MITSUBISHI ELECTRIC

MOTION CONTROLLERS

Changes for the Better

MOTION CONTROLLER

MR-MQ100

User's Manual

(Details)

● SAFETY PRECAUTIONS ●

(Please read these instructions before using this equipment.)

Before using this product, please read this manual and the relevant manuals introduced in this manual carefully and pay full attention to safety to handle the product correctly.
These precautions apply only to this product.
In this manual, the safety instructions are ranked as "DANGER" and "CAUTION".

⚠DANGER	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠CAUTION	Indicates that incorrect handling may cause hazardous conditions, resulting in medium or slight personal injury or physical damage.

Depending on circumstances, procedures indicated by ⚠ CAUTION may also be linked to serious results.
In any case, it is important to follow the directions for usage.

Please save this manual to make it accessible when required and always forward it to the end user.

For Safe Operations

1. Prevention of electric shocks

⚠DANGER

- Never open the front case or terminal covers while the power is ON or the unit is running, as this may lead to electric shocks.
- Never run the unit with the front case or terminal cover removed. The high voltage terminal and charged sections will be exposed and may lead to electric shocks.
- Never open the front case or terminal cover at times other than wiring work or periodic inspections even if the power is OFF. The insides of the Motion controller and servo amplifier are charged and may lead to electric shocks.
- Completely turn off the externally supplied power used in the system before mounting or removing the module, performing wiring work, or inspections. Failing to do so may lead to electric shocks.
- When performing wiring work or inspections, turn the power OFF, wait at least ten minutes, and then check the voltage with a tester, etc.. Failing to do so may lead to electric shocks.
- Be sure to ground the Motion controller, servo amplifier and servomotor. (Ground resistance : 100 Ω or less) Do not ground commonly with other devices.
- The wiring work and inspections must be done by a qualified technician.
- Wire the units after installing the Motion controller, servo amplifier and servomotor. Failing to do so may lead to electric shocks or damage.
- Never operate the switches with wet hands, as this may lead to electric shocks.
- Do not damage, apply excessive stress, place heavy things on or sandwich the cables, as this may lead to electric shocks.
- Do not touch the Motion controller, servo amplifier or servomotor terminal blocks while the power is ON, as this may lead to electric shocks.
- Do not touch the built-in power supply, built-in grounding or signal wires of the Motion controller and servo amplifier, as this may lead to electric shocks.

2. For fire prevention

⚠CAUTION

- Install the Motion controller, servo amplifier, servomotor and regenerative resistor on incombustible. Installing them directly or close to combustibles will lead to fire.
- If a fault occurs in the Motion controller or servo amplifier, shut the power OFF at the servo amplifier's power source. If a large current continues to flow, fire may occur.
- When using a regenerative resistor, shut the power OFF with an error signal. The regenerative resistor may abnormally overheat due to a fault in the regenerative transistor, etc., and may lead to fire.
- Always take heat measures such as flame proofing for the inside of the control panel where the servo amplifier or regenerative resistor is installed and for the wires used. Failing to do so may lead to fire.
- Do not damage, apply excessive stress, place heavy things on or sandwich the cables, as this may lead to fire.

3. For injury prevention

⚠CAUTION

- Do not apply a voltage other than that specified in the instruction manual on any terminal. Doing so may lead to destruction or damage.
- Do not mistake the terminal connections, as this may lead to destruction or damage.
- Do not mistake the polarity (+ / -), as this may lead to destruction or damage.
- Do not touch the heat radiating fins of controller or servo amplifier, regenerative resistor and servomotor, etc., while the power is ON and for a short time after the power is turned OFF. In this timing, these parts become very hot and may lead to burns.
- Always turn the power OFF before touching the servomotor shaft or coupled machines, as these parts may lead to injuries.
- Do not go near the machine during test operations or during operations such as teaching. Doing so may lead to injuries.

4. Various precautions

Strictly observe the following precautions.

Mistaken handling of the unit may lead to faults, injuries or electric shocks.

(1) System structure

⚠CAUTION

- Always install a leakage breaker on the Motion controller and servo amplifier power source.
- If installation of an electromagnetic contactor for power shut off during an error, etc., is specified in the instruction manual for the servo amplifier, etc., always install the electromagnetic contactor.
- Install the emergency stop circuit externally so that the operation can be stopped immediately and the power shut off.
- Use the Motion controller, servo amplifier, servomotor and regenerative resistor with the correct combinations listed in the instruction manual. Other combinations may lead to fire or faults.
- Use the Motion controller, base unit and motion module with the correct combinations listed in the instruction manual. Other combinations may lead to faults.
- If safety standards (ex., robot safety rules, etc.,) apply to the system using the Motion controller, servo amplifier and servomotor, make sure that the safety standards are satisfied.
- Construct a safety circuit externally of the Motion controller or servo amplifier if the abnormal operation of the Motion controller or servo amplifier differ from the safety directive operation in the system.
- In systems where coasting of the servomotor will be a problem during the forced stop, emergency stop, servo OFF or power supply OFF, use dynamic brakes.
- Make sure that the system considers the coasting amount even when using dynamic brakes.
- In systems where perpendicular shaft dropping may be a problem during the forced stop, emergency stop, servo OFF or power supply OFF, use both dynamic brakes and electromagnetic brakes.

⚠CAUTION

- The dynamic brakes must be used only on errors that cause the forced stop, emergency stop, or servo OFF. These brakes must not be used for normal braking.
- The brakes (electromagnetic brakes) assembled into the servomotor are for holding applications, and must not be used for normal braking.
- The system must have a mechanical allowance so that the machine itself can stop even if the stroke limits switch is passed through at the max. speed.
- Use wires and cables that have a wire diameter, heat resistance and bending resistance compatible with the system.
- Use wires and cables within the length of the range described in the instruction manual.
- The ratings and characteristics of the parts (other than Motion controller, servo amplifier and servomotor) used in a system must be compatible with the Motion controller, servo amplifier and servomotor.
- Install a cover on the shaft so that the rotary parts of the servomotor are not touched during operation.
- There may be some cases where holding by the electromagnetic brakes is not possible due to the life or mechanical structure (when the ball screw and servomotor are connected with a timing belt, etc.). Install a stopping device to ensure safety on the machine side.

(2) Parameter settings and programming

⚠CAUTION

- Set the parameter values to those that are compatible with the Motion controller, servo amplifier, servomotor and regenerative resistor model and the system application. The protective functions may not function if the settings are incorrect.
- The regenerative resistor model and capacity parameters must be set to values that conform to the operation mode, servo amplifier and servo power supply module. The protective functions may not function if the settings are incorrect.
- Set the mechanical brake output and dynamic brake output validity parameters to values that are compatible with the system application. The protective functions may not function if the settings are incorrect.
- Set the stroke limit input validity parameter to a value that is compatible with the system application. The protective functions may not function if the setting is incorrect.
- Set the servomotor encoder type (increment, absolute position type, etc.) parameter to a value that is compatible with the system application. The protective functions may not function if the setting is incorrect.
- Set the servomotor capacity and type (standard, low-inertia, flat, etc.) parameter to values that are compatible with the system application. The protective functions may not function if the settings are incorrect.
- Set the servo amplifier capacity and type parameters to values that are compatible with the system application. The protective functions may not function if the settings are incorrect.
- Use the program commands for the program with the conditions specified in the instruction manual.

⚠CAUTION

- Set the sequence function program capacity setting, device capacity, latch validity range, I/O assignment setting, and validity of continuous operation during error detection to values that are compatible with the system application. The protective functions may not function if the settings are incorrect.
- Some devices used in the program have fixed applications, so use these with the conditions specified in the instruction manual.
- The input devices and data registers assigned to the link will hold the data previous to when communication is terminated by an error, etc. Thus, an error correspondence interlock program specified in the instruction manual must be used.
- Use the interlock program specified in the intelligent function module's instruction manual for the program corresponding to the intelligent function module.

(3) Transportation and installation

⚠CAUTION

- Transport the product with the correct method according to the mass.
- Use the servomotor suspension bolts only for the transportation of the servomotor. Do not transport the servomotor with machine installed on it.
- Do not stack products past the limit.
- When transporting the Motion controller or servo amplifier, never hold the connected wires or cables.
- When transporting the servomotor, never hold the cables, shaft or detector.
- When transporting the Motion controller or servo amplifier, never hold the front case as it may fall off.
- When transporting, installing or removing the Motion controller or servo amplifier, never hold the edges.
- Install the unit according to the instruction manual in a place where the mass can be withstood.
- Do not get on or place heavy objects on the product.
- Always observe the installation direction.
- Keep the designated clearance between the Motion controller or servo amplifier and control panel inner surface or the Motion controller and servo amplifier, Motion controller or servo amplifier and other devices.
- Do not install or operate Motion controller, servo amplifiers or servomotors that are damaged or that have missing parts.
- Do not block the intake/outtake ports of the Motion controller, servo amplifier and servomotor with cooling fan.
- Do not allow conductive matter such as screw or cutting chips or combustible matter such as oil enter the Motion controller, servo amplifier or servomotor.
- The Motion controller, servo amplifier and servomotor are precision machines, so do not drop or apply strong impacts on them.
- Securely fix the Motion controller, servo amplifier and servomotor to the machine according to the instruction manual. If the fixing is insufficient, these may come off during operation.

⚠CAUTION

- Always install the servomotor with reduction gears in the designated direction. Failing to do so may lead to oil leaks.
- Store and use the unit in the following environmental conditions.

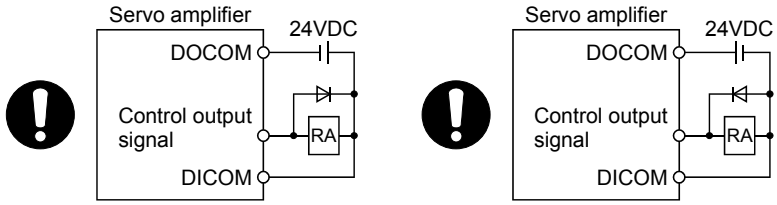
Environment	Conditions	
	Motion controller/Servo amplifier	Servomotor
Ambient temperature	According to each instruction manual.	0°C to +40°C (With no freezing) (32°F to +104°F)
Ambient humidity	According to each instruction manual.	80% RH or less (With no dew condensation)
Storage temperature	According to each instruction manual.	-20°C to +65°C (-4°F to +149°F)
Atmosphere	Indoors (where not subject to direct sunlight). No corrosive gases, flammable gases, oil mist or dust must exist	
Altitude	1000m (3280.84ft.) or less above sea level	
Vibration	According to each instruction manual	

- When coupling with the synchronous encoder or servomotor shaft end, do not apply impact such as by hitting with a hammer. Doing so may lead to detector damage.
- Do not apply a load larger than the tolerable load onto the synchronous encoder and servomotor shaft. Doing so may lead to shaft breakage.
- When not using the module for a long time, disconnect the power line from the Motion controller or servo amplifier.
- Place the Motion controller and servo amplifier in static electricity preventing vinyl bags and store.
- When storing for a long time, please contact with our sales representative.
  Also, execute a trial operation.

(4) Wiring

⚠CAUTION

- Correctly and securely wire the wires. Reconfirm the connections for mistakes and the terminal screws for tightness after wiring. Failing to do so may lead to run away of the servomotor.
- After wiring, install the protective covers such as the terminal covers to the original positions.
- Do not install a phase advancing capacitor, surge absorber or radio noise filter (option FR-BIF) on the output side of the servo amplifier.
- Correctly connect the output side (terminal U, V, W) and ground. Incorrect connections will lead the servomotor to operate abnormally.
- Do not connect a commercial power supply to the servomotor, as this may lead to trouble.
- Do not mistake the direction of the surge absorbing diode installed on the DC relay for the control signal output of brake signals, etc. Incorrect installation may lead to signals not being output when trouble occurs or the protective functions not functioning.



