all other data required for operation is transferred to or set in the new Coordinator Module before starting operation, including DM Area and System Setup settings. If data area and other data are not correct for the user program, unexpected operation or accidents may occur.
- (2) The System Setup is stored in the parameter area within the Coordinator Module or Motion Control Module. Be sure to transfer these settings to the new Coordinator Module or Motion Control Module when replacing a Module.
- (3) After replacing a Motion Control Module, always set the required settings.

- (4) In some cases, parameter data used in the Motion Control Modules is actually stored in the Coordinator Module's DM Area, so be sure to transfer the DM Area settings when replacing a Coordinator Module.
- (5) When a CPU Bus Unit or Special I/O Unit has been replaced, input any required settings. Refer to the Unit's Operation Manual for details on required settings.

Appendix A

Programming

A-1 Programs and Tasks

There are basically two types of task.

1. Cyclic Task

The cyclic task is executed once each cycle.

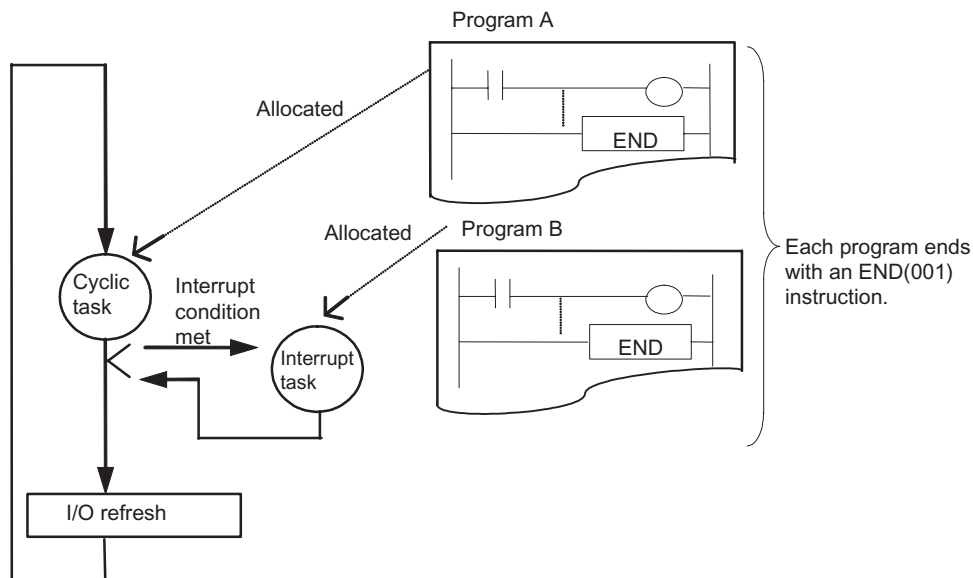
2. Interrupt Tasks

An interrupt task is executed when the interrupt condition is met, even if this occurs while the cyclic task is being executed.

There are three types of interrupt task.

Type of task	Description
Sync mode scheduled interrupt tasks	The sync mode scheduled interrupt task is executed once every sync cycle. This interrupt task is supported only by the Coordinator Module.
Input interrupt tasks	Input interrupt tasks are executed when a built-in input turns ON, OFF, or both on a Motion Control Module.
Normal interrupt tasks	Other interrupt tasks can be executed according to task number specified in programming instructions. These include one-shot interrupts, interval timer interrupts, high-speed counter target value interrupts, pulse output counter target value interrupts, etc.

The CX-Programmer can be used to allocate one program to each of many tasks, as required by the system.



A-2 Subroutines

A-2-1 What Are Subroutines?

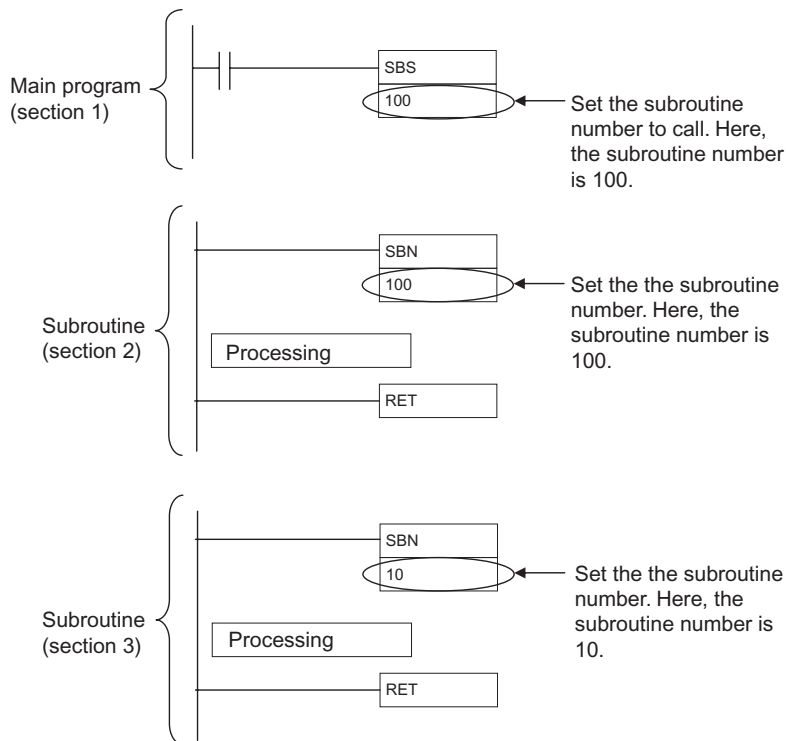
A subroutine is a program written between the SBN(092) and RET(093) instructions in a special subroutine area. A subroutine is called from the main program using the SBS(091), MCRO(099), or JSB(982) instruction. There are three types of interrupt tasks, which are described in the following table.

Type of subroutine	Description	Calling instruction
Normal subroutines	Normal subroutines are executed without passing parameters.	SBS(091)
Subroutines for which parameters are passed	<ul style="list-style-type: none"> Parameters can be passed to the subroutine. The results of processing in the subroutine can be returned to the main program. 	MCRO(099)
	<ul style="list-style-type: none"> Flags can be used to access the input condition to the subroutine while the subroutine is being executed. It's possible to check to see if a subroutine has been executed in the past. Parameters can be passed to and from the subroutine using storage registers. 	JSB(982)

A-2-2 Using Normal Subroutines

A normal subroutine is written between the SBN(092) and RET(093) instructions and called using the SBS(091) instruction.

1. Write the program to be executed between SBN(092) and RET(093).
2. Set the subroutine number for the operand of SBN(092).
3. Call the subroutine using SBS(091)



A-2-3 Using Subroutines That Pass Parameters

With these subroutines, parameters can be passed to the subroutine when it is called and then the results of processing in the subroutine can be returned to the main program. This enables using one subroutine while changing the I/O addresses that are used. One subroutine can thus be used in multiple locations with similar logic in the program to reduce the number of program steps and make the program easier to understand.

When passing parameters to a subroutine, execution is possible either with or without using Subroutine Input Condition Flags.

Execution without Subroutine Input Condition Flags

The MCRO(099) instruction is used to call subroutines without Subroutine Input Condition Flags.

MCRO(099)
Subroutine number
First input parameter word
First output parameter word

The following process is performed when MCRO(099) is executed.

1. Five words starting with the first input parameter word are copied to A540 through A544 (macro area inputs).
2. The specified subroutine is executed through RET(093).
3. When the subroutine is completed, the contents of A545 through A549 (macro area outputs) are copied to five words starting with the first output parameter word.
4. Program execution continues with the next instruction after MCRO(099).

The first input and output parameter words can be changed when executing MCRO(099) to use the same subroutine for different purposes at different locations in the program.

As shown by the above process, using the macro function has the following limitations.

- The parameters being passed must be stored in 5 continuous words.
- The specified I/O parameters must be passed so that they correctly correspond to the program in the subroutine.

- Note**
- (1) A540 through A544 (macro area inputs) and A545 through A549 (macro area outputs) can be used as work bits if MCRO(099) is not used.
 - (2) The words specified for the input/output parameter words can be I/O words, Auxiliary Area words, DM Area words, or words in other memory areas.
 - (3) The subroutines called by MCRO(099) must be written in the same way as a normal subroutine, e.g., between SBN(092) and RET(093).

Execution with Subroutine Input Condition Flags

Overview

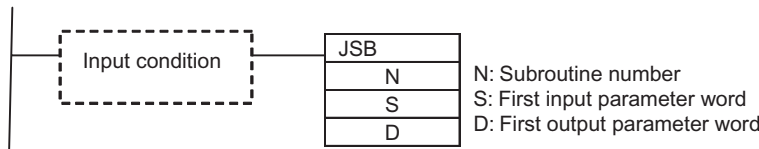
Subroutines called with JSB(982) are always executed regardless of the input condition to the instruction. The status of the input condition, however, is stored in an Auxiliary Area bit so that the status can be used to control program execution within the subroutine.

Subroutines called with JSB(982) are executed even if their input condition is OFF and even in program sections interlocked with IL(002). The status of the input condition is stored in the Subroutine Input Condition Flag corresponding to the subroutine. Subroutine Input Condition Flags are from A019 to A034 and correspond to the subroutine numbers. The Subroutine Input Condition Flag can be used within the subroutine to control program execution.

For example, a subroutine could perform jogging when the input condition is ON and perform stop processing or deceleration when the input condition is OFF, or a subroutine could execute a communications instruction when the input condition turned ON and then continue to monitor communications until a response is received after the input condition turns OFF.

- Note**
- (1) Index registers have been used to increase the usability of subroutines called with JSB(982). The actual addresses in I/O memory of the first input parameter word and first output parameter word are automatically stored in index registers IR0 and IR1, respectively. This enables accessing the input parameter words in the subroutine by indirectly addressing IR0 to read the input parameters for specific processing, as well as accessing the output parameter words in the subroutine by indirectly addressing IR1 to write data for output.
 - (2) When a subroutine is called with SBS(091), the entire subroutine will be skipped when the input condition is OFF, making it impossible to program processing for OFF input conditions (e.g., stopping processing or decelerating for an OFF input condition in a subroutine that performs jogging for an ON input condition).
 - (3) When a subroutine is called with SBS(091), it is not possible to tell from within the subroutine if the subroutine has been executed before. This makes it impossible to perform different processing in different cycles, such as spreading processing over multiple cycles.

JSB(982) Operation



Note JSB(982) will be executed even if the input condition is OFF.

The following process is performed when JSB(982) is executed.

1. When the subroutine is called, the status of the input condition for JSB(982) is stored in the corresponding Subroutine Input Condition Flag.

Address		Corresponding subroutines
Word	Bits	
A019	00 to 15	SBN000 to SBN015
A020	00 to 15	SBN016 to SBN031
A021	00 to 15	SBN032 to SBN047
.	.	.
.	.	.
.	.	.
A034	00 to 15	SBN240 to SBN255

2. The actual addresses in I/O memory of the first input parameter word and first output parameter word are automatically stored in index registers IR0 and IR1, respectively
3. The specified subroutine is executed through RET(093).
4. Program execution continues with the next instruction after JSB(982).

Note If JSB(982) is within a program section interlocked by IL(002) and ILC(003), the subroutine will still be executed, but the interlock will apply to the program in the subroutine as well.

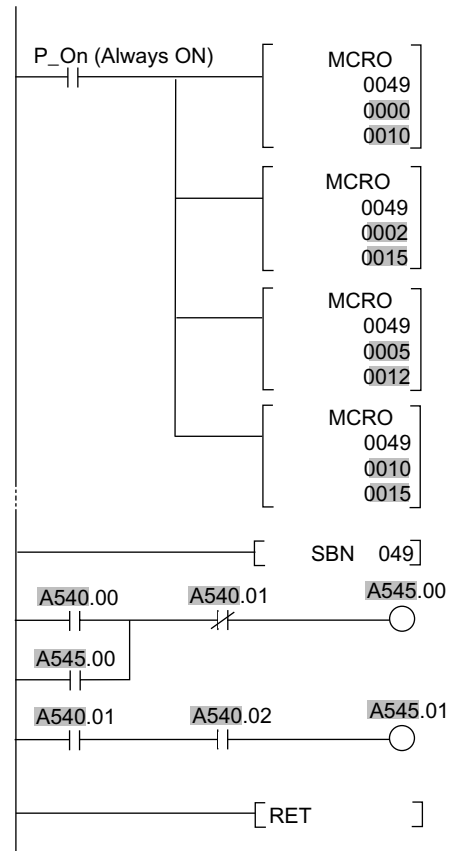
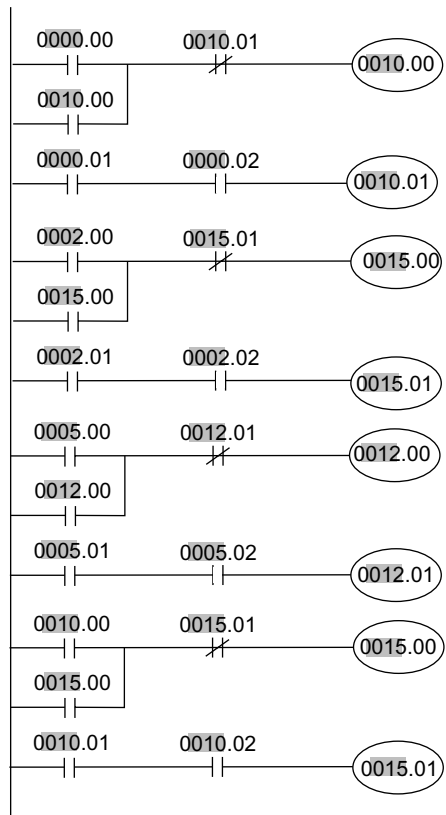
Application Examples

Execution without Subroutine Input Condition Flags

Without Macro Function

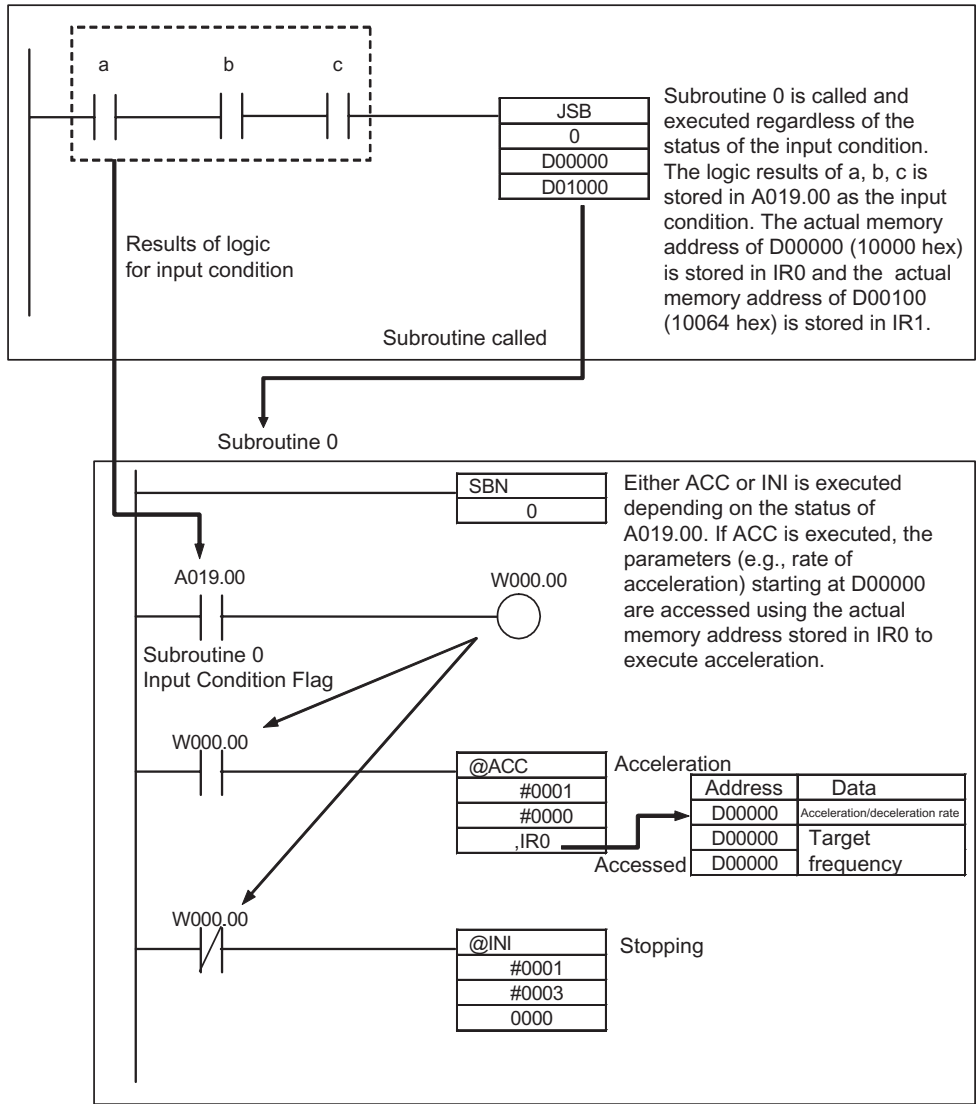


With Macro Function



Execution with Subroutine Input Condition Flags

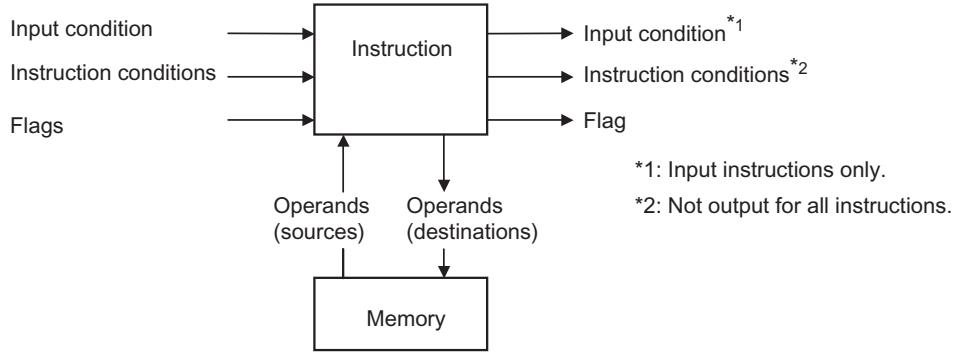
Main Program



A-3 Basic Information on Programming

A-3-1 Basic Information on Instructions

Programs consist of instructions. The conceptual structure of the inputs to and outputs from an instruction is shown in the following diagram.

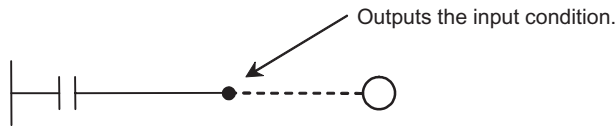


Power Flow

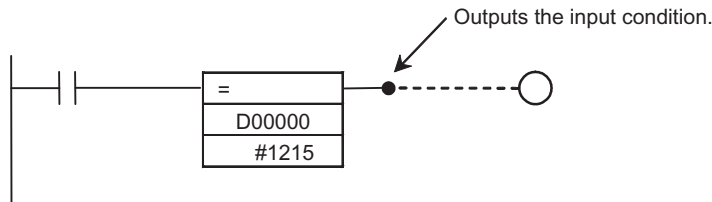
The power flow is the input condition that is used to control the execution of instructions when programs are executing normally. In a ladder program, power flow represents the status of the input condition.

1. Input Instructions

- Load instructions indicate a logical start and output the input condition.

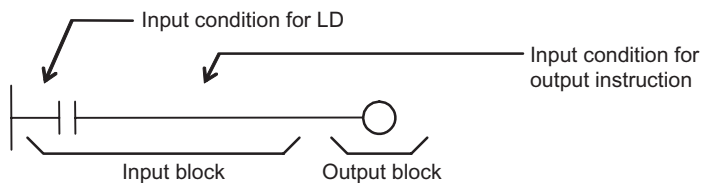


- Intermediate instructions input the power flow as an input condition and output the power flow to an intermediate or output instruction as an input condition.



2. Output Instructions

Output instructions execute functions, using the power flow as an input condition.



Instruction Conditions

Instruction conditions are special conditions related to overall instruction execution that are output by the instructions listed below. Instruction conditions have a higher priority than the input condition when it comes to deciding whether or not to execute an instruction. An instruction may not be executed or may act differently depending on instruction conditions. Instruction conditions are reset (canceled) at the start of each task, i.e., they are reset when the task changes.

The following instructions are used in pairs to set and cancel certain instruction conditions. Each pair of instructions must be in the same task.

Instruction condition	Description	Setting instruction	Canceling instruction
Interlocked	An interlock turns OFF part of the program. Special conditions, such as turning OFF output bits, resetting timers, and holding counters, are in effect.	IL(002)	ILC(003)
Break	A break causes execution of a repeated FOR-NEXT loop to end in the middle of the loop. (All instructions in the loop to NEXT are not executed.)	BREAK	NEXT
	Instructions from JMP0 to JME0 are executed.	JMP0	JME0
Block program execution	A program block from BPRG(096) to BEND(801) is executed.	BPRG(096)	BEND(801)

Flags

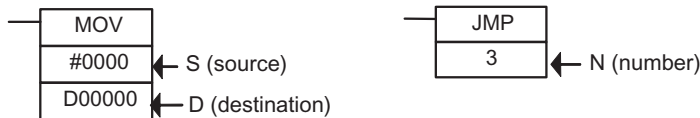
In this context, a flag is a bit that serves as an interface between instructions.

Input flags	Output flags
<ul style="list-style-type: none"> • Differentiation Flags Differentiation result flags. The status of these flags are input automatically to the instruction for all differentiated up/down output instructions and the DIFU(013)/DIFD(014) instructions. • Carry (CY) Flag The Carry Flag is used as an unspecified operand in data shift instructions and addition/subtraction instructions. 	<ul style="list-style-type: none"> • Condition Flags Condition Flags include the Always ON/OFF Flags, as well as flags that are updated by results of instruction execution. In user programs, these flags can be specified by labels, such as ER, CY, >, =, A1, A0, rather than by addresses.

Operands

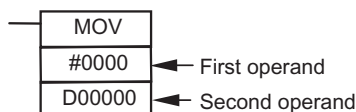
Operands specify preset instruction parameters (boxes in ladder diagrams) that are used to specify I/O memory area contents or constants. An instruction can be executed by entering an address or constant as the operands. Operands are classified as source, destination, or number operands.

Example





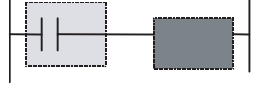
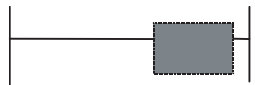
Operand types	Operand symbol	Description		
Source	Specifies the address of the data to be read or a constant.	S	Source operand	Source operand other than control data (C)
		C	Control data	Compound data in a source operand that has different meanings depending bit status.
Destination (Results)	Specifies the address where data will be written.	D	---	
Number	Specifies a particular number used in the instruction, such as a jump number or subroutine number.	N	---	

Note Operands are also called the first operand, second operand, and so on, starting from the top of the instruction.



A-3-2 Instruction Location and Input Conditions

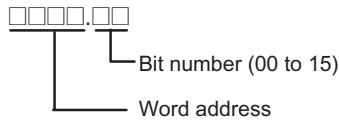
The following table shows the possible locations for instructions. Instructions are grouped into those that do and those do not require input conditions.

Instruction type		Possible location	Input condition	Diagram	Examples
Input instructions	Logical start (Load instructions)	Connected directly to the left bus bar or is at the beginning of an instruction block.	Not required.		LD, LD >, and other symbol comparison instructions
	Intermediate instructions	Between a logical start and the output instruction.	Required.		AND, OR, AND >, and other symbol comparison instructions)
Output instructions		Connected directly to the right bus bar.	Required.		Most instructions including OUT and MOV(021).
			Not required.		END(001), JME(005), ILC(003), etc.

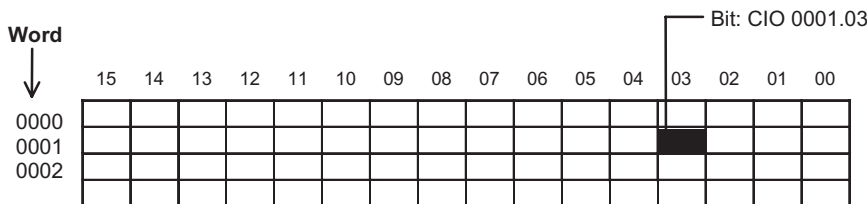
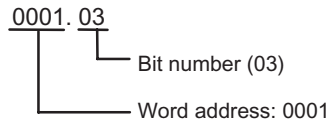
- Note**
- (1) There is another group of instructions that executes a series of mnemonic instructions based on a single input. These are called block programming instructions. Refer to the *Instructions Reference Manual* (Cat. No. 0011) for details on these block programs.
 - (2) If an instruction requiring an input condition is connected directly to the left bus bar without a logical start instruction, a program error will occur when checking the program on the CX-Programmer.

A-3-3 Addressing I/O Memory Areas

Bit Addresses



Example: The address of bit 03 in word 0001 in the CIO Area would be as shown below. This address is given as “CIO 0001.03” in this manual.



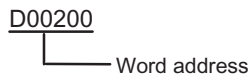
Word Addresses



Example: The address of bits 00 to 15 in word 0010 in the CIO Area would be as shown below. This address is given as “CIO 0010” in this manual.



DM Area addresses are given with “D” prefixes, as shown below for the address D00200.



A-3-4 Specifying Operands

Operand	Description	Notation	Application examples
Specifying bit addresses	<p>The word address and bit number are specified directly to specify a bit (input input bits).</p> <p>□□□□. □□</p> <p>└── Word address</p> <p>└── Bit number (00 to 15)</p> <p>Note The same addresses are used to access timer/counter Completion Flags and Present Values.</p>	<p>0001 02</p> <p>└── Word address: 0001</p> <p>└── Bit number (02)</p>	<p>0001.02</p> <p>—|—</p>
Specifying word addresses	<p>The word address is specified directly to specify the 16-bit word.</p> <p>□□□□</p> <p>└── Word address</p>	<p>0003</p> <p>└── Word address: 0003</p> <p>D00200</p> <p>└── Word address: 00200</p>	<p>MOV 0003</p> <p>D00200</p>

Operand	Description	Notation	Application examples
Specifying indirect DM addresses in Binary Mode	<p>The offset from the beginning of the area is specified. The contents of the address will be treated as binary data (00000 to 32767) to specify the word address in Data Memory (DM). Add the @ symbol at the front to specify an indirect address in binary mode.</p> <p style="text-align: center;">@D□□□□□</p> <p style="text-align: center;">↓</p> <p>Contents 00000 to 32767 (0000 Hex to 7FFF Hex)</p> <p style="text-align: center;">↓</p> <p>D </p>		
	<p>1) D00000 to D32767 are specified if @D(□□□□□) contains 0000 hex to 7FFF hex (00000 to 32767).</p>	<p>@D00300</p> <p style="text-align: center;"> 0 1 0 0 Contents Binary: 256 ↓ Specifies D00256. </p> <p>— Add the @ symbol.</p>	<p>MOV #0001 @D00300</p>
	<p>The offset from the beginning of the area is specified. The contents of the address will be treated as BCD data (0000 to 9999) to specify the word address in Data Memory (DM). Add an asterisk (*) at the front to specify an indirect address in BCD Mode.</p> <p style="text-align: center;">*D□□□□□</p> <p style="text-align: center;">↓</p> <p>Contents : : : 00000 to 9999 (BCD)</p> <p style="text-align: center;">↓</p> <p>D : : :</p>	<p>*D00200</p> <p style="text-align: center;"> 0 1 0 0 Contents ↓ Specifies D0100 — Add an asterisk (*). </p>	<p>MOV #0001 *D00200</p>

Note With indirect address specifications in binary mode, the DM Area addresses are treated as consecutive memory addresses.

Operand	Description	Notation	Application examples
Specifying a register directly	To specify an index register (IR) or data register (DR), specify the register directly as IR□ (□: 0 to 15) or DR□ (□: 0 to 15).	<p>IR0</p> <p>IR1</p>	<p>MOVR 000102 IR0 Stores the memory address of bit CIO 0001.02 in IR0.</p> <p>MOVR 0010 IR1 Stores the memory address of word CIO 0010 in IR1.</p>

Operand	Description		Notation	Application examples
Specifying an indirect address using a register	Indirect address (No offset)	The bit or word with the memory address contained in IR□ will be specified. Specify ,IR□ to specify bits and words for instruction operands.	,IR0 ,IR1	LD ,IR0 Loads the bit with the memory address in IR0. MOV #0001 ,IR1 Stores #0001 in the word with the memory address in IR1.
	Constant offset	The bit or word with the memory address in IR□ + or – the constant is specified. Specify +/- <i>constant</i> ,IR□. Constant offsets range from –2048 to +2047 (decimal). The offset is converted to binary data when the instruction is executed.	+5,IR0 +31,IR1	LD +5 ,IR0 Loads the bit with the memory address in IR0 + 5. MOV #0001 +31 ,IR1 Stores #0001 in the word with the memory address in IR1 + 31
	DR (Data Register) offset	The bit or word with the memory address in IR□ + the content of DR□ is specified. Specify DR□,IR□. The content of the Data Register is treated as signed hexadecimal. If the content is negative, it is subtracted from the content of IR□.	DR0,IR0 DR0,IR1	LD DR0,IR0 Loads the bit with the memory address = content of IR0 + content of DR0. MOV #0001 DR0,IR1 Stores #0001 in the word with the memory address = content of IR0 + content of DR0.
	Auto Increment	The contents of IR□ is incremented by +1 or +2 after referencing the value as an memory address. +1: Specify ,IR□+ +2: Specify ,IR□ ++	,IR0 ++ ,IR1 +	LD ,IR0 ++ Increments the contents of IR0 by 2 after the bit with the memory address in IR0 is loaded. MOV #0001 ,IR1 + Increments the contents of IR1 by 1 after #0001 is stored in the word with the memory address in IR1.
	Auto Decrement	The contents of IR□ is decremented by –1 or –2 after referencing the value as an memory address. –1: Specify ,–IR□ –2: Specify ,– –IR□	,– –IR0 ,–IR1	LD ,– –IR0 After decrementing the contents of IR0 by 2, the bit with the memory address in IR0 is loaded. MOV #0001 ,–IR1 After decrementing the contents of IR1 by 1, #0001 is stored in the word with the memory address in IR1.

Data	Operand	Data form	Symbol	Range	Application example
16-bit constant	All binary data or a limited range of binary data	Unsigned binary	#	#0000 to #FFFF	---
		Signed decimal	±	–32768 to +32767	---
		Unsigned decimal	&	&0 to &65535	---
	All BCD data or a limited range of BCD data	BCD	#	#0000 to #9999	---
32-bit constant	All binary data or a limited range of binary data	Unsigned binary	#	#00000000 to #FFFFFFFF	---
		Signed decimal	±	–2147483648 to +2147483647	---
		Unsigned decimal	&	&0 to &4294967295	---
	All BCD data or a limited range of BCD data	BCD	#	#00000000 to #99999999	---

Data	Operand	Data form	Symbol	Range	Application example																								
Text string	Text string data is stored in ASCII (one byte except for special characters) in order from the leftmost to the rightmost byte and from the rightmost (lower) to the leftmost word. 00 hex (NUL code) is stored in the rightmost byte of the last word if there is an odd number of characters. 0000 hex (2 NUL codes) is stored in the leftmost and rightmost vacant bytes of the last word + 1 if there is an even number of characters.		---		<p>'ABCDE'</p> <table border="1"> <tr><td>'A'</td><td>'B'</td></tr> <tr><td>'C'</td><td>'D'</td></tr> <tr><td>'E'</td><td>NUL</td></tr> </table> <p> </p> <table border="1"> <tr><td>41</td><td>42</td></tr> <tr><td>43</td><td>44</td></tr> <tr><td>45</td><td>00</td></tr> </table> <p>'ABCD'</p> <table border="1"> <tr><td>'A'</td><td>'B'</td></tr> <tr><td>'C'</td><td>'D'</td></tr> <tr><td>NUL</td><td>NUL</td></tr> </table> <p> </p> <table border="1"> <tr><td>41</td><td>42</td></tr> <tr><td>43</td><td>44</td></tr> <tr><td>00</td><td>00</td></tr> </table>	'A'	'B'	'C'	'D'	'E'	NUL	41	42	43	44	45	00	'A'	'B'	'C'	'D'	NUL	NUL	41	42	43	44	00	00
'A'	'B'																												
'C'	'D'																												
'E'	NUL																												
41	42																												
43	44																												
45	00																												
'A'	'B'																												
'C'	'D'																												
NUL	NUL																												
41	42																												
43	44																												
00	00																												

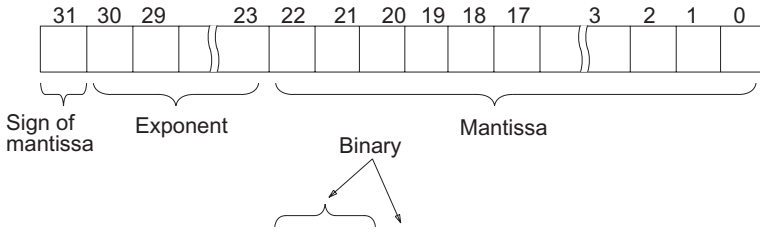
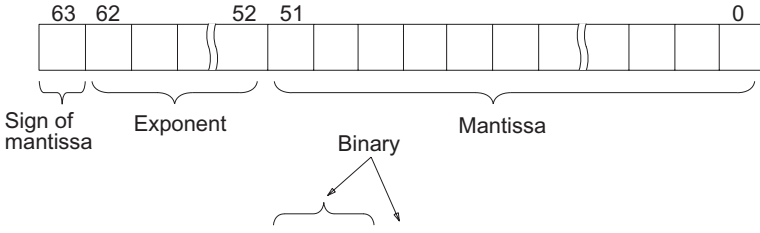
ASCII characters that can be used in a text string includes alphanumeric characters, Katakana and symbols (except for special characters). The characters are shown in the following table.

		Upper 4 bits																	
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F		
Lower 4 bits	0			sp	0	@	P	'	p					一	タ	ミ			
	1			!	1	A	Q	a	q					。	ア	チ	ム		
	2			”	2	B	R	b	r					「	イ	ツ	メ		
	3			#	3	C	S	c	s					」	ウ	テ	モ		
	4			\$	4	D	T	d	t					、	エ	ト	ヤ		
	5			%	5	E	U	e	u					・	オ	ナ	ユ		
	6			&	6	F	V	f	v					ヲ	カ	ニ	ヨ		
	7			'	7	G	W	g	w					ア	キ	ヌ	ラ		
	8			(	8	H	X	h	x					イ	ク	ネ	リ		
	9			)	9	I	Y	i	y					ウ	ケ	ノ	ル		
	A			*	:	J	Z	j	z					エ	コ	ハ	レ		
	B			+	;	K	[	k	{					オ	サ	ヒ	ロ		
	C			,	<	L	¥	|	|					ヤ	シ	フ	ワ		
	D			-	=	M	]	m	}					ユ	ス	ヘ	ン		
	E			.	>	N	^	n	~					ヨ	セ	ホ	”		
	F			/	?	O	_	o						ツ	ソ	マ	°		

A-3-5 Data Formats

The following table shows the data formats that the FQM1 can handle.

Data type	Data format	Decimal	4-digit hexadecimal																																																																																																			
Unsigned binary	<table style="width:100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">15</td><td style="text-align: center;">14</td><td style="text-align: center;">13</td><td style="text-align: center;">12</td><td style="text-align: center;">11</td><td style="text-align: center;">10</td><td style="text-align: center;">9</td><td style="text-align: center;">8</td><td style="text-align: center;">7</td><td style="text-align: center;">6</td><td style="text-align: center;">5</td><td style="text-align: center;">4</td><td style="text-align: center;">3</td><td style="text-align: center;">2</td><td style="text-align: center;">1</td><td style="text-align: center;">0</td> </tr> <tr> <td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td><td style="border: 1px solid black; width: 20px; height: 15px;"></td> </tr> <tr> <td>Binary</td> <td style="text-align: center;">2^{15}</td><td style="text-align: center;">2^{14}</td><td style="text-align: center;">2^{13}</td><td style="text-align: center;">2^{12}</td><td style="text-align: center;">2^{11}</td><td style="text-align: center;">2^{10}</td><td style="text-align: center;">2^9</td><td style="text-align: center;">2^8</td><td style="text-align: center;">2^7</td><td style="text-align: center;">2^6</td><td style="text-align: center;">2^5</td><td style="text-align: center;">2^4</td><td style="text-align: center;">2^3</td><td style="text-align: center;">2^2</td><td style="text-align: center;">2^1</td><td style="text-align: center;">2^0</td> </tr> <tr> <td>Decimal</td> <td style="text-align: center;">32768</td><td style="text-align: center;">16384</td><td style="text-align: center;">8192</td><td style="text-align: center;">4096</td><td style="text-align: center;">2048</td><td style="text-align: center;">1024</td><td style="text-align: center;">512</td><td style="text-align: center;">256</td><td style="text-align: center;">128</td><td style="text-align: center;">64</td><td style="text-align: center;">32</td><td style="text-align: center;">16</td><td style="text-align: center;">8</td><td style="text-align: center;">4</td><td style="text-align: center;">2</td><td style="text-align: center;">1</td> </tr> <tr> <td>Hex</td> <td style="text-align: center;">2^3</td><td style="text-align: center;">2^2</td><td style="text-align: center;">2^1</td><td style="text-align: center;">2^0</td><td style="text-align: center;">2^3</td><td style="text-align: center;">2^2</td><td style="text-align: center;">2^1</td><td style="text-align: center;">2^0</td><td style="text-align: center;">2^3</td><td style="text-align: center;">2^2</td><td style="text-align: center;">2^1</td><td style="text-align: center;">2^0</td><td style="text-align: center;">2^3</td><td style="text-align: center;">2^2</td><td style="text-align: center;">2^1</td><td style="text-align: center;">2^0</td> </tr> </table>	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0																	Binary	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Decimal	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1	Hex	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	0 to 65535	0000 to FFFF																
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0																																																																																							
Binary	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0																																																																																						
Decimal	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1																																																																																						
Hex	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0																																																																																						
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Data type	Data format	Decimal	4-digit hexadecimal
Single-precision floating-point decimal	 <p>Value = $(-1)^{\text{Sign}} \times 1.[\text{Mantissa}] \times 2^{\text{Exponent}}$ Sign (bit 31) 1: negative or 0: positive Mantissa The 23 bits from bit 00 to bit 22 contain the mantissa, i.e., the portion below the decimal point in 1.□□□....., in binary. Exponent The 8 bits from bit 23 to bit 30 contain the exponent. The exponent is expressed in binary as 127 plus n in 2^n.</p> <p>Note This format conforms to IEEE754 standards for single-precision floating-point data and is used only with instructions that convert or calculate floating-point data. It can be used to set or monitor from the I/O memory Edit and Monitor Screen on the CX-Programmer. As such, users do not need to know this format although they do need to know that the formatting takes up two words.</p>	---	---
Double-precision floating-point decimal	 <p>Value = $(-1)^{\text{Sign}} \times 1.[\text{Mantissa}] \times 2^{\text{Exponent}}$ Sign (bit 63) 1: negative or 0: positive Mantissa The 52 bits from bit 00 to bit 51 contain the mantissa, i.e., the portion below the decimal point in 1.□□□....., in binary. Exponent The 11 bits from bit 52 to bit 62 contain the exponent. The exponent is expressed in binary and the actual value is 2^{n-1023}.</p> <p>Note This format conforms to IEEE754 standards for double-precision floating-point data and is used only with instructions that convert or calculate floating-point data. It can be used to set or monitor from the I/O memory Edit and Monitor Screen on the CX-Programmer. As such, users do not need to know this format although they do need to know that the formatting takes up four words.</p>	---	---

Note Signed Binary Data

In signed binary data, the leftmost bit indicates the sign of binary 16-bit data. The value is expressed in 4-digit hexadecimal.

Positive Numbers: A value is positive or 0 if the leftmost bit is 0 (OFF). In 4-digit hexadecimal, this is expressed as 0000 to 7FFF hex.

Negative Numbers: A value is negative if the leftmost bit is 1 (ON). In 4-digit hexadecimal, this is expressed as 8000 to FFFF hex. The absolute of the negative value (decimal) is expressed as a two's complement.

Example: To treat -19 in decimal as signed binary, 0013 hex (the absolute value of 19) is subtracted from FFFF hex and then 0001 hex is added to yield FFED hex.

	F	F	F	F
	1111	1111	1111	1111

True number	0	0	1	3
—)	0000	0000	0001	0011

	F	F	E	C
	1111	1111	1110	1100

	0	0	0	1
+)	0000	0000	0000	0001

Two's complement	F	F	E	D
	1111	1111	1110	1101

Complements

Generally the complement of base x refers to a number produced when all digits of a given number are subtracted from $x - 1$ and then 1 is added to the rightmost digit. (Example: The ten's complement of 7556 is $9999 - 7556 + 1 = 2444$.) A complement is used to express a subtraction and other functions as an addition.

Example: With $8954 - 7556 = 1398$, $8954 +$ (the ten's complement of 7556) $= 8954 + 2444 = 11398$. If we ignore the leftmost bit, we get a subtraction result of 1398.

Two's Complements

A two's complement is the base-two complement. Here, we subtract all digits from 1 ($2 - 1 = 1$) and add one.

Example: The two's complement of binary number 1101 is 1111 (F hex) $- 1101$ (D hex) $+ 1$ (1 hex) $= 0011$ (3 hex). The following shows this value expressed in 4-digit hexadecimal.

The two's complement b hex of a hex is $FFFF$ hex $- a$ hex $+ 0001$ hex $= b$ hex. To determine the two's complement b hex of "a hex," use b hex $= 10000$ hex $- a$ hex.

Example: To determine the two's complement of 3039 hex, use 10000 hex $- 3039$ hex $= CFC7$ hex.

Similarly use a hex $= 10000$ hex $- b$ hex to determine the value a hex from the two's complement b hex.

Example: To determine the real value from the two's complement CFC7 hex, use 10000 hex $- CFC7$ hex $= 3039$ hex.

Two instructions, `NEG(160)(2'S COMPLEMENT)` and `NEGL(161) (DOUBLE 2'S COMPLEMENT)`, can be used to determine the two's complement from the true number or to determine the true number from the two's complement.

Note Signed BCD Data

Signed BCD data is a special data format that is used to express negative numbers in BCD. Although this format is found in applications, it is not strictly defined and depends on the specific application. The FQM1 supports four data formats and supports the following instructions to convert the data formats: SIGNED BCD-TO-BINARY: BINS(470) and SIGNED BINARY-TO-BCD: BCDS(471). Refer to the *Instructions Reference Manual* (Cat. No. 0011) for more information.

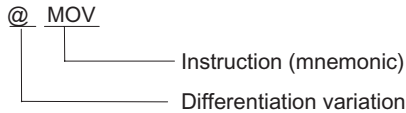
Decimal	Hexadecimal	Binary	BCD	
0	0	0000	0000	
1	1	0001	0001	
2	2	0010	0010	
3	3	0011	0011	
4	4	0100	0100	
5	5	0101	0101	
6	6	0110	0110	
7	7	0111	0111	
8	8	1000	1000	
9	9	1001	1001	
10	A	1010	0001	0000
11	B	1011	0001	0001
12	C	1100	0001	0010
13	D	1101	0001	0011
14	E	1110	0001	0100
15	F	1111	0001	0101
16	10	10000	0001	0110

Decimal	Unsigned binary (4-digit hexadecimal)	Signed binary (4-digit hexadecimal)
+65,535	FFFF	Cannot be expressed.
+65,534	FFFE	
.	.	
.	.	
+32,769	8001	7FFF
+32,768	8000	
+32,767	7FFF	
+32,766	7FFE	
.	.	7FFE
.	.	
.	.	
.	.	
+2	0002	0002
+1	0001	0001
0	0000	0000
-1	Cannot be expressed.	FFFF
-2		FFFE
.		.
.		.
-32,767		8001
-32,768		8000

A-3-6 Instruction Variations

The following differentiation variations are available for the instruction's execution condition.

Variation	Symbol	Description	
Differentiation	Up	@	Specifies an instruction with an up-differentiated execution condition, which is executed when the input condition turns ON.
	Down	%	Specifies an instruction with a down-differentiated execution condition, which is executed when the input condition turns OFF.



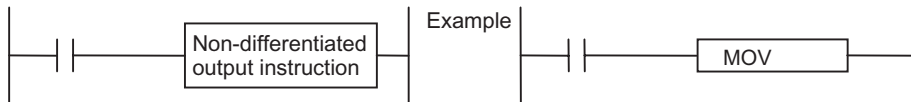
A-3-7 Input Conditions

The FQM1 offers the following types of basic and special instructions.

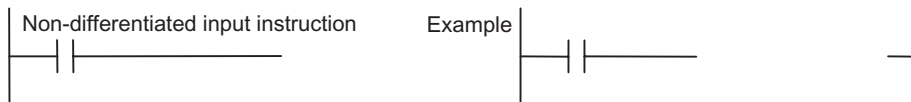
- Non-differentiated instructions executed every cycle
- Differentiated instructions executed only once

Non-differentiated Instructions

- Output instructions that require input conditions are executed once every cycle while the input condition is valid (ON or OFF).



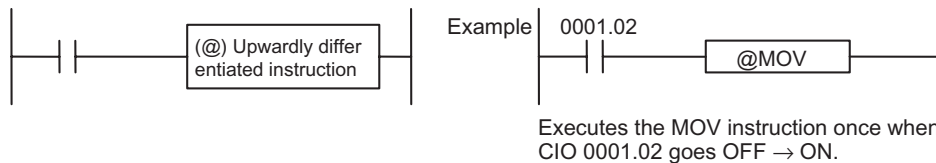
- Input instructions that create logical starts and intermediate instructions that read bit status, make comparisons, test bits, or perform other types of processing every cycle. If the results are ON, power flow is output (i.e., the input condition is turned ON).



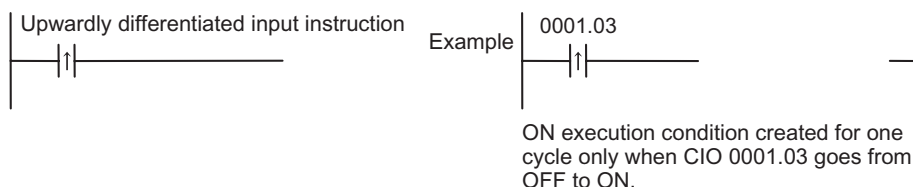
Input-differentiated Instructions

- **Upwardly Differentiated Instructions (Instructions Preceded by @)**

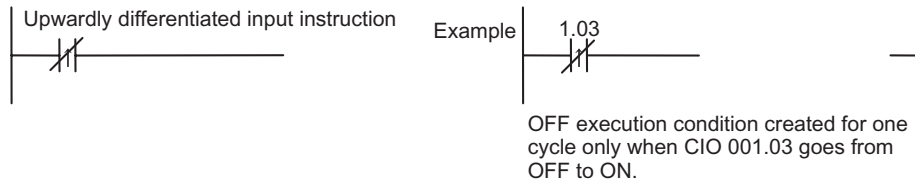
- **Output Instructions:** The instruction is executed only during the cycle in which the input condition turns ON (OFF → ON) and are not executed in the following cycles.



- **Input Instructions (Logical Starts and Intermediate Instructions):** The instruction reads bit status, makes comparisons, tests bits, or perform other types of processing every cycle and will output an ON execution condition (power flow) when results switch from OFF to ON. The execution condition will turn OFF the next cycle.

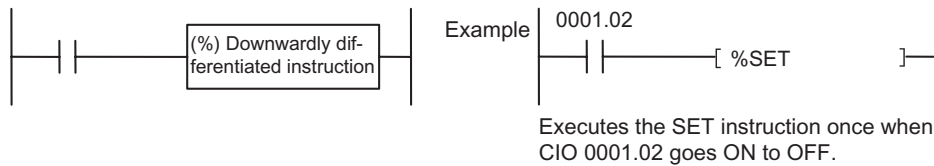


- **Input Instructions (Logical Starts and Intermediate Instructions):** The instruction reads bit status, makes comparisons, tests bits, or perform other types of processing every cycle and will output an OFF execution condition (power flow stops) when results switch from OFF to ON. The execution condition will turn ON the next cycle.

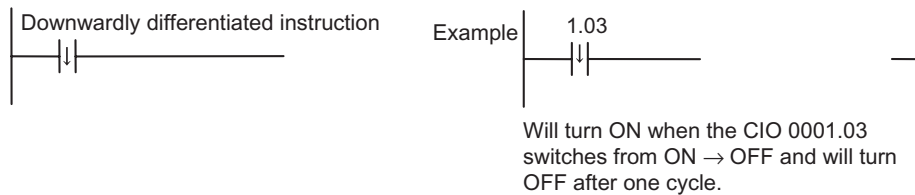


- **Downwardly Differentiated Instructions (Instruction preceded by %)**

- **Output instructions:** The instruction is executed only during the cycle in which the input condition turned OFF (ON → OFF) and is not executed in the following cycles.

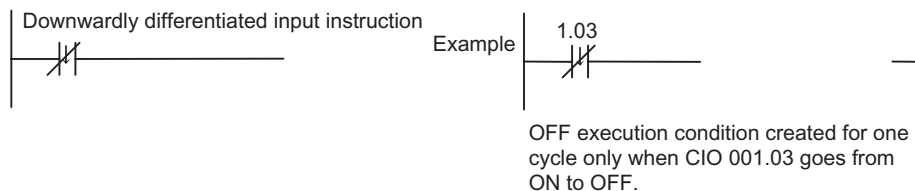


- **Input Instructions (Logical Starts and Intermediate Instructions):** The instruction reads bit status, makes comparisons, tests bits, or perform other types of processing every cycle and will output the execution condition (power flow) when results switch from ON to OFF. The execution condition will turn OFF the next cycle.



Note Unlike the upwardly differentiated instructions, downward differentiation variation (%) can be added only to LD, AND, OR, SET and RSET instructions. To execute downward differentiation with other instructions, combine the instructions with a DIFD instruction.

- **Input Instructions (Logical Starts and Intermediate Instructions):** The instruction reads bit status, makes comparisons, tests bits, or perform other types of processing every cycle and will output an OFF execution condition (power flow stops) when results switch from ON to OFF. The execution condition will turn ON the next cycle.



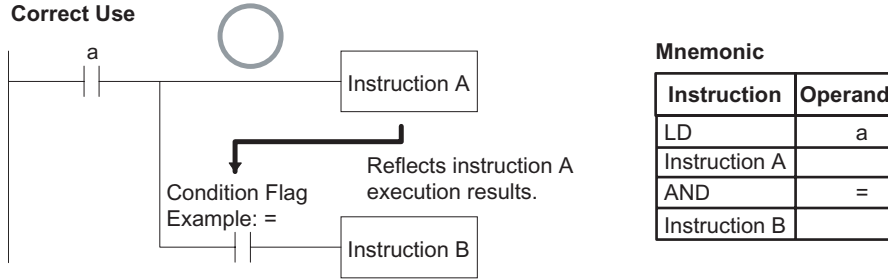
A-4 Programming Precautions

A-4-1 Condition Flags

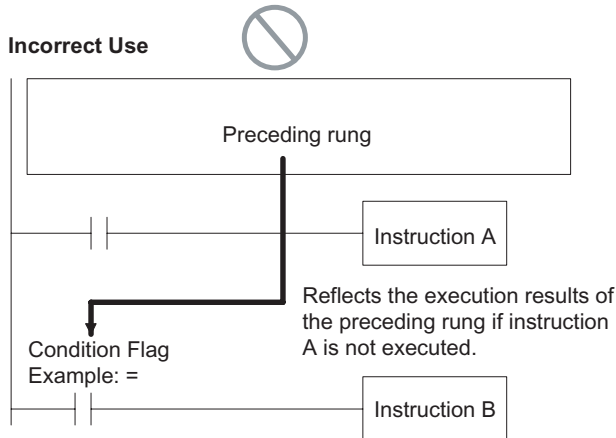
Using Condition Flags

Condition flags are shared by all instructions, and will change during a cycle depending on results of executing individual instructions. Therefore, be sure to use Condition Flags on a branched output with the same input condition immediately after an instruction to reflect the results of instruction execution. Never connect a Condition Flag directly to the bus bar because this will cause it to reflect execution results for other instructions.

Example: Using Instruction A Execution Results



The same input condition (a) is used for instructions A and B to execute instruction B based on the execution results of instruction A. In this case, instruction B will be executed according to the Condition Flag only when instruction A is executed.



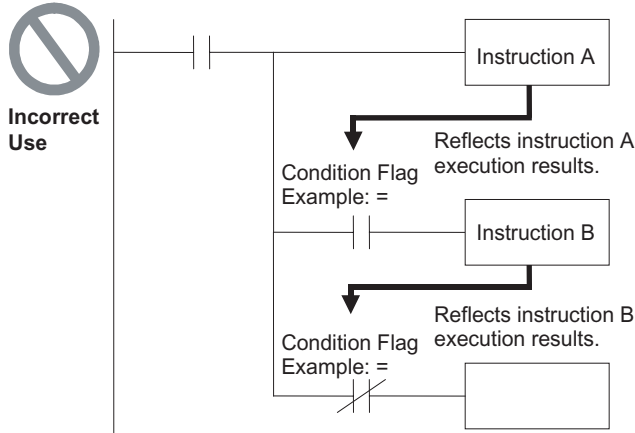
If the Condition Flag is connected directly to the left bus bar, instruction B will be executed based on the execution results of a previous rung if instruction A is not executed.

Note Condition Flags are used by all instruction within a single program (task) but they are cleared when the task switches. Therefore execution results in the preceding task will not be reflected later tasks.

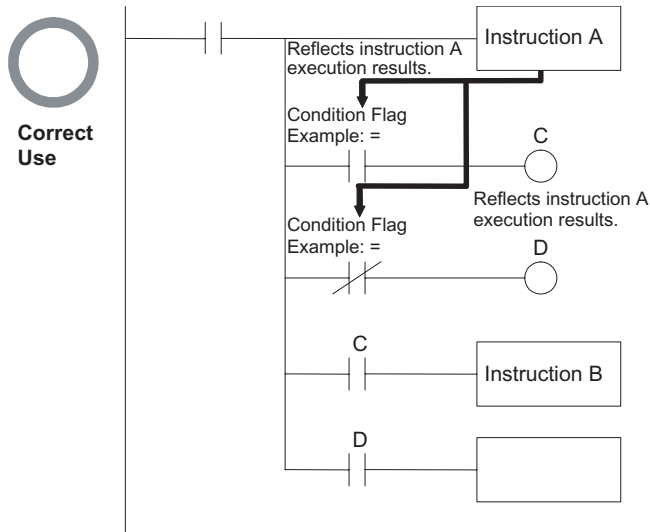
Since condition flags are shared by all instructions, make absolutely sure that they do not interfere with each other within a single ladder-diagram program. The following are examples.

1. Using Execution Results in NC and NO Inputs

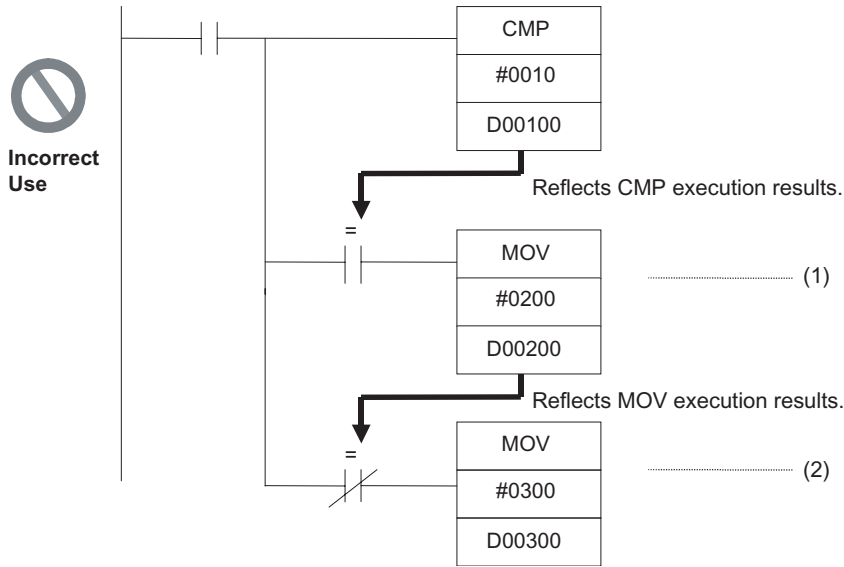
The Condition Flags will pick up instruction B execution results as shown in the example below even though the NC and NO input bits are executed from the same output branch.



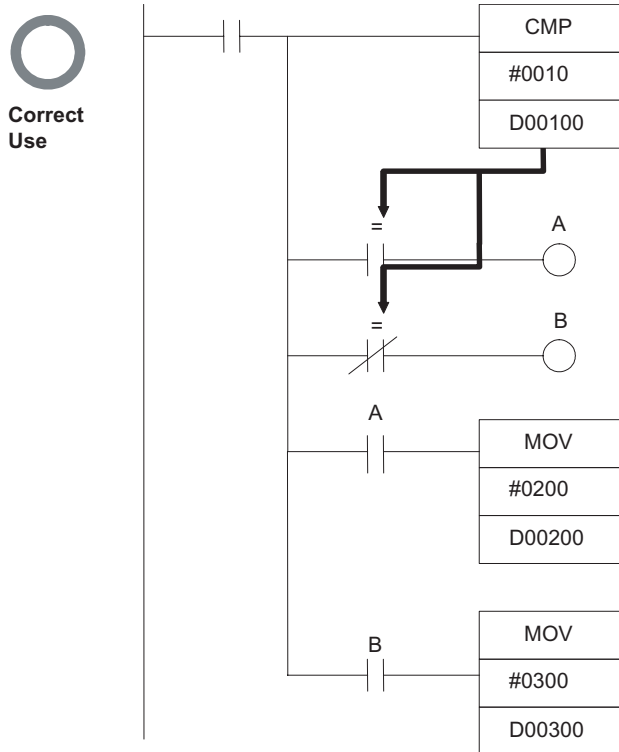
Make sure each of the results is picked up once by an OUTPUT instruction to ensure that execution results for instruction B will be not be picked up.



Example: The following example will move #0200 to D00200 if D00100 contains #0010 and move #0300 to D00300 if D00100 does not contain #0010.



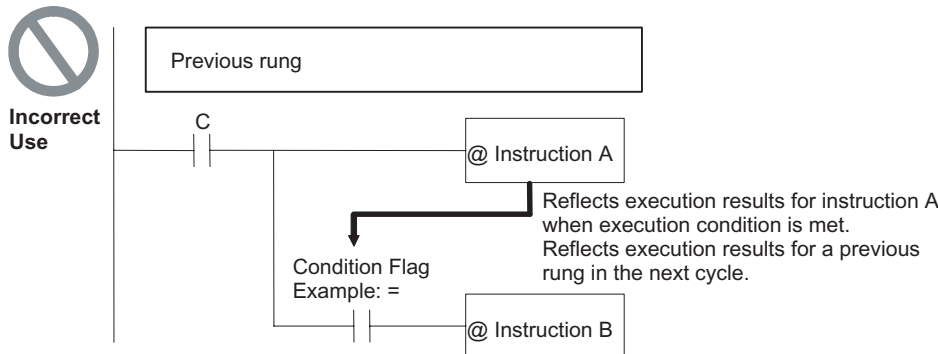
The Equals Flag will turn ON if D00100 in the rung above contains #0010. #0200 will be moved to D00200 for instruction (1), but then the Equals Flag will be turned OFF because the #0200 source data is not 0000 hex. The MOV instruction at (2) will then be executed and #0300 will be moved to D00300. A rung will therefore have to be inserted as shown below to prevent execution results for the first MOVE instruction from being picked up.



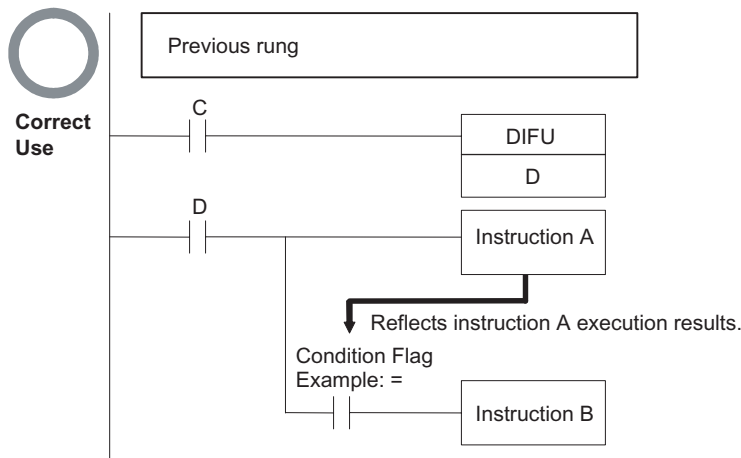
2. Using Execution Results from Differentiated Instructions

With differentiated instructions, execution results for instructions are reflected in Condition Flags only when input condition is met, and results for a previous rung (rather than execution results for the differentiated instruction) will be reflected in Condition Flags in the next cycle. You must therefore be aware of what Condition Flags will do in the next cycle if execution results for differentiated instructions to be used.

In the following for example, instructions A and B will execute only if input condition C is met, but the following problem will occur when instruction B picks up execution results from instruction A. If input condition C remains ON in the next cycle after instruction A was executed, then instruction B will unexpectedly execute (by the input condition) when the Condition Flag goes from OFF to ON because of results reflected from a previous rung.



In this case then, instructions A and B are not differentiated instructions, the DIFU(013) (or DIFD(014)) instruction is used instead as shown below and instructions A and B are both upwardly (or downwardly) differentiated and executed for one cycle only.



Main Conditions Turning ON Condition Flags

Error Flag

The ER Flag will turn ON under special conditions, such as when operand data for an instruction is incorrect. The instruction will not be executed when the ER Flag turns ON.

When the ER Flag is ON, the status of other Condition Flags, such as the <, >, OF, and UF Flags, will not change and status of the = and N Flags will vary from instruction to instruction.

Refer to the descriptions of individual instructions in the *Instructions Reference Manual* (O011) for the conditions that will cause the ER Flag to turn ON. Caution is required because some instructions will turn OFF the ER Flag regardless of conditions.

Equals Flag

The Equals Flag is a temporary flag for all instructions except when comparison results are equal (=). It is set automatically by the system, and it will change. The Equals Flag can be turned OFF (ON) by an instruction after a previous instruction has turned it ON (OFF). The Equals Flag will turn ON, for example, when MOV or another move instruction moves 0000 hex as source data and will be OFF at all other times. Even if an instruction turns the Equals Flag ON, the move instruction will execute immediately and the Equals Flag will turn ON or OFF depending on whether the source data for the move instruction is 0000 hex or not.

Carry Flag

The CY Flag is used in shift instructions, addition and subtraction instructions with carry input, and addition and subtraction instructions with borrows and carries. Note the following precautions.

1. The CY Flag can remain ON (OFF) because of execution results for a certain instruction and then be used in other instruction (an addition and subtraction instruction with carry or a shift instruction). Be sure to clear the Carry Flag when necessary.
2. The CY Flag can be turned ON (OFF) by the execution results for a certain instruction and be turned OFF (ON) by another instruction. Be sure the proper results are reflected in the Carry Flag when using it.

Less Than and Greater Than Flags

The < and > Flags are used in comparison instructions.

The < or > Flag can be turned OFF (ON) by another instruction even if it is turned ON (OFF) by execution results for a certain instruction.

Negative Flag

The N Flag is turned OFF when the leftmost bit of the instruction execution results word is "1" for certain instructions and it is turned OFF unconditionally for other instruction.

Overflow Flag

The OF Flag is turned ON when the result of calculation overflows the capacity of the result word(s).

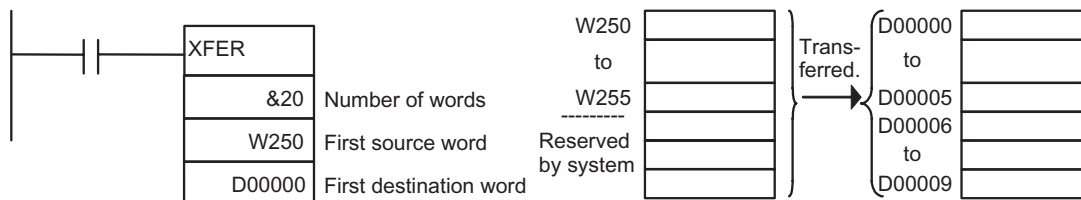
Underflow Flag

The UF Flag is turned ON when the result of calculation underflows the capacity of the result word(s).

Specifying Operands for Multiple Words

An instruction will be executed as written even if an operand requiring multiple words is specified so that all of the words for the operand are not in the same area. In this case, words will be taken in order of the memory addresses. The Error Flag will **not** turn ON.

As an example, consider the results of executing a block transfer with XFER(070) if 10 words are specified for transfer beginning with W250. Here, the Work Area, which ends at W255, will be exceeded, but the instruction will be executed without turning ON the Error Flag. In the memory addresses, words reserved by the system come after the Work Area, and thus for the following instruction, W250 to W255 will be transferred to D00000 to D00005 and contents of the system-reserved words will be transferred to D00006 to D00009.



A-4-2 Special Program Sections

FQM1 programs have special program sections that will control instruction conditions.

The following special program sections are available.

Program section	Instructions	Instruction condition	Status
Subroutine	SBS(091), JSB(982), SBN(092), and RET(093) instructions	Subroutine program being executed.	The subroutine program section between SBN(092) and RET(093) instructions is being executed.
IL(002) - ILC(003) section	IL(002) and ILC(003) instructions	Section is interlocked	The output bits are turned OFF and timers are reset. Other instructions will not be executed and previous status will be maintained.
Step Ladder section	STEP(008) instruction		
FOR(512) - NEXT(513) section	FOR(512) and NEXT(513) instructions	BREAK(514) execution	Repeatedly executes instructions in the loop between FOR(512) and NEXT(513).
JMP0(515) - JME0(516) section	JMP0(515) and JME0(516) instructions		Jumps from JMP0(515) to the next JME0(516) and treats all instructions in the jumped section as NOP(000).
Block program section	BPRG(096) instructions and BEND(801) instructions	Block program being executed.	The block program listed in mnemonics between the BPRG(096) and BEND(801) instructions is being executed.

Instruction Combinations

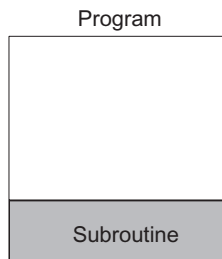
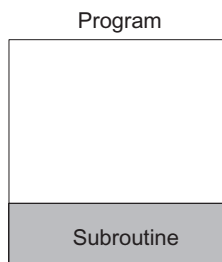
The following table shows which of the special instructions can be used inside other program sections.

	Subroutine	IL(002) - ILC(003) section	Step ladder section	FOR(512) - NEXT(513) loop	JMP0(515) - JME0(516) section	Block program section
Subroutine	Not possible.	Not possible.	Not possible.	Not possible.	Not possible.	Not possible.
IL(002) - ILC(003)	OK	Not possible.	Not possible.	OK	OK	Not possible.
Step ladder section	Not possible.	OK	Not possible.	Not possible.	OK	Not possible.
FOR(512) - NEXT(513)	OK	OK	Not possible.	OK	OK	Not possible.
JMP0(515) - JME0(516)	OK	OK	Not possible.	Not possible.	Not possible.	Not possible.
Block program section	OK	OK	OK	Not possible.	OK	Not possible.

Note Instructions that specify program areas cannot be used between two different tasks.

Subroutines

Place all the subroutines together just before the END(001) instruction in all programs but after programming other than subroutines. A subroutine cannot be placed in a step ladder, block program, or other subroutine. If instructions other than a subroutine program are placed after a subroutine program (SBN(092) to RET(093)), those instructions will not be executed.



Instructions Not Allowed in Subroutines

The following instructions cannot be placed in a subroutine.

Function	Mnemonic	Instruction
Ladder Step Control	STEP(008)	Define step ladder section
	SNXT(009)	Step through the step ladder

Note Block Program Sections

A subroutine can include a block program section.

Instructions Not Allowed in Step Ladder Program Sections

Function	Mnemonic	Instruction
Sequence Control	FOR(512), NEXT(513), and BREAK(514)	FOR, NEXT, and BREAK LOOP
	END(001)	END
	IL(002) and ILC(003)	INTERLOCK and INTERLOCK CLEAR
	JMP(004) and JME(005)	JUMP and JUMP END
	CJP(510) and CJPN(511)	CONDITIONAL JUMP and CONDITIONAL JUMP NOT
	JMP0(515) and JME0(516)	MULTIPLE JUMP and MULTIPLE JUMP END
Subroutines	SBN(092) and RET(093)	SUBROUTINE ENTRY and SUBROUTINE RETURN
Block Programs	IF(802) (NOT), ELSE(803), and IEND(804)	Branching instructions
	BPRG(096) and BEND(801)	BLOCK PROGRAM BEGIN/END

- Note**
- (1) A step ladder program section can be used in an interlock section (between IL(002) and ILC(003)). The step ladder section will be completely reset when the interlock is ON.
 - (2) A step ladder program section can be used between MULTIPLE JUMP (JMP0(515)) and MULTIPLE JUMP END (JME0(516)).

Instructions Not Allowed in Block Program Sections

The following instructions cannot be placed in block program sections.

Classification by Function	Mnemonic	Instruction
Sequence Control	FOR(512), NEXT(513), and BREAK(514)	FOR, NEXT, and BREAK LOOP
	IL(002) and ILC(003)	INTERLOCK and INTERLOCK CLEAR
	JMP0(515) and JME0(516)	MULTIPLE JUMP and MULTIPLE JUMP END
	END(001)	END

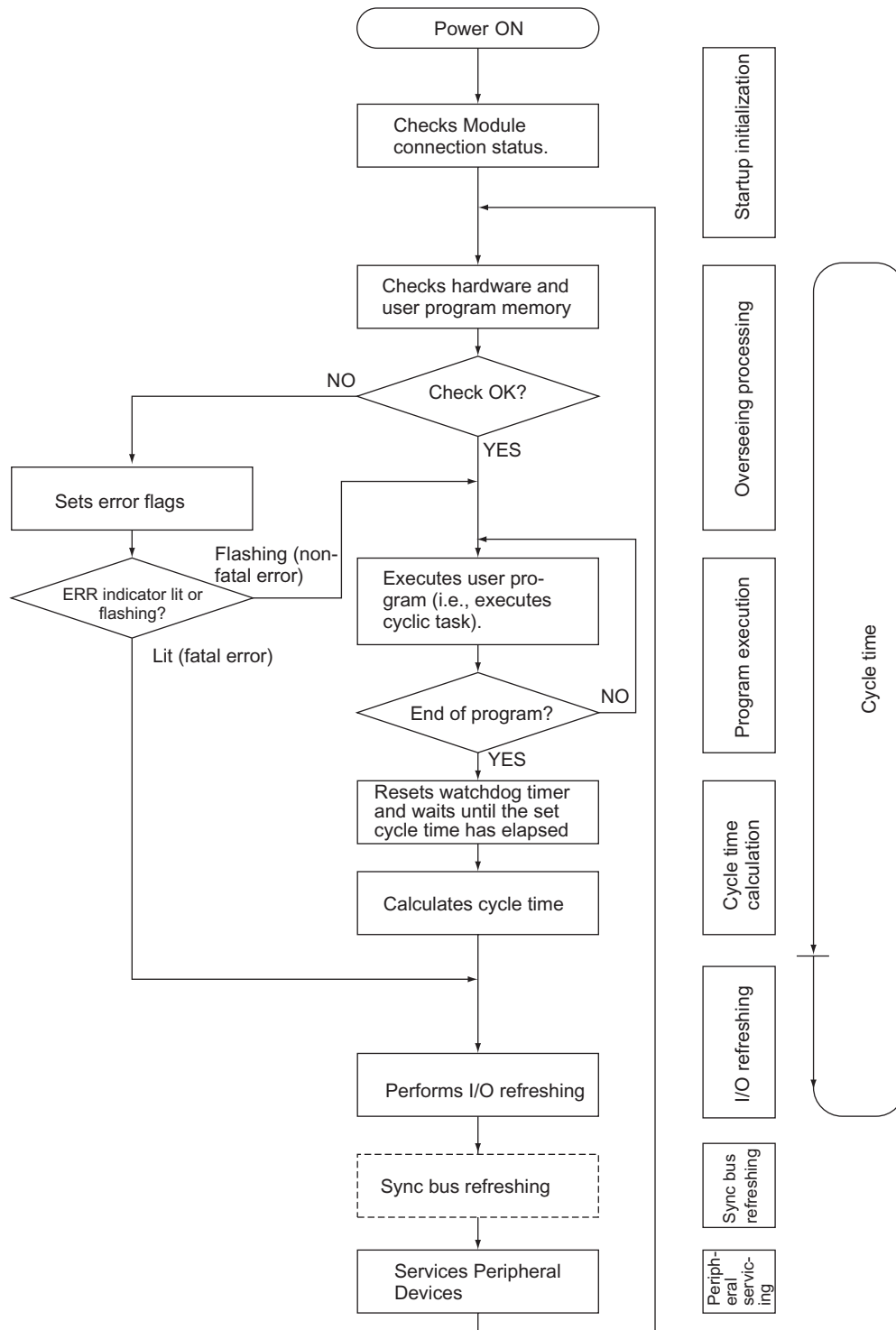
Classification by Function	Mnemonic	Instruction
Sequence Input	UP(521)	CONDITION ON
	DOWN(522)	CONDITION OFF
Sequence Output	DIFU(013)	DIFFERENTIATE UP
	DIFD(014)	DIFFERENTIATE DOWN
	KEEP(011)	KEEP
	OUT	OUTPUT
	OUT NOT	OUTPUT NOT
Timer/Counter	TIM	TIMER
	TIMH	HIGH-SPEED TIMER
	TMHH(540)	ONE-MS TIMER
	CNT	COUNTER
	CNTR	REVERSIBLE COUNTER
Subroutines	SBN(092) and RET(093)	SUBROUTINE ENTRY and SUBROUTINE RETURN
Data Shift	SFT(010)	SHIFT
Ladder Step Control	STEP(008) and SNXT(009)	STEP DEFINE and STEP START
Block Program	BPRG(096)	BLOCK PROGRAM BEGIN

- Note**
- (1) Block programs can be used in a step ladder program section.
 - (2) A block program can be used in an interlock section (between IL(002) and ILC(003)). The block program section will not be executed when the interlock is ON.
 - (3) A JUMP instruction (JMP(004)) can be used in a block program section, but the JUMP (JMP(004)) and JUMP END (JME(005)) instructions must be used in a pair within the block program section. The program will not execute properly unless these instructions are paired.

A-5 Computing the Cycle Time

A-5-1 FQM1 Operation Flowchart

The Coordinator Module and Motion Control Modules process data in repeating cycles from the overseeing processing up to peripheral servicing as shown in the following diagram.



A-5-2 Overview of Cycle Time Calculations

Coordinator Module

The cycle time of the Coordinator Module will vary with the following factors.

- Type and number of instructions in the user programs (in the cyclic task and within interrupt tasks for which the execution conditions have been satisfied)
- Type and number of Motion Control Modules

- Type and number of Basic I/O Units
- Type and number of Special I/O Units and CPU Bus Units
- Specific servicing for the following Units:
Remote I/O for DeviceNet (Master) Units and the number of remote I/O words
- Setting a constant cycle time in the System Setup
- Type and frequency of event servicing through the communications ports for Motion Control Modules, Special I/O Units, and CPU Bus Units
- Use of peripheral, RS-232C, and RS-422A ports
- Setting the *Set Time to All Events* in the System Setup

Note (1) The cycle time is not affected by the number of tasks that are used in the user program.
 (2) When the mode is switched from MONITOR mode to RUN mode, the cycle time will be extended by 10 ms (this will not, however, will not create a cycle time exceeded error).

Motion Control Modules

The cycle time of the Motion Control Module will vary with the following factors.

- Type and number of instructions in the user programs (in the cyclic task and within interrupt tasks for which the execution conditions have been satisfied)
- Setting a constant cycle time in the System Setup
- Event servicing with the Coordinator Module

Note (1) The cycle time is not affected by the number of tasks that are used in the user program.
 (2) When the mode is switched from MONITOR mode to RUN mode, the cycle time will be extended by 10 ms (this will not, however, will not create a cycle time exceeded error).

Calculating the Cycle Time of the Coordinator Module

The cycle time is the total time required for the Coordinator Module to perform the operations shown in the following tables.

Cycle time = (1) + (2) + (3) + (4) + (5) + (6) + (7)

1. Overseeing Process

Details	Processing time and fluctuation cause
Checks the buses, user program memory, etc.	39 μs

2. Program Execution

Details	Processing time and fluctuation cause
Executes the user program. This is the total time taken for the instructions to execute the program.	40 μs + total instruction execution time

3. Cycle Time Calculation

Details	Processing time and fluctuation cause
Waits for the specified cycle time to elapse when a constant (minimum) cycle time has been set in the System Setup. Calculates the cycle time.	Cycle time calculation: 8 μs Waiting time for a constant cycle time = Set cycle time – Actual cycle time

4. I/O Refreshing

Details	Processing time and fluctuation cause
The built-in I/O on the Coordinator Module are refreshed.	5 μs Coordinator Module I/O refresh time

5. Sync Bus Refreshing

Details	Processing time and fluctuation cause
The sync bus between the Coordinator Module and Motion Control Modules is refreshed.	Async Mode: 0 μ s Sync Mode: 170 μ s min. (depends on number of Motion Control Modules)

6. Cyclic Refreshing (between the Coordinator Module and Motion Control Modules)

Details	Processing time and fluctuation cause
The allocated bit areas are refreshed.	4 μ s + Cyclic refresh time (40 μ s) x Number of Motion Control Modules

7. Cyclic Refreshing (between the Coordinator Module and CJ-series Units)

Details	Processing time and fluctuation cause
I/O refreshing with each Unit, when CJ-series Units are mounted	When no CJ-series Units are mounted: 0 μ s (no effect on cycle time) When CJ-series Units are mounted: 50 μ s + processing time for Basic I/O Units (see below) + processing time for Special I/O Units (see below) + processing time for CPU Bus Units (see below)
Refer to A-5-4 I/O Refreshing Time for CJ-series Units for details on the I/O refreshing times for the following CJ-series Units.	
Basic I/O Units	Basic I/O Units are refreshed. Outputs (from the CPU Unit to the I/O Unit) are refreshed first, and then inputs (from the I/O Unit to the CPU Unit). I/O refresh time for each Unit multiplied by the number of Units used.
Special I/O Units	Refreshing of words allocated in CIO Area Refreshing of data specific to the Special I/O Units For example, processing of Compo-Bus/S remote I/O communications I/O refresh time for each Unit multiplied by the number of Units used.
CPU Bus Units	Refreshing of words allocated in CIO Area and DM Area Refreshing of data specific to the CPU Bus Units For example, processing of DeviceNet remote I/O communications I/O refresh time for each Unit multiplied by the number of Units used.

8. Peripheral Service

Details	Processing time and fluctuation cause
Peripheral service overhead: 76 μ s Event servicing with Motion Control Modules Note Does not include I/O refreshing.	If a uniform peripheral servicing time hasn't been set as the <i>Set Time to All Events</i> in the System Setup, 6.25% of the previous cycle time (calculated in step (3)) will be allowed for peripheral servicing. If a uniform peripheral servicing time has been set in the System Setup, servicing will be performed for the set time. At least 0.1 ms, however, will be serviced whether the peripheral servicing time is set or not. If no Modules are connected, the servicing time is 0 ms.
Peripheral port servicing	If a uniform peripheral servicing time hasn't been set as the <i>Set Time to All Events</i> in the System Setup, 6.25% of the previous cycle time (calculated in step (3)) will be allowed for peripheral servicing. If a uniform peripheral servicing time has been set in the System Setup, servicing will be performed for the set time. At least 0.1 ms, however, will be serviced whether the peripheral servicing time is set or not. If the port is not connected, the servicing time is 0 ms.

Details	Processing time and fluctuation cause
RS-232C port servicing	Same as for peripheral port servicing.
RS-422A port servicing	If a uniform peripheral servicing time hasn't been set as the <i>Set Time to All Events</i> in the System Setup, 6.25% of the previous cycle time (calculated in step (3)) will be allowed for peripheral servicing. If a uniform peripheral servicing time has been set in the System Setup, servicing will be performed for the set time. At least 0.1 ms, however, will be serviced whether the peripheral servicing time is set or not. If the communications port is not used, the servicing time is 0 ms.

Calculating the Cycle Time of a Motion Control Module

The cycle time is the total time required for the Motion Control Module to perform the operations shown in the following tables.

Cycle time = (1) + (2) + (3) + (4) + (5) + (6) + (7)

1. Overseeing Process

Details	Processing time and fluctuation cause
User program check, etc.	29 μs

2. Program Execution

Details	Processing time and fluctuation cause
Executes the user program. This is the total time taken for the instructions to execute the program.	40 μs + total instruction execution time

3. Cycle Time Calculation

Details	Processing time and fluctuation cause
Waits for the specified cycle time to elapse when a constant (minimum) cycle time has been set in the System Setup. Calculates the cycle time.	Cycle time calculation: 8 μs Waiting time for a constant cycle time = Set cycle time – Actual cycle time (1 + 2 + 4 + 5)

4. I/O Refreshing

Details	Processing time and fluctuation cause
The built-in I/O and special inputs (pulse/analog) on the Motion Control Module are refreshed.	MMP22: 48 μs MMA22: 135 μs Motion Control Module I/O refresh time

5. Cyclic Refreshing

Details	Processing time and fluctuation cause
Cyclic refresh with the Coordinator Module	21 μs

6. Sync Bus Refreshing

Details	Processing time and fluctuation cause
The sync bus between the Coordinator Module and Motion Control Modules is refreshed.	60 μs

7. Peripheral Service

Details	Processing time and fluctuation cause
Event servicing with Motion Control Modules	40 μs + Event service time Event service time includes event servicing for DM area transfers requested by the Coordinator Module, event processing for requests from the CX-Programmer, etc.

A-5-3 Module I/O Refresh Times

Cyclic Refresh Time in the Coordinator Module

Model	I/O refresh time
FQM1-MMP22/MMA22	40 μ s per Module

Cyclic Refresh Time in Motion Control Modules

Model	I/O refresh time
FQM1-MMP22/MMA22	21 μ s

A-5-4 I/O Refreshing Time for CJ-series Units

Typical Basic I/O Unit Refresh Times

Name	Model	I/O refresh time per Unit
8/16-point DC Input Units	CJ1W-ID201/211	0.003 ms
32-point DC Input Units	CJ1W-ID231/232	0.005 ms
64-point DC Input Units	CJ1W-ID261/262	0.011 ms
8/16-point AC Input Units	CJ1W-IA201/111	0.003 ms
8/16-point Transistor Output Units	CJ1W-OD201/202/203/204/211/212	0.003 ms
32-point Transistor Output Units	CJ1W-OD231/232/233	0.005 ms
64-point Transistor Output Units	CJ1W-OD261/262/263	0.011 ms
8/16-point Relay Output Units	CJ1W-OC201/211	0.003 ms
8-point Triac Output Units	CJ1W-OA201	0.003 ms
24-V DC Input/Transistor Output Units (16 inputs/16 outputs)	CJ1W-MD231/232/233	0.005 ms
24-V DC Input/Transistor Output Units (32 inputs/32 outputs)	CJ1W-MD261/263	0.011 ms
TTL Input/TTL Output Units (16 inputs/16 outputs)	CJ1W-MD563	0.011 ms
B7A Interface Unit (64 inputs)	CJ1W-B7A14	0.011 ms
B7A Interface Unit (64 outputs)	CJ1W-B7A04	0.011 ms
B7A Interface Unit (32 inputs/32 outputs)	CJ1W-B7A22	0.011 ms

Typical Special I/O Unit Refresh Times

Name	Model		I/O refresh time per Unit
CompoBus/S Master Unit	CJ1W-SRM21	Assigned 1 unit number	0.17 ms
		Assigned 2 unit numbers	0.18 ms

Increase in Cycle Time due to CPU Bus Units

Name	Model		I/O refresh time per Unit
SPU Unit	CJ1W-SPU01		1.0 ms + 1 μs for each word sampled
DeviceNet Unit	CJ1-DRM21		0.5 ms + 0.7 μs for each allocated word
Position Control Unit	CJ1W-NCF71	1 axis connected	0.3 ms
		3 axes connected	0.45 ms
		6 axes connected	0.6 ms

A-5-5 Example of Calculating the Cycle Time

An example is given here for a Coordinator Module with FQM1-MMP22 Motion Control Modules and CJ-series Units connected.