For the sink output interface　　For the source output interface

- Do not connect or disconnect the connection cables between each unit, the encoder cable or PLC expansion cable while the power is ON.
- Securely tighten the cable connector fixing screws and fixing mechanisms. Insufficient fixing may lead to the cables combing off during operation.
- Do not bundle the power line or cables.

(5) Trial operation and adjustment

⚠CAUTION

- Confirm and adjust the program and each parameter before operation. Unpredictable movements may occur depending on the machine.
- Extreme adjustments and changes may lead to unstable operation, so never make them.
- When using the absolute position system function, on starting up, and when the Motion controller or absolute value motor has been replaced, always perform a home position return.
- Before starting test operation, set the parameter speed limit value to the slowest value, and make sure that operation can be stopped immediately by the forced stop, etc. if a hazardous state occurs.

(6) Usage methods

⚠CAUTION

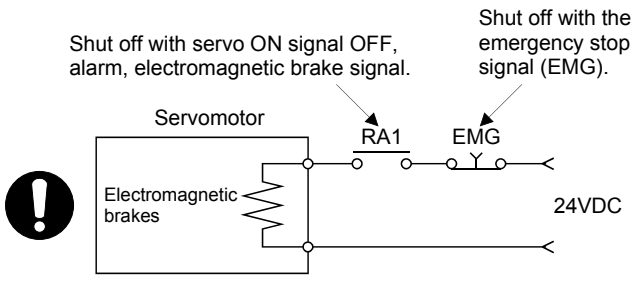
- Immediately turn OFF the power if smoke, abnormal sounds or odors are emitted from the Motion controller, servo amplifier or servomotor.
- Always execute a test operation before starting actual operations after the program or parameters have been changed or after maintenance and inspection.
- Do not attempt to disassemble and repair the units excluding a qualified technician whom our company recognized.
- Do not make any modifications to the unit.
- Keep the effect or electromagnetic obstacles to a minimum by installing a noise filter or by using wire shields, etc. Electromagnetic obstacles may affect the electronic devices used near the Motion controller or servo amplifier.
- When using the CE Mark-compliant equipment, refer to this manual for the Motion controllers and refer to the corresponding EMC guideline information for the servo amplifiers, inverters and other equipment.
- Use the units with the following conditions.

Item	Conditions
Input power	According to each instruction manual.
Input frequency	According to each instruction manual.
Tolerable momentary power failure	According to each instruction manual.

(7) Corrective actions for errors

⚠CAUTION

- If an error occurs in the self diagnosis of the Motion controller or servo amplifier, confirm the check details according to the instruction manual, and restore the operation.
- If a dangerous state is predicted in case of a power failure or product failure, use a servomotor with electromagnetic brakes or install a brake mechanism externally.
- Use a double circuit construction so that the electromagnetic brake operation circuit can be operated by emergency stop signals set externally.



- If an error occurs, remove the cause, secure the safety and then resume operation after alarm release.
- The unit may suddenly resume operation after a power failure is restored, so do not go near the machine. (Design the machine so that personal safety can be ensured even if the machine restarts suddenly.)

(8) Maintenance, inspection and part replacement

⚠CAUTION

- Perform the daily and periodic inspections according to the instruction manual.
- Perform maintenance and inspection after backing up the program and parameters for the Motion controller and servo amplifier.
- Do not place fingers or hands in the clearance when opening or closing any opening.
- Periodically replace consumable parts such as batteries according to the instruction manual.
- Do not touch the lead sections such as ICs or the connector contacts.
- Before touching the module, always touch grounded metal, etc. to discharge static electricity from human body. Failure to do so may cause the module to fail or malfunction.
- Do not directly touch the module's conductive parts and electronic components. Touching them could cause an operation failure or give damage to the module.
- Do not place the Motion controller or servo amplifier on metal that may cause a power leakage or wood, plastic or vinyl that may cause static electricity buildup.
- Do not perform a megger test (insulation resistance measurement) during inspection.
- When replacing the Motion controller or servo amplifier, always set the new module settings correctly.
- When the Motion controller or absolute value motor has been replaced, carry out a home position return operation using one of the following methods, otherwise position displacement could occur.
  1) After writing the servo data to the Motion controller using programming software, switch on the power again, then perform a home position return operation.
  2) Using the backup function of the programming software, load the data backed up before replacement.
- After maintenance and inspections are completed, confirm that the position detection of the absolute position detector function is correct.
- Do not drop or impact the battery installed to the module. Doing so may damage the battery, causing battery liquid to leak in the battery. Do not use the dropped or impacted battery, but dispose of it.
- Do not short circuit, charge, overheat, incinerate or disassemble the batteries.
- The electrolytic capacitor will generate gas during a fault, so do not place your face near the Motion controller or servo amplifier.
- The electrolytic capacitor and fan will deteriorate. Periodically replace these to prevent secondary damage from faults. Replacements can be made by our sales representative.
- Lock the control panel and prevent access to those who are not certified to handle or install electric equipment.
- Do not burn or break a module and servo amplifier. Doing so may cause a toxic gas.

(9) About processing of waste

When you discard Motion controller, servo amplifier, a battery (primary battery) and other option articles, please follow the law of each country (area).

⚠CAUTION

- This product is not designed or manufactured to be used in equipment or systems in situations that can affect or endanger human life.
- When considering this product for operation in special applications such as machinery or systems used in passenger transportation, medical, aerospace, atomic power, electric power, or submarine repeating applications, please contact your nearest Mitsubishi sales representative.
- Although this product was manufactured under conditions of strict quality control, you are strongly advised to install safety devices to forestall serious accidents when it is used in facilities where a breakdown in the product is likely to cause a serious accident.

(10) General cautions

- All drawings provided in the instruction manual show the state with the covers and safety partitions removed to explain detailed sections. When operating the product, always return the covers and partitions to the designated positions, and operate according to the instruction manual.

REVISIONS

* The manual number is given on the bottom left of the back cover.

Print Date	* Manual Number	Revision
Oct., 2008	IB(NA)-0300150-A	First edition
Sep., 2009	IB(NA)-0300150-B	[Additional correction/partial correction] About manuals, EMC directive, Battery transportation, Symbol for the new EU battery directive, MC protocol communication, Synchronous encoder current value monitor in real mode, Connection of the servo amplifier for direct drive motor
July., 2010	IB(NA)-0300150-C	[Additional correction/partial correction] Connection with GOT, Connection of the extension IO unit (MR-J3-D01)
April., 2011	IB(NA)-0300150-D	[Additional correction/partial correction] Postscript of MR-Configurator2
Dec., 2011	IB(NA)-0300150-E	[Partial correction] Section 4.2.1 Partial change of sentence

INTRODUCTION

Thank you for choosing the Mitsubishi Motion controller MR-MQ100.
Before using the equipment, please read this manual carefully to develop full familiarity with the functions and performance of the Motion controller you have purchased, so as to ensure correct use.

CONTENTS

About Manuals

The following manuals are also related to this product.

If necessary, order them by quoting the details in the tables below.

Related Manuals

(1) Motion controller

Manual Name	Manual Number (Model Code)
Q173DCPU/Q172DCPU Motion controller Programming Manual (COMMON) This manual explains the Multiple CPU system configuration, performance specifications, common parameters, auxiliary/applied functions, error lists and others. (Optional)	IB-0300134 (1XB928)
Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (Motion SFC) This manual explains the functions, programming, debugging, error lists and others for Motion SFC. (Optional)	IB-0300135 (1XB929)
Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE) This manual explains the servo parameters, positioning instructions, device lists, error lists and others. (Optional)	IB-0300136 (1XB930)
Q173DCPU/Q172DCPU Motion controller (SV22) Programming Manual (VIRTUAL MODE) This manual explains the dedicated instructions to use the synchronous control by virtual main shaft, mechanical system program create mechanical module, servo parameters, positioning instructions, device lists, error lists and others. (Optional)	IB-0300137 (1XB931)
Motion Controller Setup Guidance(for MR-MQ100) (MT Developer2 Version1) This manual describes those items related to the setup of the Motion controller programming software MT Developer2 (for MR-MQ100).	IB-0300152

(2) Servo amplifier

Manual Name	Manual Number (Model Code)
SSCNETⅢ Compatible MR-J3-□B Servo amplifier Instruction Manual This manual explains the I/O signals, parts names, parameters, start-up procedure and others for MR-J3-□B Servo amplifier. (Optional)	SH-030051 (1CW202)
SSCNETⅢ interface 2-axis AC Servo Amplifier MR-J3W-□B Servo amplifier Instruction Manual This manual explains the I/O signals, parts names, parameters, start-up procedure and others for 2-axis AC Servo Amplifier MR-J3W-□B Servo amplifier. (Optional)	SH-030073 (1CW604)
SSCNETⅢ Compatible Linear Servo MR-J3-□B-RJ004 Instruction Manual This manual explains the I/O signals, parts names, parameters, start-up procedure and others for Linear Servo MR-J3-□B-RJ004 Servo amplifier. (Optional)	SH-030054 (1CW943)
SSCNETⅢ Compatible Fully Closed Loop Control MR-J3-□B-RJ006 Servo amplifier Instruction Manual This manual explains the I/O signals, parts names, parameters, start-up procedure and others for Fully Closed Loop Control MR-J3-□B-RJ006 Servo amplifier. (Optional)	SH-030056 (1CW304)
SSCNETⅢ interface Drive Safety integrated MR-J3-□B Safety Servo amplifier Instruction Manual This manual explains the I/O signals, parts names, parameters, start-up procedure and others for safety integrated MR-J3-□B Safety Servo amplifier. (Optional)	SH-030084 (1CW205)

MEMO

1. OVERVIEW

1.1 Overview

This User's Manual describes the hardware specifications, the software specifications and handling methods of the Motion controller.
This manual explains the changes between the MR-MQ100 and Q173DCPU / Q172DCPU.
Refer to the other motion controller manuals for details of each function.
In this manual, the following abbreviations are used.

Generic term/Abbreviation	Description
MR-MQ100 or Motion controller	MR-MQ100 Single Axis Motion Controller
MR-J3-□B	Servo amplifier model MR-J3-□B
AMP or Servo amplifier	General name for "Servo amplifier model MR-J3-□B "
Programming software package	General name for MT Developer2 /MR Configurator□
Operating system software	General name for "SW9DNC-SV22QW"
SV22	Operating system software for automatic machinery : SW9DNC -SV22QW
MELSOFT MT Works2	Abbreviation for "Motion controller engineering environment MELSOFT MT Works2 for MR-MQ100" SW1DNC-MTW2MQ-E (Version 1.04E or later)
MT Developer2(Note-1)	Abbreviation for "Motion controller programming software MT Developer2"
MR Configurator	Abbreviation for "Servo setup software package MR Configurator (Version C1 or later)"
MR Configurator2	Abbreviation for "Servo setup software package MR Configurator2 (Version 1.00B or later)"
SSCNETⅢ(Note-2)	High speed synchronous network between Motion controller and servo amplifier
Absolute position system	General name for "system using the servomotor and servo amplifier for absolute position"

(Note-1) : This software is included in Motion controller engineering environment "MELSOFT MT Works2"

(Note-2) : SSCNET: Servo System Controller NETwork

REMARK

For information about each module and design methods for programs and parameters, refer to the following manuals.