Conditions

Item	Condition	
Motion Control Modules	FQM1-MMP22	2 Modules
Basic I/O Units	CJ1W-MD261	2 Units
Special I/O Units	CJ1W-SRM21	1 Unit (assigned 2 unit numbers)
CPU Bus Units	CJ1W-DRM21	1 Unit (uses 10 words)
User program	10 Ksteps	LD: 5.0 Ksteps OUT: 5.0 Ksteps
Sync bus refresh	Used.	
Peripheral port connection	None	
Constant cycle time setting	None	
RS-232C port connection	None	
RS-422A port connection	None	
Other peripheral servicing	None	

Calculation Example for FQM1-CM002

Process	Calculation	Processing time
		Without CX-Programmer connected to peripheral port
1. Overseeing	---	0.039 ms
2. Program execution	$40 \mu\text{s} + 0.1 \mu\text{s} \times 1000 + 0.35 \mu\text{s} \times 1000$	0.490 ms
3. Cycle time calculation	(No cycle time set)	0.008 ms
4. I/O refresh	---	0.005 ms
5. Sync bus Refresh	---	0.170 ms
6. Cyclic refresh (with Motion Control Modules)	$4 \mu\text{s} + 40 \mu\text{s} \times 2$	0.084 ms
7. Cyclic refresh (with CJ-series Units)	$50 \mu\text{s} + (11 \mu\text{s} \times 2) + 180 \mu\text{s} + (500 \mu\text{s} + 0.7 \mu\text{s} \times 10)$	0.759 ms
8. Peripheral servicing		0.076 ms
Cycle time	1. + 2. + 3. + 4. + 5. + 6. + 7. + 8.	1.631 ms

Calculation Example for FQM1-MMP22

Process	Calculation	Processing time
		Without CX-Programmer connected to peripheral port
1. Overseeing	---	0.029 ms
2. Program execution	$40 \mu\text{s} + 0.1 \mu\text{s} \times 1000 + 0.35 \mu\text{s} \times 1000$	0.490 ms
3. Cycle time calculation	(No cycle time set)	0.008 ms
4. I/O refresh		0.048 ms
5. Cyclic refresh		0.021 ms
6. Sync bus Refresh		0.06 ms
7. Peripheral servicing		0.04 ms
Cycle time	1. + 2. + 3. + 4. + 5. + 6. + 7.	0.696 ms

A-5-6 Online Editing Cycle Time Extension

When online editing is executed from the CX-Programmer while the FQM1 is operating in MONITOR mode to change the program, the Coordinator Module will momentarily suspend operation while the program is being changed. The period of time that the cycle time is extended is determined by the following conditions.

- The number of steps that is changed
- Editing operations (insert/delete/overwrite)
- Instructions used

The cycle time extension for online editing will be negligibly affected by the size of largest task program. If the maximum program size for each task is 10 Ksteps, the online editing cycle time extension will be as shown in the following table.

Module	Online editing cycle time extension
FQM1-CM002	65 ms max., 14 ms typical (for a program size of 10 Ksteps)
FQM1-MMP22/MMA22	

When editing online, the cycle time will be extended by the above time.

Note When there is only one task, online editing is processed entirely in the cycle time following the cycle in which online editing is executed. When there are multiple tasks (cyclic task and interrupt tasks), online editing is separated, so that for n tasks, processing is executed over n to $n \times 2$ cycles max.

A-6 Response Time

A-6-1 I/O Response Time for Built-in FQM1 I/O Points

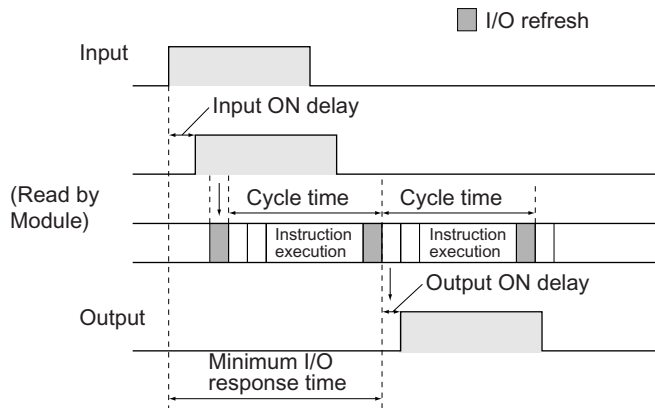
The I/O response time is the time it takes from when an built-in input on a Module turns ON, the data is recognized by the Module, and the user program is executed, up to the time for the result to be output to the built-in output terminals. The length of the I/O response time depends on the following conditions.

- Timing of input bit turning ON
- Cycle time

Coordinator Module I/O Response Time

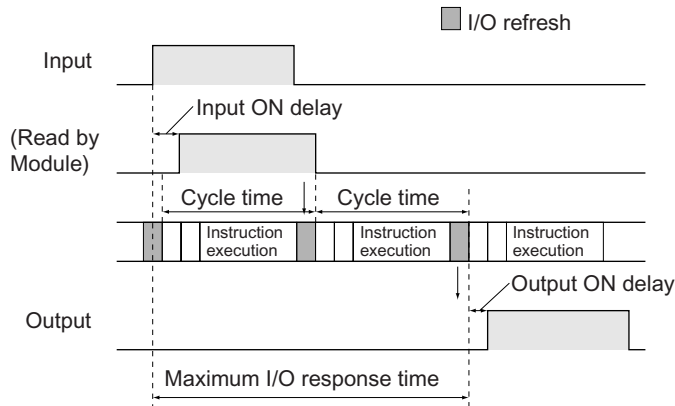
Minimum I/O Response Time

The I/O response time is shortest when data is retrieved immediately before I/O refresh of the Coordinator Module. The minimum I/O response time is the total of the Input ON delay, the Cycle time, and the Output ON delay.



Maximum I/O Response Time

The I/O response time is longest when data is retrieved immediately after I/O refresh of the Coordinator Module. The maximum I/O response time is the total of the Input ON delay, (the Cycle time × 2), and the Output ON delay.



Calculation Example

Conditions: Input ON delay: 0.1 ms
 Output ON delay: 0.1 ms
 Cycle time: 2 ms

Minimum I/O response time = 0.1 ms + 2 ms + 0.1 ms = 2.2 ms

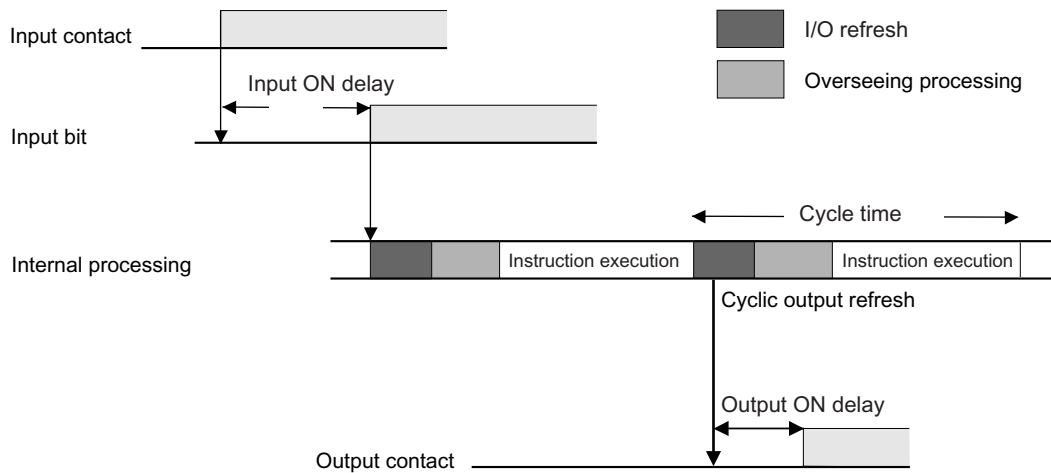
Maximum I/O response time = 0.1 ms + (2 ms × 2) + 0.1 ms = 4.2 ms

Motion Control Module I/O Response Time

Minimum I/O Response Time (General-purpose I/O 0 to 3)

The I/O response time is shortest when the input refresh is executed immediately after a Motion Control Module detects an input, as shown in the figure below.

The minimum I/O response time is the total of the Input ON delay, the Cycle time, and the Output ON delay.



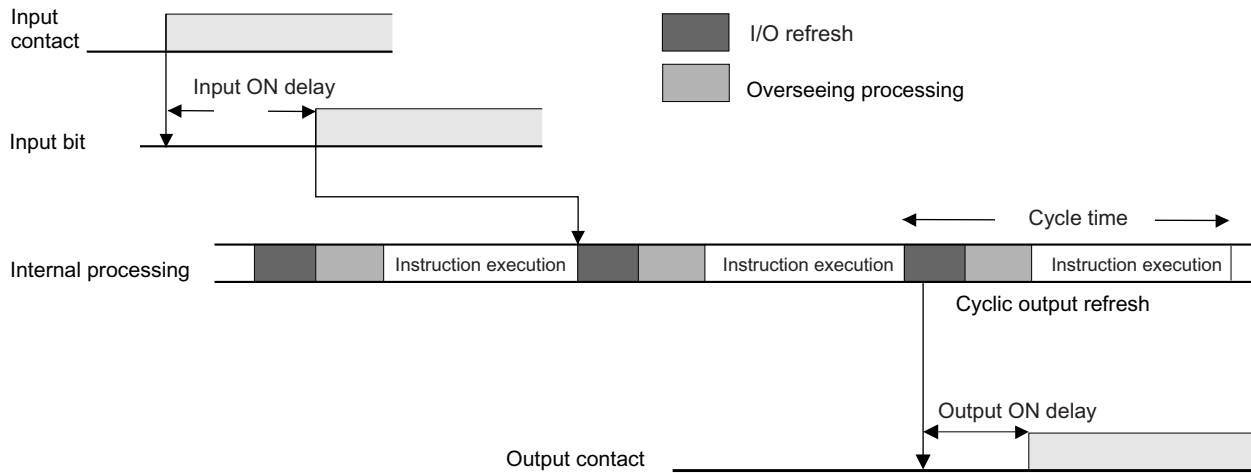
- Cyclic Output Refresh Time
 Minimum I/O response time = 0.03 + 0.194 + 0.1 = 0.324 (ms)

Note Input interrupts and the IORF(097) instruction can be used to obtain a faster response (100 μs typical).

Maximum I/O Response Time

The I/O response time is longest when a Motion Control Module detects an input immediately after input refresh has been executed, as shown in the figure below. The response time will be one cycle longer than for the minimum I/O response time.

The maximum I/O response time is the total of the Input ON delay, (the Cycle time × 2), and the Output ON delay.



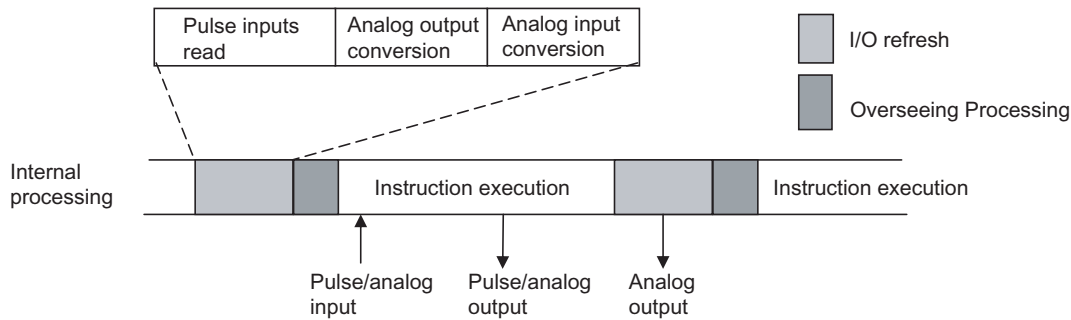
- Cyclic Output Refresh Time
 Maximum I/O response time = 0.03 + 0.388 + 0.1 = 0.518 (ms)

Calculation Example

Input ON delay: 0.03 ms
 Overhead time: 0.193 ms
 Instruction execution time: 0.001 ms
 Output ON delay: 0.1 ms
 Position of OUT: Beginning of program.

I/O Response Time for Pulse and Analog I/O

As shown in the following diagram, an MPU in the Motion Control Module directly controls pulse and analog I/O processing with hardware. The cycle time for pulse and analog I/O is thus included in the cycle time of a Motion Control Module. Hardware control means that the most recent data is handled for this I/O.



The pulse and analog input data read with the I/O refresh in one cycle will thus be used immediately and can be output from the ladder program in the next cycle.

A-6-2 I/O Response Times of Basic I/O Units

The I/O response time is the time it takes from when a CJ-series Input Unit's input turns ON, the data is recognized by the Coordinator Module, the user program is executed, and the result is output to a CJ-series Output Unit's output terminals.

The length of the I/O response time depends on the following conditions.

- Timing of Input Bit turning ON
- Cycle time
- Type of Rack to which Input and Output Units are mounted (CPU Rack or Expansion Rack)

I/O Response Times of CJ-series Basic I/O Units

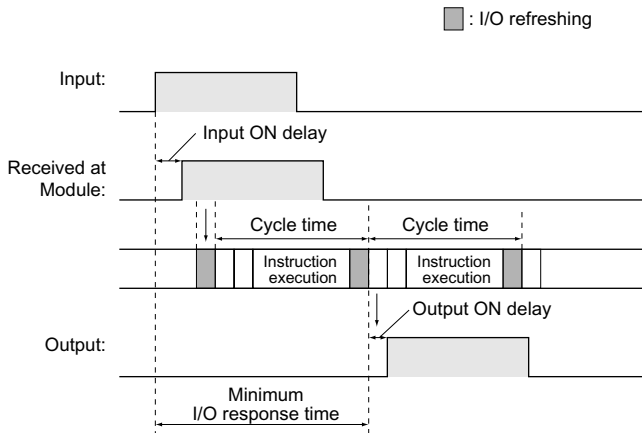
Minimum I/O Response Time

The I/O response time is shortest when data is retrieved immediately before I/O refreshing in the Coordinator Module.

The minimum I/O response time is the total of the Input ON delay, the cycle time, and the Output ON delay.

$\text{Minimum I/O response time} = \text{Input ON delay} + \text{cycle time} + \text{output ON delay}$

Note The Input and Output ON delay times depend on the Modules being used.

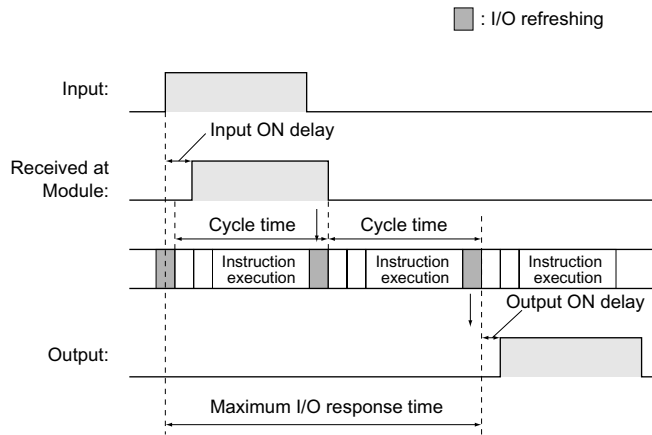


Maximum I/O Response Time

The I/O response time is longest when data is retrieved immediately after I/O refreshing in the Coordinator Module.

The maximum I/O response time is the total of the Input ON delay, (the cycle time × 2), and the Output ON delay.

$\text{Maximum I/O response time} = \text{Input ON delay} + (\text{cycle time} \times 2) + \text{output ON delay}$
--



Calculation Examples

Conditions: Input ON delay = 1.5 ms
 Output ON delay = 0.2 ms
 Cycle time = 2 ms

Minimum I/O response time = 1.5 ms + 2 ms + 0.2 ms = 3.7 ms

Maximum I/O response time = 1.5 ms + (2 ms × 2) + 0.2 ms = 5.7 ms

A-6-3 Interrupt Response Times for Built-in FQM1 Inputs

Motion Control Module Interrupt Response Times

Input Interrupt Tasks

The interrupt response time for an input interrupt task is the time required from when a built-in input on a Motion Control Module turns ON (upward differentiation) or turns OFF (downward differentiation) until the input interrupt task is actually executed. The interrupt response time for an input interrupt task would be the total of the hardware and software response times given in the following table.

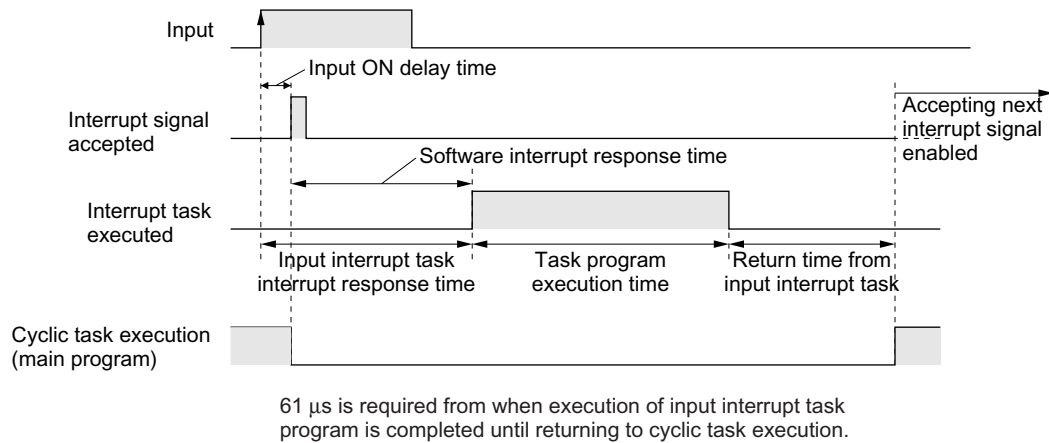
- Response Times for Built-in Inputs

Item	Description
Hardware response time	Upward differentiation: 0.03 ms Downward differentiation: 0.2 ms
Software response time	72 to 82 μs (See note 2.)

- Note**
- (1) Input interrupt tasks can be executed during execution of the user program, I/O refresh, peripheral servicing, or overseeing processes. (During user program execution, instruction execution is suspended to execute the interrupt task.) The response time is not affected by the type of process being executed when the input interrupt is generated. An input interrupt task, however, will not be executed immediately if another interrupt task is already being executed. Execution of the next interrupt task will wait until the current interrupt task has completed execution and then interrupt tasks will be executed in order of priority after the Software interrupt response time.
 - (2) For the FQM1-MMA22, interrupt processing is prohibited during analog I/O conversion. A minimum of 72 to 130 μs will be required.
 - (3) If an interrupt occurs during an instruction that is processed using hardware, interrupt task execution will be postponed until the instruction has finished execution. A minimum of 10 μs will be required.

The interrupt response time for an input interrupt task is shown below.

Input interrupt response time = Input ON delay + Software interrupt response time

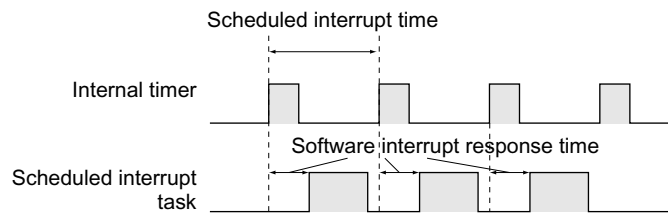


Scheduled Interrupt Task

The interrupt response time of scheduled interrupt tasks is the time taken from after the scheduled time specified by the STIM(980) instruction has elapsed until the interrupt task is actually executed. The maximum interrupt response time for scheduled interrupt tasks is 0.1 ms.

Also, a dedicated timer is used for the specified scheduled interrupt time (minimum of 0.5 ms), so there is essentially no error in the time.

Note Scheduled interrupt tasks can be executed during execution of the user program, I/O refresh, peripheral servicing, or overseeing processes. (During user program execution, instruction execution is suspended to execute the interrupt task.) The response time is not affected by the type of process being executed when the input interrupt is generated. A schedule interrupt task, however, will not be executed immediately if another interrupt task is already being executed. Execution of the next scheduled interrupt task will wait until the current interrupt task has completed execution and then start after the software interrupt response time.



Motion Control Module Interrupt Processing Times

This section describes the processing time required to generate the interrupt and call the interrupt task, and the processing time to return to the original location after completing the interrupt task. This information applies to the following four types of interrupt.

- Input interrupts
- Interval timer interrupts
- High-speed counter interrupts
- Pulse output interrupts

Processing Time

The time required from when the interrupt factor occurs until the interrupt task is called and the time required from completing the interrupt task until program execution returns to the original position are shown below.

	Item	Description	Time
1	Interrupt input ON delay	This is the additional time required from when the interrupt input contact turns ON until the interrupt is generated. This time applies only to input interrupts.	30 μ s

↓

Interrupt condition established

↓

2	Waiting for interrupt prohibition to be released	Time may be required to wait for interrupt prohibition to be released. See below for details.	See below.
---	--	---	------------

↓

3	Switchover time	This is the time required to switch over to interrupt processing.	72 μ s
---	-----------------	---	------------

↓

Interrupt processing routine executed

↓

4	Return	This is the time from the END(001) in the interrupt task until returning to the process that was being performed when the interrupt occurred.	61 μ s
---	--------	---	------------

- Online Editing: If online editing is performed during operation, operation will be stopped for a maximum of 65 ms, during which time interrupts will be prohibited and the program will be overwritten.
- Data Exchange with Coordinator Module: Interrupts will be prohibited for 10 μ s when data is exchanged with the Coordinator Module.
- Analog I/O Refreshing: Interrupts will be prohibited for approximately 40 μ s while analog conversion is being performed for analog I/O.
- Hardware-supported Instructions: Some FQM1 ladder instructions are implemented using hardware. Interrupts will be placed on standby during execution of hardware-supported instructions that require time to process, such as XFER(070) and BSET(071).

Interrupt Response Time Calculation Example

The interrupt response times from the interrupt input turning ON until the interrupt task is started for when an input interrupt occurs under the following conditions are given below.

- No 1-ms timers are being used.
- No non-fatal errors occur or are cleared.
- Online editing is not performed.

Minimum Response Time

	Interrupt input ON delay:	30 μ s
	Interrupt prohibition release time:	0 μ s
+	Switchover time:	<u>72 μs</u>
Total:	Minimum response time:	102 μ s

Maximum Response Time

	Interrupt input ON delay:	30 μ s
	Interrupt prohibition release time:	10 μ s
+	Switchover time:	<u>72 μs</u>
Total:	Minimum response time:	112 μ s

Note (1) To return to the process being performed before the interrupt occurred, the execution time of the interrupt task and 61 μ s are required in addition to the above response time.

- (2) When using interrupt tasks frequently, be sure to consider the time required for interrupt processing and its affect on the overall system.
- (3) The results of executing an interrupt task can be output immediately from within the interrupt task by using the IORF(097) instruction. (This can also be performed to output the results of execution in the main program immediately after execution.)
- (4) The results of executing an interrupt task can be output immediately from within the interrupt task by selecting *Immediate refresh* for an analog output in the System Setup and then using the SPED(885) and ACC(888) instructions. (This can also be performed to output the results of execution in the main program immediately after execution.)

Appendix B

I/O Memory

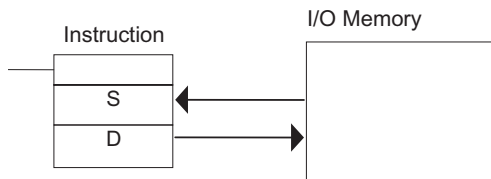
B-1 Overview of I/O Memory

B-1-1 Introduction

This section describes the I/O Memory and other parts of memory in the Modules other than that containing the user program.

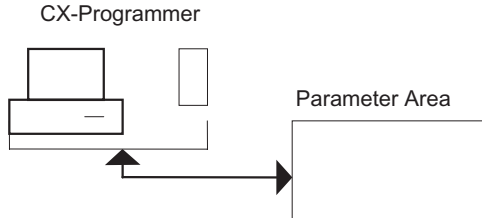
I/O Memory

This region of memory contains the data areas which can be accessed by instruction operands. The data areas include the CIO Area, Work Area, Auxiliary Area, DM Area, Timer Area, Counter Area, Index Registers, Condition Flag Area, and Clock Pulse Area.



Parameter Area

This region of memory contains various settings that cannot be specified by instruction operands; they can be specified from the CX-Programmer only. The settings include the System Setup.



B-2 I/O Memory Structure

B-2-1 Coordinator Module

The following table shows the basic structure of the I/O Memory for the Coordinator Module.

Area	Size	Range	Task usage	External I/O allocation	Bit access	Word access	Access		Change from CX-Programmer	Status at power ON	Status at mode change	Forcing bit status		
							Read	Write						
CIO Area	I/O Area (CJ-series Units)	320 bits (20 words)	CIO 0000 to CIO 0019	Shared by all tasks	Basic I/O Units	OK	OK	OK	OK	OK	Cleared	Cleared	OK	
	CPU Bus Unit Area	6,400 bits (400 words)	CIO 1500 to CIO 1899		CPU Bus Units	OK	OK	OK	OK	OK				OK
	Special I/O Unit Area	13,760 bits (860 words)	CIO 2100 to CIO 2959		Special I/O Units	OK	OK	OK	OK	OK				OK
	I/O Area (Built-in I/O)	24 bits (2 words)	CIO 2960 to CIO 2961		Coordinator Module	OK	OK	OK	OK	OK				OK
	Serial PLC Link Area (Complete Link)	1,440 bits (90 words)	CIO 3100 to CIO 3189		Serial PLC Link	OK	OK	OK	OK	OK				OK
	Serial PLC Link Area (Master Link)	320 bits (20 words)	CIO 3100 to CIO 3119		Serial PLC Link	OK	OK	OK	OK	OK				OK
	DeviceNet Area	9,600 bits (600 words)	CIO 3200 to CIO 3799		DeviceNet	OK	OK	OK	OK	OK				OK
	Cyclic Refresh Bit Area	600 bits (40 words)	CIO 4000 to CIO 4039		---	OK	OK	OK	OK	OK				OK
	Synchronous Data Link Bit Area	320 bits (20 words)	CIO 1200 to CIO 1219		---	OK	OK	OK	OK	OK				OK
	FB Instance Area (Non-retained, see note 1.)	16,000 bits (1,000 words)	CIO 5000 to CIO 5999		---	OK	OK	OK	OK	OK				OK
Work Areas	49,792 bits (3,112 words)	CIO 0020 to CIO 1199 CIO 1220 to CIO 1499 CIO 1900 to CIO 2099 CIO 2962 to CIO 3099 CIO 3190 to CIO 3199 CIO 3800 to CIO 3999 CIO 4040 to CIO 4999 CIO 6000 to CIO 6143	---	OK	OK	OK	OK	OK				OK		
Work Area	4,096 bits (256 words)	W000 to W255	---	OK	OK	OK	OK	OK	Cleared	Cleared		OK		
Auxiliary Area	15,360 bits (960 words)	A000 to A959	---	OK	OK	OK	OK	OK	Cleared	Maintained		No		
TR Area	16 bits	TR0 to TR15	---	OK	---	OK	OK	No	Cleared	Cleared		No		
DM Area	20,000 words	D00000 to D19999	---	No (See note 2.)	OK	OK	OK	OK	Cleared	Maintained		No		
	12,768 words	D20000 to D32767	---	No (See note 2.)	OK	OK	OK	OK	Maintained (See note 1.)	Maintained		No		
Timer Area	256 words	T0000 to T0255	---	OK	---	OK	OK	OK	Cleared	Cleared		OK		
Counter Area	256 words	C0000 to C0255	---	OK	---	OK	OK	OK	Cleared	Maintained		OK		
FB Instance Area (Timers, see note 1)	50 bits	T0206 to T0255	---	OK	---	OK	OK	OK	Cleared	Maintained		OK		
FB Instance Area (Counters, see note 1)	50 bits	C0206 to C0255	---	OK	---	OK	OK	OK	Cleared	Cleared		OK		

Area	Size	Range	Task usage	External I/O allocation	Bit access	Word access	Access		Change from CX-Programmer	Status at power ON	Status at mode change	Forcing bit status
							Read	Write				
Index Registers	16 bits	IR0 to IR15	Shared by all tasks	---	OK	OK	See note 4.	See note 4.	No	Cleared	Cleared	No
Data Registers	16 bits	DR0 to DR15		---	No	OK	OK	OK	No	Cleared	Cleared	No

- Note**
- (1) The FB Instance Areas (CIO 5000 to CIO 5999, T0206 to T0255, and C0206 to C0255) are set to their default settings by the CX-Programmer. If function blocks are being used, the CX-Programmer will output an error when it compiles the function if there are any instructions in the ladder program that access words in these areas. Change the default settings with the CX-Programmer if necessary.
 - (2) Bits can be manipulated using TST(350), TSTN(351), SET, SETB(532), RSTB(533), OUTB(534).
 - (3) When data is written from the CX-Programmer or a host controller, the data is stored in flash memory and read out each time the power is turned ON.
 - (4) The index registers can be read or written by indirect addressing only.

B-2-2 Motion Control Modules

The following table shows the basic structure of the I/O Memory Area for the Motion Control Modules.

Area	Size	Range	Task usage	External I/O allocation	Bit access	Word access	Access		Change from CX-Programmer	Status at power ON	Status at mode change	Forcing bit status		
							Read	Write						
CIO Area	I/O Area (Built-in I/O)	20 bits (2 words)	CIO 2960 to CIO 2961	Shared by all tasks	OK Motion Control Module	OK	OK	OK	OK	OK	Cleared	Cleared	OK	
	Cyclic Refresh Bit Area	600 bits (40 words)	CIO 4000 to CIO 4039		---	OK	OK	OK	OK	OK				OK
	Synchronous Data Link Bit Area	320 bits (20 words)	CIO 1200 to CIO 1219		---	OK	OK	OK	OK	OK				OK
	FB Instance Area (Non-retained, see note 1.)	16,000 bits (1,000 words)	CIO 5000 to CIO 5999		---	OK	OK	OK	OK	OK				OK
	Internal I/O Areas	81,792 bits (5,112 words)	CIO 0000 to CIO 1199 CIO 1220 to CIO 2959 CIO 2962 to CIO 3999 CIO 4010 to CIO 4999 CIO 6000 to CIO 6143		---	OK	OK	OK	OK	OK				OK
Work Area	4,096 bits (256 words)	W000 to W255	---	OK	OK	OK	OK	OK		Cleared	Cleared	OK		
Auxiliary Area	15,360 bits (960 words)	A000 to A959	---	OK	OK	OK	OK	OK		Cleared	Maintained	No		
TR Area	16 bits	TR0 to TR15	---	OK	---	OK	OK	No		Cleared	Cleared	No		
DM Area	30,000 words	D00000 to D29999	---	No	OK	OK	OK	OK		Maintained (See note 3.)	Maintained	No		
	2,768 words	D30000 to D32767	---	No	OK	OK	OK	OK		Maintained (See note 4.)	Maintained	No		
Timer Area	256 words	T0000 to T0255	---	OK	---	OK	OK	OK		Cleared	Cleared	OK		
Counter Area	256 words	C0000 to C0255	---	OK	---	OK	OK	OK		Cleared	Maintained	OK		
FB Instance Area (Timers, see note 1)	50 bits	T0206 to T0255	---	OK	---	OK	OK	OK		Cleared	Cleared	OK		
FB Instance Area (Counters, see note 1)	50 bits	C0206 to C0255	---	OK	---	OK	OK	OK		Cleared	Maintained	OK		
Index Registers	16 bits	IR0 to IR15	---	OK	OK	See note 5.	See note 5.	No		Cleared	Cleared	No		
Data Registers	16 bits	DR0 to DR15	---	No	OK	OK	OK	No		Cleared	Cleared	No		

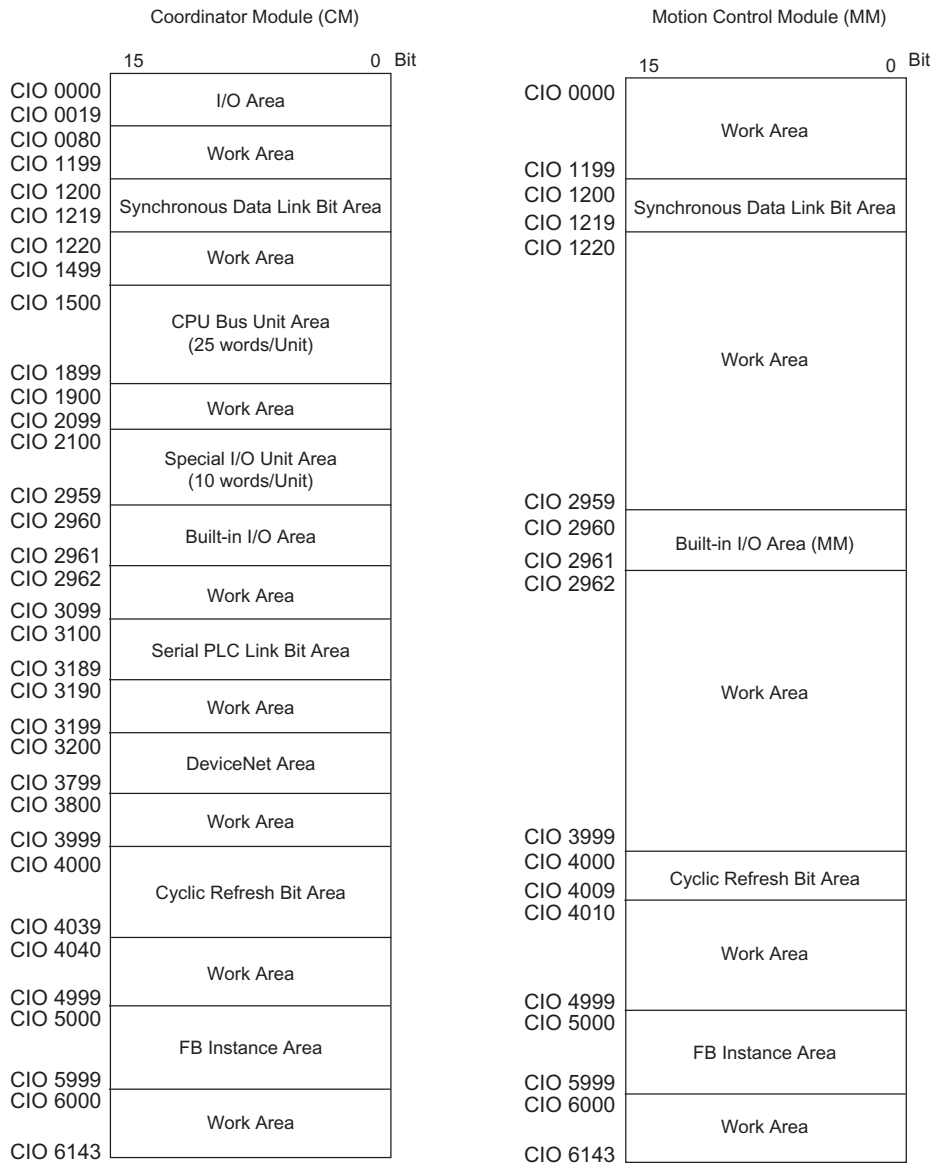
- Note**
- (1) The FB Instance Areas (CIO 5000 to CIO 5999, T0206 to T0255, and C0206 to C0255) are set to their default settings by the CX-Programmer. If function blocks are being used, the CX-Programmer will output an error when it compiles the function if there are any instructions in the ladder program that access words in these areas. Change the default settings with the CX-Programmer if necessary.
 - (2) Bits can be manipulated using TST(350), TSTN(351), SETA(530), RSTA(531), SETB(532), RSTB(533), OUTB(534).
 - (3) These DM words can be saved to flash memory by setting the Save DM Password (A752) to A5A5 hex and turning ON the Save DM Start Bit (A751.15).

- (4) These DM Area words are backed up by a super capacitor. If the Memory Not Held Flag (A316.14) is ON, these words are cleared to all zeros.
- (5) The index registers can be read or written by indirect addressing only.

B-3 CIO Area

B-3-1 Overview

It is not necessary to input the “CIO” prefix when specifying an address in the CIO Area. The CIO Area is generally used for data exchanges, such as I/O refreshing between Modules (Coordinator Module and Motion Control Modules). Words that are not allocated to Modules may be used as work words and work bits in the program only.



The CIO Area includes the following nine areas.

- I/O Areas (Basic I/O Area and Built-in I/O Area)
- Cyclic Refresh Bit Area
- Synchronous Data Link Bit Area
- Work Areas

- Serial PLC Link Bit Areas (Coordinator Module)
- I/O Area (Coordinator Module)
- CPU Bus Area (Coordinator Module)
- Special I/O Unit Area (Coordinator Module)
- DeviceNet Area (Coordinator Module)
- FB Instance Area

Built-in I/O Area: CIO 2960 and CIO 2961

These words are allocated to built-in I/O terminals the Coordinator Module or Motion Control Module.

Cyclic Refresh Bit Area: CIO 4000 to CIO 4039 for Coordinator Module (CIO 4000 to CIO 4009 for Motion Control Modules)

In the Coordinator Module, 10 words are refreshed every cycle for each Motion Control Module. These words contain Motion Control Module status, general-purpose I/O, and other information. (Refreshing these words is not necessarily synchronized with the Motion Control Module Cycles.)

This area can be used to transfer information between Modules that does not required high-speed exchange. The user can allocate the information to be transferred and the information can be used accessed from the ladder programs in the Coordinator Module and Motion Control Modules to coordinate programming.

Synchronous Data Link Bit Area: CIO 1200 to 1219

Each Module (Coordinator Module and Motion Control Modules) broadcasts up to two items (four words) of data at the specified cycle. The data can be specified separately for each Module and is allocated for this area. All of the linked Modules can access the data that is broadcast by other Modules.

Work Areas

These words can be used only in the program; they cannot be used for I/O exchange with external I/O terminals. Be sure to use the work words provided in the Work Area before allocating the work words in the CIO Areas.

Serial PLC Link Bit Area: CIO 3100 to CIO 3189

These words are used for data links with OMRON PLCs.

- CIO 3100 to (CIO 3100 + No. of linked words – 1): CJ1M to FQM1 Coordinator Module
- (CIO 3100 + No. of linked words) to (CIO 3100 + No. of linked words + No. of linked words – 1): FQM1 Coordinator Module to CJ1M

Addresses not used for Serial PLC Link can be used only in the program, the same as the Work Area.

I/O Area: CIO 0000 to CIO 0019

These words are allocated to external I/O terminals on CJ-series Basic I/O Units. Words that aren't allocated may be used only in the program as work words.

CPU Bus Unit Area: CIO 1500 to CIO 1899

These words are allocated to CJ-series CPU Bus Units to transfer status information. Each Unit is allocated 25 words and up to 16 Units (with unit numbers 0 to 15) can be used. Words that aren't used by CPU Bus Units may be used only in the program as work words.

Special I/O Unit Area: CIO 2100 to CIO 2959

These words are allocated to CJ-series Special I/O Units. Each Unit is allocated 10 words and up to 86 Units (unit numbers 10 to 95) can be used). Words that aren't used by Special I/O Units may be used only in the program as work words.

DeviceNet Area: CIO 3200 to CIO 3799

This data link area is allocated for DeviceNet Remote I/O Communications (fixed allocation). The FQM1 can be used in Slave mode only, so part of this area is used when memory is allocated by the fixed allocation method. Words in this area that aren't used by DeviceNet devices can be used only in the program as work words.

FB Instance Area: CIO 5000 to CIO 5999

These words are allocated for addresses in function blocks. When function blocks are being used, the CX-Programmer will output an error when it compiles the function if there are any instructions in the ladder program that access words in these areas. The CX-Programmer sets this area to its default settings, but the ranges and sizes of the areas can be changed with CX-Programmer.

B-4 I/O Area (for CJ-series Basic I/O Units)

There are 320 bits (20 words) in the I/O Area with addresses ranging from CIO 0000 to CIO 0019 (CIO bits 0000.00 to 0019.15). The words in this area can be allocated to I/O terminals on CJ-series Basic I/O Units.

The required number of words are allocated to each Basic I/O Unit in order, based on the Unit's mounting position (left to right, starting with the Unit closest to the I/O Control Module or I/O Interface Unit). Complete words (16-bit units) are allocated, even if a Unit requires fewer than 16 bits. Words in the I/O Area that aren't allocated to Basic I/O Units can be used only in the program as work words.

Bits in the I/O Area can be force-set and force-reset.

The contents of the I/O Area will be cleared in the following cases:

1. The operating mode is changed from PROGRAM to RUN or MONITOR mode or vice-versa.
2. The FQM1's power supply is turned OFF and ON again.
3. The I/O Area is cleared from the CX-Programmer
4. PLC operation is stopped when a fatal error other than an FALS(007) error occurs. (The contents of the I/O Area will be retained if FALS(007) is executed.)

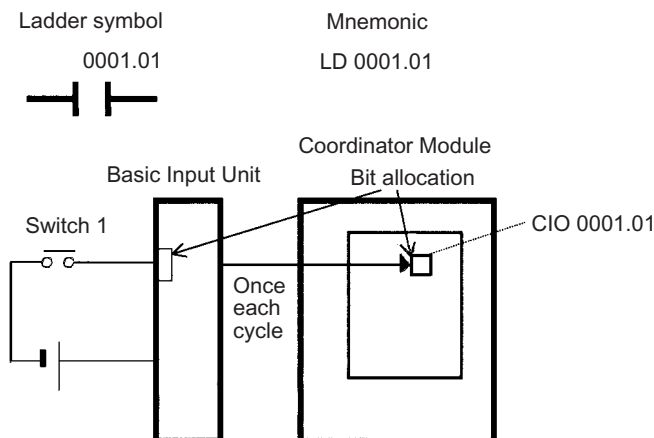
B-4-1 Input Bits

A bit in the I/O Area is called an input bit when it is allocated to an Input Unit. Input bits reflect the ON/OFF status of devices such as push-button switches, limit switches, and photoelectric switches. There are two ways for the status of input bits to be refreshed from an Input Unit: normal I/O refreshing and IORF(097) refreshing.

Normal I/O Refreshing

The ON/OFF status of I/O points allocated to external devices is read once each cycle after the entire program is executed. The status of the input bits does not change at other times.

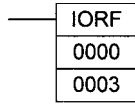
In the following example, CIO 0001.01 is allocated to switch 01, an external switch connected to the input terminal of an Input Unit. The ON/OFF status of switch 1 is reflected in CIO 0001.01 once each cycle.



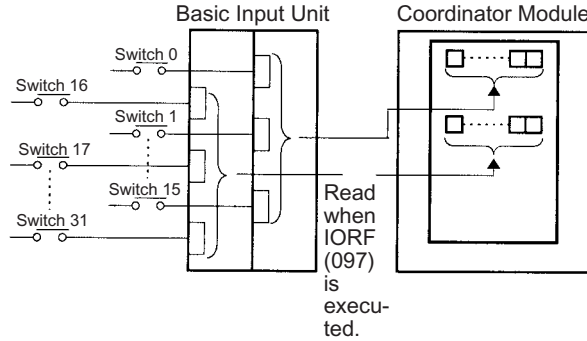
IORF(097) Refreshing

When IORF(097) (I/O REFRESH) is executed, the input bits in the specified range of words are refreshed. This I/O refreshing is performed in addition to the normal I/O refreshing performed once each cycle.

In the following example, IORF(097) refreshes the I/O points in the four I/O Area words CIO 0000 to CIO 0003. The status of inputs is read from the Input Units and the status of output bits is written to the Output Units.



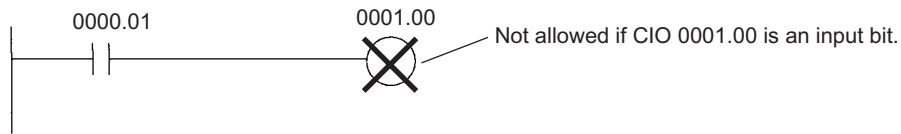
In this case, the status of input points allocated to CIO 0000 and CIO 0001 are read from the Input Unit. (CIO 0002 and CIO 0003 are allocated to Output Units.)



Limitations on Input bits

There is no limit on the number of times that input bits can be used as normally open and normally closed conditions in the program and the addresses can be programmed in any order.

An input bit cannot be used as an operand in an Output instruction.

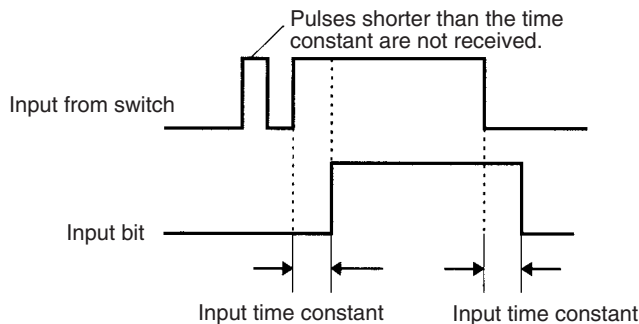


Input Response Time Settings

The input response times for each Input Unit can be set in the System Setup. Increasing the input response time will reduce chattering and the effects of noise. Decreasing the input response time allows higher speed input pulses to be received. (The input's ON time and OFF time must be longer than the cycle time.)

The default value for input response times is 8 ms and the setting range is 0 ms to 32 ms.

Note If the time is set to 0 ms, there will still be an ON delay time of 20 μs max. and an OFF delay time of 300 μs due to delays caused by internal elements.



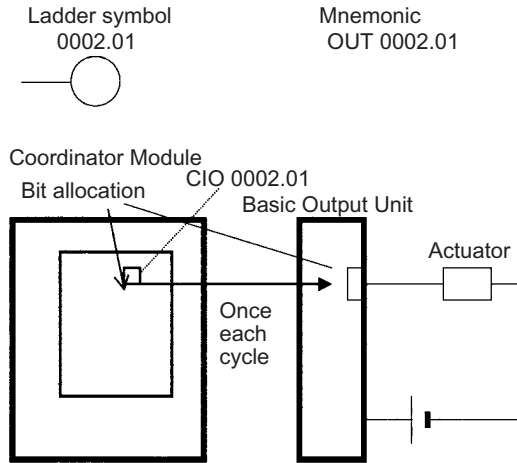
B-4-2 Output Bits

A bit in the I/O Area is called an output bit when it is allocated to a Basic Output Unit. The ON/OFF status of output bits are output to devices such as actuators. There are two ways for the status of output bits to be refreshed to an Output Unit: normal I/O refreshing and IORF(097) refreshing.

Normal I/O Refreshing

The ON/OFF status of output bits is output to external devices once each cycle after the entire program is executed. The status is not output at other times.

In the following example, CIO 0002.01 is allocated to an actuator, an external device connected to an output terminal of an Output Unit. The ON/OFF status of CIO 0002.01 is output to that actuator once each cycle.

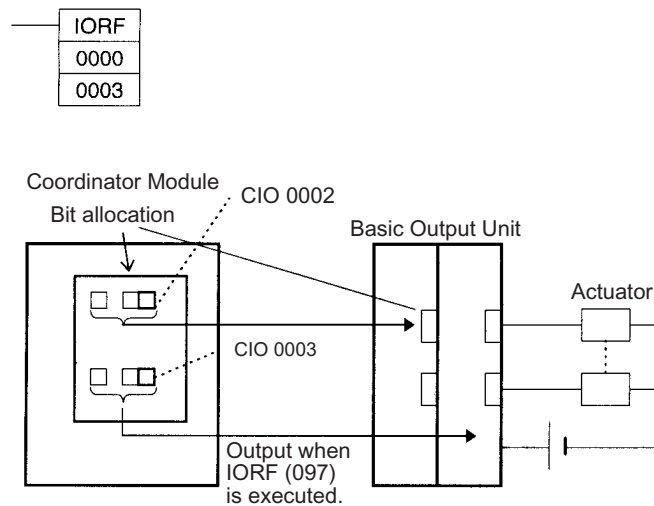


IORF(097) Refreshing

When IORF(097) (I/O REFRESH) is executed, the ON/OFF status of output bits in the specified range of words is output to their external devices. This I/O refreshing is performed in addition to the normal I/O refreshing performed once each cycle.

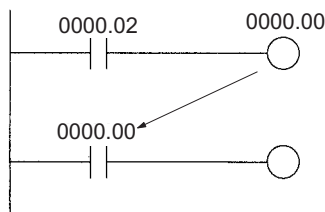
In the following example, IORF(097) refreshes the status of all I/O points in I/O Area words CIO 0000 to CIO 0003. The status of input points is read from the Input Units and the status of output bits is written to the Output Units.

In this case, the status of input points allocated to CIO 0002 and CIO 0003 are output to the Output Unit. (CIO 0000 and CIO 0001 are allocated to Input Units.)

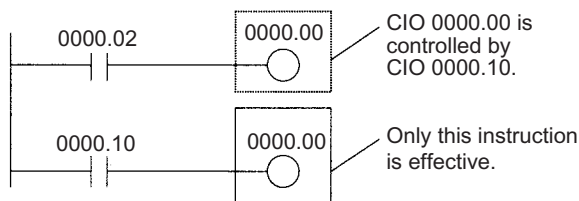


Limitations on Output Bits

Output bits can be programmed in any order. Output bits can be used as operands in Input instructions and there is no limit on the number of times that an output bit is used as a normally open and normally closed condition.



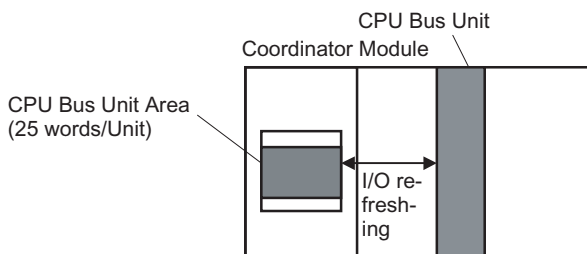
An output bit can be used in only one Output instruction that controls its status. If an output bit is used in two or more Output instructions, only the last instruction will be effective.



B-5 CPU Bus Unit Area

The CPU Bus Unit Area contains 400 words with addresses ranging from CIO 1500 to CIO 1899. Each Unit is allocated 25 words based on the Unit's unit number setting. Words in the CPU Bus Unit Area can be allocated to CPU Bus Units to transfer data such as the operating status of the Unit.

Data is exchanged with CPU Bus Units once each cycle during I/O refreshing, which occurs after program execution. (Words in this data area cannot be refreshed with immediate-refreshing or IORF(097).)



Each CPU Bus Unit is allocated 25 words based on its unit number, as shown in the following table.

Allocated words	Unit number
CIO 1500 to CIO 1524	0
CIO 1525 to CIO 1549	1
CIO 1550 to CIO 1574	2
CIO 1575 to CIO 1599	3
CIO 1600 to CIO 1624	4
CIO 1625 to CIO 1649	5
CIO 1650 to CIO 1674	6
CIO 1675 to CIO 1699	7
CIO 1700 to CIO 1724	8
CIO 1725 to CIO 1749	9
CIO 1750 to CIO 1774	A
CIO 1775 to CIO 1799	B
CIO 1800 to CIO 1824	C
CIO 1825 to CIO 1849	D
CIO 1850 to CIO 1874	E
CIO 1875 to CIO 1899	F

The function of the 25 words depends upon the CPU Bus Unit being used. For details, refer to the Unit's operation manual.

Words in the CPU Bus Unit Area that aren't allocated to CPU Bus Units can be used only in the program as work words. Bits in the CPU Bus Unit Area can be force-set and force-reset.

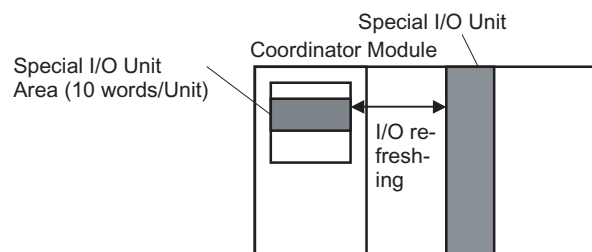
The contents of the CPU Bus Unit Area will be cleared in the following cases:

1. The operating mode is changed from PROGRAM to RUN or MONITOR mode or vice-versa.
2. The FQM1's power supply is turned OFF and ON again.
3. The CPU Bus Unit Area is cleared from the CX-Programmer.
4. PLC operation is stopped when a fatal error other than an FALS(007) error occurs. (The contents of the CPU Bus Unit Area will be retained when FALS(007) is executed.)

B-6 Special I/O Unit Area

The Special I/O Unit Area contains 860 words with addresses ranging from CIO 2100 to CIO 2959. Words in the Special I/O Unit Area are used to transfer data such as the operating status of the Unit. Each Unit is allocated 10 words based on its unit number setting.

Data is exchanged with Special I/O Units once each cycle during I/O refreshing, which occurs after program execution.



Each Special I/O Unit is allocated 10 words based on its unit number, as shown in the following table.

Allocated words	Unit number
CIO 2000 to CIO 2009	Do not use unit numbers 0 to 9 in the FQM1. These words (CIO 2000 to CIO 2099) can be used as work words.
CIO 2010 to CIO 2019	
CIO 2020 to CIO 2029	
CIO 2030 to CIO 2039	
CIO 2040 to CIO 2049	
CIO 2050 to CIO 2059	
CIO 2060 to CIO 2069	
CIO 2070 to CIO 2079	
CIO 2080 to CIO 2089	
CIO 2090 to CIO 2099	
CIO 2100 to CIO 2109	10
CIO 2110 to CIO 2119	11
CIO 2120 to CIO 2129	12
CIO 2130 to CIO 2139	13
CIO 2140 to CIO 2149	14
CIO 2150 to CIO 2159	15
CIO 2160 to CIO 2169	16
CIO 2170 to CIO 2179	17
CIO 2950 to CIO 2959	95

Words in the Special I/O Unit Area that are not allocated to Special I/O Units can be used only in the program as work words. Bits in the Special I/O Unit Area can be force-set and force-reset.

The contents of the Special I/O Unit Area will be cleared in the following cases:

1. The operating mode is changed from PROGRAM to RUN or MONITOR mode or vice-versa.
2. The FQM1's power supply is turned OFF and ON again.
3. The Special I/O Unit Area is cleared from the CX-Programmer.
4. PLC operation is stopped when a fatal error other than an FALS(007) error occurs. (The contents of the Special I/O Unit Area will be retained when FALS(007) is executed.)

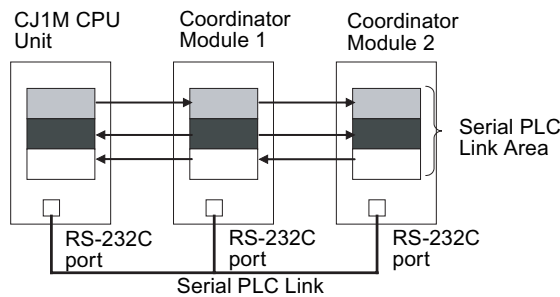
B-7 Serial PLC Link Area

The Serial PLC Link Area contains 90 words with addresses ranging from CIO 3100 to CIO 3189. Words in the Serial PLC Link Area can be used for data links with other PLCs.

Serial PLC Links exchange data among CPU Units and Coordinator Modules via the built-in RS-232C ports, with no need for special programming.

The Serial PLC Link allocation is set automatically by means of the following PLC Setup settings at the Polling Unit.

- Serial PLC Link Mode
- Number of Serial PLC Link transfer words
- Maximum Serial PLC Link unit number



Words in the Serial PLC Link Area that are not used for Serial PLC Links can be used only in the program as work words. Bits in the Serial PLC Link Area can be force-set and force-reset.

The contents of the Serial PLC Link Area will be cleared in the following cases:

1. The operating mode is changed from PROGRAM to RUN or MONITOR mode or vice-versa.
2. The FQM1's power supply is turned OFF and ON again.
3. The Serial PLC Link Area is cleared from the CX-Programmer
4. PLC operation is stopped when a fatal error other than an FALS(007) error occurs. (The contents of the Serial PLC Link Area will be retained when FALS(007) is executed.)

B-8 DeviceNet Area

The DeviceNet Area consists of 600 words from CIO 3200 to CIO 3799. Words in the DeviceNet Area are allocated for DeviceNet remote I/O communications (with fixed allocation).

The FQM1 can be used in Slave mode only, so part of this area is used when memory is allocated by the fixed allocation method. Words that aren't used by DeviceNet devices for DeviceNet remote I/O communications can be used only in the program as work words.

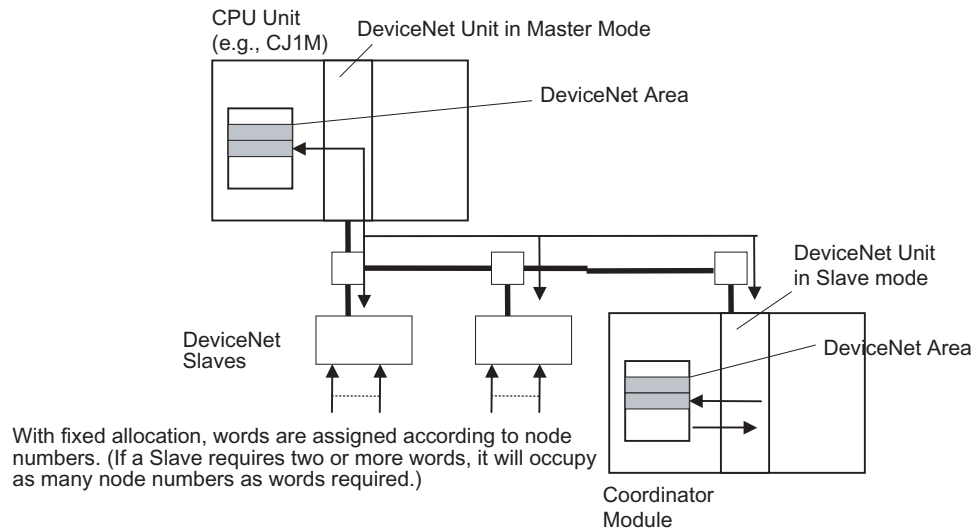
Words in the DeviceNet Area are allocated to Slaves using fixed allocations according to fixed allocation setting 1, 2, or 3. The default setting is fixed allocation area 1.

Area	Output Area (Master to Slaves)	Input Area (Slaves to Master)
Fixed Allocation Area 1	CIO 3370	CIO 3270
Fixed Allocation Area 2	CIO 3570	CIO 3470
Fixed Allocation Area 3	CIO 3770	CIO 3670

Data is exchanged regularly to Slaves in the network (independent of the program) through the DeviceNet Unit. Bits in the DeviceNet Area can be force-set and force-reset.

- Note**
- (1) The FQM1 supports the CJ1W-DRM21 Master Unit operating in Remote I/O Slave mode only. The Master Unit cannot be used in Master mode.
 - (2) The FQM1 does not support the CJ1W-DRM21 Master Unit's message communications function. Use the Master Unit only as a Remote I/O Slave.
 - (3) To allocate memory from a Programming Device (user-set allocation), either connect the CX-Integrator to the host PLC (such as a CJ1M) in which the Master Unit is mounted or use a Configurator to make the settings. With the FQM1-CM002, the FQM1's allocated DM Area can also be used.
 - (4) There are two ways to allocate I/O in DeviceNet networks: Fixed allocations according to node addresses and user-set allocations. For details on word allocations, refer to the *DeviceNet Operation Manual (W267)*.
 - With fixed allocations, words are automatically allocated to the slave in the specified fixed allocation area according to the node addresses.

- With user-set allocations, the user can allocate words to Slaves from the following words.
CIO 0000 to CIO 6143
W000 to W255
D00000 to D32767



The contents of the DeviceNet Area will be cleared in the following cases:

1. The operating mode is changed from PROGRAM to RUN or MONITOR mode or vice-versa.
2. The FQM1's power supply is turned OFF and ON again.
3. The DeviceNet Area is cleared from the CX-Programmer
4. PLC operation is stopped when a fatal error other than an FALS(007) error occurs. (The contents of the DeviceNet Area will be retained when FALS(007) is executed.)

B-9 Work Area

B-9-1 Work Area: W000 to W255 (W000.00 to W255.15), 4,096 Bits

Words in the Work Area can be used only in the program; they cannot be used for I/O exchange with external I/O terminals. Use this area for work words and bits before any other words in the CIO Area. Bits in the Work Area can be force-set and force-reset.

Note There are two kinds of work words in the FQM1 Series.

1. Words in the CIO Area (CIO 0000 to CIO 6143) that are not allocated for special purpose, such as the Cyclic Refresh Bit Area
2. Words in the dedicated Work Area (W000 to W255)

The difference between work words in the CIO Area and the dedicated Work Area (W000 to W255) is that unused words in the CIO Area may be allocated to new functions in future versions of FQM1-series Controllers. Use any available words in the Work Area first to avoid potential future conflicts.

The contents of the Work Area will be cleared in the following cases:

1. The operating mode is changed from PROGRAM to RUN or MONITOR mode or vice-versa.
2. The FQM1's power supply is turned OFF and ON again.
3. The Work Area is cleared from the CX-Programmer
4. PLC operation is stopped when a fatal error other than an FALS(007) error occurs. (The contents of the DeviceNet Area will be retained when FALS(007) is executed.)

B-10 Auxiliary Area

B-10-1 Auxiliary Area: A000 to A959 (A000.00 to A959.15)

The Auxiliary Area contains flags (controlled by the system) and control bits (controlled by the user) used to monitor and control FQM1 operation. The functions of these flags and bits are predetermined and include error flags from self-diagnosis, initial settings, operation controls, and operation status monitor data.

The bits and words in this area can be read and written from the program or from the CX-Programmer.

The bits in this area cannot be force-set or force-reset continuously.;

The CX-Programmer read/write operations include setting and resetting bits online (not forced), changing present values from address monitor displays, and transfer operations to the FQM1 after editing FQM1 data tables on the CX-Programmer. Refer to the *CX-Programmer Operation Manual* (Cat. No. W437) for details.

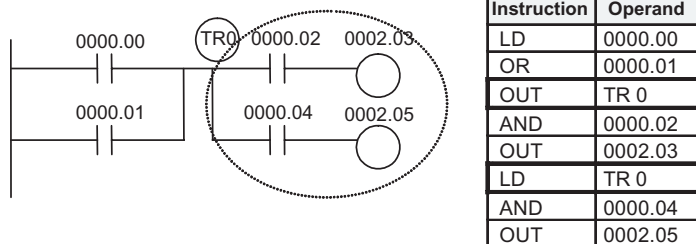
B-11 Temporary Relay Area (TR)

The TR Area contains bits that record the ON/OFF input condition status at program branches. The TR bits are used with mnemonics only.

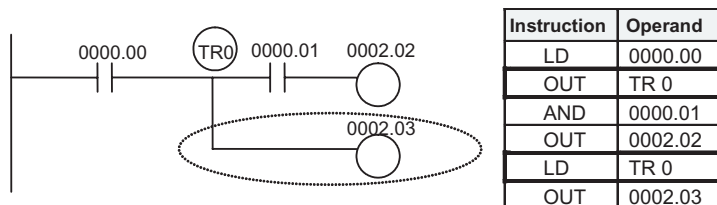
- TR0 to TR15 can be used in any order and any number of times.
- TR bits can be used only in OUT and LD instructions.
 - OUT instructions (OUT TR0 to OUT TR15) are used to store the input conditions at branch points. LD instructions (LD TR0 to LD TR15) are used to read the input conditions previously stored at branch points.
- Each TR bit can be used only once in one program section.
- The status of TR bits cannot be changed from the CX-Programmer.

TB bits are used in the following cases.

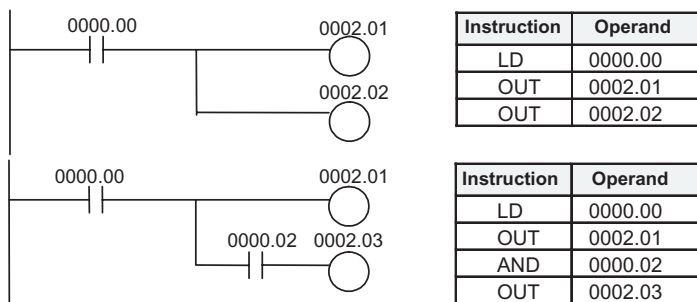
- When there are two outputs with different LD instructions after the last branch point:



- When there is no LD instruction on the lower rung after a branch point:



Note In the following cases, there are either no LD instructions after the branch points, or any LD instructions are on the bottom rung. TR bits are not required in these types of branches.



B-12 Timer Area

The 256 timer numbers (T0000 to T0255) are shared by the TIM, TIMH(015), and TMHH(540) instructions. Timer Completion Flags and present values (PVs) for these instructions are accessed with the timer numbers.

When a timer number is used in an operand that requires bit data (e.g., in LD, AND, or OR instructions), the timer number accesses the Completion Flag of the timer. When a timer number is used in an operand that requires word data (e.g., in MOV(021) or CMP(020) instructions), the timer number accesses the PV of the timer. Timer Completion Flags can be used as often as necessary as normally open and normally closed conditions and the values of timer PVs can be read as normal word data.

Timer Completion Flags can be force-set and force-reset.

Timer PVs cannot be force-set or force-reset, although the PVs can be refreshed indirectly by force-setting/resetting the Completion Flag.

There are no restrictions in the order of using timer numbers or in the number of NC or NO conditions that can be programmed. Timer PVs can be read as word data and used in programming.

Note It is not recommended to use the same timer number in two timer instructions because the timers will not operate correctly if they are timing simultaneously. (If two or more timer instructions use the same timer number, an error will be generated during the program check, but the timers will operate as long as the instructions are not executed in the same cycle.)

The following table shows when timer PVs and Completion Flags will be reset.

Instruction	Mode change between PROGRAM and RUN/MONITOR (See note 1.)	FQM1 startup	Operation in jumps (JMP-JME) or tasks on standby	Operation in interlocks (IL-ILC)
TIMER: TIM	PV → 0	PV → 0	PVs refreshed in operating timers	PV → SV (Reset to SV.) Flag → OFF
HIGH-SPEED TIMER: TIMH(015)	Flag → OFF	Flag → OFF		
ONE-MS TIMER: TMHH(540)				

Note

- (1) The present value of TIM, TIMH(015), and TMHH(540) timers programmed will be updated even when jumped between JMP and JME instructions.
- (2) When function blocks are being used, timer numbers T0206 to T0255 are part of the default FB Instance Area, so the CX-Programmer will automatically allocate these timers to variables used in the function blocks if the default FB Instance Area settings are used. When function blocks are being used, a compiling error will be generated if any of these timer numbers are used in the ladder program. If you want to use these timer numbers in the ladder program, the default FB Instance Area settings can be changed in the CX-Programmer.

B-13 Counter Area

The 256 counter numbers (C0000 to C0255) are shared by the CNT and CNTR(012) instructions. Counter Completion Flags and present values (PVs) for these instructions are accessed with the counter numbers.

When a counter number is used in an operand that requires bit data, the counter number accesses the Completion Flag of the counter. When a counter number is used in an operand that requires word data, the counter number accesses the PV of the counter.

Note It is not recommended to use the same counter number in two counter instructions because the counters will not operate correctly if they are counting simultaneously. If two or more counter instructions use the same counter number, an error will be generated during the program check, but the counters will operate as long as the instructions are not executed in the same cycle.

Counters are reset at the following times.

Instruction	PV and Completion Flag after reset	Mode change between PROGRAM and RUN/MONITOR (See note 1.)	FQM1 startup	Operation in jumps (JMP-JME) or tasks on standby	Operation in interlocks (IL-ILC)
COUNTER: CNT	PV: 0000	Held	Reset	Reset	Held
REVERSIBLE COUNTER: CNTR(012)	Completion Flag: OFF				

Counter Completion Flags can be force-set and force-reset.

Counter PVs cannot be force-set or force-reset, although the PVs can be refreshed indirectly by force-setting/resetting the Completion Flag.

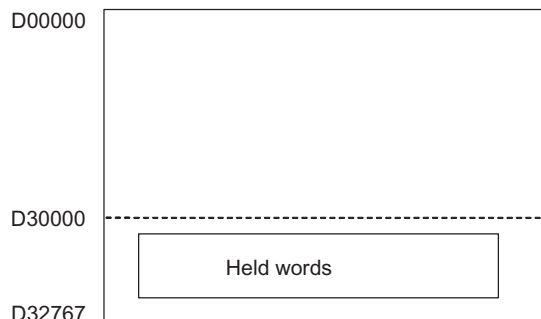
There are no restrictions in the order of using counter numbers or in the number of N.C. or N.O. conditions that can be programmed. Counter PVs can be read as word data and used in programming.

Note When function blocks are being used, counter numbers C0206 to C0255 are part of the default FB Instance Area, so the CX-Programmer will automatically allocate these counters to variables used in the function blocks if the default FB Instance Area settings are used.

When function blocks are being used, a compiling error will be generated if any of these counter numbers are used in the ladder program. If you want to use these counter numbers in the ladder program, the default FB Instance Area settings can be changed in the CX-Programmer.

B-14 Data Memory (DM) Area

Word addresses



The DM Area is a multi-purpose data area that can be accessed in word-units only.

Coordinator Module words D00000 to D19999 are cleared to all zeros when the power supply is turned OFF and ON again, but are held when the operating mode is changed from PROGRAM mode to RUN/MONITOR mode or vice-versa.

Motion Control Module words D00000 to D29999 can be saved with a control bit operation, and can be saved in PROGRAM mode only.

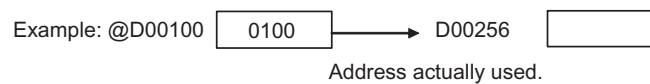
Coordinator Module words D20000 to D32767 and Motion Control Module words D30000 to D32767 are held when the FQM1 is turned OFF and ON again or the operating mode is changed from PROGRAM mode to RUN/MONITOR mode or vice-versa. (These words are backed up by a super capacitor in a Motion Control Module and by flash memory in the Coordinator Module.)

Bits in the DM Area cannot be accessed directly and cannot be force-set or force-reset.

Words in the DM Area can be indirectly addressed in two ways: binary-mode and BCD-mode, as described below.

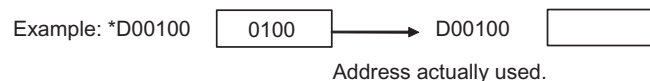
B-14-1 Binary-mode Addressing (@D)

When a “@” character is input before a DM address, the content of that DM word is treated as binary and the instruction will operate on the DM word at that binary address. The entire DM Area (D00000 to D32767) can be indirectly addressed with hexadecimal values 0000 to 7FFF.



B-14-2 BCD-mode Addressing (*D)

When a “*” character is input before a DM address, the content of that DM word is treated as BCD and the instruction will operate on the DM word at that BCD address. Only part of the DM Area (D00000 to D09999) can be indirectly addressed with BCD values 0000 to 9999.



B-15 Index Registers

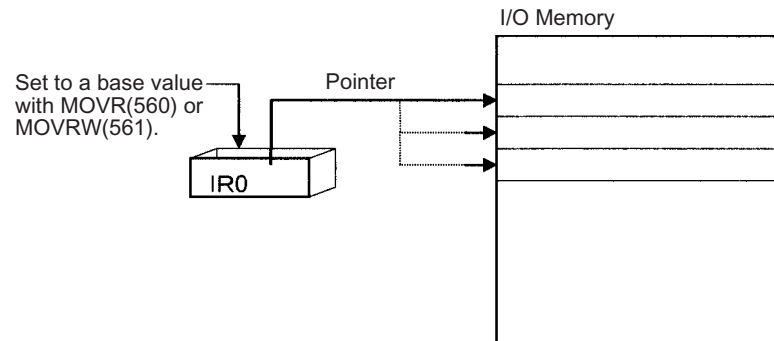
The sixteen Index Registers (IR0 to IR15) are used for indirect addressing. Each Index Register can hold a single PLC memory address, which is the absolute memory address of a word in I/O memory. Use MOVR(560) to convert a regular data area address to its equivalent PLC memory address and write that value to the specified Index Register. (Use MOVRW(561) to set the PLC memory address of a timer/counter PV in an Index Register.)

Note Refer to *D-2-3 Memory Map* for more details on PLC memory addresses.

When an Index Register is used as an operand with a “,” prefix, the instruction will operate on the word indicated by the PLC memory address in the Index Register, not the Index Register itself. Basically, the Index Registers are I/O memory pointers.

- All addresses in I/O memory (except Index Registers, Data Registers, and Condition Flags) can be specified seamlessly with PLC memory addresses. It isn't necessary to specify the data area.
- In addition to basic indirect addressing, the PLC memory address in an Index Register can be offset with a constant or Data Register, auto-incremented, or auto-decremented. These functions can be used in loops to read or write data while incrementing or decrementing the address by one each time that the instruction is executed.

With the offset and increment/decrement variations, the Index Registers can be set to base values with MOVR(560) or MOVRW(561) and then modified as pointers in each instruction. Pointer operations can be performed with the special instructions that can manipulate Index Registers directly (such as MOVR(560)) or indirect methods such as offsetting the Index Register content, auto-incrementing, or auto-decrementing.



Note It is possible to specify regions outside of I/O memory and generate an Illegal Access Error when indirectly addressing memory with Index Registers. Refer to *Appendix D Auxiliary Area Allocations* for details on the limits of PLC memory addresses.

B-15-1 Indirect Addressing Methods

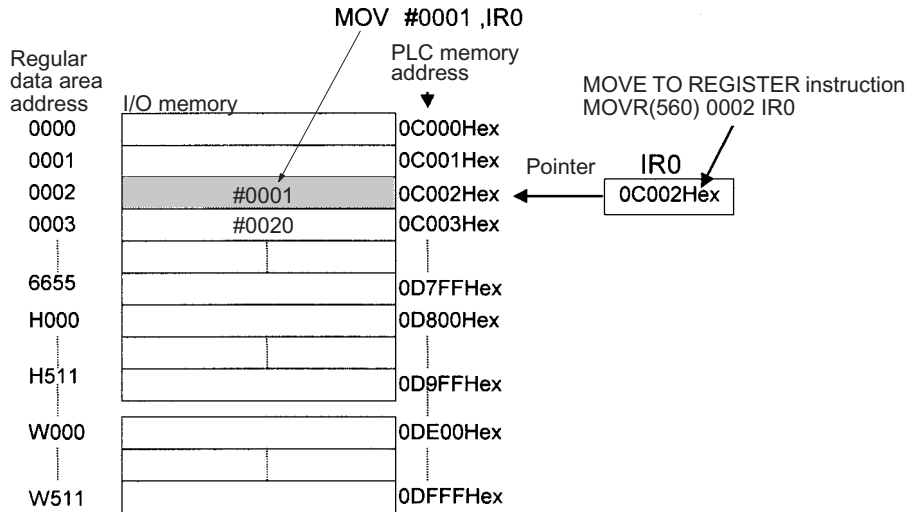
The following table shows the variations available when indirectly addressing I/O memory with Index Registers. (IR□ represents an Index Register from IR0 to IR15.)

Variation	Function	Syntax	Example	
Indirect addressing	The content of IR□ is treated as the PLC memory address of a bit or word.	,IR□	LD ,IR0	Loads the bit at the PLC memory address contained in IR0.
Indirect addressing with constant offset	The constant prefix is added to the content of IR□ and the result is treated as the PLC memory address of a bit or word. The constant may be any integer from -2,048 to 2,047.	Constant ,IR□ (Include a + or - in the constant.)	LD +5,IR0	Adds 5 to the contents of IR0 and loads the bit at that PLC memory address.
Indirect addressing with DR offset	The content of the Data Register is added to the content of IR□ and the result is treated as the PLC memory address of a bit or word.	DR□,IR□	LD DR0,IR0	Adds the contents of DR0 to the contents of IR0 and loads the bit at that PLC memory address.
Indirect addressing with auto-increment	After referencing the content of IR□ as the PLC memory address of a bit or word, the content is incremented by 1 or 2.	Increment by 1: ,IR□+ Increment by 2: ,IR□++	LD ,IR0++	Loads the bit at the PLC memory address contained in IR0 and then increments the content of IR0 by 2.
Indirect addressing with auto-decrement	The content of IR□ is decremented by 1 or 2 and the result is treated as the PLC memory address of a bit or word.	Decrement by 1: ,-IR□ Decrement by 2: ,--IR□	LD ,--IR0	Decrements the content of IR0 by 2 and then loads the bit at that PLC memory address.

B-15-2 Example

This example shows how to store the PLC memory address of a word (CIO 0002) in an Index Register (IR0), use the Index Register in an instruction, and use the auto-increment variation.

MOVR(560)	0002	IR0	Stores the PLC memory address of CIO 0002 in IR0.
MOV(021)	#0001	,IR0	Writes #0001 to the PLC memory address contained in IR0.
MOV(021)	#0020	+1,IR0	Reads the content of IR0, adds 1, and writes #0020 to that PLC memory address.



Note The PLC memory addresses are listed in the diagram above, but it isn't necessary to know the PLC memory addresses when using Index Registers.

Since some operands are treated as word data and others are treated as bit data, the meaning of the data in an Index Register will differ depending on the operand in which it is used.

1. Word Operands:

```
MOVR(560)  0000    IR2
MOV(021)   D00000 , IR2
```

When the operand is treated as a word, the contents of the Index Register are used "as is" as the PLC memory address of a word.

In this example MOVR(560) sets the PLC memory address of CIO 0000 in IR2 and the MOV(021) instruction copies the contents of D00000 to CIO 0000.

2. Bit Operands:

```
MOVR(560)  000013 ,IR2
SET        +5 , IR2
```

When the operand is treated as a bit, the leftmost 7 digits of the Index Register specify the word address and the rightmost digit specifies the bit number. In this example, MOVR(560) sets the PLC memory address of CIO 0000.13 (0C000D hex) in IR2. The SET instruction adds +5 from bit 13 to this PLC memory address, so it turns ON bit CIO 0001.02.

The Index Registers will be cleared in the following cases:

1. The operating mode is changed from PROGRAM mode to RUN/MONITOR mode or vice-versa.
2. The FQM1's power supply is turned OFF and ON again.

Note

- (1) Do not use Index Registers until a PLC memory address has been set in the register. The pointer operation will be unreliable if the registers are used without setting their values.
- (2) In the FQM1, Index Registers are shared by all tasks, including interrupt tasks. The Index Registers cannot be used independently in the tasks.
- (3) There is a limited number of instructions that can directly manipulate Index Registers. See the table in *B-15-3 Instructions Supporting Direct IR Addressing*, below, for a list of these instructions. Use these instructions to operate on the Index Registers as pointers. The Index Registers cannot be directly addressed in any other instructions, although they can usually be used for indirect addressing.

B-15-3 Instructions Supporting Direct IR Addressing

Instruction group	Instruction name	Mnemonic
Data Movement Instructions	MOVE TO REGISTER	MOVR(560)
	MOVE TIMER/COUNTER PV TO REGISTER	MOVRW(561)
	DOUBLE MOVE	MOVL(498)
	DOUBLE DATA EXCHANGE	XCGL(562)
Increment/Decrement Instructions	DOUBLE INCREMENT BINARY	++L(591)
	DOUBLE DECREMENT BINARY	--L(593)
Comparison Instructions	DOUBLE EQUAL	=L(301)
	DOUBLE NOT EQUAL	<>L(306)
	DOUBLE LESS THAN	<L(311)
	DOUBLE LESS THAN OR EQUAL	<=L(316)
	DOUBLE GREATER THAN	>L(321)
	DOUBLE GREATER THAN OR EQUAL	>=L(326)
	DOUBLE COMPARE	CMPL(060)
Symbol Math Instructions	DOUBLE SIGNED BINARY ADD WITHOUT CARRY	+L(401)
	DOUBLE SIGNED BINARY SUBTRACT WITHOUT CARRY	-L(411)

- Note**
- (1) The SRCH(181), MAX(182), and MIN(183) instructions can output the PLC memory address of the word with the desired value (search value, maximum, or minimum) to IR0. In this case, IR0 can be used in later instructions to access the contents of that word.
 - (2) Index Registers IR00 and IR01 are used to pass argument data to a subroutine when the JUMP TO SUBROUTINE instruction (JSB(982)) is used. Be sure to avoid conflicts with IR00 and IR01 in programs that contain JSB(982).

B-15-4 Precautions

The Index Registers are not local to each task. Index Registers are shared by all tasks, including interrupt tasks. In addition, the following limitations apply.

Limitations when Using Index Registers

- It is only possible to read the Index Register for the last task executed within the cycle from the Programming Devices (CX-Programmer).
- It is not possible to either read or write to the Index Registers using Host Link commands or FINS commands.

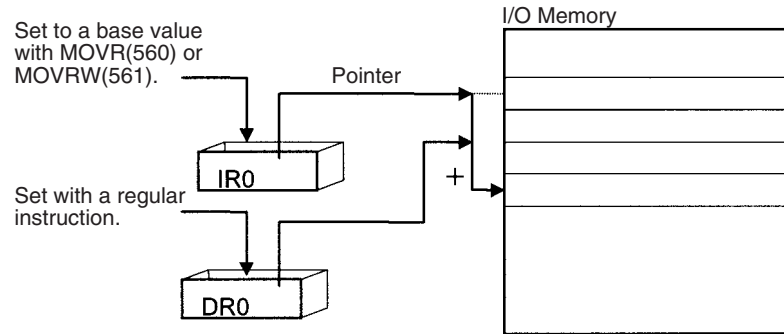
B-16 Data Registers

The sixteen Data Registers (DR0 to DR15) are used to offset the PLC memory addresses in Index Registers when addressing words indirectly.

The value in a Data Register can be added to the PLC memory address in an Index Register to specify the absolute memory address of a bit or word in I/O memory. Data Registers contain signed binary data, so a Data Register containing a negative number will offset the content of an Index Register to a lower address.

Bits in Data Registers cannot be force-set and force-reset.

Normal instructions can use to store data in Data Registers.



B-16-1 Examples

The following examples show how Data Registers are used to offset the PLC memory addresses in Index Registers.

- LD DR0 ,IR0 Adds the contents of DR0 to the contents of IR0 and loads the bit at that PLC memory address.
- MOV(021) #0001 DR0 ,IR1 Adds the contents of DR0 to the contents of IR1 and writes #0001 to that PLC memory address.

The contents of data registers are treated as signed binary data and thus have a range of -32,768 to 32,767.

Hexadecimal content	7FFF	↔	0, FFFF	↔	8000
Decimal equivalent	32767	↔	0, -1	↔	-32768

The Data Registers are not local to each task. The Data Registers are shared by all tasks, including interrupt tasks.

The content of Data Registers cannot be accessed (read or written) from a Programming Device (CX-Programmer).

The Data Registers will be cleared in the following cases:

1. The operating mode is changed from PROGRAM mode to RUN/MONITOR mode or vice-versa.
2. The FQM1's power supply is turned OFF and ON again.

- Note**
- (1) Do not use Data Registers until a value has been set in the register. The register's operation will be unreliable if they are used without setting their values.
 - (2) In the FQM1, Data Registers are shared by all tasks, including interrupt tasks. The Index Registers cannot be used independently in the tasks.

B-17 Condition Flags

These flags include the Error Flag and Carry Flag, which indicate the results of instruction execution. The Condition Flags are specified with labels, such as CY and ER, or with symbols, such as P_Carry and P_Instr_Error, rather than addresses. The status of these flags reflects the results of instruction execution, but the flags are read-only; they cannot be written directly from instructions or CX-Programmer.

Note The CX-Programmer treats condition flags as global symbols beginning with P_.

All Condition Flags are cleared when the program switches tasks, so the status of the ER and AER flags are maintained only in that cycle and in the task in which the error occurred.

The Condition Flags **cannot** be force-set and force-reset except for the Carry Flag, which can be manipulated with the STC(040) and CLC(041) instructions.

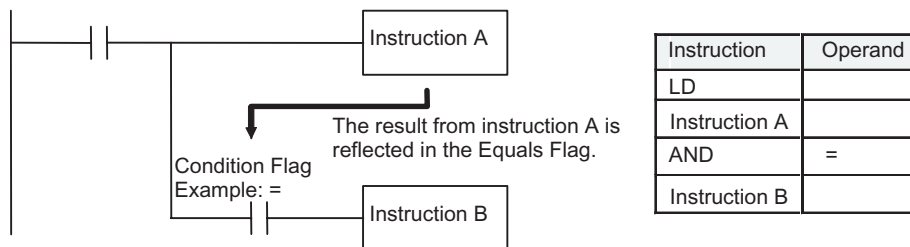
Summary of the Condition Flags

The following table summarizes the functions of the Condition Flags, although the functions of these flags will vary slightly from instruction to instruction. Refer to the description of the instruction for complete details on the operation of the Condition Flags for a particular instruction.