Item		Reference Manual
Operation method for MT Developer2		Help of each software
SV22	• Performance specification • Design method for common parameter • Auxiliary and applied functions (common)	Q173DCPU/Q172DCPU Motion controller Programming Manual (COMMON)
	• Design method for Motion SFC program • Design method for Motion SFC parameter	Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (Motion SFC)
	• Design method for positioning control program in the real mode • Design method for positioning control parameter	Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)
SV22 (Virtual mode)	• Design method for mechanical system program	Q173DCPU/Q172DCPU Motion controller (SV22) Programming Manual (VIRTUAL MODE)

1.2 Comparison between MR-MQ100 and Q173DCPU/Q172DCPU

Items		MR-MQ100	Q173DCPU	Q172DCPU
Operation cycle (default)	SV22	0.44ms/ 1 axis	0.44ms/ 1 to 4 axes 0.88ms/ 5 to 12 axes 1.77ms/13 to 28 axes 3.55ms/29 to 32 axes	0.44ms/ 1 to 4 axes 0.88ms/ 5 to 8 axes
Medium of operating system software		CD-ROM (1 disk)	CD-ROM (1 disk)	
Model of operating system software		SW9DNC-SV22QW	SW8DNC-SV□Q□	
Peripheral I/F		PERIPHRAL I/F	Via PLC CPU (USB/RS-232)	
Control modes		PTP(Point to Point) control, Speed control, Speed-position control (The changing signal comes via servo amplifier) (Note-1), Fixed-pitch feed, Constant speed control, Position follow-up control, Speed control with position stop, Speed switching control, High-speed oscillation control, Synchronous control(SV22)	PTP(Point to Point) control, Speed control, Speed-position control, Fixed-pitch feed, Constant speed control, Position follow-up control, Speed control with position stop, Speed switching control, High-speed oscillation control, Synchronous control(SV22)	
Manual pulse generator		Possible to connect 1 module	Possible to connect 3 modules	
Synchronous encoder operation function		Possible to connect 1 module (Only incremental)	Possible to connect 12 modules	Possible to connect 8 modules
Number of SSCNETⅢ systems (Note-2)		1 system	2 systems	1 system
External input signal		External input signal of servo amplifier (FLS,RLS,DOG)	Q172DLX or External input signal of servo amplifier	
Forced stop input		Servo amplifier has EM1 as the forced stop input. (The motion controller does not have the forced stop input.)	• Use EMI terminal of Motion CPU module • Use device set by forced stop input setting in the system setting.	
Necessity of Operating System Software Installation		No need to install. (It is already installed.)	Need to install	

(Note-1) : "DOG" signal of servo amplifier is used as "Speed-position changing signal" of Speed-position control mode.

(Note-2) : SSCNET: Servo System Controller NETwork

1.3 Combination of software version and a function

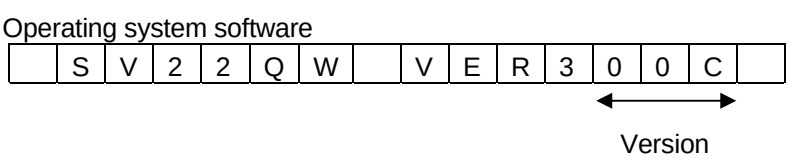
There are combination in the function that can be used by the version of the operating system software and programming software.
The combination of each version and a function is shown below.

(1) Combination of software version and a function

Function	Operating system software version	Programming software version (MELSOFT MT Works2)	Serial number of Motion controller	Section of reference
MC protocol communication	00B	1.06G	-	Section 13.3
Incremental synchronous encoder current value in real mode	00B	-	-	Section 13.4
Connection of the servo amplifier for direct drive motor	00B	1.06G	-	-
Connection with GOT by RS-422 communication	00C	-	G********	Section 12
Connection of the extension IO unit (MR-J3-D01)	00C	-	-	Section 13.5

(2) Confirmation method of the operating system software's version

The operating system software's version of connected Motion controller is displayed on the Operating system type item of the [Read from CPU] screen in MT Developer2.

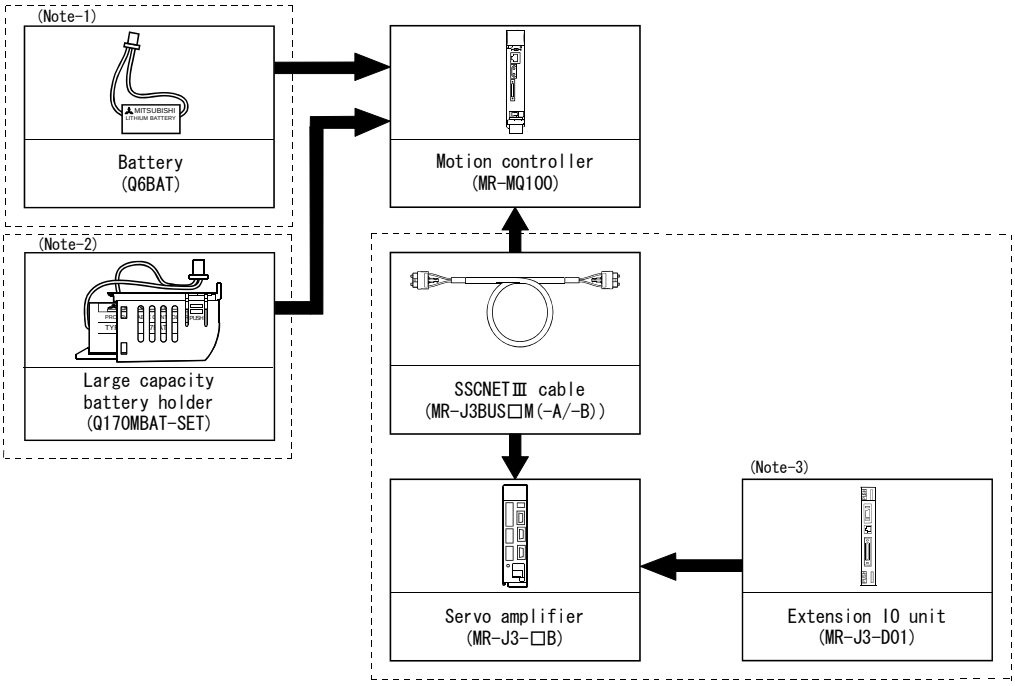


2. SYSTEM CONFIGURATION

This section describes MR-MQ100 system configurations and usage precautions.

2.1 Motion System Configuration

(1) Equipment configuration for MR-MQ100 system

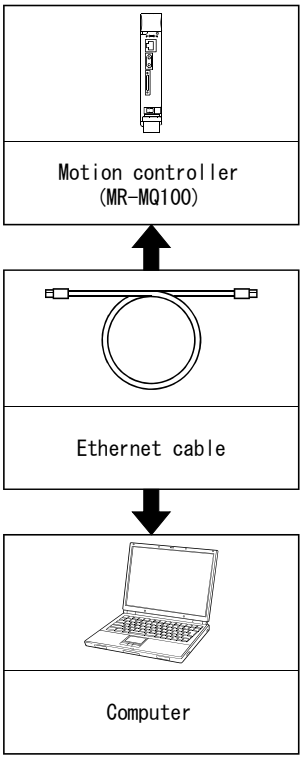


It is possible to select the best according to the system.

(Note-1): Be sure to install the Battery (Q6BAT) to the Battery holder.
(It is packed together with MR-MQ100.)
(Note-2): Large capacity battery use (Q7BAT is included), sold separately.
(Note-3): The extension IO unit has the limitation of the servo amplifier that can be used. Refer to section 13.5 for details.

(2) Peripheral device configuration for the MR-MQ100 system

Peripheral connection options are shown below.

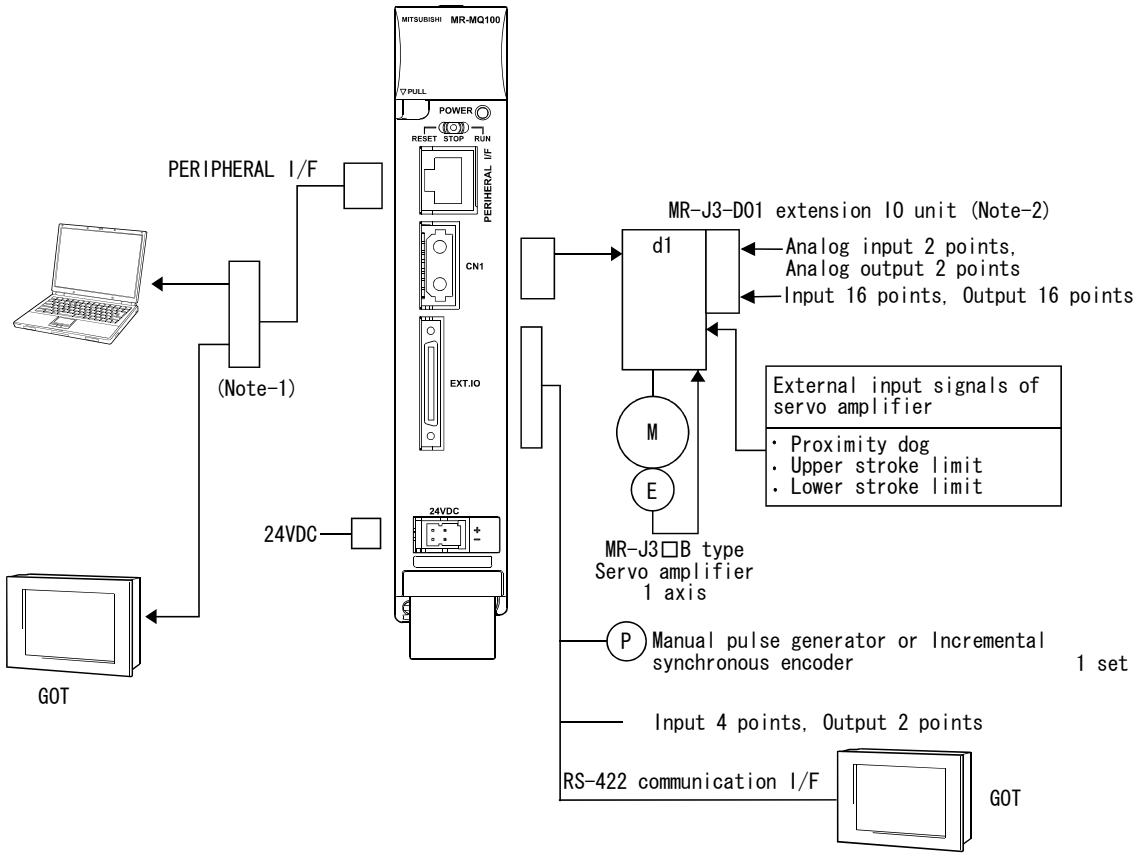


Part name	Connection type	Cable type	Ethernet standard	Model name
Ethernet cable	Connection with HUB	Straight cable	10BASE-T	Compliant with Ethernet standards, category 5 or higher. • Shielded twisted pair cable (STP cable)
			100BASE-TX	
	Direct connection	Crossover cable	10BASE-T	
			100BASE-TX	

(a) Selection criterion of cable

- Category : 5 or higher
- Diameter of lead : AWG26 or higher
- Shield : Copper braid shield and drain wire
  Copper braid shield and aluminium layered type shield

2.1.1 MR-MQ100 System overall configuration



(Note-1) Up to 16 different equipments can access to a single motion controller.

(Note-2) The extension IO unit has the limitation of the servo amplifier that can be used. Refer to section 13.5 for details.

POINT

The latest operating system software "SW9DNC-SV22QW" is preinstalled in the MR-MQ100. There is no need for customer installation.

⚠CAUTION

- Construct a safety circuit externally of the Motion controller or servo amplifier if the abnormal operation of the Motion controller or servo amplifier differ from the safety directive operation in the system.
- The ratings and characteristics of the parts (other than Motion controller, servo amplifier and servomotor) used in a system must be compatible with the Motion controller, servo amplifier and servomotor.
- Set the parameter values to those that are compatible with the Motion controller, servo amplifier, servomotor and regenerative resistor model and the system application. The protective functions may not function if the settings are incorrect.

Restriction matter

The Motion controller does not have a forced stop input, therefore the forced stop function on the servo amplifier should be used.

2.1.2 Function explanations of the MR-MQ100 Motion Controller

(1) Each MR-MQ100 system can control a single servo amplifier axis.

(2) The program is synchronized with the motion operation cycle and can be set to a fixed cycle (0.44[ms], 0.88[ms], 1.77[ms], 3.55[ms], 7.11[ms], 14.2[ms]).

(3) Download of servo parameters, sending of servo ON/OFF and position commands, etc. can be accomplished by connecting a SSCNET Ⅲ cable between MR-MQ100 and servo amplifier.

(4) A single incremental synchronous encoder can be used for synchronous control with an external axis. Please note, hereafter, "INC" will be used instead of "incremental ".

(5) The Motion controller uses the servo amplifier's "stroke limit" and "DOG signal" inputs.

(6) The MR-MQ100 has 4 digital inputs and 2 digital outputs. (The input signals can be used as "Mark detection signals")

(7) RS-422 communication I/F functionality has been added to the internal I/F connector of the Motion controller. This will enable connection with even the GOTs that do not have Ethernet I/F connectivity.

(8) MR-J3-D01 extension IO unit for I/O signal, and analog I/O data can be controlled by the Motion controller.

2.1.3 Restrictions on Motion controller

(1) Since the Motion controller does not contain a forced stop input, the forced stop function of the servo amplifier should be used.

(2) Be sure to connect the battery (Q6BAT) which is included with MR-MQ100.

(3) It takes about 10 sec for the Motion controller to power up after 24VDC power is applied.

(4) Set the rotary switch on the servo amplifier to "0".

2.2 Checking Serial Number

The serial number of the Motion controller can be viewed both on the rating plate and the face of the module.

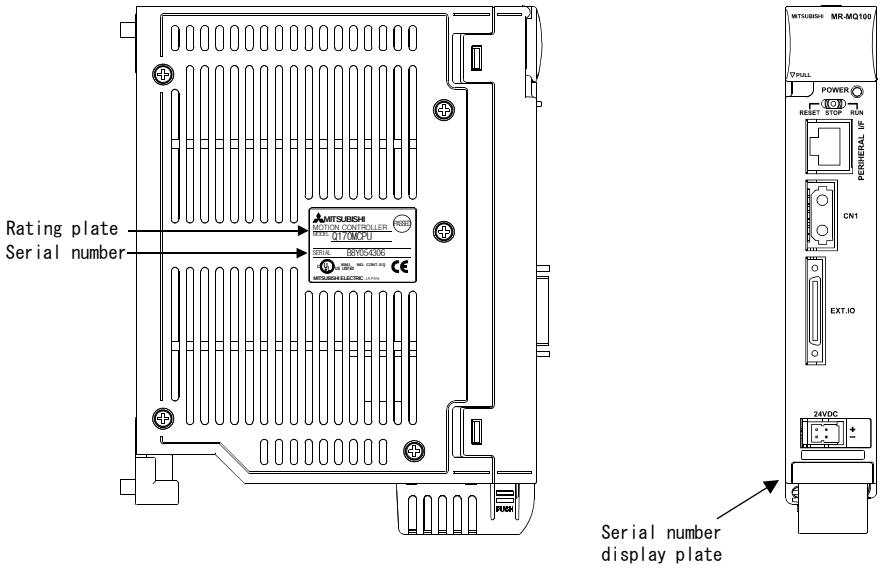
(1) Location of the Motion Controller serial number information.

(a) On the rating plate

The rating plate is located on the left side of the Motion controller.

(b) On the face of the Motion Controller

The serial number is printed on the bottom area of the face of the motion controller.



2.3 System Configuration Equipment

(1) Table of Motion Controller related items

Item	Model name (Note-1)	Description	Remark
Motion controller	MR-MQ100	1 axis control, Operation cycle 0.44[ms] or more, Servo program capacity 16k steps, Internal I/F (Incremental synchronous encoder interface 1ch, Input signal/Mark detection input signal 4 points, Output signal 2 points) (Attachment battery (Q6BAT), Internal I/F connector , 24VDC power supply connector)	
Battery	Q6BAT	For memory data backup of SRAM built-in Motion controller Nominal current: 1800mAh	included with MR-MQ100
Large capacity battery	Q7BAT	For memory data backup of SRAM built-in Motion controller Nominal current: 5000mAh	
Large capacity battery holder	Q170MBAT-SET	Battery holder for Q7BAT (Attachment Q7BAT)	
Internal I/F connector set	Q170MIOCON	Incremental synchronous encoder , Mark detection signal interface connector	included with MR-MQ100
Internal I/F connector cable	Q170MIOCBL1M-A	Incremental synchronous encoder , Mark detection signal interface connector The GOT side is pigtail cable.	
	Q170MIOCBL1M-B	Incremental synchronous encoder , Mark detection signal interface connector The GOT side is D-SUB (9pin).	
24VDC power supply cable	Q170MPWCBL2M	Length 2m(6.56ft.), With solderless terminal R1.25-3.5	
	Q170MPWCBL2M-E	Length 2m(6.56ft.), With solderless terminal R1.25-3.5, With EMI terminal	
24VDC power supply connector set	Q170MPWCON	Connector for 24VDC power supply cable	included with MR-MQ100
SSCNETⅢ cable	MR-J3BUS□M	• MR-MQ100 ↔ MR-J3-□B • Standard code for inside panel • 0.15m(0.49ft.), 0.3m(0.98ft.), 0.5m(1.64ft.), 1m(3,28ft.), 3m(9.84ft.)	
	MR-J3BUS□M-A	• MR-MQ100 ↔ MR-J3-□B • Standard cable for outside panel • 5m(16.40ft.), 10m(32.81ft.), 20m(65.62ft.)	
	MR-J3BUS□M-B (Note-2)	• MR-MQ100 ↔ MR-J3-□B • Long distance cable • 30m(98.43ft.), 40m(131.23ft.), 50m(164.04ft.)	

(Note-1) : □=Cable length (015: 0.15m(0.49ft.), 03: 0.3m(0.98ft.), 05: 0.5m(1.64ft.), 1: 1m(3.28ft.), 2: 2m(6.56ft.), 3: 3m(9.84ft.), 5: 5m(16.40ft.), 10: 10m(32.81ft.), 20: 20m(65.62ft.), 25: 25m(82.02ft.), 30: 30m(98.43ft.), 40: 40m(131.23ft.), 50:50m(164.04ft.)

(Note-2) : Please contact your nearest Mitsubishi sales representative for the cable of less than 30m(98.43ft.).

(2) Table of Servo amplifier related items

Item	Model name	Description	Remark
MR-J3 series servo amplifier	MR-J3-□B		Refer to the servo amplifier instruction manuals.
	MR-J3-□B-RJ004	For linear servo motor	
	MR-J3-□B-RJ006	For fully closed control	
	MR-J3-□B-RJ080W	For direct drive motor	
	MR-J3-□S	For safety servo	
Extension IO unit	MR-J3-D01	For I/O signal, analog I/O data	
Battery	MR-J3BAT	Back-up for the absolute position detection	

(3) Software packages

(a) Operating system software

Application	Model name	Medium
For automatic machinery SV22	SW9DNC-SV22QW	CD-ROM (1 disk)

(b) Motion controller engineering environment

Part name	Model name	Medium
MELSOFT MT Works2 for MR-MQ100 (MT Developer2 (Note-1))	SW1DNC-MTW2MQ-E	CD-ROM (1 disk)

(Note-1) : This software is included in Motion controller engineering environment "MELSOFT MT Works2".

(c) Servo set up software package

Part name	Model name	Details
MR Configurator	MRZJW3-SETUP221E	Version C1 or later
MR Configurator2	SW1DNC-MRC2-E	Version 1.00B or later

POINT

(1) When operating this software, if the operation of Windows is unclear, please refer to a Windows manual or guide-book from another supplier.

(2) Use "standard size font" setting in Windows. When using the "Big font", setting the display might not be shown properly.

2.4 General Specifications

General specifications of MR-MQ100 Motion Controller are shown below.

Item	Specification				
Operating ambient temperature	0 to 55°C (32 to 131°F)				
Storage ambient temperature	-25 to 75°C (-13 to 167°F) (Note-3)				
Operating ambient humidity	5 to 95% RH, non-condensing				
Storage ambient humidity	5 to 95% RH, non-condensing				
Vibration resistance		Frequency	Acceleration	Amplitude	Sweep count
	Under intermittent vibration	5 to 9Hz	——	3.5mm (0.14inch)	10 times each in X, Y, Z directions (For 80 min.)
		9 to 150Hz	9.8m/s^2	——	
	Under continuous vibration	5 to 9Hz	——	1.75mm (0.07inch)	
		9 to 150Hz	4.9m/s^2	——	
Shock resistance	147m/s^2, 3 times in each of 3 directions X, Y, Z				
Operating ambience	No corrosive gases				
Operating altitude	2000m(6561.68ft.) or less				
Mounting location	Inside control panel				
Overvoltage category (Note-1)	II or less				
Pollution level (Note-2)	2 or less				

(Note-1) : This indicates the section of the power supply to which the equipment is assumed to be connected between the public electrical power distribution network and the machinery within premises.
Category Ⅱ applies to equipment for which electrical power is supplied from fixed facilities.
The surge voltage withstand level for up to the rated voltage of 300V is 2500V.

(Note-2) : This index indicates the degree to which conductive material is generated in terms of the environment in which the equipment is used.
Pollution level 2 is when only non-conductive pollution occurs. A temporary conductivity caused by condensing must be expected occasionally.

(Note-3) : Do not use or store the Motion controller under pressure higher than the atmospheric pressure of altitude 0m. Doing so can cause an operation failure.

⚠CAUTION

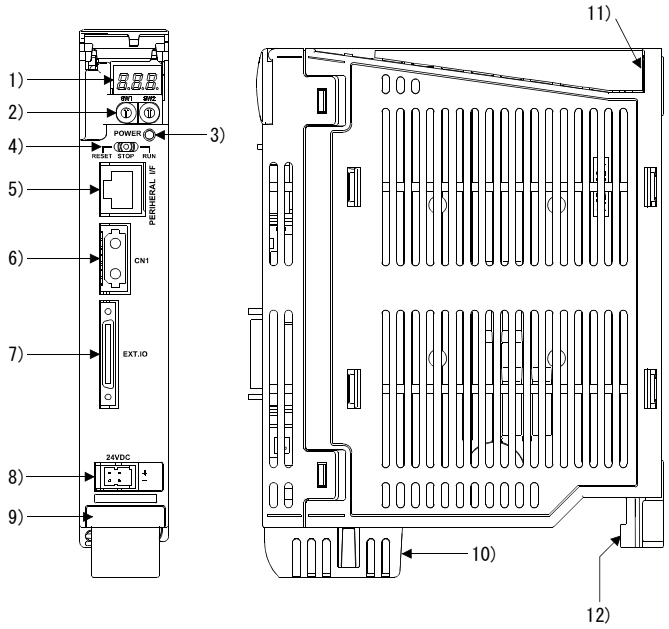
- The Motion controller must be stored and used under the conditions listed in the table of specifications above.
- When not using the module for a long time, disconnect the power line from the Motion controller or servo amplifier.
- Place the Motion controller and servo amplifier in static electricity preventing vinyl bags and store.
- When storing for a long time, please contact with our sales representative.
  Also, execute a trial operation.

2.5 Specifications of Equipment and Settings

2.5.1 Name of parts for MR-MQ100

This section explains the names and settings of the module.

(1) MR-MQ100



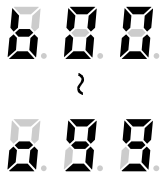
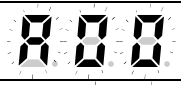
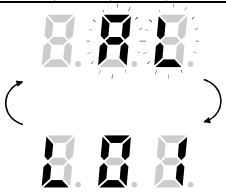
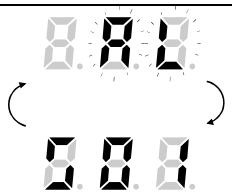
⚠CAUTION
● Close the clear cover, after using the rotary switches.