Name	CX-Programmer symbol	Function
Error Flag	P_ER	Turned ON when the operand data in an instruction is incorrect (an instruction processing error) to indicate that an instruction ended because of an error.
Access Error Flag	P_AER	Turned ON when an Illegal Access Error occurs. The Illegal Access Error indicates that an instruction attempted to access an area of memory that should not be accessed.
Carry Flag	P_CY	Turned ON when there is a carry in the result of an arithmetic operation or a "1" is shifted to the Carry Flag by a Data Shift instruction. The Carry Flag is part of the result of some Data Shift and Math instructions.
Greater Than Flag	P_GT	Turned ON when the first operand of a Comparison Instruction is greater than the second or a value exceeds a specified range.
Equals Flag	P_EQ	Turned ON when the two operands of a Comparison Instruction are equal or the result of a calculation is 0.
Less Than Flag	P_LT	Turned ON when the first operand of a Comparison Instruction is less than the second or a value is below a specified range.
Negative Flag	P_N	Turned ON when the most significant bit (sign bit) of a result is ON.
Overflow Flag	P_OF	Turned ON when the result of calculation overflows the capacity of the result word(s).
Underflow Flag	P_UF	Turned ON when the result of calculation underflows the capacity of the result word(s).
Greater Than or Equals Flag	P_GE	Turned ON when the first operand of a Comparison Instruction is greater than or equal to the second.
Not Equal Flag	P_NE	Turned ON when the two operands of a Comparison Instruction are not equal.
Less Than or Equals Flag	P_LE	Turned ON when the first operand of a Comparison Instruction is less than or equal to the second.
Always ON Flag	P_On	Always ON. (Always 1.)
Always OFF Flag	P_Off	Always OFF. (Always 0.)

Using the Condition Flags

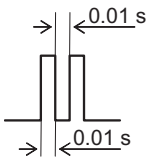
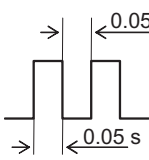
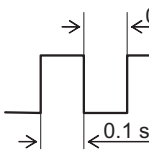
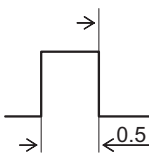
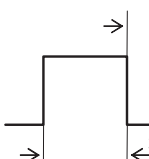
The Condition Flags are shared by all of the instructions, so their status may change often in a single cycle. Be sure to read the Condition Flags immediately after the execution of instruction, preferably in a branch from the same input condition.



- Note**
- (1) Since the Condition Flags are shared by all of the instructions, program operation can be changed from its expected course by interruption of a single task. Be sure to consider the effects of Condition Flags when writing the program. Refer to *Condition Flags* on page 340 for details.
 - (2) The Condition Flags are cleared when the program switches tasks, so the status of a Condition Flag cannot be passed to another task.

B-18 Clock Pulses

The Clock Pulses are flags that are turned ON and OFF at regular intervals by the system.

Name	Label	CX-Programmer Symbol	Operation
0.02 s Clock Pulse	0.02s	P_0_02s	 ON for 0.01 s OFF for 0.01 s
0.1 s Clock Pulse	0.1s	P_0_1s	 ON for 0.05 s OFF for 0.05 s
0.2 s Clock Pulse	0.2s	P_0_2s	 ON for 0.1 s OFF for 0.1 s
1 s Clock Pulse	1s	P_1s	 ON for 0.5 s OFF for 0.5 s
1 min Clock Pulse	1min	P_1min	 ON for 30 s OFF for 30 s

The Clock Pulses are specified with labels (or symbols) rather than addresses.

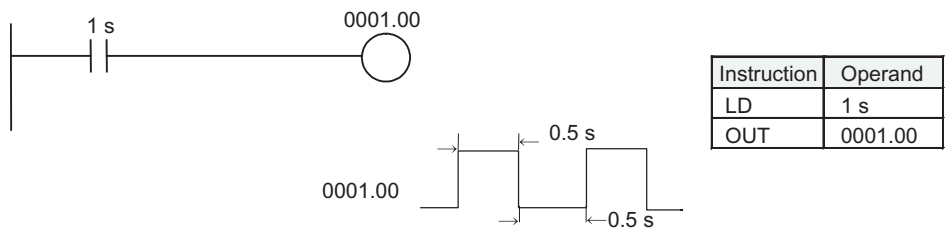
Note The CX-Programmer treats Clock Pulses as global symbols beginning with P_.

The Clock Pulses are read-only; they cannot be overwritten from instructions or the CX-Programmer.

The Clock Pulses are cleared at the start of operation.

Using the Clock Pulses

The following example turns CIO 0001.00 ON and OFF at 0.5 s intervals.



B-19 Parameter Area

Unlike the data areas in I/O Memory, which can be used in instruction operands, the Parameter Area can be accessed only from the CX-Programmer. The Parameter Area is made up of the following parts.

- The System Setup
- The Routing Tables

B-19-1 System Setup

The user can customize the basic specifications of the Coordinator Module and Motion Control Modules with the settings in the System Setups. The System Setups contain settings such as the serial port communications settings and constant cycle time setting.

Appendix C

System Setup, Auxiliary Area Allocations, and Built-in I/O Allocations

C-1 Overview of System Setups

A System Setup contains software settings that the user can change to customize FQM1 operation. Module functions are set using its System Setup.

The Coordinator Module and Motion Control Modules all have System Setups, which are set from the CX-Programmer to customize operation for the following types of applications.

Cases when settings must be changed	Setting(s) to be changed
<ul style="list-style-type: none"> • When programming the FQM1 for the first time and the Motion Control Modules are being programmed before the Coordinator Module. • When editing or debugging the program in a specific Motion Control Module. 	Sync Mode
<ul style="list-style-type: none"> • When you want the FQM1 to go into RUN mode or MONITOR mode and start operating immediately after startup. • When you want the operating mode to be other than RUN mode when the power is turned ON. 	Startup Mode
When the peripheral port will not be used with the CX-Programmer (peripheral bus) communications speed auto-detection and will not be used with the default Host Link communications settings, such as 9,600 bps.	Peripheral Port Settings
When the RS-232C port will not be used with the CX-Programmer (peripheral bus) communications speed auto-detection and will not be used with the default Host Link communications settings, such as 9,600 bps.	Host Link Port Settings
When you want to communicate with a PT via an NT Link.	Peripheral Port Settings or Host Link Port Settings
You want a constant (minimum) cycle time setting to create a consistent I/O refresh cycle or cycle time.	Cycle Time
You want to set a maximum cycle time other than 50 ms (1 ms to 100 ms).	Watch Cycle Time
You want to extend peripheral servicing time because peripheral services are being executed over several cycles, delaying completion of servicing (want to set a specific time rather than a percent of the cycle time).	Set Time to All Events
You want to improve input response in CJ-series Basic I/O Units. <ul style="list-style-type: none"> • Reducing input chattering and the effects of noise • Receiving short pulse inputs (only pulse inputs longer than the cycle time) 	Basic I/O Unit Input Response Time
At startup, you want to automatically read DM data stored in the Motion Control Module.	Read DM Data at Startup

The addresses given for the settings in the System Setup are not required for actually making the settings. Use the menus of the CX-Programmer (Ver. 6.11 or later).

C-2 System Setup in the Coordinator Module

Sync Settings between Modules (CX-Programmer: Module Settings Tab Page)

Allow Writing to User Memory

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+304	00	0: Writing enabled 1: Writing disabled Default: Writing enabled	Sets and releases write-protection for the user memory and System Setup.	---	When disabling: At power ON or at start of operation When enabling: When changed

Prohibit System Interrupt of the Sync Mode

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+304	08	0: Not prohibited 1: Prohibited Default: Not prohibited	Sets and releases prohibition of system interrupts during program execution. Set to 1: Prohibit coordinating (matching) the operation start timings among Modules in Sync Mode.	---	At start of operation

Sync Cycle Time

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+319	00 to 14	0000 hex: Default (Coordinator Module cycle time) 0001 to 0064 hex: 0.1 to 10.0 ms (unit: 0.1 ms) Default: Coordinator Module cycle time	Sets the cycle time for the Coordinator Module when high-speed synced operation is to be used only between Motion Control Modules.	A316.06 (Sync Cycle Time Too Long Flag)	At power ON

Sync Mode

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+319	15	0: Sync mode 1: Async mode Default: Sync mode	Sets either Sync Mode or Async Mode. Sync Mode is used to sync operation between the Coordinator Module and Motion Control Modules. Async Mode is convenient for debugging Motion Control Modules even if Sync Mode is to be used for actual operation.	---	At power ON

Startup Mode Setting (CX-Programmer: Startup Tab Page)

Startup Mode

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+81	00 to 11	00 hex: PROGRAM mode 01 hex: MONITOR mode 02 hex: RUN mode	Sets the mode in which the Coordinator Module will start. The mode set here can also be enabled and disabled. If this setting is disabled, the Coordinator Module will start in RUN mode.	---	At power ON
	15	00: Setting disabled 01: Setting enabled Default: Setting disabled			

Basic I/O Unit Input Response Times (CX-Programmer: Unit Settings)

Item	Address		Settings	Function	Related flags and words	When setting is read			
	Word	Bits							
Rack 0, Slot 0	+10	0 to 7	00 hex: 8 ms	Sets the input response time (ON response time = OFF response time) for CJ-series Basic I/O Units. The default setting is 8 ms and the setting range is 0 ms to 32 ms. This value can be increased to reduce the effects of chattering and noise, or it can be reduced to allow reception of shorter input pulses.	A220 to A259: Actual input response times for Basic I/O Units	At power ON			
Rack 0, Slot 1		8 to 15	10 hex: 0 ms						
Rack 0, Slot 2	+11	0 to 7	11 hex: 0.5 ms						
Rack 0, Slot 3		8 to 15	12 hex: 1 ms						
Rack 0, Slot 4	+12	0 to 7	13 hex: 2 ms						
Rack 0, Slot 5		8 to 15	14 hex: 4 ms						
Rack 0, Slot 6	+13	0 to 7	15 hex: 8 ms						
Rack 0, Slot 7		8 to 15	16 hex: 16 ms						
Rack 0, Slot 8	+14	0 to 7	17 hex: 32 ms						
Rack 0, Slot 9		8 to 15							
Rack 0, Slots 0 to 9	+15 to +19	Same as above							

Cycle Time Settings (CX-Programmer: Timer/Peripheral Service)**Cycle Time**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+307	00 to 15	0001 to 03E8 hex: 0.1 to 100.0 ms (unit: 0.1 ms) Default: 0000 hex (variable cycle time)	Set to 0001 to 03E8 hex to specify a constant (minimum) cycle time. If the cycle time is less than this setting, it will be extended until this time passes. Leave this setting at 0000 for a variable cycle time.	A316.05 (Constant Cycle Time Exceeded Flag)	At start of operation (cannot be changed during operation)

Watch Cycle Time

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+308	00 to 15	0001 to 0064 hex: 1 to 100 ms (unit: 0.1 ms) Default: 0000 hex (50 ms)	Change this setting only when you want to change the default maximum cycle time. The Cycle Time Too Long Flag (A401.08) will be turned ON if the actual cycle time exceeds this setting.	A264 to A265 (Present Cycle Time)	At start of operation (cannot be changed during operation)

Peripheral Port Settings (CX-Programmer: Peripheral Port Tab Page)**Communications Settings**

Address		Settings					Function	Related flags and words	When setting is read
Word	Bits	Setting	Data length	Start bits	Stop bits	Parity			
+144	00 to 07	00 hex:	7	1	2	Even	Sets the communications conditions for the peripheral port.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)
		01 hex:	7	1	2	Odd			
		02 hex:	7	1	2	None			
		04 hex:	7	1	1	Even			
		05 hex:	7	1	1	Odd			
		06 hex:	7	1	1	None			
		08 hex:	8	1	2	Even			
		09 hex:	8	1	2	Odd			
		0A hex:	8	1	2	None			
		0C hex:	8	1	1	Even			
		0D hex:	8	1	1	Odd			
		0E hex:	8	1	1	None			
				Default: 00					

Peripheral Port Settings for Host Link**Standard/Custom Setting**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+144	15	0: Standard 1: Custom Default: 0	The standard settings are for 1 start bit, 7-bit data, even parity, 2 stop bits, and 9,600 baud.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Serial Communications Mode

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+144	08 to 11	00 hex: Host Link Default: 00 hex	This setting determines whether the peripheral port will operate in Host Link mode or another serial communications mode. Set 00 for Host Link Mode.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Baud Rate

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+145	00 to 07	00 hex: 9,600 01 hex: 300 02 hex: 600 03 hex: 1,200 04 hex: 2,400 05 hex: 4,800 06 hex: 9,600 07 hex: 19,200 08 hex: 38,400 09 hex: 57,600 Unit: bit/s Default: 00 hex	This setting is valid when the peripheral port is set for the Host Link Serial Communications Mode. Set the Standard/Custom setting to 1 to enable this setting.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Host Link Unit Number

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+147	00 to 07	00 to 1F hex: Unit number 0 to 31 Default: 00 hex	This setting determines the Coordinator Module's unit number when it is connected in a 1-to-N (N=2 to 32) Host Link.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Peripheral Port Settings for NT Link**Serial Communications Mode**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+144	08 to 11	02 hex: NT Link Default: 0 hex	This setting determines whether the peripheral port will operate in NT Link mode or another serial communications mode. Set 02 for NT Link Mode. Note Communications will not be possible with PTs set for 1:1 NT Links.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Baud Rate

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+145	00 to 07	08 hex: Standard NT Link Default: 00 hex	Only the standard setting of 38,400 can be used for the NT Link Serial Communications Mode.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Maximum Unit Number for NT Link (NT Link Max.)

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+150	00 to 03	0 to 7 hex Default: 0 hex	This setting determines the highest unit number of PT that can be connected to the FQM1.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Peripheral Port Settings for Peripheral Bus (ToolBus)**Standard/Customer Setting**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+144	15	0: Standard 1: Custom Default: 0	The standard setting is for 9,600 baud.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Serial Communications Mode

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+144	08 to 11	04 hex: Peripheral bus Default: 0 hex	This setting determines whether the peripheral port will operate in Peripheral Bus Mode or another serial communications mode. Set 04 for Peripheral Bus Mode. Peripheral Bus Mode is used to communicate with the CX-Programmer.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Baud Rate

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+145	00 to 07	00 hex: 9,600 06 hex: 9,600 07 hex: 19,200 08 hex: 38,400 09 hex: 57,600 Unit: bit/s Default: 00 hex	Only settings 00 hex and 06 to 09 hex can be used in peripheral bus mode.	A619.01 (Peripheral Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

RS-232C Port Settings (CX-Programmer: Host Port Tab Page)**RS-232C Port Settings for Host Link****Serial Communications Mode**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+160	08 to 11	00 hex: Host Link 05 hex: Host Link Default: 00 hex	This setting determines whether the RS-232C port will operate in Host Link mode or another serial communications mode. Specify either 00 or 05 for Host Link Mode.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Format

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+160	15	0: Default format 1: Custom Default: 00 hex	The standard settings are for 1 start bit, 7-bit data, even parity, 2 stop bits, and 9,600 baud.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)
	03	0: 7-bit 1: 8-bit Default: 0	Sets the data length.		
	02	0: 2 bits 1: 1 bit Default: 0	Sets the number of stop bits.		
	00 and 01	00: Even 01: Odd 10: None Default: 00 hex	Sets the parity.		

Baud Rate

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+161	00 to 07	00 hex: 9,600 01 hex: 300 02 hex: 600 03 hex: 1,200 04 hex: 2,400 05 hex: 4,800 06 hex: 9,600 07 hex: 19,200 08 hex: 38,400 09 hex: 57,600 Unit: bit/s Default: 00 hex	Sets the Host Link baud rate. Set the Standard/Custom setting to 1 to enable this setting.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Host Link Unit Number

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+163	00 to 07	00 to 1F hex: 0 to 31 Default: 00 hex	This setting determines the Coordinator Module's unit number when it is connected in a 1-to-N (N=2 to 32) Host Link.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

RS-232C Port Settings for NT Link**Serial Communications Mode**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+160	08 to 11	02 hex: NT Link Default: 00 hex	This setting determines whether the RS-232C port will operate in NT Link mode or another serial communications mode. Set 02 for NT Link Mode. Note Communications will not be possible with PTs set for 1:1 NT Links.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Baud Rate

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+161	00 to 07	08 hex: Standard setting Default: 00 hex	Only the standard setting of 38,400 can be used for the NT Link Serial Communications Mode.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Maximum Unit Number for NT Link (NT Link Max.)

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+166	00 to 03	0 to 7 hex Default: 00 hex	This setting determines the highest unit number of PT that can be connected to the FQM1.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

RS-232C Port Settings for Peripheral Bus (ToolBus)**Standard/Custom Setting**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+160	15	0: Standard 1: Custom Default: 0	The standard setting is for 9,600 baud.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Serial Communications Mode

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+160	08 to 11	04 hex: Peripheral bus Default: 0 hex	This setting determines whether the RS-232C port will operate in Peripheral Bus Mode or another serial communications mode. Set 04 for Peripheral Bus Mode. Peripheral Bus Mode is used to communicate with the CX-Programmer.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Baud Rate

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+161	00 to 07	00 hex: 9,600 06 hex: 9,600 07 hex: 19,200 08 hex: 38,400 09 hex: 57,600 Unit: bit/s Default: 00 hex	Only settings 00 hex and 06 to 09 hex can be used in peripheral bus mode.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

RS-232 Port Settings for No-protocol Communications (RS-232C)**Serial Communications Mode**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+160	08 to 11	03 hex: No-protocol Default: 00 hex	This setting determines whether the RS-232C port will operate in No-protocol mode or another serial communications mode. Set 03 for No-protocol Mode.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Number of Received Bytes

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+165	00 to 07	00 hex: 256 bytes 01 to FF hex: 1 to 255 Default: 00 hex	Specifies the data length to send and receive for no-protocol communications. The start code and end code are not included in the data length. This setting is valid only when bits 08 and 09 of +165 are set to 00. The default setting for each TXD(236)/RXD(235) instruction is 256 bytes. This setting can be set to 01 to FF to set 255 bytes or less.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

RS-232C Port Settings for PLC Link (PC Link (Slave))**Serial Communications Mode**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+160	08 to 11	07 hex: Serial PLC Link Slave (Polled Unit) Default: 00 hex	This setting determines whether the RS-232C port will operate in Serial PLC Link Slave mode or another serial communications mode. Set 07 for Serial PLC Link Slave Mode.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Baud Rate

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+161	00 to 07	00 hex: Standard setting Default: 00 hex	Only the standard setting of 38,400 can be used for the Serial PLC Link Slave Serial Communications Mode.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

PLC Link Unit No. (PC Link Unit Number)

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+167	00 to 03	0 to 7 hex Default: 0 hex	Sets the unit number of the FQM1 as a Serial PLC Link Slave.	A619.02 (RS-232C Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

RS-422A Port Settings (CX-Programmer: Drive Tab Page)**RS-422A Port Settings for Serial Gateway****Standard/Custom Setting**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+360	15	0: Standard settings Default: 0	The standard settings are for 1 start bit, 7-bit data, even parity, 2 stop bits, and 9,600 baud.	A318.15 (RS-422A Port Settings Changing Flag)	---

Serial Communications Mode

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+360	08 to 11	00 or 09 hex: Serial Gateway Default: 00 hex	This setting determines whether the RS-422A port will operate in Serial Gateway mode or another serial communications mode. Set 00 or 09 for Serial Gateway Mode.	A318.15 (RS-422A Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

RS-422A Response Timeout Time (RS422 Response Timeout of Command)

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+367	00 to 15	0001 to 00FF hex: 0.1 to 25.5 s Default: 0000 hex (5 s)	Sets the timeout time for a response from the Servo Driver.	A318.15 (RS-422A Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

RS-422A Port Settings for No-protocol Communications (Non-procedural)**Serial Communications Mode**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+360	08 to 11	03 hex: No-protocol Default: 00 hex	This setting determines whether the RS-422A port will operate in no-protocol mode or another serial communications mode. Set 03 for No-protocol Mode.	A318.15 (RS-422A Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Send Delay Time

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+362	00 to 15	Send delay time, 0 to 99,990 ms (0000 to 270F hex, unit: 10 ms) Default: 0000 hex	When TXD(236) is executed, data will be sent from the RS-422A port after the delay time set here.	A318.15 (RS-422A Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Start Code and End Code

Address		Settings	Function		Related flags and words	When setting is read
Word	Bits					
+364	00 to 07	00 to FF hex Default: 00 hex	The frame format for no-protocol communications data (messages) can be specified.	Specifies the end code. This setting is valid when bits 08 to 09 of +365 are set to 01.	A318.15 (RS-422A Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)
	08 to 15	00 to FF hex Default: 00 hex		Specifies the start code. This setting is valid when bit 12 of +365 is set to 1.		
+365	12	0: Don't add start code 1: Add start code Default: 0	Specifies whether the frame format for no-protocol communications is specified.	Specifies whether to add a start code.	A318.15 (RS-422A Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)
	08 and 09	00: Don't add end code and use number of received bytes setting 01: Add end code 11: Add CR+LF Default: 00		Specifies whether to add an end code.		

Number of Received Bytes

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+365	00 to 07	00 hex: 256 bytes 01 to FF hex: 1 to 255 Default: 00 hex	Specifies the data length to send and receive for no-protocol communications. The start code and end code are not included in the data length. This setting is valid only when bits 08 and 09 of +365 are set to 00. The default setting for each TXD(236)/RXD(235) instruction is 256 bytes. This setting can be set to 01 to FF to set 255 bytes or less.	A318.15 (RS-422A Port Settings Changing Flag)	At next cycle (Also can be changed with STUP (237).)

Peripheral Service Time Settings (CX-Programmer: Timer/Peripheral Tab Page)**Fixed Service Time Enable Setting (Set Time to All Events)**

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+218	15	0: Default (6.25% of cycle time) 1: Custom Default: 0	Sets the default service time or enables setting of a custom service time.	---	At start of operation (cannot be changed during operation)

Peripheral Service Time

Address		Settings	Function	Related flags and words	When setting is read
Word	Bits				
+218	00 to 07	00 to FF hex: 0.0 to 25.5 ms (unit: 0.1 ms) Default: 00 hex	Sets the time to allocate to peripheral servicing. Bit 15 of +218 must be set to 1 to enable this setting.	---	At start of operation (cannot be changed during operation)

C-3 System Setup in Motion Control Modules**Settings Used by All Motion Control Modules****Startup Mode Settings (CX-Programmer: Startup Tab Page)**

Address	Bits	Function	Remarks	When setting is read
+82	15	Read DM Data at Startup	0 hex: Disabled 1 hex: Enabled The default setting for this Motion Control Module startup mode disables Reading DM Data at Startup. Set this bit to 1 to enable the Reading of DM Data at Startup.	At power ON

CX-Programmer: Module Settings Tab Page

Address	Bits	Function	Remarks	When setting is read
+304	00	Allow writing to user memory (user memory protection)	0 hex: Writing enabled 1 hex: Writing disabled Note Set this bit to 1 to disable writing the following areas from the CX-Programmer: user program and System Setup	When disabling: At power ON or at start of operation When enabling: When changed
	08	Prohibit system interruption of the sync mode	0 hex: Allow interrupts 1 hex: Prohibit interrupts Set this bit to 1 to prohibit system interrupts during program execution and I/O memory refreshing to maintain synced operation between Modules in Sync Mode.	At power ON
	12	Detect cycle time over warming (detection of cycle times longer than 10 ms)	0 hex: Detect long cycles 1 hex: Do not detect long cycles Note CIO 4005.09 will turn ON if this bit is set to 0 and the cycle time exceeds 10 ms.	At start of operation

Address	Bits	Function	Remarks	When setting is read
+305	00 to 03	Interrupt Input Settings, Input 0 (CIO 0000.00) function	0 hex: Normal 1 hex: Interrupt input (at rising edge) 2 hex: Interrupt input (at falling edge) 3 hex: Interrupt input (at both edges) Note Interrupt input settings of 1 to 3 hex apply to input interrupt mode and counter mode.	At power ON
	04 to 07	Interrupt Input Settings, Input 1 (CIO 0000.01) function		
	08 to 11	Interrupt Input Settings, Input 2 (CIO 0000.02) function		
	12 to 15	Interrupt Input Settings, Input 3 (CIO 0000.03) function		
+306	00 to 07	Select Synchronous Data	Upper 2 words (+0 and +1)	00 hex: Normal (via Ladder) 01 hex: High-speed counter PV (Counter 1 values) 02 hex: High-speed counter PV (Counter 2 values) 03 hex: Pulse output 1 PV 04 hex: Pulse output 2 PV 05 hex: Analog input 06 hex: Reserved 07 hex: Analog output 1 value 08 hex: Analog output 2 value 09 hex: Built-in input value (Inner I/O input) 5A hex: No data
	08 to 15		Lower 2 words (+2 and +3)	

CX-Programmer: Cycle Time Tab Page

Address	Bits	Function	Remarks	When setting is read
+307	00 to 15	Cycle time	0000 hex: Variable cycle time 0001 to 03E8 hex: Constant (minimum) cycle time of 0.1 to 100.0 ms (unit: 0.1 ms) If the actual cycle time is less than this setting, it will be extended until this time passes. Note A316.05 will turn ON if the minimum cycle time set here is exceeded.	At start of operation
+308	00 to 15	Watch cycle time	Change this setting only when you want to change the default maximum cycle time. The Cycle Time Too Long Flag (A401.08) will be turned ON if the actual cycle time exceeds this setting.	At start of operation

CX-Programmer: Other Tab Page

These settings are reserved for future expansion of Motion Control Module functionality.

FQM1-MMP22 Motion Control Modules with Pulse I/O

CX-Programmer: Pulse Input Tab Page

Address	Bits	Function	Remarks	When setting is read
+320	00 to 03	High-speed counter 1 (Counter 1)	Input method 0 hex: Phase differential x1 1 hex: Phase differential x2 2 hex: Phase differential x4 3 hex: Increment/decrement pulse inputs 4 hex: Pulse + direction inputs	At power ON
	04 to 07		Reset method 0 hex: Software reset 1 hex: Phase Z and software reset	
	08 to 11		Counting speed 0 hex: 50 kHz 1 hex: 500 kHz	
	12 to 15		Counter operating mode (Counter operation) 0 hex: Linear counter 1 hex: Circular counter 2 hex: Absolute linear counter (CW-) 3 hex: Absolute circular counter 4 hex: Absolute linear counter (CW+) Note When setting any mode except for a linear counter (0 hex), be sure to set the Circular Maximum Count/Absolute Encoder Resolution.	
+321	00 to 03	Counter data to monitor (Counter data display)	0 hex: Do not monitor (Non-monitor) 1 hex: Counter PV changes (Counter movements (mode 1)) 2 hex: Frequency (mode 2) Note The frequency (mode 2) can be set only for high-speed counter 1.	
	04 to 15		Reserved	
+322	00 to 15	Sampling time (for mode 1 only)	Sets the sampling time for monitoring counter PV changes (mode 1) 0000: Cycle time 0001 to 270F hex: 1 to 9,999 ms (unit: 1 ms) Note This setting is valid only when the Counter Data Display (bits 00 to 03 of +321) is set to 1 hex (mode 1).	

Address	Bits	Function		Remarks	When setting is read
+323	00 to 03	High-speed counter 2 (Counter 2)	Input method	Same as for high-speed counter 1 except that frequency measurement (Counter data to monitor, bit 00 to 03 of +324: 02 hex) cannot be set for high-speed counter 2.	At power ON
	04 to 07		Reset method		
	08 to 11		Counting speed		
	12 to 15		Counter operating mode (Counter operation)		
+324	00 to 03		Counter data to monitor (Counter data display)		
	04 to 15		Reserved		
+325	00 to 15		Sampling time (for mode 1 only)		
+326 to 327	00 to 15	High-speed counter 1 (Counter 1)	Circular maximum count	Sets the maximum circular counter value. Range: 0000 0001 to FFFF FFFF hex	
			Absolute encoder resolution	0000 0001 to 0000 FFFF hex Note Set this value in pulses/rotation according to the encoder dividing ratio set for the Servo Driver and the input method multiplier set for the Module. Example: If the Servo Driver setting is 1,000 and the Module setting is x4, set FA0 (4,000).	
+328 to 329	00 to 15	High-speed counter 2 (Counter 2)	Circular maximum count	Same as for high-speed counter 1.	
			Absolute encoder resolution		
+330 to 331	00 to 15	High-speed counter 1 (Counter 1)	Absolute offset	8000 0000 to 7FFF FFFF hex	
+332 to 333	00 to 15	High-speed counter 2 (Counter 2)	Absolute offset	8000 0000 to 7FFF FFFF hex	

CX-Programmer: Pulse Output Tab Page

Address	Bits	Function		Remarks	When setting is read
+340	00 to 07	Pulse output 1	Operation mode (Refer to 7-6-6 <i>Pulse Output Function Details.</i>)	00 hex: Relative pulse output	At power ON
				01 hex: Absolute pulse output in linear mode	
	02 hex: Absolute pulse output in circular mode (See note.)				
	03 hex: Electronic cam control in linear mode (See note.)				
	04 hex: One-shot pulse output				
	05 hex: Time measurement using pulse counter				
06 hex: Electronic cam control in circular mode (See note.)					
08 to 15	Clock	00 hex: 20 MHz	Pulse output frequency: 400 Hz to 1 MHz		
		01 hex: 10 MHz	Pulse output frequency: 200 Hz to 200 kHz		
		02 hex: 5 MHz	Pulse output frequency: 100 Hz to 100 kHz		
		03 hex: 2.5 MHz	Pulse output frequency: 40 Hz to 50 kHz		
		04 hex: 1.25 MHz	Pulse output frequency: 20 Hz to 20 kHz		
+341	00 to 07	Pulse output 2	Operation mode	Same as for pulse output 1.	
	08 to 15		Clock		
+342 to 343	00 to 15	Pulse output 1	Circular maximum count	Sets the maximum circular counter value when the pulse output mode is set to absolute pulse output in circular mode or electronic cam control in circular mode. Range: 0000 0001 to FFFF FFFF hex (See note.)	
+344 to +345	00 to 15	Pulse output 2	Circular maximum count	Same as for pulse output 1.	

Note Always set the Circular Maximum Count when setting any of the circular operation modes.

FQM1-MMA22 Motion Control Modules with Analog I/O

CX-Programmer: Pulse Input Tab Page

Address	Bits	Function	Remarks	When setting is read		
+320	00 to 03	High-speed counter 1 (Counter 1)	Input method	0 hex: Phase differential x1 1 hex: Phase differential x2 2 hex: Phase differential x4 3 hex: Increment/decrement pulse inputs 4 hex: Pulse + direction inputs	At power ON	
	04 to 07		Reset method			0 hex: Software reset 1 hex: Phase Z and software reset
	08 to 11		Counting speed			0 hex: 50 kHz 1 hex: 500 kHz
	12 to 15		Counter operating mode (Counter operation)			0 hex: Linear counter 1 hex: Circular counter 2 hex: Absolute linear counter (CW-) 3 hex: Absolute circular counter 4 hex: Absolute linear counter (CW+)
+321	00 to 03	Counter data to monitor (Counter data display)	0 hex: Do not monitor (Non-monitor) 1 hex: Counter PV changes (Counter movements (mode 1)) 2 hex: Frequency (mode 2) Note The frequency (mode 2) can be set only for high-speed counter 1.			
	04 to 15		Reserved			
+322	00 to 15	Sampling time (for mode 1 only)	Sets the sampling time for monitoring counter PV changes (mode 1) 0000: Cycle time 0001 to 270F hex: 1 to 9,999 ms (unit: 1 ms) Note This setting is valid only when the Counter Data Display (bits 00 to 03 of +321) is set to 1 hex (mode 1).			
+323	00 to 03	High-speed counter 2 (Counter 2)	Input method	Same as for high-speed counter 1 except that frequency measurement (Counter data to monitor, bit 00 to 03 of +324: 02 hex) cannot be set for high-speed counter 2.		
	04 to 07		Reset method			
	08 to 11		Counting speed			
	12 to 15		Counter operating mode (Counter operation)			
+324	00 to 03	Counter data to monitor (Counter data display)	Reserved			
	04 to 15		Reserved			
+325	00 to 15	Sampling time (for mode 1 only)				
+326 to 327	00 to 15	High-speed counter 1 (Counter 1)	Circular maximum count	Sets the maximum circular counter value. Range: 0000 0001 to FFFF FFFF hex		
			Absolute encoder resolution	0000 0001 to 0000 FFFF hex Note Set this value in pulses/rotation according to the encoder dividing ratio set for the Servo Driver and the input method multiplier set for the Module. Example: If the Servo Driver setting is 1,000 and the Module setting is x4, set FA0 (4,000).		
+328 to 329	00 to 15	High-speed counter 2 (Counter 2)	Circular maximum count	Same as for high-speed counter 1.		
			Absolute encoder resolution			

Address	Bits	Function		Remarks	When setting is read
+330 to 331	00 to 15	High-speed counter 1 (Counter 1)	Absolute offset	8000 0000 to 7FFF FFFF hex Application origin when using an absolute encoder.	Immediately
+332 to 333	00 to 15	High-speed counter 2 (Counter 2)	Absolute offset	Same as high-speed counter 1.	

CX-Programmer: Analog Input/Output Tab Page

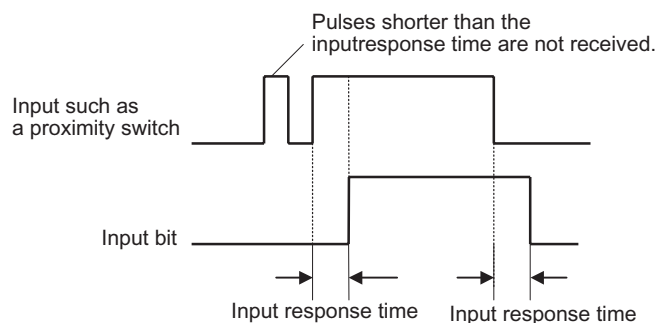
Address	Bits	Function		Remarks	When setting is read
+350	00 to 03	Analog I/O	Input method	0 hex: END refresh 1 hex: Immediate refresh (using PRV(881) instruction)	At power ON
	04 to 07		Output method	0 hex: END refresh (Analog value output to A810 and A811 after executing END(001).) 1 hex: Immediate refresh (using instructions (Analog value output when SPED(885) or ACC(888) is executed.) (A810 and A811 are used for monitoring.)	
+351	00 to 07	Analog input	Input range	00 hex: -10 to 10 V 01 hex: 0 to 10 V 02 hex: 1 to 5 V (4 to 20 mA) 03 hex: 0 to 5 V	At power ON
+353	00 to 07	Analog output 1	Output range	00 hex: -10 to 10 V 01 hex: 0 to 10 V 02 hex: 1 to 5 V 03 hex: 0 to 5 V 5A hex: Output disabled (Can be used to shorten I/O refresh time.) (See note.)	At power ON
	08 to 11		Output stop function	0 hex: Clear 1 hex: Hold 2 hex: Maximum value	
+354	00 to 07	Analog output 2	Output range	Same as for analog output 1.	
	08 to 15		Output stop function		

Note Analog outputs that are not being used can be disabled to decrease the cycle time.

C-4 Details on System Setup Settings

C-4-1 Basic I/O Unit Input Response Time

The input response time can be set for Basic I/O Units by Rack and Slot number. Increasing this value reduces the effects of chattering and noise. Decreasing this value allows reception of shorter input pulses, (but do not set the ON response time or OFF response time to less than the cycle time).



The default setting for the input response time is 8 ms and the setting range is 0 to 32 ms. When the input response time is set to 0 ms, the only delay will be the delays in the Unit's internal elements (ON delay of 20 μ s max., OFF delay of 300 μ s max.). The input response time settings are transferred to the Basic I/O Units when the power is turned ON.

When the Unit's settings are changed, they are stored in A220 to A259 (Actual Input Response Times for Basic I/O Units). When the settings in the System Setup have been changed with the FQM1 in PROGRAM mode, the System Setup settings will differ from the actual settings in the Units. In this case, the values in A220 to A259 can be monitor to see the input response times actually in the Units.

Startup Mode

This setting determines the operating mode that will be used when the power supply to the Coordinator Module is turned ON.

System Setup mode setting disabled	RUN mode
System Setup mode setting enabled	Program: PROGRAM mode Monitor: MONITOR mode Run: RUN mode

Note The Coordinator Module will start in RUN mode unless the Startup Mode setting in the System Setup is enabled.

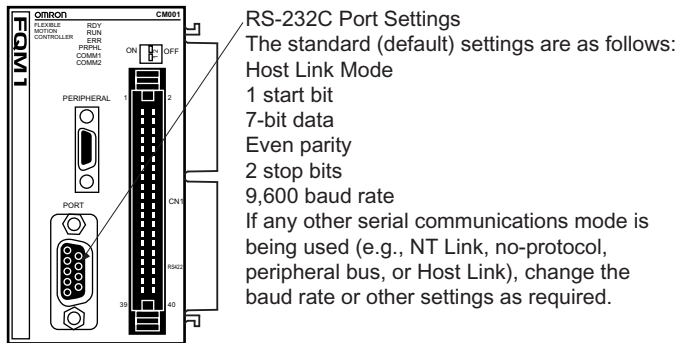
Peripheral Port Settings

The standard settings are for Host Link Mode, 1 start bit, 7-bit data, even parity, 2 stop bits, and 9,600 baud. Change the System Setup if any other settings are required.

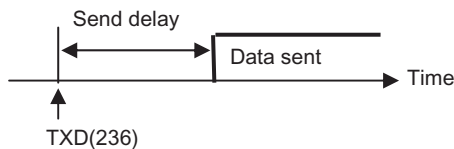
RS-232C Port Settings (Host Link Port)

The standard settings are for Host Link Mode, 1 start bit, 7-bit data, even parity, 2 stop bits, and 9,600 baud. Change the System Setup if any other settings are required. If no-protocol communications are to be used, be sure to change the frame format.

Note The RS-232C port settings can also be changed with the STUP (237) instruction. The RS-232C Port Settings Changing Flag (A619.01) will remain ON from the time STUP (237) is executed until the settings have actually been changed.



Note The following data is set for no-protocol mode.



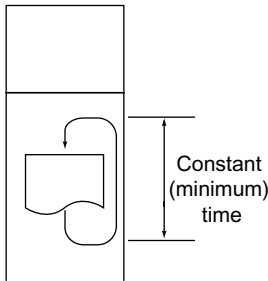
Messages Sent and Received with No-protocol Mode

		End code		
		No	Yes	CR+LF
Start code	No	Data	Data ED	Data CR+LF
	Yes	ST Data	ST Data ED	ST Data CR+LF
Received bytes		Data: 1 to 256 bytes		

Constant Cycle Time

Set the cycle time to a non-zero value, e.g., to create a consistent motor control cycle. This setting is effective only when the actual cycle time is shorter than the constant cycle time setting. If the actual cycle time is longer than the constant cycle time setting, the actual cycle time will remain unchanged.

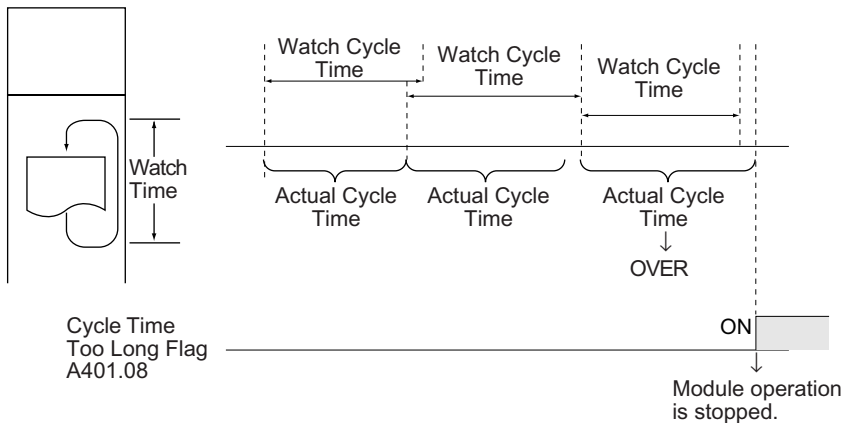
Note The constant cycle time setting cannot be changed while the Module is in RUN or MONITOR mode.



Watch Cycle Time

If the cycle time exceeds the watch (maximum) cycle time setting, the Cycle Time Too Long Flag (A401.08) will be turned ON and FQM1 operation will be stopped. This setting must be changed if the normal cycle time exceeds the default watch cycle time setting of 50 ms.

Note The watch cycle time setting cannot be changed while the Module is in RUN or MONITOR mode.

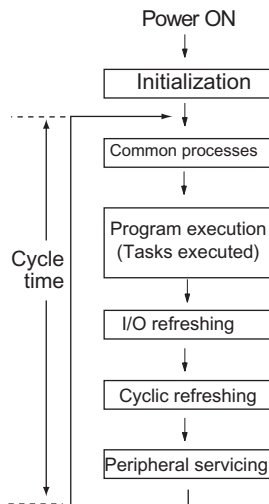


Note The default value for the watch cycle time is 50 ms.

Fixed Peripheral Servicing Time (Coordinator Module)

This setting determines whether the peripheral servicing for the following processes is performed with the default settings or all together in a fixed servicing time.

Exchange data with Modules when necessary
 Exchange data with peripheral port
 Exchange data with serial communications ports



The following table shows a breakdown of the peripheral servicing time.

Peripheral servicing time	Default value	Setting range
Event service time for Motion Control Modules	6.25% of the previous cycle's cycle time	Uniform servicing time in ms: 0.0 to 25.5 ms (unit: 0.1 ms)
Event service time for peripheral port	Same as above.	
Event service time for RS-232C port	Same as above.	
Event service time for RS-422A port	Same as above.	

Note A default value of 100 μ s is allocated in Motion Control Modules for event servicing with the Coordinator Module

The default value for each servicing process is 6.25% of the last cycle's cycle time. In general, it is recommended that the default value be used. Set a uniform servicing time only when peripheral servicing is being delayed because each service process is being spread over several cycles.

- Note**
- (1) When the peripheral servicing time is set to a time longer than the default value, the cycle time will also be longer.
 - (2) The fixed peripheral servicing time setting cannot be changed while the Module is in RUN mode or MONITOR mode.

Read DM at Startup Setting (Motion Control Modules)

Part of the DM Area in Motion Control Modules can be saved to flash memory. This setting specifies whether or not to automatically retrieve the saved data when the power is turned ON.

If there isn't valid data in flash memory to retrieve, the data won't be retrieved and the corresponding DM Area words will be cleared to zeroes. In this case, the Saved DM Data Invalid Flag (A751.11) can be read to check whether or not the data was retrieved.

C-5 Auxiliary Area Allocations by Function

The following tables list the words and bits allocated in the Auxiliary Area by function. These tables provide only an overview of the functionality. Refer to *Appendix D Auxiliary Area Allocations* for details or a list of allocations by address.