No.	Name	Application
1)	7-segment LED	• Indicates the operating status and error information.
2)	Rotary function select 1 switch (SW1) Rotary function select 2 switch (SW2)	• Set the operation mode. (Normal operation mode, Installation mode, Mode operated by ROM, etc) • Each switch setting is 0 to F. (Shipped from the factory in SW1 "0", SW2 "0" position)
3)	POWER LED	• ON (Red) : The internal power (5VDC) is on. • OFF : The internal power (5VDC) is off.
4)	RUN/STOP/RESET switch	• Move to RUN/STOP RUN : Motion SFC program is started. STOP : Motion SFC program is stopped. •RESET (Momentary switch) Set the switch to the "RESET" position 1 second or more to reset the hardware.
5)	PERIPHERAL I/F connector	• For communication I/F with peripherals. (Ethernet connector) • The upper LED of the connector for PERIPHERAL I/F. Remains flashing : It communicates with the personal computer. OFF : It doesn't communicate with the personal computer. •The lower LED of the PERIPHERAL I/F connector ON : 100Mbps OFF : 10Mbps
6)	SSCNETⅢ connector (Note-1)	Connector to connect the servo amplifier
7)	Internal I/F connector	• Incremental synchronous encoder input. Incremental synchronous encoder input has Differential-output type, Voltage-output/Open-collector type. • The signal is input, the signal is output. • RS-422 communication I/F for GOT
8)	24VDC power supply connector	•The DC power of 24VDC is connected.
9)	Serial number display plate	•The serial number written on the rating plate is displayed.
10)	Battery holder	•Battery holder to set the Q6BAT/ Q7BAT
11)	Hole for module fixing screw	Screw used to fix to the control box. (M5 screw)
12)	FG terminal (Terminal for earth)	Earth terminal which is connected to shield patterns on the print circuit board.

(Note-1) : Refer to "2.5.4 SSCNETⅢ cable and connection" about a notification and a method of connection for SSCNETⅢ.

(2) 7-segment LED display

The LED displays/flashes in the combination with errors.

Item		7-segment LED		Remark
Start			Initializing	It takes about 10 seconds to initialize (RUN/STOP display). Execute the power cycle of the Motion controller if the operation stopped at initializing. It may be Motion controller's hardware fault when it is not improved. Explain the error symptom (LED display) and get advice from our sales representative for the modules with failure.
Normal			" ☀" remains flashing	Normal operation
Installation mode			Steady "INS" display, " ☀" remains flashing	Mode for installing operating system software via personal computer.
Operation mode	Mode operated by RAM		" ☀" remains flashing	Mode for operating based on user programs and parameters stored in the SRAM built-in Motion controller.
	Mode operated by ROM		Steady "INS" display, " ☀" remains flashing	Mode for operating after the user programs and parameters stored in the FLASH ROM built-in Motion controller are read to the SRAM built-in Motion controller.
STOP			Steady "STP" display	Stopped the Motion SFC program.
RUN			Steady "RUN" display	Executed the Motion SFC program.
Battery error	Early stage warning (2.7V or less)		Steady "BT1" display	Displayed at battery voltage 2.7V or less. Refer to Section "6.5 External Battery".
	Final stage warning (2.5V or less)		Steady "BT2" display	Displayed at battery voltage 2.5V or less. Refer to Section "6.5 External Battery".
Operating system software not installed			"A00" remains flashing	Installation status mode when the operating system software is not installed.
System setting error			" AL" flashes 3 times ↓ Steady " L01" display	System setting error of the Motion controller Refer to the "Q173DCPU/Q172DCPU Motion controller Programming Manual (COMMON)" for details.
Servo error			" AL" flashes 3 times ↓ Steady " S01" display	Motion controller servo error. Refer to the "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" or "Q173DCPU/Q172DCPU Motion controller (SV22) Programming Manual (VIRTUAL MODE)" for details.
WDT error			Steady "..." display	Hardware fault or software fault Refer to the "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" or "Q173DCPU/Q172DCPU Motion controller (SV22) Programming Manual (VIRTUAL MODE)" for details.

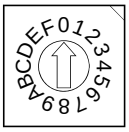
POINT

(1) When an error is displayed on the 7-segment LED, confirm the error number etc. using MT Developer2.

(2) Refer to the Motion controller error batch monitor of MT Developer2 or error list of the programming manual for error details.

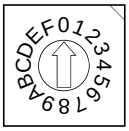
(3) Rotary switch assignment

(a) Rotary function select switch 1 (SW1)

Rotary switch	Setting (Note)	Mode	Description
	0	Normal mode	Normal operation mode
	A	Installation mode	When installing the operating system software using MT Developer2

(Note): Should not be set to anything except the above settings.

(b) Rotary function select switch 2 (SW2)

Rotary switch	Setting (Note)	Mode	Description
	0	Mode operated by RAM	Normal operation mode (Operation by the setting data and parameters stored in the Motion controller's SRAM.)
	6	Mode operated by ROM	Mode to operate based on the setting data and the parameters written to the Motion controller's FLASH ROM.
	8	Ethernet IP address display mode	Ethernet Internet Protocol address display mode.
	C	SRAM clear	SRAM "0" clear

(Note): Not to be set except above setting.

⚠CAUTION

● Be sure to turn OFF the Motion controller power supply before the rotary switch setting change.

(4) Operation mode

(a) Rotary switch setting and operation mode

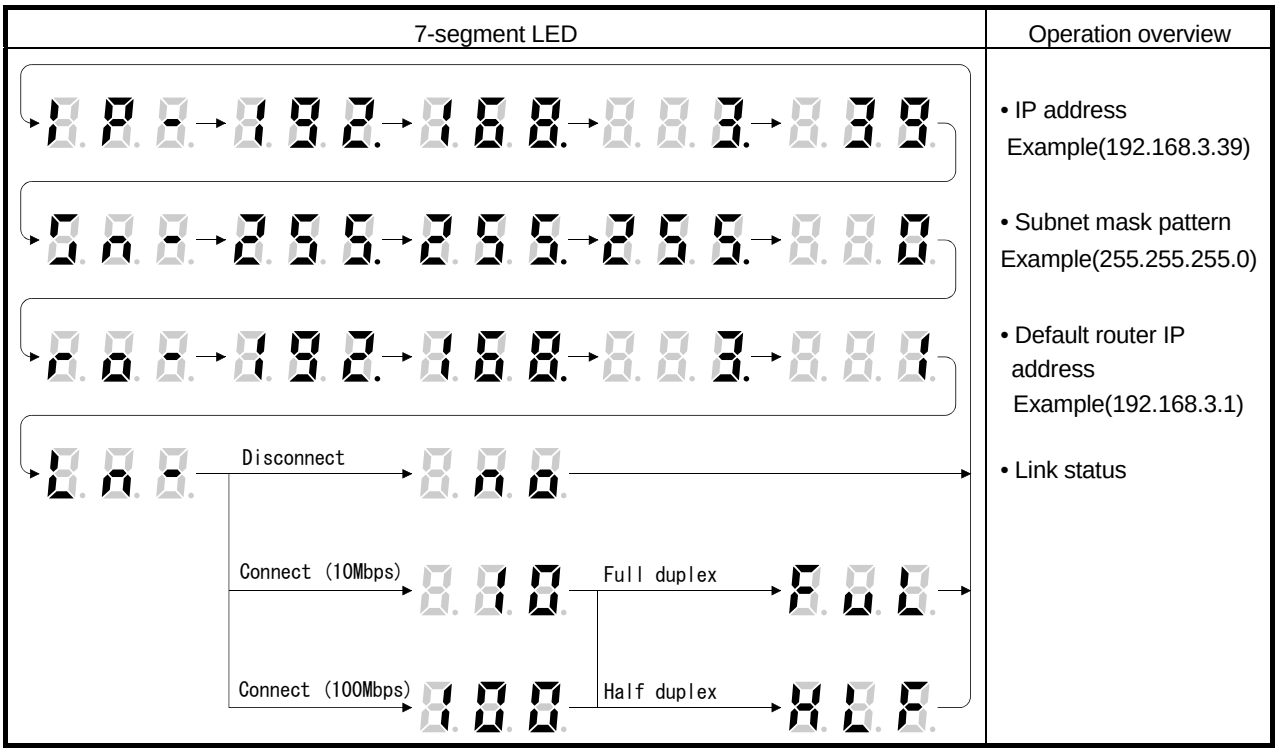
Rotary switch setting (Note)		Operation mode
SW1	SW2	
A	Any setting (Except C)	Installation mode
0	0	Mode operated by RAM
0	6	Mode operated by ROM
0	8	Ethernet IP address display mode
Any setting	C	SRAM clear (Note)

(Note) : The programs, parameters, absolute position data, and latch data built-in Motion controller are cleared.

(b) Operation mode overview

Operation mode	7-segment LED	Operation overview
Mode operated by RAM		• " . " remains flashing in the first digit of 7-segment LED. • Operates based on the user program and parameters stored in the SRAM of the Motion controller.
Mode operated by ROM		• " . " remains flashing in the first digit and steady " . " display in the second digit of 7-segment LED. • Operation starts after the user programs and parameters stored in the Motion controller's FLASH ROM are read to the SRAM built-in Motion controller at power supply on or reset of the Motion controller. If the ROM writing is not executed, even if the user programs and parameters are changed using the MT Developer2 during mode operated by ROM, operation starts with the contents of the FLASH ROM at next power supply on or reset. Also, If the ROM writing is not executed, even if the auto tuning data are reflected on the servo parameter of the Motion controller by operation in the auto-tuning setting, operation starts with the contents of the FLASH ROM at next power on or reset.
Ethernet IP address display mode	-	• Refer to next page "(c) Ethernet IP address display mode overview". • Digital oscilloscope function cannot be used.
SRAM clear		• " . " remains flashing in the first digit and steady. • When rotary switch 2 is set to "C", and a power ON is done, the SRAM area is cleared. • The programs, parameters, absolute position data, and latch data in the Motion controller are cleared.
Installation mode		• Steady "INS" display at the 7-segment LED. • Operating system software can be installed. • STOP status is maintained regardless of the RUN/STOP/RESET switch position on the front side of Motion controller. • Digital oscilloscope function cannot be used.

(c) Ethernet IP address display mode overview



(Note): When the Ethernet parameters are not written in the Motion controller , the address are displayed as follows.

- IP address : 192.168.3.39
- Subnet mask pattern : 255.255.255.0
- Default router IP address : 192.168.3.1

POINT
● Be sure to turn OFF the Motion controller power supply before a rotary switch setting change.

2.5.2 MR-MQ100 hardware and wiring

(1) Module specification

(a) Module specification

Item		Specifications
24VDC power supply	Input voltage (Note-1), (Note-2)	21.6 to 26.4VDC (24VDC +/-10%, ripple ratio 5% or less)
	Inrush current (Note-3)	100A 1ms or less (at 24VDC input)
	Max. input current	0.69A
Efficiency		80% (TYP.)
Input type		connector
Power consumption		16.6W
Permissible instantaneous power off time (Note-4), (Note-5)		10ms (at 24VDC input)
Mass		0.7kg
Exterior dimensions		178 (H) × 30(W) × 135(D)mm (Note-6) (7.01(H) × 1.18(W) × 5.31(D))inch
Installation method		It fixes directly to the control panel.

POINT

(Note-1) : Input power supply
MR-MQ100 is rated for use with a 24VDC input power supply only. The MR-MQ100 unit breaks down when 28VDC or more is input.

(Note-2) : Select 24VDC power supply and electric wire within the range of 21.6 to 26.4VDC including any input ripple or spike voltage measured at the input connector of the MR-MQ100.

(Note-3) : Inrush current
Take care that the inrush current of several amperes may flow when the sharp square voltage is applied, or the power supply is turned ON with the mechanical switch.
Turn on the primary(AC side) of power supply.
When selecting a fuse and breaker in the external circuit, take account of the blow-out, detection characteristics and above points.

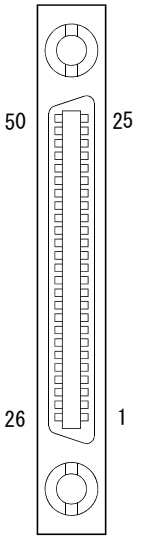
(Note-4) : Allowable momentary power failure period
(a) An instantaneous power failure lasting less than 10ms(Note) will cause 24VDC down to be detected, but operation will continue.
(b) An instantaneous power failure lasting in excess of 10ms(Note) may cause the operation to continue or initial start to take place depending on the power supply load.
(Note) : This is for a 24VDC input. This is 10ms or less for less than 24VDC.

(Note-5) : Select 24VDC power supply with allowable momentary power failure period of 20ms or more .

(Note-6) : Exterior dimensions
The stated height (H) of the MR-MQ100 does include the battery holder dimensions.

(b) Pin layout of the Internal I/F connector

Use the internal I/F connector on the front of the MR-MQ100 to connect to manual pulse signals and incremental synchronous encoder signals.
The following is the pin layout of the MR-MQ100's internal I/F connector as viewed from the front.



Internal I/F connector

	PIN No.	Signal name	PIN No.	Signal name	
	50	SG	25	HBL	(Note-3)
(Note-1)	49	SEL	24	HBH	
	48	SG	23	HAL	
	47	SG	22	HAH	
	46	5V	21	HB	(Note-2)
	45	5V	20	HA	
	44	No connect	19	No connect	(Note-6)
	43	No connect	18	No connect	
	42	RXDL	17	TXDL	
	41	RXDH	16	TXDH	
	40	No connect	15	No connect	
	39	No connect	14	No connect	
(Note-6)	38	SG	13	AB	
	37	SG	12	No connect	
	36	No connect	11	No connect	
	35	No connect	10	No connect	
	34	No connect	9	No connect	
	33	No connect	8	No connect	
(Note-5)	32	COM2	7	COM2	(Note-5)
	31	DO2	6	DO1	
(Note-4)	30	COM1	5	COM1	(Note-4)
	29	DI4	4	DI3	
	28	DI2	3	DI1	
(Note-6)	27	No connect	2	No connect	(Note-6)
	26	No connect	1	No connect	

Applicable connector model name

HDR type connector (HONDA TSUSHIN KOGYO CO. LTD)
HDR-E50MSG1+ connector } (Attachment)
HDR-E50LPH connector case

(Note-1) : Input type from manual pulse generator/ Incremental synchronous encoder switched by SEL .
Not connected: Voltage-output/open-collector type.
SEL-SG connection : Differential -output type.

(Note-2) : Voltage-output/open-collector type
Connect the A-phase signal to HA, and the B-phase signal to HB.

(Note-3) : Differential-output type
Connect the A-phase signal to HAH, and the A-phase inverse signal HAL.
Connect the B-phase signal to HBH, and the B-phase inverse signal HBL.

(Note-4) : "COM1" is the common terminal of DI1, DI2, DI3 and DI4.

(Note-5) : "COM2" is the common terminal of DO1 and DO2.

(Note-6) : Do not connect to any of the terminal is explained as "No connect ".

(2) Input signal/ Mark detection

(a) Specifications of input signal/ mark detection input signal

Item		Specifications
Number of input points		4 points
Input method		Positive common/ Negative common shared
Isolation method		Photo coupler
Rated input voltage		24VDC
Rated input current (I_{IN})		Approx.5mA
Operating voltage range		21.6 to 26.4VDC (24VDC +/ -10%, ripple ratio 5% or less)
ON voltage/current		17.5VDC or more/3.5mA or more
OFF voltage/current		5VDC or less/0.9mA or less
Input resistance		Approx. 5.6kΩ
Response time	OFF to ON	1ms or less
	ON to OFF	
Common terminal arrangement		4 points/common(Common contact: COM1)
Indicates to display		None

(b) Interface of input signal/ mark detection input signal

Input or output	Signal name		Pin No. DI1	DI2	DI3	DI4	Wiring example	Internal circuit	Description
Input	Input/ Mark detection input	DI□ Note-1	3	28	4	29			Signal input, Mark detection signal input
		COM1	5 30				+ − 24VDC Note-2		

(Note-1) : □ =1 to 4

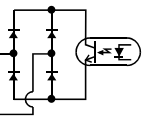
(Note-2) : Both "positive common" and "negative common" can be used.

(3) Output signal

(a) Specification of output signal

Item		Specifications
Number of output points		2 points
Output method		Sink/Source type
Isolation method		Photo coupler
Rated load voltage		24VDC +/ -10%
Maximum load current (I_{out})		40mA/point, 80mA/common
External supply power		21.6 to 26.4VDC (24VDC +/ -10%, ripple ratio 5% or less)
Maximum voltage drop at ON (V_{dorp})		2.75VDC or less
OFF voltage/ current		11VDC or less/ 1.7mA or less
Input resistance		Approx. 5.6kΩ
Response time	OFF to ON	1ms or less
	ON to OFF	1ms or less(Rated load, resistance load)
Common terminal arrangement		2 points/common(Common contact: COM2)
Indicates to display		None

(b) Interface of output signal

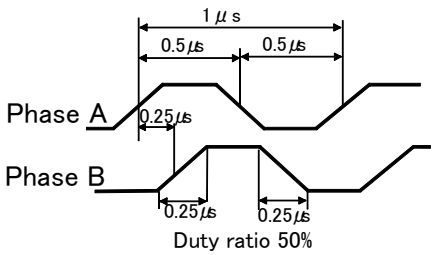
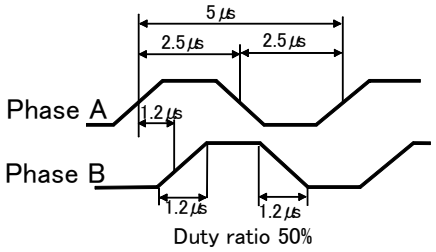
Input or output	Signal name		Pin No. DO1	Pin No. DO2	Wiring example	Internal circuit	Description
Output	Output	DO□ Note-1	6	31	Load		Signal output
		COM2	7 32		+ − 24VDC Note-2		

(Note-1) : □ = 1 to 2

(Note-2) : Both "sink type" and "source type" can be used.

(4) Manual pulse generator/ Incremental synchronous encoder input

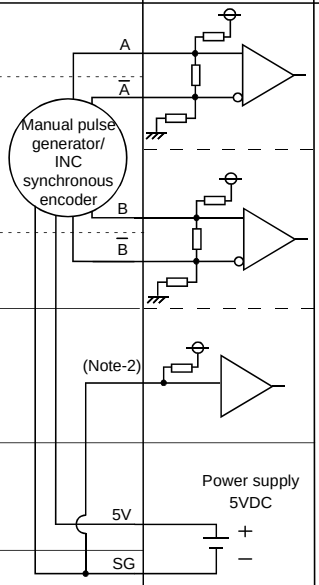
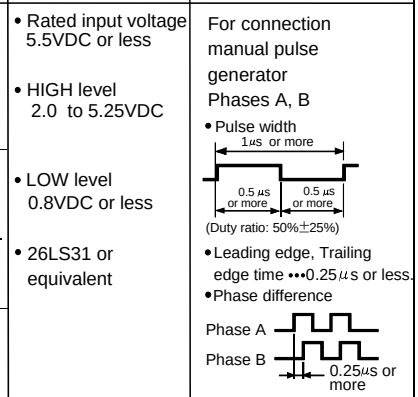
(a) Specification of manual pulse generator/ Incremental synchronous encoder

Item		Specifications
Signal input form		Phase A/ Phase B
Differential-output type (26LS31 or equivalent)	Maximum input pulse frequency	1Mpps (After magnification by 4, up to 4Mpps)
	Pulse width	1 μs or more
	Leading edge/trailing edge time	0.25μs or less
	Phase difference	0.25μs or more
	High-voltage	2.0 to 5.25 VDC
	Low-voltage	0 to 0.8 VDC
	Differential voltage	-0.2 to 0.2 V
	Adjustment type	Differential-output type(26LS31 or equivalent)
	Cable length	30m (98.43ft.)
	Example of waveform	
Voltage-output/ Open-collector type	Maximum input pulse frequency	200kpps (After magnification by 4, up to 800kpps)
	Pulse width	5μs or more
	Leading edge/trailing edge time	1.2μs or less
	Phase difference	1.2μs or more
	High-voltage	3.0 to 5.25 VDC
	Low-voltage	0 to 1 VDC
	Adjustment type	Voltage-output/ Open-collector type(5VDC)
	Cable length	10m (32.8ft.)
	Example of waveform	

POINT

● Use a manual pulse generator or an incremental synchronous encoder that consumes less than 0.2[A] of current.

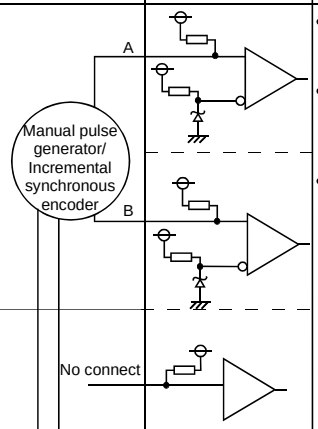
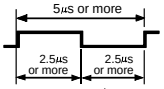
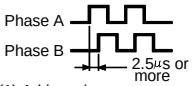
(b) Interface between Manual pulse generator (Differential-output type)/ Incremental synchronous encoder

<table>
<tr><th>Input or Output</th><th colspan="2">Signal name</th><th>Pin No.</th><th>Wiring example</th><th>Internal circuit</th><th>Specification</th><th>Description</th></tr>
<tr><td rowspan="5">Input</td><td rowspan="2">Manual pulse generator, phase A</td><td>A+
HAH</td><td>22</td><td rowspan="5"> 
</td><td rowspan="5">  </td><td rowspan="5">• Rated input voltage 5.5VDC or less
• HIGH level 2.0 to 5.25VDC
• LOW level 0.8VDC or less
• 26LS31 or equivalent</td><td rowspan="5">For connection manual pulse generator Phases A, B
• Pulse width
1μs or more
0.5 μs or more
0.5 μs or more
(Duty ratio: 50%±25%)
• Leading edge, Trailing edge time •••0.25μs or less.
• Phase difference
Phase A
Phase B
0.25μs or more
(1) Address increases if Phase A leads Phase B.
(2) Address decreases if Phase B leads Phase A.</td></tr>
<tr><td>A−
HAL</td><td>23</td></tr>
<tr><td rowspan="2">Manual pulse generator, phase B</td><td>B+
HBH</td><td>24</td></tr>
<tr><td>B−
HBL</td><td>25</td></tr>
<tr><td colspan="2">Select type signal SEL</td><td>49</td></tr>
<tr><td rowspan="2">Power supply</td><td colspan="2">5V(Note-1)</td><td>45
46</td></tr>
<tr><td colspan="2">SG</td><td>47
48
50</td></tr>
</table>

(Note-1) : The 5VDC power supply from the MR-MQ100 must not be used if a separate power supply is applied to the Manual pulse generator/ incremental synchronous encoder.
If a separate power supply is used, be sure it is 5V voltage. Anything else may cause a failure.

(Note-2) : Connect SEL to the SG terminal if the manual pulse generator (differential-output type)/ incremental synchronous encoder is used.