Motion Control Modules

Allocations that are the Same for All Modules

Address	Bits	Name	Function	Controlled by
A270	00	Motion Control Module slot 1	ON if the Motion Control Module is in slot 1.	Module
	01	Motion Control Module slot 2	ON if the Motion Control Module is in slot 2.	
	02	Motion Control Module slot 3	ON if the Motion Control Module is in slot 3.	
	03	Motion Control Module slot 4	ON if the Motion Control Module is in slot 4.	
A751	11	Saved DM Data Invalid Flag	ON if the DM data in flash memory was invalid when it was read. This flag is cleared when DM data is saved.	Module
	12	Invalid DM Save Password Flag	ON if A752 contains the wrong password.	
	13	DM Backup Error Flag	ON if the DM data save operation failed.	
	14	Saving DM Flag	ON when DM data is being saved to flash memory.	
	15	DM Save Start Bit	Write the password to A752 and turn this bit ON to save DM data to flash memory. The data can be saved only when the Motion Control Module is in PROGRAM mode.	User
A752	00 to 15	DM Save Password	Write A5A5 hex to this word and turn ON the DM Save Start Bit (A751.15) to transfer DM data to flash memory (PROGRAM mode only). When the DM data transfer is completed, this word is automatically cleared.	

Error-related Settings (Same for All Modules)

Module Errors

Address	Bits	Name	Function	Controlled by
A402	08	Coordinator Module WDT Error Flag (Motion Control Modules only)	Turns ON in the Motion Control Modules when a WDT error occurs in the Coordinator Module.	Module
	14	Coordinator Module Fatal Error Flag (Motion Control Modules only)	Turns ON in the Motion Control Modules when a fatal error occurs in the Coordinator Module.	

Memory Errors

Address	Bits	Name	Function	Controlled by
A403	13	Analog Offset/Gain Error Flag	Turns ON when there is an error in the analog I/O offset/gain adjustment value in flash memory. Note This flag is valid for the FQM1-MMA22 only.	Module

FQM1-MMP22 Motion Control Modules with Pulse I/O

Address	Bits	Name		Function	Controlled by	
A850	00 to 15	High-speed Counter 1 PV		Range: 8000 0000 to 7FFF FFFF	Module	
A851	00 to 15			Note For a Linear Counter, high-speed counter overflows/underflows are checked when the PV is read (i.e., when Module internal I/O is refreshed).		
A852	00 to 15	High-speed Counter 2 PV				
A853	00 to 15					
A854 to A855	00 to 15	High-speed Counter 1	For following counter modes	PV of absolute number of rotations	Contains the number of rotations data (PV) read from the Encoder when the SEN signal is input to the Servo Driver. 8000 0000 to 7FFF FFFF hex	
			<ul style="list-style-type: none"> • Absolute linear (CW-) • Absolute circular • Absolute linear (CW+) 			
			For following counter modes	Monitor data	<ul style="list-style-type: none"> • When monitoring counter movements (mode 1), contains the absolute value of the amount of change in the PV of the high-speed counter over the specified sampling time as a 8-digit hexadecimal value (0000 0000 to FFFF FFFF hex). • When monitoring the counter frequency (mode 2), contains the frequency of the high-speed counter calculated from the PV of the high-speed counter between 0 and 7A120 hex (0 and 500 kHz). 	
A856 to A857	00 to 15	High-speed Counter 2	For following counter modes	PV of absolute number of rotations	Same as for A604 and A605 for high-speed counter 1 except that measuring the high-speed counter frequency is not possible for high-speed counter 2.	
			<ul style="list-style-type: none"> • Absolute linear (CW-) • Absolute circular • Absolute linear (CW+) 			
			For following counter modes	Monitor data		
			<ul style="list-style-type: none"> • Linear counter • Circular counter 			
A858	00	High-speed counter 1 status	Target Comparison In-progress Flag		OFF: Target value comparison is not being performed for CTBL(882). Note This flag is always OFF for range comparison. ON: Target value comparison is being performed for CTBL(882). Note Target comparison is continued without interruption once it has been started (as opposed to range comparison), so this flag can be used to check whether target comparison is in progress.	Module
	01		PV Overflow/Underflow Flag	OFF: There is no counter overflow or underflow in Linear Counter Mode. This flag will always be OFF in Circular Counter Mode. ON: There is a counter overflow or underflow in Linear Counter Mode. The counter PV will be fixed at the overflow or underflow limit. This flag will be cleared when the High-speed Counter Start Bit is turned OFF.		
	02		Reserved	---		
	03		Phase Z Input Reset Flag (ON for one cycle)	ON for one cycle when the counter PV is reset with the counter reset method set to a phase Z + software reset. Note This flag will turn ON for one cycle after the counter PV is reset if the phase Z signal (reset input) turns ON while the High-speed Counter Reset Bit (A860.01) is ON.		
	04		Absolute No. of Rotations Read Error Flag	OFF: No error ON: Error		
	05		Absolute No. of Rotations Read Completed Flag	OFF: Rotations being read or reading has not been executed. ON: Reading has been completed (Turned ON when serial reception of the number of rotations has been completed.)		

Address	Bits		Name	Function	Controlled by
A858	06	High-speed counter 1 status	Measuring Flag (measurement mode 1 or 2)	OFF: Changes in the counter PV or the counter frequency is not being measured. ON: Changes in the counter PV or the counter frequency is being measured. In measurement mode 1, this flag will turn ON at the beginning of the sampling time after the Measurement Start Bit (A860.02) is turned ON. Note Valid when Counter Data Display in System Setup is set to Counter Movements (mode 1) or Frequency (mode 2).	Module
	07		High-speed Counter Operating Flag	OFF: Counter is not operating. ON: Counter is operating.	
	08		Count Latched Flag	OFF: Count has not been latched. ON: Latching the count has been completed for the latch input.	
	09 to 11		Reserved	---	
	12		Absolute Offset Preset Error Flag	OFF: No error occurred when saving the absolute offset. ON: An error occurred when saving the absolute offset.	
	13 to 15		Reserved	---	
A859	00	High-speed counter 2 status	Target Comparison In-progress Flag	Same as for high-speed counter 1.	Module
	01		PV Overflow/Underflow Flag		
	02		Reserved		
	03		Phase Z Input Reset Flag (ON for one cycle)		
	04		Absolute No. of Rotations Read Error Flag		
	05		Absolute No. of Rotations Read Completed Flag		
	06		Measuring Flag (measurement mode 1 or 2)		
	07		High-speed Counter Operating Flag		
	08		Count Latched Flag		
	09 to 11		Reserved		
	12		Absolute Offset Preset Error Flag		
	13 to 15		Reserved		
A860	00	High-speed counter 1 command bits	Start Bit	OFF: Stops counter operation. The counter PV will be maintained. ON: Starts counter operation. The counter PV will not be reset.	User
	01		Reset Bit	OFF: If a software reset is set in the System Setup, the counter PV will not be reset when internal I/O is refreshed in the Motion Control Module. If a phase Z + software reset is set, disables the phase Z input. ON: If a software reset is set in the System Setup, resets the counter PV to 0 when internal I/O is refreshed in the Motion Control Module. If a phase Z + software reset is set, enables the phase Z input.	
	02		Measurement Start Bit	OFF: Disables measuring changes in counter PV or the counter frequency. ON: Starts measuring changes in counter PV or the counter frequency. Note Measuring the high-speed counter frequency is possible only for high-speed counter 1. Note Valid when Counter Data Display in System Setup is set to Counter Movements (mode 1) or Frequency (mode 2).	

Address	Bits		Name	Function	Controlled by
A860	03	High-speed counter 1 command bits	Measurement Direction Bit (measurement mode 2)	OFF: Forward (up) ON: Reverse (down) This bit specifies the up/down direction of the pulse input for frequency measurement. Note Always set this bit before turning ON the Measurement Start Bit.	User
	04		Range Comparison Results Clear Bit	OFF: Does not clear the execution results (A862) or output bit pattern (A863) from CTBL(882) execution for range comparison for the counter. ON: Clears the execution results (A862) or output bit pattern (A863) from CTBL(882) execution for range comparison for the counter.	
	05		Absolute Offset Preset Bit	OFF: Does not preset the offset. OFF to ON: Stores the number of multi-turns read from the Servo Driver and the number of initial incremental pulses as an offset in the Absolute Offset value in the System Setup. When establishing the machine origin, the position from the absolute encoder origin is set as the Absolute Offset in the System Setup as the machine origin.	
	06		Absolute Present Value Preset Bit	OFF: Disables the absolute present value preset. OFF to ON: Stores the Absolute PV in the counter 1 PV (A850 and A851). Note Refer to 7-7-6 <i>Absolute Present Value</i> for details on the absolute PV.	
	07		Absolute Number of Rotations Read Bit	OFF: Disables reading the number of rotations data from the Servo Driver. OFF to ON: Outputs the SEN output to the Servo Driver and receives the number of rotations data on the phase A input.	
	08		Latch Input 1 Enable Bit	OFF: Disables the exterior latch input 1 signal. ON: Enables the exterior latch input 1 signal.	
	09		Latch Input 2 Enable Bit	OFF: Disables the exterior latch input 2 signal. ON: Enables the exterior latch input 2 signal.	
	10 to 15		Reserved	---	
A861	00	High-speed counter 2 command bits	Start Bit	Same as command bits for high-speed counter 1.	User
	01		Reset Bit		
	02		Measurement Start Bit		
	03		Reserved		
	04		Range Comparison Results Clear Bit		
	05		Absolute Offset Preset Bit		
	06		Absolute Present Value Preset Bit		
	07		Absolute Number of Rotations Read Bit		
	08		Latch Input 1 Enable Bit		
	09		Latch Input 2 Enable Bit		
10 to 15	Reserved				
A862	00 to 15	High-speed counter 1 monitor data	Range Comparison Execution Results Flags	Contains the CTBL(882) execution results for range comparison. Bits 00 to 15 correspond to ranges 1 to 16. OFF: No match ON: Match	Module
A863	00 to 15		Output Bit Pattern	Contains the output bit pattern when a match is found for CTBL(882) execution results for range comparison Note If more than one match is found, an OR of the output bit patterns with matches will be stored here.	
A864	00 to 15	High-speed counter 2 monitor data	Range Comparison Results	Same as for high-speed counter 1 monitor data.	
A865	00 to 15		Output Bit Pattern		

Address	Bits	Name	Function	Controlled by	
A870 to A871	00 to 15	Pulse Output 1 PV Note This item applies when the operation mode is relative pulse output, absolute pulse output in linear mode, absolute pulse output in circular mode, or electronic cam mode.	Contains the pulse output PV as an 8-digit hexadecimal number. Relative mode: 00000000 to FFFFFFFF hex Absolute linear mode: 80000000 to 7FFFFFFF hex Absolute circular mode: 00000000 to circular maximum count	Module	
		One-shot Pulse Output 1 ON Time Note This item applies when the operation mode is one-shot output mode.	Contains the time that the one-shot pulse output has been ON as an 8-digit hexadecimal number. 0000 0000 to 0000 270F (unit: set by STIM(980))		
		Pulse Time Measurement 1 Note This item applies when the operation mode is time measurement mode using a pulse counter.	Contains the time measured by the pulse counter as an 8-digit hexadecimal number. 0000 0000 to FFFF FFFF hex (unit: set by STIM(980))		
A872 to A873	00 to 15	Pulse Output 2 PV	Same as for Pulse Output 1 PV.		
		One-shot Pulse Output 2 ON Time	Same as for One-shot Pulse Output 1 ON time.		
		Pulse Time Measurement 2	Same as for Pulse Time Measurement 1.		
A874	00	Pulse Output 1 Status	Pulse Output Completed Flag	OFF: Pulse output not completed (OFF during pulse output). ON: Pulse output completed (ON when pulse distribution has been completed).	
	01		Pulse Output Set Flag	OFF: Pulse output amount not set by PULS(886). ON: Pulse output amount set by PULS(886).	
	02		Target Frequency Not Reached Flag	OFF: Target speed has been reached during pulse output for PLS2(887). ON: Decelerated before reaching the target speed during pulse output for PLS2(887).	
	03		Target Comparison Flag	OFF: Comparison stopped. ON: Comparison in progress.	
	04		Independent Pulse Output Flag	OFF: Pulses not being output or being output continuously. ON: Pulses being output.	
	05		PLS2 Positioning Flag	OFF: Not positioning. ON: Positioning in progress.	
	06		Accelerating/Decelerating Flag	OFF: No output or constant-speed output. ON: Acceleration or deceleration in progress for ACC(888) or PLS2(887).	
	07		Pulse Output Flag	OFF: Pulse output stopped. ON: Pulse output in progress.	
	08		Pulse Output Direction Flag	OFF: CW or stopped ON: CCW	
	09 to 15		Reserved	---	
A875	00	Pulse Output 2 Status	Pulse Output Completed Flag	Same as for Pulse Output 1 Status.	Module
	01		Pulse Output Set Flag		
	02		Target Frequency Not Reached Flag		
	03		Target Comparison Flag		
	04		Independent Pulse Output Flag		
	05		PLS2 Positioning Flag		
	06		Accelerating/Decelerating Flag		
	07		Pulse Output Flag		
	08		Pulse Output Direction Flag		
	09 to 15		Reserved		
A876	00	Pulse Output 1 Command Bits	PV Reset Bit	OFF: Pulse output 1 PV not reset. ON: Resets pulse output 1 PV.	User
	01		Range Comparison Results Clear Bit	OFF: Does not clear the execution results (A880) or output bit pattern (A881) from CTBL(882) execution for range comparison for the pulse output PV. ON: Clears the execution results (A880) or output bit pattern (A881) from CTBL(882) execution for range comparison for the pulse output PV.	
	02 to 15		Reserved	---	

Address	Bits	Name	Function	Controlled by	
A877	00	Pulse Output 2 Command Bits	PV Reset Bit	Same as for Pulse Output 1 Command Bits.	User
	01		Range Comparison Results Clear Bit		
	02 to 15		Reserved		
A878	00 to 06	Pulse Output Control Bits (Apply to both pulse outputs 1 and 2.)	Reserved	---	
	07		Speed Change Cycle Bit	OFF: Sets the speed change cycle to 2 ms during pulse output for ACC(888) or PLS2(887). ON: Sets the speed change cycle to 1 ms during pulse output for ACC(888) or PLS2(887).	
	08 to 13		Reserved	---	
	14		PLS2 Pulse Output Direction Priority Mode Bit	OFF: Sets Direction Priority Mode. In Direction Priority Mode, pulses are output only when the pulse output direction and the direction of the specified absolute position are the same. ON: Sets Absolute Position Priority Mode. In Absolute Position Priority Mode, pulses are always output in the direction of the specified absolute position.	
	15		Reserved	---	
A879	00 to 15	Reserved	---	---	---
A880	00 to 15	Pulse Output 1 Monitor Data	Range Comparison Results	Contains the CTBL(882) execution results for range comparison. Bits 00 to 15 correspond to ranges 1 to 16. OFF: No match ON: Match	Module
A881	00 to 15		Output Bit Pattern			Contains the output bit pattern when a match is found for CTBL(882) execution results for range comparison Note If more than one match is found, an OR of the output bit patterns with matches will be stored here.
A882	00 to 15	Pulse Output 2 Monitor Data	Range Comparison Results	Same as for Pulse Output 1 Monitor Data.	
A883	00 to 15		Output Bit Pattern		

FQM1-MMA22 Motion Control Modules with Analog I/O

Address	Bits	Name	Function	Controlled by
A800	00 to 15	Analog Input PV	Contains the value input from the analog input port (using either the END refresh or immediate refresh) in 4-digit hexadecimal. The PV range depends on the input range: • 0 to 10 V: FE70 to 20D0 hex • 0 to 5 V or 1 to 5 V: FF38 to 1068 hex • -10 to 10 V: DDA0 to 2260 hex	Module
A802	00	Analog Input Status	User Adjustment Completed	OFF: Not adjusted ON: Adjustment completed
	01 to 06		Reserved	
	07		Analog Sampling Started	OFF: Not started ON: Started
	08		Factory Adjustment Data Error	OFF: No Error ON: Error (Checked at power ON.)
	09		User Adjustment Data Error	OFF: No Error ON: Error (Checked at power ON.)
	10 to 14		Reserved	
	15		Analog Sampling Overlap	OFF: Normal sampling ON: The next sampling operation occurred before the present sampling operation completed.
A809	01 to 15	Number of Analog Samples	Indicates the number of data samples actually input since sampling started.	

Address	Bits	Name	Function		Controlled by
A810	00 to 15	Analog Output 1 Output Value	<p>When an END refresh is selected, the 4-digit hexadecimal value set here by the user is output from analog output port 1.</p> <p>When immediate refreshing is selected, the 4-digit hexadecimal value being output from analog output port 1 is stored here for monitoring. The output value range depends on the output range, as shown below.</p> <ul style="list-style-type: none"> • 0 to 10 V, 0 to 5 V or 1 to 5 V: FF38 to 1068 hex • -10 to 10 V: EA84 to 157C hex <p>Note</p> <ol style="list-style-type: none"> 1. Set the analog output method (END or immediate refreshing) with the System Setup's output method setting. A setting of 0 hex specifies an END refresh. This setting applies to both analog output 1 and 2. 2. Specify the output range with the output 1 setting. 		With immediate refresh: Module With END refresh: User
A811	00 to 15	Analog Output 2 Output Value	<p>This word has the same settings as the analog output 1 output value (A560), above. (When an END refresh is selected, set the value to output from analog output port 2. When an immediate refresh is selected, the output value is stored here for monitoring.)</p> <p>Note</p> <ol style="list-style-type: none"> 1. Set the analog output method (END or immediate refresh) with the System Setup's output method setting. A setting of 0 hex specifies an END refresh. This setting applies to both analog output 1 and 2. 2. Specify the output range with the output 2 setting. 		
A812	00	Analog Output 1 Flags	User Adjustment Completed	Initial value is 0. Set to 1 if user performs offset/gain adjustment and Returns to factory default setting of 0 if adjustment value is cleared.	Module
	01 to 03		Reserved	---	
	04		Operating	ON: ON while the analog output is being changed by ACC(888). OFF: Turned OFF when target value is reached.	
	05 to 07		Reserved	---	
	08		Output SV Error	ON: ON when the output SV setting is outside of the allowed setting range. OFF: OFF when the output SV is within range. Note Only for END refresh.	
	09 to 11		Reserved	---	
	12		Factory Adjustment Value Error	ON: ON when the factory-set data stored in flash memory is invalid. OFF: OFF when the factory-set data stored in flash memory is normal.	
	13		Reserved	---	
	14		User Adjustment Value Error	ON: ON when the user-set adjustment value stored in flash memory is invalid. OFF: OFF when the user-set adjustment value stored in flash memory is normal.	
	15		Reserved	---	
A813	00	Analog Output 2 Flags	User Adjustment Completed	Same as for Analog Output 1 Flags.	
	01 to 03		Reserved		
	04		Operating		
	05 to 07		Reserved		
	08		Output SV Error		
	09 to 11		Reserved		
	12		Factory Adjustment Value Error		
	13		Reserved		
	14		User Adjustment Value Error		
	15		Reserved		

Address	Bits	Name	Function			Controlled by	
A814	00	Analog Output 1	Conversion Enable Bit	ON: Enables D/A conversion (enables analog output). OFF: Disables DA conversion (analog values output according to Output Stop Function specification in System Setup). Note This bit is cleared when the Modules operating mode is changed between RUN or MONITOR mode and PROGRAM mode.			User
	01 to 15	Reserved			---	---	
A815	00	Analog Output 2	Conversion Enable Bit	ON: Enables D/A conversion (enables analog output). OFF: Disables DA conversion (analog values output according to Output Stop Function specification in System Setup). Note This bit is cleared when the Modules operating mode is changed between RUN or MONITOR mode and PROGRAM mode.			User
	01 to 15	Reserved			---	---	
A820	00	Adjustment Mode Command Bits (Effective only when A825 is 5A5A hex.)	Adjustment Enable	Analog Input	OFF: Adjustment disabled. ON: Adjustment enabled. When one of these bits is turned ON, the default value (offset or gain value) corresponding to the selected I/O signal range is transferred to Adjustment Mode Monitor Area (A822 and A823).	User	
	01			Reserved			
	02			Analog Output 1			
	03			Analog Output 2			
	04 to 06		Reserved				
	07		Adjustment Mode Specifier	OFF: Offset adjustment ON: Gain adjustment			
	08 to 11		Reserved				
	12		Adjustment Value Increment	While this bit is ON, the offset or gain value will be incremented by one resolution unit each 0.5 ms.			
	13		Adjustment Value Decrement	While this bit is ON, the offset or gain value will be decremented by one resolution unit each 0.5 ms.			
	14		Adjustment Value Clear	OFF to ON: Clears the adjustment data to the factory defaults.			
	15		Adjustment Value Set	OFF to ON: Reads the present value in the Adjustment Mode Monitor Area (A822 and A823) and saves this value to flash memory. This adjustment value will be used for the next normal mode operation.			
	A821		00	Adjustment Mode Status	Adjustment Operation Error		ON when an operational error has been made, such as turning ON both the Analog Input and Analog Output 2 Adjustment Enable Bits at the same time.		Module
01 to 14		Reserved					
15		Adjustment Mode Started	ON during adjustment mode operation (when A825 contains 5A5A hex).				
A822	00 to 15	Adjustment Mode Monitor (Effective only when A825 is 5A5A hex.)	Both Analog Input and Analog Outputs	Setting Offset Monitor	The values in these words can be overwritten directly, without using the Adjustment Value Increment/Decrement Bits.	Module/User	
A823	00 to 15		Gain Value Monitor	<ul style="list-style-type: none"> • -10 to 10 V: FE0C to 01F4 hex • 0 to 10 V, 0 to 5 V, 1 to 5 V: FF38 to 00C8 hex • -10 to 10 V: 1194 to 157C hex • 0 to 10 V, 0 to 5 V, 1 to 5 V: 0ED8 to 1068 hex 			
A824	00 to 15		Analog Inputs	Number of Average Value Samples in Adjustment Mode	Indicates the number of values to be averaged to obtain the Offset/Gain Value Monitor values in adjustment mode. The number of samples can be set between 0000 and 0040 hex (0 to 64). Set this parameter before turning ON the Adjustment Enable Bit.		
A825	00 to 15	Adjustment Mode Password		5A5A hex: Adjustment mode enabled. Other value: Adjustment mode disabled.		User	

Address	Bits	Name		Function	Controlled by
A850	00 to 15	High-speed Counter 1 PV		Range: 8000 0000 to 7FFF FFFF	Module
A851	00 to 15			Note For a Linear Counter, high-speed counter overflows/underflows are checked when the PV is read (i.e., when Module internal I/O is refreshed).	
A852	00 to 15	High-speed Counter 2 PV			
A853	00 to 15				
A854 to A855	00 to 15	High-speed Counter 1	For following counter modes	PV of absolute number of rotations	Contains the number of rotations data (PV) read from the Encoder when the SEN signal is input to the Servo Driver. 8000 0000 to 7FFF FFFF hex
			<ul style="list-style-type: none"> • Absolute linear (CW-) • Absolute circular • Absolute linear (CW+) 		
A856 to A857	00 to 15	High-speed Counter 2	For following counter modes	Monitor data	<ul style="list-style-type: none"> • When monitoring counter movements (mode 1), contains the absolute value of the amount of change in the PV of the high-speed counter over the specified sampling time as a 8-digit hexadecimal value (0000 0000 to FFFF FFFF hex). • When monitoring the counter frequency (mode 2), contains the frequency of the high-speed counter calculated from the PV of the high-speed counter between 0 and 7A120 hex (0 and 500 kHz).
			<ul style="list-style-type: none"> • Linear counter • Circular counter 		
A858	00	High-speed counter 1 status	For following counter modes	PV of absolute number of rotations	Same as for A854 and A855 for high-speed counter 1 except that measuring the high-speed counter frequency is not possible for high-speed counter 2.
			<ul style="list-style-type: none"> • Absolute linear (CW-) • Absolute circular • Absolute linear (CW+) 		
			For following counter modes	Monitor data	
			<ul style="list-style-type: none"> • Linear counter • Circular counter 		
A858	00	High-speed counter 1 status	Target Comparison In-progress Flag		OFF: Target value comparison is not being performed for CTBL(882). Note This flag is always OFF for range comparison. ON: Target value comparison is being performed for CTBL(882). Note Target comparison is continued without interruption once it has been started (as opposed to range comparison), so this flag can be used to check whether target comparison is in progress.
			PV Overflow/Underflow Flag		OFF: There is no counter overflow or underflow in Linear Counter Mode. This flag will always be OFF in Circular Counter Mode. ON: There is a counter overflow or underflow in Linear Counter Mode. The counter PV will be fixed at the overflow or underflow limit. This flag will be cleared when the High-speed Counter Start Bit is turned OFF.
			Reserved		---
			Phase Z Input Reset Flag (ON for one cycle)		ON for one cycle when the counter PV is reset with the counter reset method set to a phase Z + software reset. Note This flag will turn ON for one cycle after the counter PV is reset if the phase Z signal (reset input) turns ON while the High-speed Counter Reset Bit (A860.01) is ON.
			Absolute No. of Rotations Read Error Flag		OFF: No error ON: Error
			Absolute No. of Rotations Read Completed Flag		OFF: Rotations being read or reading has not been executed. ON: Reading has been completed (Turned ON when serial reception of the number of rotations has been completed.)

Address	Bits		Name	Function	Controlled by
A858	06	High-speed counter 1 status	Measuring Flag (measurement mode 1 or 2)	OFF: Changes in the counter PV or the counter frequency is not being measured. ON: Changes in the counter PV or the counter frequency is being measured. In measurement mode 1, this flag will turn ON at the beginning of the sampling time after the Measurement Start Bit (A860.02) is turned ON. Note Valid when Counter Data Display in System Setup is set to Counter Movements (mode 1) or Frequency (mode 2).	Module
	07		High-speed Counter Operating Flag	OFF: Counter is not operating. ON: Counter is operating.	
	08		Count Latched Flag	OFF: Count has not been latched. ON: Latching the count has been completed for the latch input.	
	09 to 11		Reserved	---	
	12		Absolute Offset Preset Error Flag	OFF: No error occurred when saving the absolute offset. ON: An error occurred when saving the absolute offset.	
	13 to 15		Reserved	---	
A859	00	High-speed counter 2 status	Target Comparison In-progress Flag	Same as for high-speed counter 1.	Module
	01		PV Overflow/Underflow Flag		
	02		Reserved		
	03		Phase Z Input Reset Flag (ON for one cycle)		
	04		Absolute No. of Rotations Read Error Flag		
	05		Absolute No. of Rotations Read Completed Flag		
	06		Measuring Flag (measurement mode 1 or 2)		
	07		High-speed Counter Operating Flag		
	08		Count Latched Flag		
	09 to 11		Reserved		
	12		Absolute Offset Preset Error Flag		
	13 to 15		Reserved		
A860	00	High-speed counter 1 command bits	Start Bit	OFF: Stops counter operation. The counter PV will be maintained. ON: Starts counter operation. The counter PV will not be reset.	User
	01		Reset Bit	OFF: If a software reset is set in the System Setup, the counter PV will not be reset when internal I/O is refreshed in the Motion Control Module. If a phase Z + software reset is set, disables the phase Z input. ON: If a software reset is set in the System Setup, resets the counter PV to 0 when internal I/O is refreshed in the Motion Control Module. If a phase Z + software reset is set, enables the phase Z input.	
	02		Measurement Start Bit	OFF: Disables measuring changes in counter PV or the counter frequency. ON: Starts measuring changes in counter PV or the counter frequency. Note Measuring the high-speed counter frequency is possible only for high-speed counter 1. Note Valid when Counter Data Display in System Setup is set to Counter Movements (mode 1) or Frequency (mode 2).	

Address	Bits		Name	Function	Controlled by
A860	03	High-speed counter 1 command bits	Measurement Direction Bit (measurement mode 2)	OFF: Forward (up) ON: Reverse (down) This bit specifies the up/down direction of the pulse input for frequency measurement. Note Always set this bit before turning ON the Measurement Start Bit.	User
	04		Range Comparison Results Clear Bit	OFF: Does not clear the execution results (A862) or output bit pattern (A863) from CTBL(882) execution for range comparison for the counter. ON: Clears the execution results (A862) or output bit pattern (A863) from CTBL(882) execution for range comparison for the counter.	
	05		Absolute Offset Preset Bit	OFF: Does not preset the offset. OFF to ON: Stores the number of multi-turns read from the Servo Driver and the number of initial incremental pulses as an offset in the Absolute Offset value in the System Setup. When establishing the machine origin, the position from the absolute encoder origin is set as the Absolute Offset in the System Setup as the machine origin.	
	06		Absolute Present Value Preset Bit	OFF: Disables the absolute present value preset. OFF to ON: Stores the Absolute PV in the counter 1 PV (A850 and A851). Note Refer to 7-7-6 <i>Absolute Present Value</i> for details on the absolute PV.	
	07		Absolute Number of Rotations Read Bit	OFF: Disables reading the number of rotations data from the Servo Driver. OFF to ON: Outputs the SEN output to the Servo Driver and receives the number of rotations data on the phase A input.	
	08		Latch Input 1 Enable Bit	OFF: Disables the external latch input 1 signal. ON: Enables the external latch input 1 signal.	
	09		Latch Input 2 Enable Bit	OFF: Disables the external latch input 2 signal. ON: Enables the external latch input 2 signal.	
	10 to 15		Reserved	---	
A861	00	High-speed counter 2 command bits	Start Bit	Same as command bits for high-speed counter 1.	User
	01		Reset Bit		
	02		Measurement Start Bit		
	03		Reserved		
	04		Range Comparison Results Clear Bit		
	05		Absolute Offset Preset Bit		
	06		Absolute Present Value Preset Bit		
	07		Absolute Number of Rotations Read Bit		
	08		Latch Input 1 Enable Bit		
	09		Latch Input 2 Enable Bit		
10 to 15	Reserved				
A862	00 to 15	High-speed counter 1 monitor data	Range Comparison Execution Results Flags	Contains the CTBL(882) execution results for range comparison. Bits 00 to 15 correspond to ranges 1 to 16. OFF: No match ON: Match	Module
A863	00 to 15		Output Bit Pattern	Contains the output bit pattern when a match is found for CTBL(882) execution results for range comparison Note If more than one match is found, an OR of the output bit patterns with matches will be stored here.	
A864	00 to 15	High-speed counter 2 monitor data	Range Comparison Results	Same as for high-speed counter 1 monitor data.	
A865	00 to 15		Output Bit Pattern		

Settings Related to Built-in Inputs

Input Interrupts

Address	Bits	Name	Function	Controlled by
A532	00 to 15	Interrupt Counter 0 Counter SV	Used for interrupt input 0 in counter mode. Sets the count value at which the interrupt task will start. Interrupt task 000 will start when interrupt counter 0 has counted this number of pulses. Setting range: 0000 to FFFF	User
A533	00 to 15	Interrupt Counter 1 Counter SV	Used for interrupt input 1 in counter mode. Sets the count value at which the interrupt task will start. Interrupt task 001 will start when interrupt counter 1 has counted this number of pulses. Setting range: 0000 to FFFF	
A534	00 to 15	Interrupt Counter 2 Counter SV	Used for interrupt input 2 in counter mode. Sets the count value at which the interrupt task will start. Interrupt task 002 will start when interrupt counter 2 has counted this number of pulses. Setting range: 0000 to FFFF	
A535	00 to 15	Interrupt Counter 3 Counter SV	Used for interrupt input 3 in counter mode. Sets the count value at which the interrupt task will start. Interrupt task 003 will start when interrupt counter 3 has counted this number of pulses. Setting range: 0000 to FFFF	
A536	00 to 15	Interrupt Counter 0 Counter PV	These words contain the interrupt counter PVs for interrupt input 0 to 3 operating in counter mode. The counter PV starts decrementing from the counter SV. When the counter PV reaches the 0, the PV is automatically reset to the SV. Range: 0000 to FFFF	Module
A537	00 to 15	Interrupt Counter 1 Counter PV		
A538	00 to 15	Interrupt Counter 2 Counter PV		
A539	00 to 15	Interrupt Counter 3 Counter PV		

Coordinator Module

Initial Settings

Address	Bits	Name	Function	Controlled by
A220 to A259	00 to 15	Basic I/O Unit Input Response Time	These words contain the actual input response times for CJ-series Basic I/O Units. Range: 0000 to 0017 hex	Module

Basic I/O Unit Settings

Address	Bits	Name	Function	Controlled by
A050 to A059	00 to 15	Basic I/O Unit Information (Rack 0 slot 0 to Rack 1 slot 9)	A bit will turn ON to indicate when the load short-circuit protection function alarm output has been output. Only the 4 rightmost bits are used for the CJ1W-OD202 (2-point units), only the rightmost bit is used for the CJ1W-OD212, OD204, MD232 and only the two rightmost bits are used for the CJ1W-OD232. Each bit indicates the status for one circuit.	Module
A336	00 to 15	Units Detected at Startup (Racks 0 and 1)	The number of Units detected on each Rack is stored in 1-digit hexadecimal (0 to A hex). Rack 0: A336.00 to A336.03 Rack 1: A336.04 to A336.07 Note Motion Control Modules are not included in the detected Units.	

CPU Bus Unit Settings

Address	Bits	Name	Function	Controlled by
A302	00 to 15	CPU Bus Unit Initializing Flags	These flags are ON while the corresponding CPU Bus Unit is initializing after its CPU Bus Unit Restart Bit (A501.00 to A501.15) is turned from OFF to ON or the power is turned ON.	Module
A501	00 to 15	CPU Bus Unit Restart Bits	Turn these bits ON to restart (initialize) the CPU Bus Unit with the corresponding unit number. Bits 00 to 15 correspond to unit numbers 0 to F.	User

Special I/O Unit Settings

Address	Bits	Name	Function	Controlled by
A330 to A335	00 to 15	Special I/O Unit Initializing Flags	These flags are ON while the corresponding Special I/O Unit is initializing after its Special I/O Unit Restart Bit (A502.10 to A507.15) is turned from OFF to ON or the power is turned ON. Note Unit numbers 0 to 9 cannot be set on Special I/O Units, so A330.00 to A330.09 are not used.	Module
A502 to A507	00 to 15	Special I/O Unit Restart Bits	Turn these bits ON to restart (initialize) the Special I/O Unit with the corresponding unit number. Bits A502.10 to A507.15 correspond to unit numbers 10 to 95.	User

Error-related Settings

I/O Errors

Address	Bits	Name	Function	Controlled by
A401	10	I/O Setting Error Flag	ON when more than 5 Motion Control Modules are connected to the Coordinator Module.	Module
	11	Too Many I/O Points Flag	ON when a Unit model registered in the I/O table does not match the model actually connected.	
	13	Duplication Error Flag	ON in the following cases: <ul style="list-style-type: none"> Two CPU Bus Units have been assigned the same unit number. Two Special I/O Units have been assigned the same unit number or a Special I/O Unit has been assigned a unit number between 0 and 9. Two Basic I/O Units have been allocated the same data area words. 	
A407	00 to 12	Too Many I/O Points, Details	The cause of the Too Many I/O Points Error is indicated in binary in A407.13 to A407.15. The 13-bit binary value in A407.00 to A407.12 indicates the details: the excessive value or the duplicated unit number. <ul style="list-style-type: none"> The number of I/O points will be written here when the total number of I/O points set in the I/O Table (excluding Slave Racks) exceed the maximum allowed for the Coordinator Module. The number of interrupt inputs will be written here when the number of interrupt inputs exceeds 32. The number of Racks will be written here when the number of Expansion Racks exceeds the maximum. 	
	13 to 15	Too Many I/O Points, Cause	The 3-digit binary value of these bits indicates the cause of the Too Many I/O Points Error and shows the meaning of the value written to bits A407.00 to A407.12.	
A404	00 to 07	I/O Bus Error Slot Number	Contains the 2-digit slot number (00 to 09) where an I/O Bus Error occurred. When the End Cover is not connected, 0E hex will be stored. If the error location is undetermined, 0F hex will be stored.	
	08 to 15	I/O Bus Error Rack Number	Contains the 2-digit rack number (00 or 01) where an I/O Bus Error occurred. When the End Cover is not connected, 0E hex will be stored. If the error location is undetermined, 0F hex will be stored.	

Memory Errors

Address	Bits	Name	Function	Controlled by
A403	05	Registered I/O Table Memory Error Flag	When a memory error occurs, the Memory Error Flag (A401.15) is turned ON. This flag will be ON if the error occurred in the registered I/O table.	Module
	08	CPU Bus Unit Settings Memory Error Flag	When a memory error occurs, the Memory Error Flag (A401.15) is turned ON. This flag will be ON if the error occurred in the CPU Bus Unit Settings.	

CPU Bus Unit Errors

Address	Bits	Name	Function	Controlled by
A410	00 to 15	CPU Bus Unit Number Duplication Flags	The Duplication Error Flag (A401.13) and the corresponding flag in A410 will be turned ON when an CPU Bus Unit's unit number has been duplicated. Bits 00 to 15 correspond to unit numbers 0 to F.	Module
A417	00 to 15	CPU Bus Unit Error, Unit Number Flags	When an error occurs in a data exchange between the Coordinator Module and a CPU Bus Unit, the CPU Bus Unit Error Flag (A402.07) is turned ON and the bit in A417 corresponding to the unit number of the Unit where the error occurred is turned ON. Bits 00 to 15 correspond to unit numbers 0 to F.	
A402	03	CPU Bus Unit Setting Error Flag	ON when an installed CPU Bus Unit does not match the CPU Bus Unit registered in the I/O table.	
	07	CPU Bus Unit Error Flag	ON when an error occurs in a data exchange between the Coordinator Module and a CPU Bus Unit (including an error in the CPU Bus Unit itself).	

Special I/O Unit Errors

Address	Bits	Name	Function	Controlled by
A411 to A416	00 to 15	Special I/O Unit Number Duplication Flags	The Duplication Error Flag (A401.13) and the corresponding flag in A411 through A416 will be turned ON when a Special I/O Unit's unit number has been duplicated or a Special I/O Unit's unit number has been set between 0 and 9. (Bits A411.00 to A416.15 correspond to unit numbers 0 to 95.)	Module
A402	02	Special I/O Unit Setting Error Flag	ON when an installed Special I/O Unit does not match the Special I/O Unit registered in the I/O table.	
	06	Special I/O Unit Error Flag	This flag will be turned ON when an error occurs in a data exchange between the Coordinator Module and a Special I/O Unit.	
A418 to A423	00 to 15	Special I/O Unit Error, Unit Number Flags	When an error occurs in a data exchange between the Coordinator Module and a Special I/O Unit, the Special I/O Unit Error Flag (A402.06) and the corresponding flag in this area are turned ON. Bits A418.00 to A423.15 correspond to unit numbers 0 to 95.	

Module Errors

Address	Bits	Name	Function	Controlled by
A402	05	Motion Control Module Monitoring Error Flag (Coordinator Module only)	Turns ON in the Coordinator Module when a system error, such as a WDT error, occurs in any of the Motion Control Modules.	Module

Other

Address	Bits	Name	Function	Controlled by
A316	06	Sync Cycle Time Too Long Flag	Turns ON when one of the Modules exceeds the specified sync cycle time. (Coordinator Module only)	Module

Settings Related to DM Data Transfer (Coordinator Module Only)

Address	Bits	Name	Function	Controlled by
A556	00	DM Write Request Bit (Coordinator Module to Motion Control Module)	DM data transfer is executed from the Coordinator Module to Motion Control Module when this bit turns ON.	User
	01	DM Read Request Bit (Motion Control Module to Coordinator Module)	DM data transfer is executed from the Motion Control Module to Coordinator Module when this bit turns ON.	
A557	00 to 15	Slot No. of Motion Control Module for DM Transfer	Specifies the slot number (in 4-digit hexadecimal) for the Motion Control Module with which DM data is to be transferred. 0001: Motion Control Module #1 0002: Motion Control Module #2 0003: Motion Control Module #3 0004: Motion Control Module #4	
A558	00 to 15	DM Transfer Size (number of words)	Specifies the size, in number of words, of the DM data to be transferred. 0001 to 01F3 hex (1 to 499 words)	
A559	00 to 15	First DM Transfer Source Word	Specifies the first address of the DM transfer source in the Coordinator Module or Motion Control Module. 0000 to 7FFF hex	
A560	00 to 15	First DM Transfer Destination Word	Specifies the first address of the DM transfer destination in the Coordinator Module or Motion Control Module. 0000 to 7FFF hex	
A561	14	Transfer Error Flag	Turns ON when a DM data transfer error occurs.	
	15	Transfer Busy Flag	Turns ON during DM data transfer and turns OFF when the transfer has been completed.	

Communications**Peripheral Port**

Address	Bits	Name	Function	Controlled by
A528	10 to 13	Peripheral Port Error Flags	Indicates the status of the error flags that turn ON when an error has occurred at the peripheral port.	Module
A392	12	Peripheral Port Communications Error Flag	Turns ON when a communications error has occurred at the peripheral port.	
A619	01	Peripheral Port Settings Changing Flag	Turns ON while the peripheral port's communications settings are being changed.	
A526	01	Peripheral Port Restart Bit	Turn this bit ON to restart the peripheral port. This bit is turned OFF automatically when the restart processing is completed.	User

RS-232C Port

Address	Bits	Name	Function	Controlled by
A528	02 to 05	RS-232C Port Error Flags	Indicates the status of the error flags that turn ON when an error has occurred at the RS-232C port.	Module
A392	04	RS-232C Port Communications Error Flag	Turns ON when a communications error has occurred at the RS-232C port.	
	05	RS-232C Port Send Ready Flag (no-protocol mode)	Turns ON when the RS-232C port is ready to send data in no-protocol mode.	
	06	RS-232C Port Reception Completed Flag (no-protocol mode)	Turns ON when the RS-232C port has completed the reception in no-protocol mode.	
	07	RS-232C Port Reception Overflow Flag (no-protocol mode)	Turns ON when a data overflow occurred during reception through the RS-232C port in no-protocol mode.	
A619	02	RS-232C Port Settings Changing Flag	Turns ON while the RS-232C port's communications settings are being changed.	User
A393	00 to 15	RS-232C Port Reception Counter (no-protocol mode)	Indicates (in binary) the number of bytes of data received when the RS-232C port is in no-protocol mode.	
A393	00 to 07	RS-232C Port PT Communications Flags	The corresponding bit will be ON when the RS-232C port is communicating with a PT in NT link mode. Bits 0 to 7 correspond to units 0 to 7.	
	08 to 15	RS-232C Port PT Priority Registered Flags	The corresponding bit will be ON for the PT that has priority when the RS-232C port is communicating in NT link mode. Bits 0 to 7 correspond to units 0 to 7.	
A526	00	RS-232C Port Restart Bit	Turn this bit ON to restart the RS-232C port. This bit is turned OFF automatically when the restart processing is completed.	