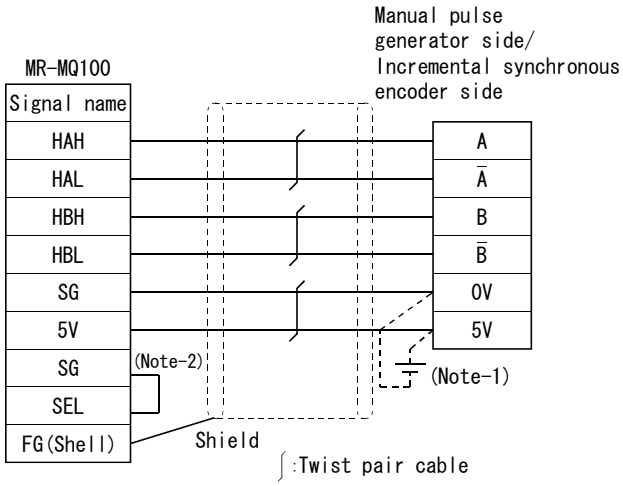
(c) Interface between Manual pulse generator (Voltage-output/ Open-collector type)/ Incremental synchronous encoder

Input or Output	Signal name	Pin No.	Wiring example	Internal circuit	Specification	Description
Input	Manual pulse generator, phase A HA	20			• Rated input voltage 5.5VDC or less • HIGH level 3 to 5.25VDC/ 2mA or less • LOW level 1VDC or less/ 5mA or more	For connection manual pulse generator Phases A, B • Pulse width  (Duty ratio: 50%±25%) • Leading edge, Trailing edge time •••1.2μs or less. • Phase difference  (1) Address increases if Phase A leads Phase B. (2) Address decreases if Phase B leads Phase A.
	Manual pulse generator, phase B HB	21				
	Select type signal SEL	49				
Power supply	5V(Note)	45 46				
	SG	47 48 50				

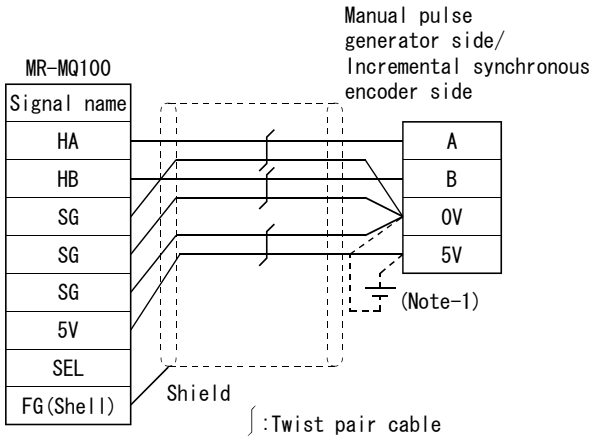
(Note) : The 5VDC power supply from the MR-MQ100 must not be used if a separate power supply is applied to the Manual pulse generator/ incremental synchronous encoder.
If a separate power supply is used, be sure it is 5V voltage. Anything else may cause a failure.

(d) Connection examples of manual pulse generator/ incremental synchronous encoder

Differential-output type



Voltage-output/ Open-collector type



(Note-1) : The 5VDC power supply from the MR-MQ100 must not be used if a separate power supply is applied to the Manual pulse generator/ incremental synchronous encoder.
If a separate power supply is used, be sure it is 5V stabilized. Anything else may cause a failure.

(Note-2) : Input type from manual pulse generator/incremental synchronous encoder switched by SEL.
Not connected: Voltage-output/open-collector type
SEL-SG connection: Difference-output type

⚠CAUTION

- If a separate power supply is used as the manual pulse generator/incremental synchronous encoder power supply, use a 5V stabilized power supply. Any other power supply may cause a failure.
- Wiring during power-on may damage the unit. Power off the unit, before wiring.
- Miss wiring may cause damage to the unit. Ensure care during wiring.

(5) PERIPHERAL I/F

Item		Specifications
Transmission	Data transmission speed	100/10Mbps
	Communication mode	Full-duplex/ Half-duplex
	Transmission method	Base band
	Cable length [m(ft)]	Up to 30 (98.43)

(6) RS-422 communication I/F

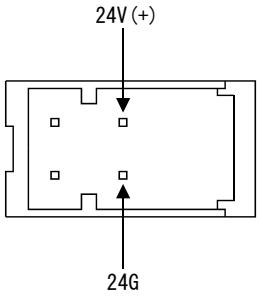
Item		Specifications
Communication mode		Full-duplex
Synchronous method		Asynchronous communication method
Data transmission speed		9600/ 19200/ 38400bps
Data type	Start bit	1
	Data bit	8
	Parity bit	Odd
	Stop bit	1
Cable length [m(ft)]		Up to 30 (98.43)

2.5.3 24VDC power supply connector

(1) Connecting of 24VDC power supply connector

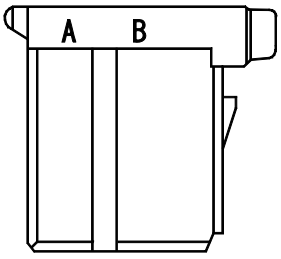
(a) Pin layout of the 24VDC power supply connector

MR-MQ100 requires 24VDC. The pins layout (from front view) of the 24VDC connector is shown below.

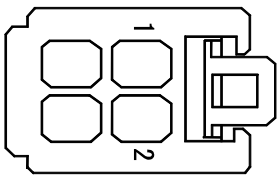


(b) DC24V power supply cable

Connect 24V(+) to the 24VDC power supply connector as shown in the table below.



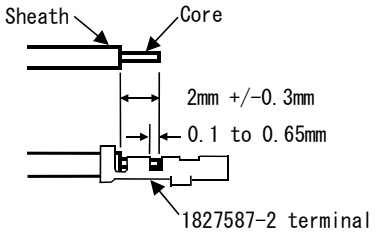
Pin No.	Signal Name
1B	24V(+)
2B	24G



• Applicable connector model name
  24VDC power supply connector set (Q170MPWCON) (Attachment)
  1-1827864-2 connector (Tyco Electronics AMP K.K. make)
  1827587-2 terminal

• Conductor size for power supply wiring
  0.34 to 0.37 mm^2 (AWG22)

• Termination of the cables
When the 24VDC power supply cable is produced with the customer, a crimping tool is necessary.
Please refer to the manual of the manufacturing maker of the crimp tool for details.



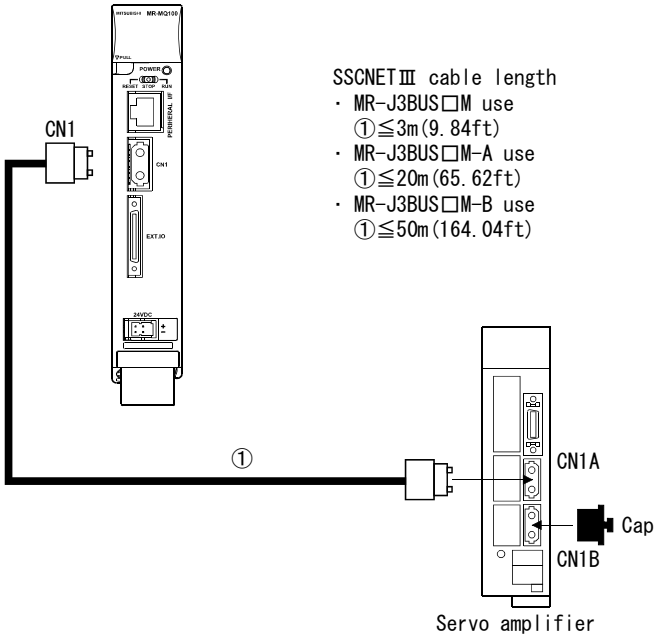
⚠CAUTION

- 24V(+) pin is upper side and 24G pin is lower side of 24VDC connector of MR-MQ100. If the polarity is wrong, the unit may be damaged.
- Recommend the use of twisted pair cabling for 24VDC input.
- Power off the unit before wiring 24VDC input.
- Use proper size wire for 24VDC.
- Do not connect to pins "1A" or "2A" of the 24VDC power input connector.

2.5.4 SSCNETⅢ cables and connection method

This section describes how to connect between the Motion controller and servo amplifier.
SSCNETⅢ cabling is used between the Motion controller and servo amplifier.

(1) Connection between the MR-MQ100 and servo amplifier



(Note): Communication will not be possible if CN1A and CN1B are mistaken for one-another.

List of SSCNETⅢ cable model name

Model name (Note)	Cable length	Description	
MR-J3BUS□M	0.15m(0.49ft.), 0.3m(0.98ft.), 0.5m(1.64ft.), 1m(3.28ft.), 3m(9.84ft.)	Standard cord for inside panel	• MR-MQ100 ↔ MR-J3-□B
MR-J3BUS□M-A	5m(16.4ft.), 10m(32.81ft.), 20m(65.62ft.)	Standard cable for outside panel	
MR-J3BUS□M-B	30m(98.43ft.), 40m(131.23ft.), 50m(164.04ft.)	Long distance cable	

(Note) : □=cable length

POINT

(1) Be sure to connect SSCNETⅢ cable as per above. If the connection is incorrect, communication between the Motion controller and servo amplifier is not possible.

(2) The SSCNETⅢ connector has a cap to protect the optical device inside from dust. For this reason, do not remove the cap until just before connecting the SSCNETⅢ cable. Also, when removing the SSCNETⅢ cable, be sure to put the cap back on.

(3) Be sure to keep the SSCNETⅢ fiber optic protective cap and tubing in a sealed plastic bag to prevent them from becoming dirty.

(4) Do not remove the SSCNETⅢ cable while the power supply of the Motion controller or servo amplifier is turned on.
Do not look directly into the light generated from SSCNETⅢ connector of the Motion controller, servo amplifier or from the end of SSCNETⅢ cable. The light can damage the eye. (The light source of SSCNETⅢ cable complies with class1 defined in JISC6802 or IEC60825-1.)

(5) When replacing the servo amplifier or the Motion controller, be sure to put a cap on the SSCNETⅢ connector. When sending a servo amplifier or Motion controller back for repairs, also be sure to put a cap on the SSCNETⅢ connector. Without a cap, the light device may be damaged during transit. If this is the exchange or repair of the light device will be required.

(2) Cable specifications

(a) MR-J3BUS□M

Item \ Model name	MR-J3BUS015M	MR-J3BUS03M	MR-J3BUS05M	MR-J3BUS1M	MR-J3BUS3M
Cable length [m(ft.)]	0.15(0.49)	0.3(0.98)	0.5(1.64)	1(3.28)	3(9.84)

(b) MR-J3BUS□M-A

Item \ Model name	MR-J3BUS5M-A	MR-J3BUS10M-A	MR-J3BUS20M-A
Cable length [m(ft.)]	5(16.40)	10(32.81)	20(65.62)

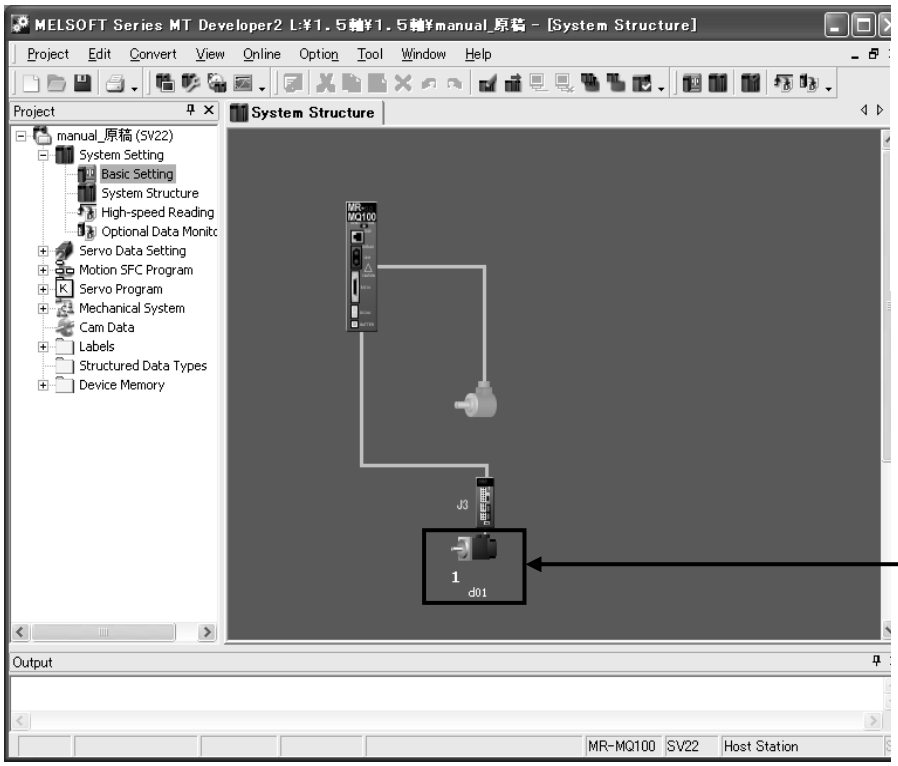
(c) MR-J3BUS□M-B

Item \ Model name	MR-J3BUS30M-B	MR-J3BUS40M-B	MR-J3BUS50M-B
Cable length [m(ft.)]	30(98.43)	40(131.23)	50(164.04)

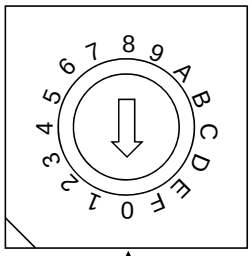
(3) Setting of the axis No. and axis select rotary switch of servo amplifier

Axis No. is used in the program to set the axis numbers of any servo amplifiers connected to the motion controller via SSCNETⅢ.
Set the axis select rotary switch of the servo amplifier to "0", because the axis number is fixed in the "system structure" display as "d01".
(The default setting of the axis select rotary switch of servo amplifier is "0".)