RS-422A Port

Address	Bits	Name	Function	Controlled by
A318	02 to 05	RS-422A Port Error Flags	Indicates the status the error flags that turn ON when an error has occurred at the RS-422A port.	Module
	08	RS-422A Port Communications Error Flag	Turns ON when a communications error has occurred at the RS-422A port.	
	09	RS-422A Port Send Ready Flag (no-protocol mode)	Turns ON when the RS-422A port is ready to send data in no-protocol mode.	
	10	RS-422A Port Reception Completed Flag (no-protocol mode)	Turns ON when the RS-422A port has completed the reception in no-protocol mode.	
	11	RS-422A Port Reception Overflow Flag (no-protocol mode)	Turns ON when a data overflow occurred during reception through the RS-422A port in no-protocol mode.	
	15	RS-422A Port Settings Changing Flag	Turns ON while the RS-422A port's communications settings are being changed.	
A319	00 to 15	RS-422A Port Reception Counter (no-protocol mode)	Indicates (in binary) the number of bytes of data received when the RS-422A port is in no-protocol mode.	User
A526	07	RS-422A Port Restart Bit	Turn this bit ON to restart the RS-422A port. This bit is turned OFF automatically when the restart processing is completed.	

Allocations That Are the Same for the Coordinator Module and Motion Control Modules

System Flags

Address	Bits	Name	Function	Controlled by																					
A019 to A034	00 to 15	Subroutine Input Condition Flags	<p>These flags contain the status of the input condition for JSB(982) when JSB(982) is used to call a subroutine.</p> <table border="1"> <thead> <tr> <th colspan="2">Address</th> <th>Corresponding subroutines</th> </tr> <tr> <th>Word</th> <th>Bits</th> <td></td> </tr> </thead> <tbody> <tr> <td>A019</td> <td>00 to 15</td> <td>SBN000 to SBN015</td> </tr> <tr> <td>A020</td> <td>00 to 15</td> <td>SBN016 to SBN031</td> </tr> <tr> <td>A021</td> <td>00 to 15</td> <td>SBN032 to SBN047</td> </tr> <tr> <td>to</td> <td>to</td> <td>to</td> </tr> <tr> <td>A034</td> <td>00 to 15</td> <td>SBN240 to SBN255</td> </tr> </tbody> </table>	Address		Corresponding subroutines	Word	Bits		A019	00 to 15	SBN000 to SBN015	A020	00 to 15	SBN016 to SBN031	A021	00 to 15	SBN032 to SBN047	to	to	to	A034	00 to 15	SBN240 to SBN255	Module
Address		Corresponding subroutines																							
Word	Bits																								
A019	00 to 15	SBN000 to SBN015																							
A020	00 to 15	SBN016 to SBN031																							
A021	00 to 15	SBN032 to SBN047																							
to	to	to																							
A034	00 to 15	SBN240 to SBN255																							
A262 to A263	00 to 15	Maximum Cycle Time	These words store the maximum cycle time every cycle. The cycle time is recorded in 8-digit hexadecimal (unit: 0.01 ms).																						
A264 to A265	00 to 15	Present Cycle Time	These words store the present cycle time every cycle in 8-digit hexadecimal (unit: 0.01 ms).																						
A200	11	First Cycle Flag	ON for just one cycle after FQM1 operation begins.																						
	12	Step Flag	ON for just one cycle when step execution is started with STEP(008).																						
A000	00 to 15	10-ms Incrementing Free Running Timer	<p>This word contains a system timer used after the power is turned ON. The timer is reset to 0000 hex when the power is turned ON and this value is automatically incremented by 1 every 10 ms. The value returns to 0000 hex after reaching FFFF hex (655,350 ms), and then continues to be automatically incremented by 1 every 10 ms.</p> <p>Note The timer will continue to be incremented when the operating mode is switched to RUN mode.</p>																						
A001	00 to 15	100-ms Incrementing Free Running Timer	<p>This word contains a system timer used after the power is turned ON. The timer is reset to 0000 hex when the power is turned ON and this value is automatically incremented by 1 every 100 ms. The value returns to 0000 hex after reaching FFFF hex (6,553,500 ms), and then continues to be automatically incremented by 1 every 100 ms.</p> <p>Note The timer will continue to be incremented when the operating mode is switched to RUN mode.</p>																						

File Memory Flags

Address	Bits	Name	Function	Controlled by
A345	01	Symbol Table File Flag	Turns ON when the comment memory contains a symbol table file (variable table file).	Module
	02	Comment File Flag	Turns ON when the comment memory contains a comment file.	
	03	Program Index File Flag	Turns ON when the comment memory contains a program index file.	

Program Error Flags

Address	Bits	Name	Function	Controlled by
A401	09	Program Error Flag (fatal error)	ON when program contents are incorrect. Module operation will stop.	Module
A295	11	No END Error Flag	ON when there isn't an END(001) instruction in each program within a task.	
	12	Task Error Flag	ON when a task error has occurred. The following conditions generate a task error. There isn't a program allocated to the task.	
	13	Differentiation Overflow Error Flag	The allowed value for Differentiation Flags which correspond to differentiation instructions has been exceeded.	
	14	Illegal Instruction Error Flag	ON when a program that cannot be executed has been stored.	
	15	UM Overflow Error Flag	ON when the last address in UM (User Memory) has been exceeded.	

Other Error Flags and Bits

Error Log and Error Code

Address	Bits	Name	Function	Controlled by
A100 to A199	00 to 15	Error Log Area	When an error has occurred, the error code and error contents are stored in the Error Log Area.	Module
A300	00 to 15	Error Log Pointer	When an error occurs, the Error Log Pointer (binary) is incremented by 1 to indicate the location where the next error will be recorded as an offset from the beginning of the Error Log Area (A100 to A199).	
A500	14	Error Log Pointer Reset and Memory Not Held Flag OFF Bit	When this bit goes from OFF to ON, the error log pointer in A408 is reset to 0000 hex and Memory Not Held Flag (A404.14) is turned OFF.	User
A400	00 to 15	Error code	When a non-fatal error (user-defined FAL(006) or system error) or a fatal error (user-defined FALS(007) or system error) occurs, the hexadecimal error code is written to this word.	Module

FAL/FALS Errors

Address	Bits	Name	Function	Controlled by
A401	06	FALS Error Flag (fatal error)	Turns ON when a non-fatal error is generated by the FALS(006) instruction. The FQM1 will stop operating.	Module
A402	15	FAL Error Flag (non-fatal error)	Turns ON when a non-fatal error is generated by executing FAL(006). The FQM1 will continue operating.	

Memory Errors

Address	Bits	Name	Function	Controlled by
A401	14	I/O Bus Error Flag	ON when an error occurs in a data transfer between the Coordinator Module and a Motion Control Module. The Module will stop operating.	Module
	15	Memory Error Flag (fatal error)	Turns ON when there is an error in the memory. FQM1 operation will stop and the ERR indicators on the front of the Modules will light.	
A403	00	UM Error Flag	Turns ON when there is an error in the user memory.	
	04	System Setup Error Flag	Turns ON when there is an error in the System Setup in the Coordinator Module or Motion Control Module.	
	07	Routing Table Error Flag	Turns ON when there is an error in the routing table.	
	10	Flash Memory Error Flag	Turns ON when the flash memory is physically destroyed.	
	14	Flash Memory DM Checksum Error Flag	Turns ON when there is an error in the DM Area data backed up in flash memory.	
A316	14	Memory Not Held Flag	Turns ON when corruption is found in the check performed after turning ON power in the areas backed up during power interruptions (DM Area (Motion Control Module only) and Error Log Area).	

System Setup

Address	Bits	Name	Function	Controlled by
A402	10	System Setup Error Flag	Turns ON when there is a setting error in the System Setup.	Module
A406	00 to 15	System Setup Error Location	When there is a setting error in the System Setup, the location (setting address) of that error is written to A406 in 4-digit hexadecimal.	

Other

Address	Bits	Name	Function	Controlled by
A401	08	Cycle Time Too Long Flag (fatal error)	Turns ON if the cycle time exceeds the maximum cycle time set in the System Setup (the Watch Cycle Time).	Module
A316	05	Constant Cycle Time Exceeded Flag	Turns ON when the actual cycle time exceeds the specified constant (minimum) cycle time.	
A555	15	Constant Cycle Time Exceeded Error Clear Bit	Used to enable the constant cycle time function again after the constant cycle time has been exceeded.	User

Debugging

Online Editing

Address	Bits	Name	Function	Controlled by
A201	10	Online Editing Wait Flag	ON when an online editing process is waiting.	Module
	11	Online Editing Processing Flag	ON when an online editing process is being executed.	
A527	00 to 07	Online Editing Disable Bit Validator	The Online Editing Disable Bit (A52709) is valid only when this byte contains 5A. 5A: Online Editing Disable Bit enabled Other value: Online Editing Disable Bit disabled	User
	09	Online Editing Disable Bit	Turn this bit ON to disable online editing.	
A540 to A544	00 to 15	Macro Area Input Words	When MCRO(099) is executed, it copies the 5 words of input data from the specified source words (input parameter words) to these words.	Module
A545 to A549	00 to 15	Macro Area Output Words	After the subroutine specified in MCRO(099) has been executed, the 5-word results of the subroutine are transferred from these words to the specified destination words (output parameter words).	

Differentiation Monitoring

Address	Bits	Name	Function	Controlled by
A508	09	Differentiate Monitor Completed Flag	ON when the differentiate monitor condition has been established during execution of differentiation monitoring. Note This flag will be cleared to 0 when differentiation monitoring starts.	Module

Data Tracing

Address	Bits	Name	Function	Controlled by
A508	15	Sampling Start Bit	When a data trace is started by turning this bit from OFF to ON from the CX-Programmer, the PLC will begin storing data in Trace Memory by one of the three following methods: 1. Periodic sampling (10 to 2,550 ms) 2. Sampling at execution of TRSM(045) 3. Sampling at the end of every cycle. These flag operations can be executed only from the CX-Programmer.	Module
	14	Trace Start Bit	Turn this bit from OFF to ON to establish the trigger condition. The offset indicated by the delay value (positive or negative) determines which data samples are valid.	
	13	Trace Busy Flag	ON when the Sampling Start Bit (A50815) is turned from OFF to ON. Goes OFF when the trace is completed.	
	12	Trace Completed Flag	ON when sampling of a region of trace memory has been completed during execution of a Trace. Goes OFF the next time the Sampling Start Bit (A50815) is turned from OFF to ON.	
	11	Trace Trigger Monitor Flag	ON when a trigger condition is established by the Trace Start Bit (A50814). Goes OFF when the next Data Trace is started by the Sampling Start bit (A50815).	

Function Block Flags

Address	Bits	Name	Function	Controlled by
A345	00	FB Program Information Flag	ON when there is FB program data in the FB program memory.	Module

C-6 Built-in I/O Allocations

The Coordinator Module and Motion Control Modules all have built-in I/O. The I/O Area allocations to the contacts on the Modules are given in the following tables.

Coordinator Module Built-in I/O Allocations

Inputs (40-pin General-purpose I/O Connector)

Name	I/O Area allocations
External input 0	CIO 2960.00
External input 1	CIO 2960.01
to	to
External input 15	CIO 2960.15

Outputs (40-pin General-purpose I/O Connector)

Name	I/O Area allocations
External output 0	CIO 2961.00
External output 1	CIO 2961.01
to	to
External output 7	CIO 2961.07

Motion Control Module Built-in I/O Allocations

Inputs (26-pin General-purpose I/O Connector)

Name	I/O Area allocations
External input 0 (interrupt)	CIO 2960.00
External input 1 (interrupt)	CIO 2960.01
External input 2 (interrupt)	CIO 2960.02
External input 3 (interrupt)	CIO 2960.03
to	to
External input 11	CIO 2960.11

Outputs (26-pin General-purpose I/O Connector)

Name	I/O Area allocations
External output 0	CIO 2961.00
External output 1	CIO 2961.01
to	to
External output 7	CIO 2961.07

Appendix D

Auxiliary Area Allocations

D-1 Auxiliary Area Allocations in Order of Address

The following table lists the Auxiliary Area allocations in order of address. Refer to *Auxiliary Area Allocations by Function* on page 408 for a list of allocations by function.

Read-only Words: A000 to A447, Read/Write Words: A448 to A959

Word	Bits	Name	Function																				
A000	00 to 15	10-ms Incrementing Free Running Timer	This word contains a system timer used after the power is turned ON. The timer is reset to 0000 hex when the power is turned ON and this value is automatically incremented by 1 every 10 ms. The value returns to 0000 hex after reaching FFFF hex (655,350 ms), and then continues to be automatically incremented by 1 every 10 ms. Note The timer will continue to be incremented when the operating mode is switched to RUN mode.																				
A001	00 to 15	100-ms Incrementing Free Running Timer	This word contains a system timer used after the power is turned ON. The timer is reset to 0000 hex when the power is turned ON and this value is automatically incremented by 1 every 100 ms. The value returns to 0000 hex after reaching FFFF hex (6,553,500 ms), and then continues to be automatically incremented by 1 every 100 ms. Note The timer will continue to be incremented when the operating mode is switched to RUN mode.																				
A019 to A034	00 to 15	Subroutine Input Condition Flags	These flags contain the status of the input condition for JSB(982) when JSB(982) is used to call a subroutine. <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Address</th> <th rowspan="2">Corresponding subroutines</th> </tr> <tr> <th>Word</th> <th>Bits</th> </tr> </thead> <tbody> <tr> <td>A019</td> <td>00 to 15</td> <td>SBN000 to SBN015</td> </tr> <tr> <td>A020</td> <td>00 to 15</td> <td>SBN016 to SBN031</td> </tr> <tr> <td>A021</td> <td>00 to 15</td> <td>SBN032 to SBN047</td> </tr> <tr> <td>to</td> <td>to</td> <td>to</td> </tr> <tr> <td>A034</td> <td>00 to 15</td> <td>SBN240 to SBN255</td> </tr> </tbody> </table>	Address		Corresponding subroutines	Word	Bits	A019	00 to 15	SBN000 to SBN015	A020	00 to 15	SBN016 to SBN031	A021	00 to 15	SBN032 to SBN047	to	to	to	A034	00 to 15	SBN240 to SBN255
Address		Corresponding subroutines																					
Word	Bits																						
A019	00 to 15	SBN000 to SBN015																					
A020	00 to 15	SBN016 to SBN031																					
A021	00 to 15	SBN032 to SBN047																					
to	to	to																					
A034	00 to 15	SBN240 to SBN255																					
A050	00 to 07 08 to 15	Basic I/O Unit Information (Rack 0 slot 0) Basic I/O Unit Information (Rack 0 slot 1)	A bit will turn ON to indicate when the load short-circuit protection function alarm output has been output.																				
A051 to A059	00 to 15	Basic I/O Unit Information (Rack 0 slot 2 to Rack 1 slot 9) The FQM1 supports only 1 Expansion Rack.	Only the 4 rightmost bits are used for the CJ1W-OD202 (2-point units), only the rightmost bit is used for the CJ1W-OD212, OD204, MD232 and only the two rightmost bits are used for the CJ1W-OD232. Each bit indicates the status for one circuit. Note This area is valid only when an FQM1-CM002 is being used.																				
A100 to A199	00 to 15	Error Log Area	When an error has occurred, the error code and error contents are stored in the Error Log Area.																				
A200	11	First Cycle Flag	ON for one cycle after FQM1 operation begins.																				
	12	Step Flag	ON for one cycle when step execution is started with STEP(008).																				
A201	10	Online Editing Wait Flag	ON when an online editing process is waiting. (An error will occur if another online editing request is received while waiting and that request will not be executed.) 1: Waiting for online editing 0: Not waiting for online editing																				
	11	Online Editing Processing Flag	ON when an online editing process is being executed. 1: Online editing being executed 0: Online editing not being executed																				
A220 to A259	00 to 15	Basic I/O Unit Input Response Time	These words contain the actual input response times for CJ-series Basic I/O Units. Range: 0000 to 0017 hex Note This area is valid only when an FQM1-CM002 is being used.																				
A262 to A263	00 to 15	Maximum Cycle Time	These words store the maximum cycle time every cycle. The cycle time is recorded in 8-digit hexadecimal (unit: 0.01 ms).																				

Word	Bits	Name	Function	
A264 to A265	00 to 15	Present Cycle Time	These words stores the present cycle time every cycle in 8-digit hexadecimal (unit: 0.01 ms).	
A270	00	Motion Control Module slot 1	ON if the Motion Control Module is in slot 1.	
	01	Motion Control Module slot 2	ON if the Motion Control Module is in slot 2.	
	02	Motion Control Module slot 3	ON if the Motion Control Module is in slot 3.	
	03	Motion Control Module slot 4	ON if the Motion Control Module is in slot 4.	
A295	11	No END Error Flag	ON when there isn't an END(001) instruction in each program within a task.	
	12	Task Error Flag	ON when a task error has occurred. The following conditions generate a task error. There isn't a program allocated to the task.	
	13	Differentiation Overflow Error Flag	The allowed value for Differentiation Flags which correspond to differentiation instructions has been exceeded.	
	14	Illegal Instruction Error Flag	ON when a program that cannot be executed has been stored.	
	15	UM Overflow Error Flag	ON when the last address in UM (User Memory) has been exceeded.	
A300	00 to 15	Error Log Pointer	When an error occurs, the Error Log Pointer (binary) is incremented by 1 to indicate the location where the next error will be recorded as an offset from the beginning of the Error Log Area (A100 to A199). Range: 00 to 14 hex	
A302	00 to 15	CPU Bus Unit Initializing Flags	These flags are ON while the corresponding CPU Bus Unit is initializing after its CPU Bus Unit Restart Bit (A501.00 to A501.15) is turned from OFF to ON or the power is turned ON. Note This area is valid only when an FQM1-CM002 is being used.	
A316	05	Constant Cycle Time Exceeded Error Clear Bit	Used to enable the constant cycle time function again after the constant cycle time has been exceeded.	
	06	Sync Cycle Time Too Long Flag	Turns ON when one of the Modules exceeds the specified sync cycle time. (Coordinator Module only)	
	14	Memory Not Held Flag	Turns ON when corruption is found in the check performed after turning ON power in the areas backed up during power interruptions (DM Area (Motion Control Module only) and Error Log Area).	
A318	02	RS-422A Port Error Flags	Parity Error Flag	These error flags turn ON when an error has occurred at the RS-422A port.
	03		Framing Error Flag	
	04		Overrun Error Flag	
	05		Timeout Error Flag	
	08	RS-422A Port Communications Error Flag	Turns ON when a communications error has occurred at the RS-422A port.	
	09	RS-422A Port Send Ready Flag (no-protocol mode)	Turns ON when the RS-422A port is ready to send data in no-protocol mode.	
	10	RS-422A Port Reception Completed Flag (no-protocol mode)	Turns ON when the RS-422A port has completed the reception in no-protocol mode.	
	11	RS-422A Port Reception Overflow Flag (no-protocol mode)	Turns ON when a data overflow occurred during reception through the RS-422A port in no-protocol mode.	
15	RS-422A Port Settings Changing Flag	Turns ON while the RS-422A port's communications settings are being changed.		
A319	00 to 15	RS-422A Port Reception Counter (no-protocol mode)	Indicates (in binary) the number of bytes of data received when the RS-422A port is in no-protocol mode.	
A330 to A335	00 to 15	Special I/O Unit Initializing Flags	These flags are ON while the corresponding Special I/O Unit is initializing after its Special I/O Unit Restart Bit (A502.10 to A507.15) is turned from OFF to ON or the power is turned ON. Note Unit numbers 0 to 9 cannot be set on Special I/O Units, so A330.00 to A330.09 are not used.	
A336	00 to 15	Units Detected at Startup (Racks 0 and 1)	The number of Units detected on each Rack is stored in 1-digit hexadecimal (0 to A hex). Rack 0: A336.00 to A336.03 Rack 1: A336.04 to A336.07 Note Motion Control Modules are not included in the detected Units.	

Word	Bits	Name	Function
A345	00	FB Program Information Flag	ON when there is FB program data in the FB program memory.
	01	Symbol Table File Flag	Turns ON when the comment memory contains a symbol table file (variable table file).
	02	Comment File Flag	Turns ON when the comment memory contains a comment file.
	03	Program Index File Flag	Turns ON when the comment memory contains a program index file.
	04	DM Data in FROM Flag	Turns ON when there is DM data saved in flash memory.
A392	04	RS-232C Port Communications Error Flag	Turns ON when a communications error has occurred at the RS-232C port.
	05	RS-232C Port Send Ready Flag (no-protocol mode)	Turns ON when the RS-232C port is ready to send data in no-protocol mode.
	06	RS-232C Port Reception Completed Flag (no-protocol mode)	Turns ON when the RS-232C port has completed the reception in no-protocol mode.
	07	RS-232C Port Reception Overflow Flag (no-protocol mode)	Turns ON when a data overflow occurred during reception through the RS-232C port in no-protocol mode.
	12	RS-232C Port Settings Changing Flag	Turns ON while the RS-232C port's communications settings are being changed.
A393	00 to 15	RS-232C Port Reception Counter (no-protocol mode)	Indicates (in binary) the number of bytes of data received when the RS-232C port is in no-protocol mode.
	00 to 07	RS-232C Port PT Communications Flags	The corresponding bit will be ON when the RS-232C port is communicating with a PT in NT link mode or Serial PLC Link mode. Bits 0 to 7 correspond to units 0 to 7.
	08 to 15	RS-232C Port PT Priority Registered Flags	The corresponding bit will be ON for the PT that has priority when the RS-232C port is communicating in NT link mode. Bits 0 to 7 correspond to units 0 to 7.
A394	00 to 07	Peripheral Port PT Communications Flags	The corresponding bit will be ON when the peripheral port is communicating with a PT in NT link mode. Bits 0 to 7 correspond to units 0 to 7.
	08 to 15	Peripheral Port PT Priority Registered Flags	The corresponding bit will be ON for the PT that has priority when the peripheral port is communicating in NT link mode. Bits 0 to 7 correspond to units 0 to 7.
A400	00 to 15	Error code	When a non-fatal error (user-defined FAL(006) or system error) or a fatal error (user-defined FALS(007) or system error) occurs, the hexadecimal error code is written to this word.
A401	06	FALS Error Flag (fatal error)	Turns ON when a non-fatal error is generated by the FALS(006) instruction. The FQM1 will stop operating.
	08	Cycle Time Too Long Flag (fatal error)	Turns ON if the cycle time exceeds the maximum cycle time set in the System Setup (the Watch Cycle Time).
	09	Program Error Flag (fatal error)	ON when program contents are incorrect. Module operation will stop.
	10	I/O Setting Error Flag	Turns ON when more than four Motion Control Modules are connected to the Coordinator Module.
	11	Too Many I/O Points Flag	ON when a Unit model registered in the I/O table does not match the model actually connected.
	13	Duplication Error Flag	ON in the following cases: <ul style="list-style-type: none"> • Two CPU Bus Units have been assigned the same unit number. • Two Special I/O Units have been assigned the same unit number or a Special I/O Unit has been assigned a unit number between 0 and 9. • Two Basic I/O Units have been allocated the same data area words.
	14	I/O Bus Error Flag	Turns ON when an error occurs in transferring data between the Coordinator Module and Motion Control Modules. Module operation will stop.
15	Memory Error Flag (fatal error)	Turns ON when there is an error in the memory. FQM1 operation will stop and the ERR indicators on the front of the Modules will light.	

Word	Bits	Name	Function
A402	05	Motion Control Module Monitoring Error Flag	Turns ON in the Coordinator Module when a system error, such as a WDT error, occurs in any of the Motion Control Modules.
	06	Special I/O Unit Error Flag	This flag will be turned ON when an error occurs in a data exchange between the Coordinator Module and a Special I/O Unit.
	07	CPU Bus Unit Error Flag	ON when an error occurs in a data exchange between the Coordinator Module and a CPU Bus Unit (including an error in the CPU Bus Unit itself).
	08	Coordinator Module WDT Error Flag (Motion Control Modules only)	Turns ON in the Motion Control Modules when a WDT error occurs in the Coordinator Module.
	10	System Setup Error Flag	Turns ON when there is a setting error in the System Setup.
	14	Coordinator Module Fatal Error Flag (Motion Control Modules only)	Turns ON in the Motion Control Modules when a fatal error occurs in the Coordinator Module.
	15	FAL Error Flag (non-fatal error)	Turns ON when a non-fatal error is generated by executing FAL(006). The FQM1 will continue operating.
A403	00	UM Error Flag	Turns ON when there is an error in the user memory.
	04	System Setup Error Flag	Turns ON when there is an error in the System Setup in the Coordinator Module or Motion Control Module.
	10	Flash Memory Error Flag	Turns ON when the flash memory is physically destroyed.
	13	Analog Offset/Gain Error Flag	Turns ON when there is an error in the analog I/O offset/gain adjustment value in flash memory.
	14	Flash Memory DM Checksum Error Flag	Turns ON when there is an error in the DM Area data backed up in flash memory.
A404	00 to 07	I/O Bus Error Slot Number	Contains the 2-digit slot number (00 to 09) where an I/O Bus Error occurred. When the End Cover is not connected, 0E hex will be stored. If the error location is undetermined, 0F hex will be stored.
	08 to 15	I/O Bus Error Rack Number	Contains the 2-digit rack number (00 or 01) where an I/O Bus Error occurred. When the End Cover is not connected, 0E hex will be stored. If the error location is undetermined, 0F hex will be stored.
A406	00 to 15	System Setup Error Location	When there is a setting error in the System Setup, the location (setting address) of that error is written to A406 in 4-digit hexadecimal.
A407	00 to 12	Too Many I/O Points, Details	The cause of the Too Many I/O Points Error is indicated in binary in A407.13 to A407.15. The 13-bit binary value in A407.00 to A407.12 indicates the details: the excessive value or the duplicated unit number. <ul style="list-style-type: none"> The number of I/O points will be written here when the total number of I/O points set in the I/O Table (excluding Slave Racks) exceed the maximum allowed for the Coordinator Module. The number of interrupt inputs will be written here when the number of interrupt inputs exceeds 32. The number of Racks will be written here when the number of Expansion Racks exceeds the maximum.
	13 to 15	Too Many I/O Points, Cause	The 3-digit binary value of these bits indicates the cause of the Too Many I/O Points Error and shows the meaning of the value written to bits A407.00 to A407.12.
A410	00 to 15	CPU Bus Unit Number Duplication Flags	The Duplication Error Flag (A401.13) and the corresponding flag in A410 will be turned ON when an CPU Bus Unit's unit number has been duplicated. Bits 00 to 15 correspond to unit numbers 0 to F.
A411 to A416	00 to 15	Special I/O Unit Number Duplication Flags	The Duplication Error Flag (A401.13) and the corresponding flag in A411 through A416 will be turned ON when a Special I/O Unit's unit number has been duplicated or a Special I/O Unit's unit number has been set between 0 and 9. (Bits A411.00 to A416.15 correspond to unit numbers 0 to 95.)
A417	00 to 15	CPU Bus Unit Error, Unit Number Flags	When an error occurs in a data exchange between the Coordinator Module and a CPU Bus Unit, the CPU Bus Unit Error Flag (A402.07) is turned ON and the bit in A417 corresponding to the unit number of the Unit where the error occurred is turned ON. Bits 00 to 15 correspond to unit numbers 0 to F.
A418 to A423	00 to 15	Special I/O Unit Error, Unit Number Flags	When an error occurs in a data exchange between the Coordinator Module and a Special I/O Unit, the Special I/O Unit Error Flag (A402.06) and the corresponding flag in this area are turned ON. Bits A418.00 to A423.15 correspond to unit numbers 0 to 95.
A450	00 to 15	CIO Area, Area ID Code	00B0 (fixed)
A451	00 to 15	WR Area, Area ID Code	00B1 (fixed)
A452	00 to 15	HR Area, Area ID Code	00B2 (fixed)
A459	00 to 15	IR Area, Area ID Code	00DC (fixed)
A460	00 to 15	DM Area, Area ID Code	0082 (fixed)

Word	Bits	Name	Function
A461 to A473	00 to 15	EM Banks 0 to C, Area ID Codes	0050 to 005C (fixed)
A500	14	Error Log Pointer Reset and Memory Not Held Flag OFF Bit	The error log pointer in A300 is reset to 0000 hex and Memory Not Held Flag (A404.14) is turned OFF when this bit is turned ON.
A501	00 to 15	CPU Bus Unit Restart Bits	Turn these bits ON to restart (initialize) the CPU Bus Unit with the corresponding unit number. Bits 00 to 15 correspond to unit numbers 0 to F.
A502 to A507	00 to 15	Special I/O Unit Restart Bits	Turn these bits ON to restart (initialize) the Special I/O Unit with the corresponding unit number. Bits A502.10 to A507.15 correspond to unit numbers 10 to 95.
A508	09	Differentiate Monitor Completed Flag	Turns ON when the differentiate monitor condition has been established during execution of differentiation monitoring. (This flag will be turned OFF when differentiation monitoring starts.)
	11	Trace Trigger Monitor Flag	Turns ON when a trigger condition is established by the Trace Start Bit (A508.14). OFF when the next Data Trace is started by the Sampling Start bit (A508.15).
	12	Trace Completed Flag	Turns ON when sampling of a region of trace memory has been completed during execution of a Trace. Turns OFF when the next time the Sampling Start Bit (A508.15) is turned from OFF to ON.
	13	Trace Busy Flag	Turns ON when the Sampling Start Bit (A508.15) is turned from OFF to ON. Turns OFF when the trace is completed.
	14	Trace Start Bit	Turn this bit ON to establish the trigger condition. The offset indicated by the delay value (positive or negative) determines which data samples are valid.
	15	Sampling Start Bit	When a data trace is started by turning this bit from OFF to ON from the CX-Programmer, the FQM1 will begin storing data in Trace Memory by one of the three following methods: 1) Data is sampled at regular intervals (10 to 2,550 ms). 2) Data is sampled when TRSM(045) is executed in the program. 3) Data is sampled at the end of every cycle. The operation of A508.15 can be controlled only from the CX-Programmer.
A526	00	RS-232C Port Restart Bit	Turn this bit ON to restart the RS-232C port. This bit is turned OFF automatically when the restart processing is completed.
	01	Peripheral Port Restart Bit	Turn this bit ON to restart the peripheral port. This bit is turned OFF automatically when the restart processing is completed.
	07	RS-422A Port Restart Bit	Turn this bit ON to restart the RS-422A port. This bit is turned OFF automatically when the restart processing is completed.
A527	00 to 07	Online Editing Disable Bit Validator	The Online Editing Disable Bit (A52709) is valid only when this byte contains 5A. 5A: Online Editing Disable Bit enabled Other value: Online Editing Disable Bit disabled
	09	Online Editing Disable Bit	Turn this bit ON to disable online editing.
A528	02	RS-232C Port Error Flags	Parity Error Flag
	03		Framing Error Flag
	04		Overrun Error Flag
	05		Timeout Error Flag
	10	Peripheral Port Error Flags	Parity Error Flag
	11		Framing Error Flag
	12		Overrun Error Flag
	13		Timeout Error Flag
A532	00 to 15	Interrupt Counter 0 Counter SV	Used for interrupt input 0 in counter mode. Sets the count value at which the interrupt task will start. Interrupt task 000 will start when interrupt counter 0 has counted this number of pulses. Setting range: 0000 to FFFF Note This area is valid only in Motion Control Modules.

Word	Bits	Name	Function
A533	00 to 15	Interrupt Counter 1 Counter SV	Used for interrupt input 1 in counter mode. Sets the count value at which the interrupt task will start. Interrupt task 001 will start when interrupt counter 1 has counted this number of pulses. Setting range: 0000 to FFFF Note This area is valid only in Motion Control Modules.
A534	00 to 15	Interrupt Counter 2 Counter SV	Used for interrupt input 2 in counter mode. Sets the count value at which the interrupt task will start. Interrupt task 002 will start when interrupt counter 2 has counted this number of pulses. Setting range: 0000 to FFFF Note This area is valid only in Motion Control Modules.
A535	00 to 15	Interrupt Counter 3 Counter SV	Used for interrupt input 3 in counter mode. Sets the count value at which the interrupt task will start. Interrupt task 003 will start when interrupt counter 3 has counted this number of pulses. Setting range: 0000 to FFFF Note This area is valid only in Motion Control Modules.
A536	00 to 15	Interrupt Counter 0 Counter PV	These words contain the interrupt counter PVs for interrupt input 0 to 3 operating in counter mode. The counter PV starts decrementing from the counter SV. When the counter PV reaches the 0, the PV is automatically reset to the SV. Range: 0000 to FFFF Note This area is valid only in Motion Control Modules.
A537	00 to 15	Interrupt Counter 1 Counter PV	
A538	00 to 15	Interrupt Counter 2 Counter PV	
A539	00 to 15	Interrupt Counter 3 Counter PV	
A540 to A544	00 to 15	Macro Area Input Words	When MCRO(099) is executed, it copies the 5 words of input data from the specified source words (input parameter words) to these words.
A545 to A549	00 to 15	Macro Area Output Words	After the subroutine specified in MCRO(099) has been executed, the 5-word results of the subroutine are transferred from these words to the specified destination words (output parameter words).
A554	00 to 15	Data Trace Period	Data will be traced using the period specified here when tracing each cycle is specified from the CX-Programmer. 0000 hex: Each cycle 0001 to 000F hex: Every 2 to 16 cycles
A555	15	Constant Cycle Time Exceeded Error Clear Bit	Used to enable the constant cycle time function again after the constant cycle time has been exceeded.
A556	00	DM Write Request Bit (Coordinator Module to Motion Control Module)	DM data transfer is executed from the Coordinator Module to Motion Control Module when this bit turns ON.
	01	DM Read Request Bit (Motion Control Module to Coordinator Module)	DM data transfer is executed from the Motion Control Module to Coordinator Module when this bit turns ON.
A557	00 to 15	Slot No. of Motion Control Module for DM Transfer	Specifies the slot number (in 4-digit hexadecimal) for the Motion Control Module with which DM data is to be transferred. 0001: Motion Control Module #1 0002: Motion Control Module #2 0003: Motion Control Module #3 0004: Motion Control Module #4
A558	00 to 15	DM Transfer Size (number of words)	Specifies the size, in number of words, of the DM data to be transferred. 0001 to 01F3 hex (1 to 499 words)
A559	00 to 15	First DM Transfer Source Word	Specifies the first address of the DM transfer source in the Coordinator Module or Motion Control Module. 0000 to 7FFF hex
A560	00 to 15	First DM Transfer Destination Word	Specifies the first address of the DM transfer destination in the Coordinator Module or Motion Control Module. 0000 to 7FFF hex
A561	14	Transfer Error Flag	Turns ON when a DM data transfer error occurs.
	15	Transfer Busy Flag	Turns ON during DM data transfer and turns OFF when the transfer has been completed.
A619	01	Peripheral Port Settings Changing Flag	Turns ON while the peripheral port's communications settings are being changed.
	02	RS-232C Port Settings Changing Flag	Turns ON while the RS-232C port's communications settings are being changed.

Word	Bits	Name	Function
A751	11	Saved DM Data Invalid Flag	ON if the DM data in flash memory was invalid when it was read. This flag is cleared when DM data is saved.
	12	Invalid DM Save Password Flag	ON if A752 contains the wrong password.
	13	DM Backup Error Flag	ON if the DM data save operation failed.
	14	Saving DM Flag	ON when DM data is being saved to flash memory.
	15	DM Save Start Bit	Write the password to A752 and turn this bit ON to save DM data to flash memory. The data can be saved only when the Motion Control Module is in PROGRAM mode.
A752	00 to 15	DM Save Password	Write A5A5 hex to this word and turn ON the DM Save Start Bit (A751.15) to transfer DM data to flash memory (PROGRAM mode only). When the DM data transfer is completed, this word is automatically cleared.
A800	00 to 15	Analog Input PV	Contains the value input from the analog input port (using either the END refresh or immediate refresh) in 4-digit hexadecimal. The PV range depends on the input range: <ul style="list-style-type: none"> • 0 to 10 V: FE70 to 20D0 hex • 0 to 5 V or 1 to 5 V: FF38 to 1068 hex • -10 to 10 V: DDA0 to 2260 hex
A802	00	Analog Input Status	User Adjustment Completed OFF: Not adjusted ON: Adjustment completed
	07		Analog Sampling Started OFF: Not started ON: Started
	08		Factory Adjustment Data Error OFF: No Error ON: Error (Checked at power ON.)
	09		User Adjustment Data Error OFF: No Error ON: Error (Checked at power ON.)
	15		Analog Sampling Overlap OFF: Normal sampling ON: The next sampling operation occurred before the present sampling operation completed.
A809	00 to 15	Number of Analog Samples	Indicates the number of data samples actually input since sampling started.
A810	00 to 15	Analog Output 1 Output Value	When an END refresh is selected, the 4-digit hexadecimal value set here by the user is output from analog output port 1. When immediate refreshing is selected, the 4-digit hexadecimal value being output from analog output port 1 is stored here for monitoring. The output value range depends on the output range, as shown below. <ul style="list-style-type: none"> • 0 to 10 V, 0 to 5 V or 1 to 5 V: FF38 to 1068 hex • -10 to 10 V: EA84 to 157C hex Note 1. Set the analog output method (END or immediate refreshing) with the System Setup's output method setting. A setting of 0 hex specifies an END refresh. This setting applies to both analog output 1 and 2. 2. Specify the output range with the output 1 setting.
A811	00 to 15	Analog Output 2 Output Value	This word has the same settings as the analog output 1 output value (A560), above. (When an END refresh is selected, set the value to output from analog output port 2. When an immediate refresh is selected, the output value is stored here for monitoring.) Note 1. Set the analog output method (END or immediate refresh) with the System Setup's output method setting. A setting of 0 hex specifies an END refresh. This setting applies to both analog output 1 and 2. 2. Specify the output range with the output 2 setting.

Word	Bits	Name	Function		
A812	00	Analog Output 1 Flags	User Adjustment Completed Initial value is 0. Set to 1 if user performs offset/gain adjustment and Returns to factory default setting of 0 if adjustment value is cleared.		
	04		Operating ON: ON while the analog output is being changed by ACC(888). OFF: Turned OFF when target value is reached.		
	08		Output SV Error ON: ON when the output SV setting is outside of the allowed setting range. OFF: OFF when the output SV is within range.		
	12		Factory Adjustment Value Error ON: ON when the factory-set data stored in flash memory is invalid. OFF: OFF when the factory-set data stored in flash memory is normal.		
	14		User Adjustment Value Error ON: ON when the user-set adjustment value stored in flash memory is invalid. OFF: OFF when the user-set adjustment value stored in flash memory is normal.		
A813	00	Analog Output 1 Flags	User Adjustment Completed		
	04		Operating		
	08		Output SV Error		
	12		Factory Adjustment Value Error		
	14		User Adjustment Value Error		
A814	00	Analog Output 1 Conversion Enable Bit	ON: Enables D/A conversion (enables analog output). OFF: Disables D/A conversion (analog values output according to Output Stop Function specification in System Setup). Note This bit is cleared when the Modules operating mode is changed between RUN or MONITOR mode and PROGRAM mode.		
A815	00	Analog Output 2 Conversion Enable Bit	ON: Enables D/A conversion (enables analog output). OFF: Disables D/A conversion (analog values output according to Output Stop Function specification in System Setup). Note This bit is cleared when the Modules operating mode is changed between RUN or MONITOR mode and PROGRAM mode.		
A820	00	Adjustment Mode Command Bits (Effective only when A825 is 5A5A hex.)	Adjustment Enable	Analog Input	OFF: Adjustment disabled. ON: Adjustment enabled. When one of these bits is turned ON, the default value (offset or gain value) corresponding to the selected I/O signal range is transferred to Adjustment Mode Monitor Area (A822 and A823).
	02			Analog Output 1	
	03			Analog Output 2	
	07		Adjustment Mode Specifier	OFF: Offset adjustment ON: Gain adjustment	
	12		Adjustment Value Increment	While this bit is ON, the offset or gain value will be incremented by one resolution unit each 0.5 ms.	
	13		Adjustment Value Decrement	While this bit is ON, the offset or gain value will be decremented by one resolution unit each 0.5 ms.	
	14		Adjustment Value Clear	OFF to ON: Clears the adjustment data to the factory defaults.	
	15		Adjustment Value Set	OFF to ON: Reads the present value in the Adjustment Mode Monitor Area (A822 and A823) and saves this value to flash memory. This adjustment value will be used for the next normal mode operation.	
A821	00	Adjustment Mode Status	Adjustment Operation Error	ON when an operational error has been made, such as turning ON both the Analog Input and Analog Output 2 Adjustment Enable Bits at the same time.	
	15		Adjustment Mode Started	ON during adjustment mode operation (when A825 contains 5A5A hex).	

Word	Bits	Name		Function		
A822	00 to 15	Adjustment Mode Monitor (Effective only when A825 is 5A5A hex.)	Both Analog Input and Analog Outputs	Setting Offset Monitor	The values in these words can be overwritten directly, without using the Adjustment Value Increment/Decrement Bits.	<ul style="list-style-type: none"> –10 to 10 V: FE0C to 01F4 hex 0 to 10 V, 0 to 5 V, 1 to 5 V: FF38 to 00C8 hex
A823	00 to 15			Gain Value Monitor			–10 to 10 V: 1194 to 157C hex 0 to 10 V, 0 to 5 V, 1 to 5 V: 0ED8 to 1068 hex
A824	00 to 15		Analog Inputs	Number of Average Value Samples in Adjustment Mode	Indicates the number of values to be averaged to obtain the Offset/Gain Value Monitor values in adjustment mode. The number of samples can be set between 0000 and 0040 hex (0 to 64). Set this parameter before turning ON the Adjustment Enable Bit.	
A825	00 to 15	Adjustment Mode Password		5A5A hex: Adjustment mode enabled. Other value: Adjustment mode disabled.		
A850	00 to 15	High-speed Counter 1 PV		Range: 8000 0000 to 7FFF FFFF		
A851	00 to 15			Note For a Linear Counter, high-speed counter overflows/underflows are checked when the PV is read (i.e., when Module internal I/O is refreshed).		
A852	00 to 15	High-speed Counter 2 PV				
A853	00 to 15					
A854 to A855	00 to 15	High-speed Counter 1	For following counter modes	PV of absolute number of rotations	Contains the number of rotations data (PV) read from the Encoder when the SEN signal is input to the Servo Driver. 8000 0000 to 7FFF FFFF hex	
			<ul style="list-style-type: none"> Absolute linear (CW–) Absolute circular Absolute linear (CW+) 			
			For following counter modes	Monitor data	<ul style="list-style-type: none"> When monitoring counter movements (mode 1), contains the absolute value of the amount of change in the PV of the high-speed counter over the specified sampling time as a 8-digit hexadecimal value (0000 0000 to FFFF FFFF hex). When monitoring the counter frequency (mode 2), contains the frequency of the high-speed counter calculated from the PV of the high-speed counter between 0 and 7A120 hex (0 and 500 kHz). 	
A856 to A857	00 to 15	High-speed Counter 2	For following counter modes	PV of absolute number of rotations	Same as for A854 and A855 for high-speed counter 1 except that measuring the high-speed counter frequency is not possible for high-speed counter 2.	
			<ul style="list-style-type: none"> Absolute linear (CW–) Absolute circular Absolute linear (CW+) 			
			For following counter modes	Monitor data		
			<ul style="list-style-type: none"> Linear counter Circular counter 			

Word	Bits	Name	Function
A858	00	High-speed counter 1 status	Target Comparison In-progress Flag OFF: Target value comparison is not being performed for CTBL(882). Note This flag is always OFF for range comparison. ON: Target value comparison is being performed for CTBL(882). Note Target comparison is continued without interruption once it has been started (as opposed to range comparison), so this flag can be used to check whether target comparison is in progress.
	01		PV Overflow/Underflow Flag OFF: There is no counter overflow or underflow in Linear Counter Mode. This flag will always be OFF in Circular Counter Mode. ON: There is a counter overflow or underflow in Linear Counter Mode. The counter PV will be fixed at the overflow or underflow limit. This flag will be cleared when the High-speed Counter Start Bit is turned OFF.
	03		Phase Z Input Reset Flag (ON for one cycle) ON for one cycle when the counter PV is reset with the counter reset method set to a phase Z + software reset. Note This flag will turn ON for one cycle after the counter PV is reset if the phase Z signal (reset input) turns ON while the High-speed Counter Reset Bit (A860.01) is ON.
	04		Absolute No. of Rotations Read Error Flag OFF: No error ON: Error
	05		Absolute No. of Rotations Read Completed Flag OFF: Rotations being read or reading has not been executed. ON: Reading has been completed (Turned ON when serial reception of the number of rotations has been completed.)
	06		Measuring Flag (measurement mode 1 or 2) Note Valid when Counter Data Display in System Setup is set to Counter Movements (mode 1) or Frequency (mode 2). OFF: Changes in the counter PV or the counter frequency is not being measured. ON: Changes in the counter PV or the counter frequency is being measured. In measurement mode 1, this flag will turn ON at the beginning of the sampling time after the Measurement Start Bit (A860.02) is turned ON.
	07		High-speed Counter Operating Flag OFF: Counter is not operating. ON: Counter is operating.
	08		Count Latched Flag OFF: Count has not been latched. ON: Latching the count has been completed for the latch input.
	12		Absolute Offset Preset Error Flag OFF: No error occurred when saving the absolute offset. ON: An error occurred when saving the absolute offset.
A859	00	High-speed counter 2 status	Target Comparison In-progress Flag
	01		PV Overflow/Underflow Flag
	03		Phase Z Input Reset Flag (ON for one cycle)
	04		Absolute No. of Rotations Read Error Flag
	05		Absolute No. of Rotations Read Completed Flag
	06		Measuring Flag (measurement mode 1 or 2)
	07		High-speed Counter Operating Flag
	08		Count Latched Flag
	12		Absolute Offset Preset Error Flag

Word	Bits	Name	Function	
A860	00	High-speed counter 1 command bits	Start Bit	OFF: Stops counter operation. The counter PV will be maintained. ON: Starts counter operation. The counter PV will be reset.
	01		Reset Bit	OFF: If a software reset is set in the System Setup, the counter PV will not be reset when internal I/O is refreshed in the Motion Control Module. If a phase Z + software reset is set, disables the phase Z input. ON: If a software reset is set in the System Setup, resets the counter PV to 0 when internal I/O is refreshed in the Motion Control Module. If a phase Z + software reset is set, enables the phase Z input.
	02		Measurement Start Bit	OFF: Disables measuring changes in counter PV or the counter frequency. ON: Starts measuring changes in counter PV or the counter frequency. Note Measuring the high-speed counter frequency is possible only for high-speed counter 1. Note Valid when Counter Data Display in System Setup is set to Counter Movements (mode 1) or Frequency (mode 2).
	03		Measurement Direction Bit (measurement mode 2)	OFF: Forward (up) ON: Reverse (down) This bit specifies the up/down direction of the pulse input for frequency measurement. Note Always set this bit before turning ON the Measurement Start Bit.
	04		Range Comparison Results Clear Bit	OFF: Does not clear the execution results (A862) or output bit pattern (A863) from CTBL(882) execution for range comparison for the counter. ON: Clears the execution results (A862) or output bit pattern (A863) from CTBL(882) execution for range comparison for the counter.
	05		Absolute Offset Preset Bit	OFF: Does not preset the offset. OFF to ON: Stores the number of multi-turns read from the Servo Driver and the number of initial incremental pulses as an offset in the Absolute Offset value in the System Setup. When establishing the machine origin, the position from the absolute encoder origin is set as the Absolute Offset in the System Setup as the machine origin.
	06		Absolute Present Value Preset Bit	OFF: Disables the absolute present value preset. OFF to ON: Stores the Absolute PV in the counter 1 PV (A850 and A851). Note Refer to 7-7-6 <i>Absolute Present Value</i> for details on the absolute PV.
	07		Absolute Number of Rotations Read Bit	OFF: Disables reading the number of rotations data from the Servo Driver. OFF to ON: Outputs the SEN output to the Servo Driver and receives the number of rotations data on the phase A input.
	08		Latch Input 1 Enable Bit	OFF: Disables the external latch input 1 signal. ON: Enables the external latch input 1 signal.
	09		Latch Input 2 Enable Bit	OFF: Disables the external latch input 2 signal. ON: Enables the external latch input 2 signal.
A861	00	High-speed counter 2 command bits	Start Bit	Same as command bits for high-speed counter 1.
	01		Reset Bit	
	02		Measurement Start Bit	
	03		Reserved	
	04		Range Comparison Results Clear Bit	
	05		Absolute Offset Preset Bit	
	06		Absolute Present Value Preset Bit	
	07		Absolute Number of Rotations Read Bit	
	08		Latch Input 1 Enable Bit	
	09		Latch Input 2 Enable Bit	

Word	Bits	Name		Function
A862	00 to 15	High-speed counter 1 monitor data	Range Comparison Execution Results Flags	Contains the CTBL(882) execution results for range comparison. Bits 00 to 15 correspond to ranges 1 to 16. OFF: No match ON: Match
A863	00 to 15		Output Bit Pattern	Contains the output bit pattern when a match is found for CTBL(882) execution results for range comparison Note If more than one match is found, an OR of the output bit patterns with matches will be stored here.
A864	00 to 15	High-speed counter 2 monitor data	Range Comparison Results	Same as for high-speed counter 1 monitor data.
A865	00 to 15		Output Bit Pattern	
A870 to A871	00 to 15	Pulse Output 1 PV Note This item applies when the operation mode is relative pulse output, absolute pulse output in linear mode, absolute pulse output in circular mode, or electronic cam mode.		Contains the pulse output PV as an 8-digit hexadecimal number. Relative mode: 00000000 to FFFFFFFF hex Absolute linear mode: 80000000 to 7FFFFFFF hex Absolute circular mode: 00000000 to circular maximum count
			One-shot Pulse Output 1 ON Time Note This item applies when the operation mode is one-shot output mode.	Contains the time that the one-shot pulse output has been ON as an 8-digit hexadecimal number. 0000 0000 to 0000 270F (unit: set by STIM(980))
			Pulse Time Measurement 1 Note This item applies when the operation mode is time measurement mode using a pulse counter.	Contains the time measured by the pulse counter as an 8-digit hexadecimal number. 0000 0000 to FFFF FFFF hex (unit: set by STIM(980))
A872 to A873	00 to 15	Pulse Output 2 PV		Same as for Pulse Output 1 PV.
		One-shot Pulse Output 2 ON Time		Same as for One-shot Pulse Output 1 ON time.
		Pulse Time Measurement 2		Same as for Pulse Time Measurement 1.
A874	00	Pulse Output 1 Status	Pulse Output Completed Flag	OFF: Pulse output not completed (OFF during pulse output). ON: Pulse output completed (ON when pulse distribution has been completed).
	01		Pulse Output Set Flag	OFF: Pulse output amount not set by PULS(886). ON: Pulse output amount set by PULS(886).
	02		Target Frequency Not Reached Flag	OFF: Target speed has been reached during pulse output for PLS2(887). ON: Decelerated before reaching the target speed during pulse output for PLS2(887).
	03		Target Comparison Flag	OFF: Comparison stopped. ON: Comparison in progress.
	04		Independent Pulse Output Flag	OFF: Pulses not being output or being output continuously. ON: Pulses being output.
	05		PLS2 Positioning Flag	OFF: Not positioning. ON: Positioning in progress.
	06		Accelerating/Decelerating Flag	OFF: No output or constant-speed output. ON: Acceleration or deceleration in progress for ACC(888) or PLS2(887).
	07		Pulse Output Flag	OFF: Pulse output stopped. ON: Pulse output in progress.
	08		Pulse Output Direction Flag	OFF: CW or stopped. ON: CCW
A875	00	Pulse Output 2 Status	Pulse Output Completed Flag	Same as for Pulse Output 1 Status.
	01		Pulse Output Set Flag	
	02		Target Frequency Not Reached Flag	
	03		Target Comparison Flag	
	04		Independent Pulse Output Flag	
	05		PLS2 Positioning Flag	
	06		Accelerating/Decelerating Flag	
	07		Pulse Output Flag	
	08		Pulse Output Direction Flag	

Word	Bits		Name	Function
A876	00	Pulse Output 1 Command Bits	PV Reset Bit	OFF: Pulse output 1 PV not reset. ON: Resets pulse output 1 PV.
	01		Range Comparison Results Clear Bit	OFF: Does not clear the execution results (A880) or output bit pattern (A881) from CTBL(882) execution for range comparison for the pulse output PV. ON: Clears the execution results (A880) or output bit pattern (A881) from CTBL(882) execution for range comparison for the pulse output PV.
A877	00	Pulse Output 2 Command Bits	PV Reset Bit	Same as for Pulse Output 1 Command Bits.
	01		Range Comparison Results Clear Bit	
A878	07	Pulse Output Control Bits (Apply to both pulse outputs 1 and 2.)	Speed Change Cycle Bit	OFF: Sets the speed change cycle to 2 ms during pulse output to ACC(888) or PLS2(887). ON: Sets the speed change cycle to 1 ms during pulse output to ACC(888) or PLS2(887).
	14		PLS2 Pulse Output Direction Priority Mode Bit	OFF: Sets Direction Priority Mode. In Direction Priority Mode, pulses are output only when the pulse output direction and the direction of the specified absolute position are the same. ON: Sets Absolute Position Priority Mode. In Absolute Position Priority Mode, pulses are always output in the direction of the specified absolute position.
A880	00 to 15	Pulse Output 1 Monitor Data	Range Comparison Results	Contains the CTBL(882) execution results for range comparison. Bits 00 to 15 correspond to ranges 1 to 16. OFF: No match ON: Match
A881	00 to 15		Output Bit Pattern	Contains the output bit pattern when a match is found for CTBL(882) execution results for range comparison Note If more than one match is found, an OR of the output bit patterns with matches will be stored here.
A882	00 to 15	Pulse Output 2 Monitor Data	Range Comparison Results	Same as for Pulse Output 1 Monitor Data.
A883	00 to 15		Output Bit Pattern	

D-1-1 Detailed Explanations on the Auxiliary Area

Error Log Area: A100 to A199

A100	Error code	} Error record
A101	Error contents	
A102	0101	
A103	0101	
A104	0101	} Error record
⋮		
A195	Error code	
A196	Error contents	
A197	0101	
A198	0101	
A199	0101	

The following data would be generated in an error record if a memory error (error code 80F1) occurred with the error located in the System Setup (04 hex).

80 F1
00 04
01 01
01 01
01 01

The following data would be generated in an error record if an FALS error with FALS number 001 occurred.

C1 01
00 00
01 01
01 01
01 01

Error Codes and Error Flags

Classification	Error code	Meaning	Error flags
System-defined fatal errors	80F1	Memory error	A403
	80C0 to 80C1	I/O bus error	A404
	80CF	Bus error (location undetermined)	
	80CE	No End Cover	---
	80CD	Sync bus error	
	80E0	I/O setting error	---
	80F0	Program error	A295
	809F	Cycle time too long error	---
	80E9	Duplicated number error	A410 to A416
	80E1	Too many I/O points error	A407
System-defined non-fatal errors	009B	System Setup setting error	A409
	0200 to 020F	CPU Bus Unit error	A417
	030A to 035F, 03FF	Special I/O Unit error	A418 to A423
User-defined fatal errors	C101 to C2FF	FALS instruction executed (See note 1.)	---
User-defined non-fatal errors	4101 to 42FF	FAL instruction executed (See note 2.)	---

- Note**
- (1) Codes C101 to C2FF will be stored for FALS numbers 001 to 511.
 - (2) Codes 4101 to 42FF will be stored for FAL numbers 001 to 511.
 - (3) Only the contents of A295 is stored as the error flag contents for program errors.
 - (4) 0000 hex will be stored as the error flag contents.

D-2 Memory Map (Actual FQM1 Memory Addresses)**D-2-1 FQM1 Memory Addresses**

FQM1 memory addresses are set in Index Registers (IR0 or IR15) to indirectly address I/O memory. In general, FQM1 memory addresses are set in Index Registers with Index Register setting instructions such as MOV_R(560) or MOV_{RW}(561). Some instructions, such as FIND MAXIMUM (MAX(182)) and FIND MINIMUM (MIN(183)), output the results of processing to an Index Register to indicate an FQM1 memory address. FQM1 memory addresses are set into the Index Registers automatically when calling subroutines with JSB(982).

There are also instructions for which Index Registers can be directly designated to use the FQM1 memory addresses stored in them by other instructions. These instructions include DOUBLE MOVE (MOV_L(498)), some symbol comparison instructions (=L,<>L, <L, >L,<=L, and >=L), DOUBLE COMPARE (CMPL(060)), DOUBLE INCREMENT BINARY (++L(591)), DOUBLE DECREMENT BINARY (--L(593)), DOUBLE SIGNED BINARY ADD WITHOUT CARRY (+L(401)), and DOUBLE SIGNED BINARY SUBTRACT WITHOUT CARRY (-L(411)).

The FQM1 memory addresses all are continuous and the user must be aware of the order and boundaries of the memory areas. As reference, the FQM1 memory addresses are provided in the next page.

Note Directly setting FQM1 memory addresses in the program should be avoided whenever possible. If FQM1 memory addresses are set in the program, the program will be less compatible with new Modules for which changes have been made to the layout of the memory.

D-2-2 Memory Configuration

There are two classifications of the RAM memory (with capacitor backup) in the FQM1.

Parameter Areas: These areas contain Coordinator Module system setting data, such as the System Setup.

I/O Memory Areas: These are the areas that can be specified as operands in the instructions in user programs.

D-2-3 Memory Map

Note Do not access the areas indicated *Reserved for system*.

Classification	FQM1 memory addresses (hex)	User addresses	Area
Parameter areas	00000 to 0B0FF	---	System Setup Area Registered I/O Table Area Routing Table CPU Bus Unit Setup Area Actual I/O Table Area Profile Area
I/O memory areas	0B100 to 0B1FF	---	Reserved for system.
	0B200 to 0B7FF	---	Reserved for system.
	0B800 to 0B801	TK0000 to TK0031	Task Flag Area
	0B802 to 0B83F	---	Reserved for system.
	0B840 to 0B9FF	A000 to A447	Read-only Auxiliary Area
	0BA00 to 0BBFF	A448 to A959	Read/Write Auxiliary Area
	0BC00 to 0BDFF	---	Reserved for system.
	0BE00 to 0BE0F	T0000 to T0255	Timer Completion Flags
	0BE10 to 0BEFF	---	Reserved for system.
	0BF00 to 0BF0F	C0000 to C0255	Counter Completion Flags
	0BF10 to 0BFFF	---	Reserved for system.
	0C000 to 0D7FF	CIO 0000 to CIO 6143	CIO Area
	0D800 to 0D9FF	---	Reserved for system.
	0DA00 to 0DDFF	---	Reserved for system.
	0DE00 to 0DEFF	W000 to W255	Work Area
	0DF00 to 0DFFF	---	Reserved for system.
	0E000 to 0E0FF	T0000 to T0250	Timer PVs
	0E100 to 0EFFF	---	Reserved for system.
	0F000 to 0F0FF	C0000 to C0255	Counter PVs
	0F100 to 0FFFF	---	Reserved for system.
10000 to 17FFF	D00000 to D32767	DM Area	
18000 to FFFFF	---	Reserved for system.	

D-3 FQM1 Instruction Execution Times and Number of Steps

The following table lists the execution times for all instructions that are available for the FQM1.

The total execution time of instructions within one whole user program is the process time for program execution when calculating the cycle time. (See note.)

Note User programs are allocated tasks that can be executed within cyclic tasks and interrupt tasks that satisfy interrupt conditions.

Execution times for most instructions differ depending on the conditions when the instruction is executed. The execution time can also vary when the execution condition is OFF.

The following table also lists the length of each instruction in the *Length (steps)* column. The number of steps required in the user program area for each of the instructions varies from 1 to 7 steps, depending upon the instruction and the operands used with it. The number of steps in a program is not the same as the number of instructions.

Note (1) Program capacity for the FQM1 is measured in steps. Basically speaking, 1 step is equivalent to 1 word.

Most instructions are supported in differentiated form (indicated with \uparrow , \downarrow , $@$, and $\%$). Specifying differentiation will increase the execution times by the following amounts.

Symbol	μs
\uparrow or \downarrow	+0.5
@ or %	+0.5

(2) Use the following time as a guideline when instructions are not executed.
Approx. 0.2 to 0.5 μs

Sequence Input Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
LOAD	LD	---	1	0.10	Yes	---
LOAD NOT	LD NOT	---	1	0.10	Yes	---
AND	AND	---	1	0.10	Yes	---
AND NOT	AND NOT	---	1	0.10	Yes	---
OR	OR	---	1	0.10	Yes	---
OR NOT	OR NOT	---	1	0.10	Yes	---
AND LOAD	AND LD	---	1	0.05	Yes	---
OR LOAD	OR LD	---	1	0.05	Yes	---
NOT	NOT	520	1	0.05	Yes	---
CONDITION ON	UP	521	3	0.50	Yes	---
CONDITION OFF	DOWN	522	4	0.50	Yes	---
LOAD BIT TEST	LD TST	350	4	0.35	Yes	---
LOAD BIT TEST NOT	LD TSTN	351	4	0.35	Yes	---
AND BIT TEST	AND TST	350	4	0.35	Yes	---
AND BIT TEST NOT	AND TSTN	351	4	0.35	Yes	---
OR BIT TEST	OR TST	350	4	0.35	Yes	---
OR BIT TEST NOT	OR TSTN	351	4	0.35	Yes	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Sequence Output Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
OUTPUT	OUT	---	1	0.35	Yes	---
OUTPUT NOT	OUT NOT	---	1	0.35	Yes	---
KEEP	KEEP	011	1	0.40	Yes	---
DIFFERENTIATE UP	DIFU	013	2	0.50	Yes	---
DIFFERENTIATE DOWN	DIFD	014	2	0.50	Yes	---
SET	SET	---	1	0.30	Yes	---
RESET	RSET	---	1	0.30	Yes	---
MULTIPLE BIT SET	SETA	530	4	7.6	---	With 1-bit set
				59.6	---	With 1,000-bit set
MULTIPLE BIT RESET	RSTA	531	4	7.6	---	With 1-bit reset
				59.6	---	With 1,000-bit reset
SINGLE BIT SET	SETB	532	2	0.50	Yes	---
SINGLE BIT RESET	RSTB	533	2	0.50	Yes	---
SINGLE BIT OUTPUT	OUTB	534	2	0.50	Yes	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Sequence Control Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
END	END	001	1	7.0	Yes	---
NO OPERATION	NOP	000	1	0.05	Yes	---
INTERLOCK	IL	002	1	0.15	Yes	---
INTERLOCK CLEAR	ILC	003	1	0.15	Yes	---
JUMP	JMP	004	2	0.95	Yes	---
JUMP END	JME	005	2	---	---	---
CONDITIONAL JUMP	CJP	510	2	0.95	Yes	When JMP condition is satisfied
CONDITIONAL JUMP NOT	CJPN	511	2	0.95	Yes	When JMP condition is satisfied
MULTIPLE JUMP	JMP0	515	1	0.15	Yes	---
MULTIPLE JUMP END	JME0	516	1	0.15	Yes	---
FOR LOOP	FOR	512	2	1.00	Yes	Designated by a constant
NEXT LOOP	NEXT	513	1	0.45	Yes	When loop continues
				0.55	Yes	When loop ends
BREAK LOOP	BREAK	514	1	0.15	Yes	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Timer and Counter Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
TIMER	TIM	---	3	1.30	Yes	---
COUNTER	CNT	---	3	1.30	Yes	---
HIGH-SPEED TIMER	TIMH	015	3	1.80	Yes	---

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
ONE-MS TIMER	TMHH	540	3	1.75	Yes	---
REVERSIBLE COUNTER	CNTR	012	3	24.8	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Comparison Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
Input Comparison Instructions (unsigned)	LD, AND, OR +=	300	4	0.35	Yes	---
	LD, AND, OR + <>	305				
	LD, AND, OR + <	310				
	LD, AND, OR +<=	315				
	LD, AND, OR +>	320				
	LD, AND, OR +>=	325				
Input Comparison Instructions (double, unsigned)	LD, AND, OR +=+L	301	4	0.35	Yes	---
	LD, AND, OR +<>+L	306				
	LD, AND, OR +<+L	311				
	LD, AND, OR +<=+L	316				
	LD, AND, OR +>+L	321				
	LD, AND, OR +>=+L	326				
Input Comparison Instructions (signed)	LD, AND, OR +=+S	302	4	0.35	Yes	---
	LD, AND, OR +<>+S	307				
	LD, AND, OR +<+S	312				
	LD, AND, OR +<=+S	317				
	LD, AND, OR +>+S	322				
	LD, AND, OR +>=+S	327				
Input Comparison Instructions (double, signed)	LD, AND, OR +=+SL	303	4	0.35	Yes	---
	LD, AND, OR +<>+SL	308				
	LD, AND, OR +<+SL	313				
	LD, AND, OR +<=+SL	318				
	LD, AND, OR +>+SL	323				
	LD, AND, OR +>=+SL	328				
COMPARE	CMP	020	3	0.10	Yes	---
DOUBLE COMPARE	CMPL	060	3	0.50	Yes	---
SIGNED BINARY COMPARE	CPS	114	3	0.30	Yes	---
DOUBLE SIGNED BINARY COMPARE	CPSL	115	3	0.50	Yes	---
TABLE COMPARE	TCMP	085	4	30.3	---	---
MULTIPLE COMPARE	MCMP	019	4	47.5	---	---
UNSIGNED BLOCK COMPARE	BCMP	068	4	50.3	---	---
EXPANDED BLOCK COMPARE	BCMP2	502	4	15.3	---	Number of data words: 1
				689.1	---	Number of data words: 255
AREA RANGE COMPARE	ZCP	088	3	11.6	---	---
DOUBLE AREA RANGE COMPARE	ZCPL	116	3	11.4	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Data Movement Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
MOVE	MOV	021	3	0.30	Yes	---
DOUBLE MOVE	MOVL	498	3	0.60	Yes	---
MOVE NOT	MVN	022	3	0.35	Yes	---
DOUBLE MOVE NOT	MVNL	499	3	0.60	Yes	---
MOVE BIT	MOVB	082	4	0.50	Yes	---
MOVE DIGIT	MOVD	083	4	0.50	Yes	---
MULTIPLE BIT TRANSFER	XFRB	062	4	14.1	---	Transferring 1 bit
				274.5	---	Transferring 255 bits
BLOCK TRANSFER	XFER	070	4	0.8	Yes	Transferring 1 word
				650.2	Yes	Transferring 1,000 words
BLOCK SET	BSET	071	4	0.55	Yes	Setting 1 word
				400.2	Yes	Setting 1,000 words
DATA EXCHANGE	XCHG	073	3	0.80	Yes	---
DOUBLE DATA EXCHANGE	XCGL	562	3	1.2	---	---
SINGLE WORD DISTRIBUTION	DIST	080	4	10.5	---	---
DATA COLLECT	COLL	081	4	10.5	---	---
MOVE TO REGISTER	MOVR	560	3	0.60	Yes	---
MOVE TIMER/COUNTER PV TO REGISTER	MOVRW	561	3	0.50	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Data Shift Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
SHIFT REGISTER	SFT	010	3	12.4	---	Shifting 1 word
				368.1	---	Shifting 1,000 words
REVERSIBLE SHIFT REGISTER	SFTR	084	4	14.0	---	Shifting 1 word
				1.44 ms	---	Shifting 1,000 words
ASYNCHRONOUS SHIFT REGISTER	ASFT	017	4	13.9	---	Shifting 1 word
				3.915 ms	---	Shifting 1,000 words
WORD SHIFT	WSFT	016	4	9.7	---	Shifting 1 word
				728.1	---	Shifting 1,000 words
ARITHMETIC SHIFT LEFT	ASL	025	2	0.45	Yes	---
DOUBLE SHIFT LEFT	ASLL	570	2	0.80	Yes	---
ARITHMETIC SHIFT RIGHT	ASR	026	2	0.45	Yes	---
DOUBLE SHIFT RIGHT	ASRL	571	2	0.80	Yes	---
ROTATE LEFT	ROL	027	2	0.45	Yes	---
DOUBLE ROTATE LEFT	ROLL	572	2	0.80	Yes	---
ROTATE LEFT WITHOUT CARRY	RLNC	574	2	0.45	Yes	---

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
DOUBLE ROTATE LEFT WITHOUT CARRY	RLNL	576	2	0.80	Yes	---
ROTATE RIGHT	ROR	028	2	0.45	Yes	---
DOUBLE ROTATE RIGHT	RORL	573	2	0.80	Yes	---
ROTATE RIGHT WITHOUT CARRY	RRNC	575	2	0.45	Yes	---
DOUBLE ROTATE RIGHT WITHOUT CARRY	RRNL	577	2	0.80	Yes	---
ONE DIGIT SHIFT LEFT	SLD	074	3	10.1	---	Shifting 1 word
				1.208 ms	---	Shifting 1,000 words
ONE DIGIT SHIFT RIGHT	SRD	075	3	11.7	---	Shifting 1 word
				1.775 ms	---	Shifting 1,000 words
SHIFT N-BITS LEFT	NASL	580	3	0.45	Yes	---
DOUBLE SHIFT N-BITS LEFT	NSLL	582	3	0.80	Yes	---
SHIFT N-BITS RIGHT	NASR	581	3	0.45	Yes	---
DOUBLE SHIFT N-BITS RIGHT	NSRL	583	3	0.80	Yes	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Increment/Decrement Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
INCREMENT BINARY	++	590	2	0.45	Yes	---
DOUBLE INCREMENT BINARY	++L	591	2	0.80	Yes	---
DECREMENT BINARY	--	592	2	0.45	Yes	---
DOUBLE DECREMENT BINARY	--L	593	2	0.80	Yes	---
INCREMENT BCD	++B	594	2	12.1	---	---
DOUBLE INCREMENT BCD	++BL	595	2	9.37	---	---
DECREMENT BCD	--B	596	2	11.5	---	---
DOUBLE DECREMENT BCD	--BL	597	2	9.3	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Symbol Math Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
SIGNED BINARY ADD WITHOUT CARRY	+	400	4	0.30	Yes	---
DOUBLE SIGNED BINARY ADD WITHOUT CARRY	+L	401	4	0.60	Yes	---
SIGNED BINARY ADD WITH CARRY	+C	402	4	0.40	Yes	---

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
DOUBLE SIGNED BINARY ADD WITH CARRY	+CL	403	4	0.60	Yes	---
BCD ADD WITHOUT CARRY	+B	404	4	16.3	---	---
DOUBLE BCD ADD WITHOUT CARRY	+BL	405	4	22.9	---	---
BCD ADD WITH CARRY	+BC	406	4	17.2	---	---
DOUBLE BCD ADD WITH CARRY	+BCL	407	4	24.1	---	---
SIGNED BINARY SUBTRACT WITHOUT CARRY	-	410	4	0.3	Yes	---
DOUBLE SIGNED BINARY SUBTRACT WITHOUT CARRY	-L	411	4	0.60	Yes	---
SIGNED BINARY SUBTRACT WITH CARRY	-C	412	4	0.40	Yes	---
DOUBLE SIGNED BINARY SUBTRACT WITH CARRY	-CL	413	4	0.60	Yes	---
BCD SUBTRACT WITHOUT CARRY	-B	414	4	16.3	---	---
DOUBLE BCD SUBTRACT WITHOUT CARRY	-BL	415	4	23.1	---	---
BCD SUBTRACT WITH CARRY	-BC	416	4	18.1	---	---
DOUBLE BCD SUBTRACT WITH CARRY	-BCL	417	4	24.2	---	---
SIGNED BINARY MULTIPLY	*	420	4	0.65	Yes	---
DOUBLE SIGNED BINARY MULTIPLY	*L	421	4	12.8	---	---
UNSIGNED BINARY MULTIPLY	*U	422	4	0.75	Yes	---
DOUBLE UNSIGNED BINARY MULTIPLY	*UL	423	4	12.4	---	---
BCD MULTIPLY	*B	424	4	16.9	---	---
DOUBLE BCD MULTIPLY	*BL	425	4	34.7	---	---
SIGNED BINARY DIVIDE	/	430	4	0.70	Yes	---
DOUBLE SIGNED BINARY DIVIDE	/L	431	4	11.9	---	---
UNSIGNED BINARY DIVIDE	/U	432	4	0.8	Yes	---
DOUBLE UNSIGNED BINARY DIVIDE	/UL	433	4	11.9	---	---
BCD DIVIDE	/B	434	4	18.3	---	---
DOUBLE BCD DIVIDE	/BL	435	4	26.7	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Conversion Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
BCD-TO-BINARY	BIN	023	3	0.40	Yes	---
DOUBLE BCD-TO-DOUBLE BINARY	BINL	058	3	7.4	---	---
BINARY-TO-BCD	BCD	024	3	8.0	---	---
DOUBLE BINARY-TO-DOUBLE BCD	BCDL	059	3	8.0	---	---
2'S COMPLEMENT	NEG	160	3	0.35	Yes	---
DOUBLE 2'S COMPLEMENT	NEGL	161	3	0.60	Yes	---
16-BIT TO 32-BIT SIGNED BINARY	SIGN	600	3	0.60	Yes	---
ASCII CONVERT	ASC	086	4	11.8	---	Converting 1 digit into ASCII
				18.1	---	Converting 4 digits into ASCII
ASCII TO HEX	HEX	162	4	12.2	---	Converting 1 digit

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Logic Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
LOGICAL AND	ANDW	034	4	0.30	Yes	---
DOUBLE LOGICAL AND	ANDL	610	4	0.60	Yes	---
LOGICAL OR	ORW	035	4	0.45	Yes	---
DOUBLE LOGICAL OR	ORWL	611	4	0.60	Yes	---
EXCLUSIVE OR	XORW	036	4	0.45	Yes	---
DOUBLE EXCLUSIVE OR	XORL	612	4	0.60	Yes	---
EXCLUSIVE NOR	XNRW	037	4	0.45	Yes	---
DOUBLE EXCLUSIVE NOR	XNRL	613	4	0.60	Yes	---
COMPLEMENT	COM	029	2	0.45	Yes	---
DOUBLE COMPLEMENT	COML	614	2	0.80	Yes	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Special Math Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
ARITHMETIC PROCESS	APR	069	4	24.3	---	Linear approximation specification, normal
				12.1	---	Linear approximation table transfer, 1 word
				126.1	---	Linear approximation table transfer, 128 words
				241.3	---	Linear approximation table transfer, 256 words
				21.5	---	Linear approximation buffer specification, 256 words, beginning
				186.9	---	Linear approximation buffer specification, 256 words, end
				104.5	---	Linear approximation buffer specification, 128 words, end
BIT COUNTER	BCNT	067	4	0.65	Yes	Counting 1 word
VIRTUAL AXIS	AXIS	981	4	47.9	---	Relative mode
				48.1	---	Absolute mode
				8.3	---	Stopping processing

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Floating-point Math Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
FLOATING TO 16-BIT	FIX	450	3	8.4	---	---
FLOATING TO 32-BIT	FIXL	451	3	7.4	---	---
16-BIT TO FLOATING	FLT	452	3	7.9	---	---
32-BIT TO FLOATING	FLTL	453	3	7.0	---	---
FLOATING-POINT ADD	+F	454	4	11.4	---	---
FLOATING-POINT SUBTRACT	-F	455	4	11.0	---	---
FLOATING-POINT DIVIDE	/F	457	4	11.1	---	---
FLOATING-POINT MULTIPLY	*F	456	4	11.0	---	---
DEGREES TO RADIANS	RAD	458	3	9.7	---	---
RADIANS TO DEGREES	DEG	459	3	9.4	---	---
SINE	SIN	460	3	15.8	---	---
COSINE	COS	461	3	15.5	---	---
TANGENT	TAN	462	3	17.5	---	---
ARC SINE	ASIN	463	3	42.7	---	---
ARC COSINE	ACOS	464	3	42.5	---	---
ARC TANGENT	ATAN	465	3	21.3	---	---
SQUARE ROOT	SQRT	466	3	25.5	---	---
EXPONENT	EXP	467	3	18.1	---	---
LOGARITHM	LOG	468	3	16.1	---	---
EXPONENTIAL POWER	PWR	840	4	31.5	---	---

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
Floating Symbol Comparison	LD, AND, OR +=F	329	3	8.9	---	---
	LD, AND, OR +<>F	330				
	LD, AND, OR +<F	331				
	LD, AND, OR +<=F	332				
	LD, AND, OR +>F	333				
	LD, AND, OR +>=F	334				

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Double-precision Floating-point Math Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
DOUBLE FLOATING TO 16-BIT BINARY	FIXD	841	3	15.0	---	---
DOUBLE FLOATING TO 32-BIT BINARY	FIXLD	842	3	15.2	---	---
16-BIT BINARY TO DOUBLE FLOATING	DBL	843	3	10.2	---	---
32-BIT BINARY TO DOUBLE FLOATING	DBLL	844	3	10.2	---	---
DOUBLE FLOATING-POINT ADD	+D	845	4	19.1	---	---
DOUBLE FLOATING-POINT SUBTRACT	-D	846	4	19.3	---	---
DOUBLE FLOATING-POINT MULTIPLY	*D	847	4	24.1	---	---
DOUBLE FLOATING-POINT DIVIDE	/D	848	4	34.7	---	---
DOUBLE DEGREES TO RADIANS	RADD	849	3	38.1	---	---
DOUBLE RADIANS TO DEGREES	DEGD	850	3	38.6	---	---
DOUBLE SINE	SIND	851	3	56.8	---	---
DOUBLE COSINE	COSD	852	3	53.5	---	---
DOUBLE TANGENT	TAND	853	3	125.4	---	---
DOUBLE ARC SINE	ASIND	854	3	27.0	---	---
DOUBLE ARC COSINE	ACOSD	855	3	29.6	---	---
DOUBLE ARC TANGENT	ATAND	856	3	19.5	---	---
DOUBLE SQUARE ROOT	SQRTD	857	3	62.3	---	---
DOUBLE EXPONENT	EXPD	858	3	158.1	---	---
DOUBLE LOGARITHM	LOGD	859	3	22.4	---	---
DOUBLE EXPONENTIAL POWER	PWRD	860	4	285.0	---	---
DOUBLE SYMBOL COMPARISON	LD, AND, OR+=D	335	3	13.1	---	---
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	LD, AND, OR+>D	339				
	LD, AND, OR+>=D	340				

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Table Data Processing Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
FIND MAXIMUM	MAX	182	4	13.0	---	Searching for 1 word
				1.41 ms	---	Searching for 1,000 words

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
FIND MINIMUM	MIN	183	4	12.8	---	Searching for 1 word
				1.412 ms	---	Searching for 1,000 words

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Data Control Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
SCALING	SCL	194	4	22.7	---	---
SCALING 2	SCL2	486	4	21.8	---	---
SCALING 3	SCL3	487	4	26.1	---	---
AVERAGE	AVG	195	4	27.9	---	Average of an operation
				27.9	---	Average of 64 operations

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Subroutine Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
SUBROUTINE CALL	SBS	091	2	25.5	Yes	---
SUBROUTINE ENTRY	SBN	092	2	---	---	---
SUBROUTINE RETURN	RET	093	1	21.9	Yes	---
MACRO	MCRO	099	4	47.4	---	---
JUMP TO SUBROUTINE	JSB	982	4	34.9	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Interrupt Control Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
SET INTERRUPT MASK	MSKS	690	3	7.6	---	---
READ INTERRUPT MASK	MSKR	692	3	5.2	---	---
CLEAR INTERRUPT	CLI	691	3	7.2	---	---
DISABLE INTERRUPTS	DI	693	1	5.3	---	---
ENABLE INTERRUPTS	EI	694	1	5.6	---	---
INTERVAL TIMER	STIM	980	4	9.5	---	One-shot timer
				11.0	---	One-shot pulse output
				9.5	---	Scheduled interrupt
				10.8	---	Reading timer PV
				7.4	---	Stopping timer
				17.8	---	Starting pulse counting
				14.7	---	Stopping pulse counting

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

High-speed Counter and Pulse Output Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
MODE CONTROL	INI	880	4	16.7	---	Starting high-speed counter comparison
				12.7	---	Stopping high-speed counter comparison
				13.3	---	Changing pulse output PV
				10.9	---	Changing high-speed counter circular value
				16.7	---	Starting pulse output comparison
				12.6	---	Stopping pulse output comparison
				14.9	---	Changing pulse output PV
				13.1	---	Changing pulse output circular value
				12.5	---	Stopping pulse output
				10.1	---	Stopping sampling counter comparison
				14.5	---	Changing sampling counter PV
HIGH-SPEED COUNTER PV READ	PRV	881	4	13.5	---	Reading pulse output PV
				15.1	---	Reading high-speed counter PV
				50.8	---	Reading analog input PV
				14.3	---	Reading high-speed counter travel distance
				12.1	---	Reading high-speed counter latched value
COMPARISON TABLE LOAD	CTBL	882	4	36.5	---	Registering target value table and starting comparison for 1 target value
				259.6	---	Registering target value table and starting comparison for 48 target values
				22.1	---	Executing range comparison for 1 range
				113.7	---	Executing range comparison for 16 ranges
				22.1	---	Only registering target value table for 1 target value
				240.1	---	Only registering target value table for 48 target values
				20.9	---	Registering a sampling counter target value table and starting comparison
42.8	---	Analog output				
SPEED OUTPUT	SPED	885	4	23.7	---	Continuous mode
				32.7	---	Independent mode
				42.9	---	Analog output
SET PULSES	PULS	886	4	15.9	---	Setting pulse output in relative mode
				16.1	---	Setting pulse output in absolute mode
				31.5	---	Absolute output mode (electronic cam)
PULSE OUTPUT	PLS2	887	4	53.5	---	---

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
ACCELERATION CONTROL	ACC	888	4	42.5	---	Continuous mode
				44.1	---	Independent mode
				18.7	---	Analog output

Step Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
STEP DEFINE	STEP	008	2	24.3	---	Step control bit ON
				13.0	---	Step control bit OFF
STEP START	SNXT	009	2	9.1	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

I/O Refresh Instruction

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
I/O REFRESH	IORF	097	3	7.7	---	Refreshing 1 input word
				7.6	---	Refreshing 1 output word
				20.1	---	Refreshing 1 input word in CJ-series Basic I/O Unit
				20.1	---	Refreshing 1 output word in CJ-series Basic I/O Unit
				57.6	---	Refreshing 10 input words in CJ-series Basic I/O Unit
				59.9	---	Refreshing 10 output words in CJ-series Basic I/O Unit

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Serial Communications Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
TRANSMIT	TXD	236	4	24.1	---	Sending 1 byte
				342.6	---	Sending 256 bytes
RECEIVE	RXD	235	4	36.2	---	Storing 1 byte
				348.9	---	Storing 256 bytes
CHANGE SERIAL PORT SETUP	STUP	237	3	441.1	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Debugging Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (μs)	Hardware implementation	Conditions
TRACE MEMORY SAMPLING	TRSM	045	1	34.6	---	Sampling 1 bit and 0 words
				148.3	---	Sampling 31 bits and 6 words

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Failure Diagnosis Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (µs)	Hardware implementation	Conditions
FAILURE ALARM	FAL	006	3	157.1	---	Recording errors
				56.0	---	Deleting errors (in order of priority)
				457.0	---	Deleting errors (all errors)
				53.6	---	Deleting errors (individually)
SEVERE FAILURE ALARM	FALS	007	3	---	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Other Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (µs)	Hardware implementation	Conditions
SET CARRY	STC	040	1	0.15	Yes	---
CLEAR CARRY	CLC	041	1	0.15	Yes	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Block Programming Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (µs)		Conditions
BLOCK PROGRAM BEGIN	BPRG	096	2	20.3	---	---
BLOCK PROGRAM END	BEND	801	1	17.2	---	---
Branching	IF (input condition)	802	1	6.8	Yes	IF true
				12.2		IF false
Branching	IF (relay number)	802	2	11.0	Yes	IF true
				16.5		IF false
Branching (NOT)	IF NOT (relay number)	802	2	11.5	Yes	IF true
				16.8		IF false
Branching	ELSE	803	1	11.4	Yes	IF true
				13.4		IF false
Branching	IEND	804	1	13.5	Yes	IF true
				7.0		IF false

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

Special Function Block Instructions

Instruction	Mnemonic	Code	Length (steps) (See note.)	ON execution time (µs)	Hardware implementation	Conditions
GET VARIABLE ID	GETID	286	4	9.6	---	---

Note When a double-length operand is used, add 1 to the value shown in the length column in the above table.

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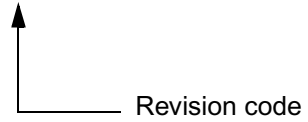
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