• System structure (Allocation of axis No.)



• Axis select rotary switch (Servo amplifier)



Set the servo amplifier's rotary switch to "0".

The axis number "d01" is fixed on the "system structure" display.

2.5.5 Battery

Below explains the specification, install procedure and handling of the Motion controller battery.

(1) Battery specifications

Item \ Model name	Q6BAT	Q7BAT
Classification	Manganese dioxide lithium primary battery	
Initial voltage [V]	3.0	
Nominal current [mAh]	1800	5000
Storage life	5 years typical (Room temperature)	5 years typical (Room temperature)
Lithium content [g]	0.49	1.52
Applications	For memory data backup of SRAM built-in Motion controller	
Exterior dimensions [mm(inch)]	ϕ16(0.63)×32(1.26)	ϕ24(0.94)×52(2.05)

(Note) : The following points are changed for lithium metal batteries transportation by sea or air due to Recommendations of the United Nations Rev. 15 and ICAO-TI 2009-2010 edition.

1) A package containing 24 cells or 12 batteries or less that are not contained in equipment are no longer exempt from the following: attachment of a handling label,
submission of the Shipper's Declaration for Dangerous Goods, and a 1.2m drop test.

2) A battery handling label (size: 120 x 110mm) is required. Emergency telephone number must be filled out in the additional handling information of the Shipper's Declaration for Dangerous Goods.

3) New label design containing battery illustration must be used (in air transportation only).

Fig.2.1 Example of Label with Battery Illustration

• Transportation precaution for customers
Documentations like the handling label in the specified design and the Shipper's Declaration for Dangerous Goods are required for air and sea transportation. Please attach documentations like the handling label in the specified design and the Shipper's Declaration for Dangerous Goods to the package.

If you need the self-certification form for the battery safety test, contact Mitsubishi. For more information, contact Mitsubishi.

(2) Data back-up of the Motion controller by the battery

Be sure to set the battery to the Motion controller.
Set the battery (Q6BAT/Q7BAT) to battery holder.
The data (Refer to Section 6.5.) of SRAM built-in Motion controller are backed up without using the battery.
In the following status, the backup time after power OFF is 3 minutes.

- The Q6BAT/Q7BAT lead connector is disconnected.
- The lead wire of Q6BAT/Q7BAT is broken.

Battery type	Battery life (Total power failure time) [h] (Note-1)				
	Power-on time ratio (Note-2)	Guaranteed value (Note-3) (MIN) (75°C (167°F))	Guaranteed value (Note-4) (TYP) (40°C (104°F))	Actual service value (Note-5) (Reference value) (TYP) (25°C (77°F))	Backup time after alarm
Battery (Q6BAT)	0%	20000	43800	43800	90 (After SM51,SM52 ON)
	30%	27000			
	50%	31000			
	70%	36000			
	100%	43800			
Large capacity battery (Q7BAT)	0%	39000	43800	43800	90 (After SM51,SM52 ON)
	30%	43800			
	50%				
	70%				
	100%				

(Note-1) : The actual service value indicates the average value, and the guaranteed time indicates the minimum time.
(Note-2) : The power-on time ratio indicates the ratio of Motion controller power-on time to one day (24 hours).

$$\text{Power-on time ratio} = \frac{17}{24} \times 100 = 70[\%]$$

(When the total power-on time is 17 hours and the total power-off time is 7 hours, the power-on time ratio is 70%.)
(Note-3) : The guaranteed value (MIN) ; equivalent to the total power failure time that is calculated based on the characteristics value of the memory (SRAM) supplied by the manufacturer and under the storage ambient temperature range of -25°C to 75°C (-13 to 167°F) (operating ambient temperature of 0°C to 55°C (32 to 131°F)).
(Note-4) : The guaranteed value (TYP) ; equivalent to the total power failure time that is calculated based on the normal air-conditioned environment (40°C (104°F)).
(Note-5) : The actual service value (Reference value) ; equivalent to the total power failure time that is calculated based on the measured value and under the storage ambient temperature of 25°C (77°F). This value is intended for reference only, as it varies with characteristics of the memory.

POINT

The self-discharge influences the life of battery without the connection to Motion controller. The battery should be exchanged approximately every 4 or 5 years. And, exchange the battery with a new one every 4 to 5 years even if the total power failure time is equal to or less than the guaranteed value.

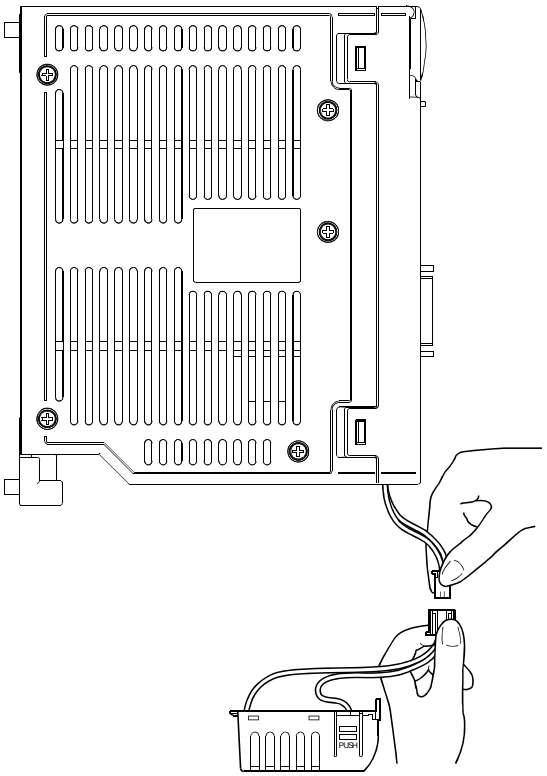
⚠CAUTION

- Do not short a battery.
- Do not charge a battery.
- Do not disassemble a battery.
- Do not burn a battery.
- Do not overheat a battery.
- Do not solder the battery terminal.
- The data (Refer to Section 6.5.) of SRAM built-in Motion controller are backed up without using the battery.

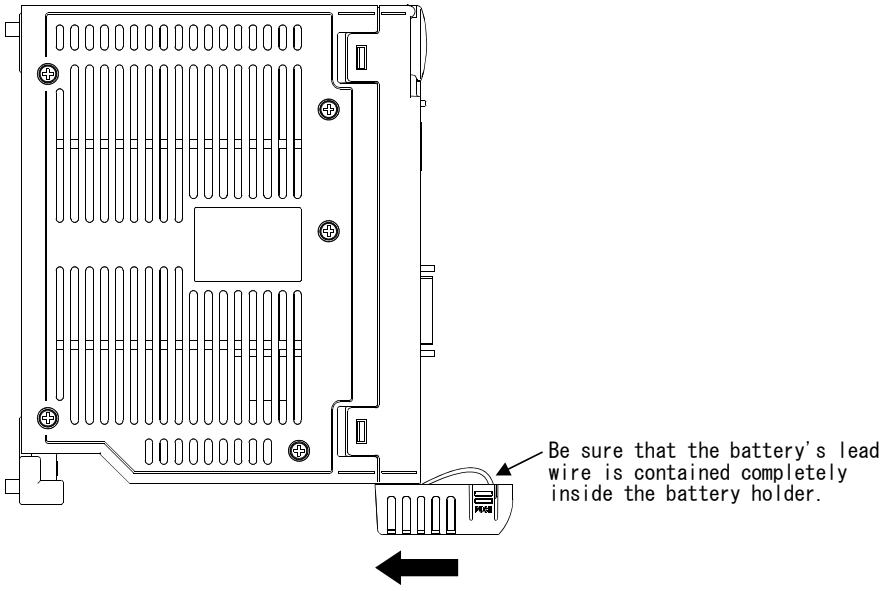
(3) Motion Controller connection procedure

(a) Connection of the battery connector

Connect the battery connector first, then store the connector and lead wire into the battery holder.



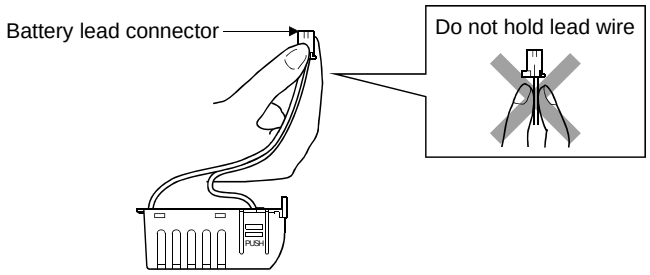
(b) Install the battery holder to the motion controller.



(4) Handling the battery lead wire

(a) Precautions for handling the battery lead wire

• Be sure to securely hold the battery lead wire connector while connecting or removing the battery connection.



(b) Connection of the battery lead wire

• Hold the battery lead connector and connect it securely to the battery connector of the Motion controller. Be sure to insert it until it clicks.

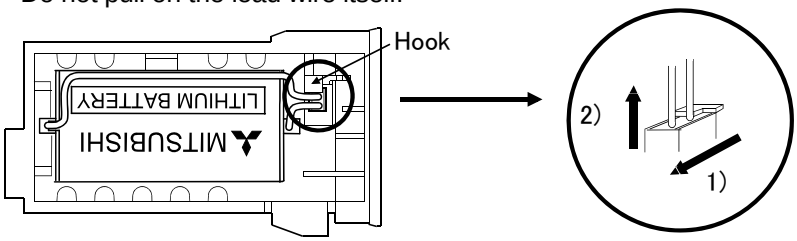
(c) Removal of the battery lead wire from battery case

• Remove the battery lead wire from battery case by pulling it out while holding the battery lead connector.

(d) Detaching of the battery connector

• Please remove the battery connector by pulling on the connector hook in the manner shown below.

• Do not pull on the lead wire itself.



1) Pull forward.

2) Pull up.

POINT

(1) Forcible removal of the battery lead wire from the connector will damage the battery connector or battery lead wire.

(2) The programs, parameters, absolute position data, and latch data of the Motion controller's SRAM are not backed up if the battery connector is not properly connected.

2.5.6 Software specification of MR-MQ100

(1) Motion control specifications

Item	Specifications
Number of control axes	1 axis
Operation cycle (default)	0.44ms/ 1 axis
Interpolation functions	None
Control modes	PTP(Point to Point) control, Speed control, Speed-position control (Note-3), Fixed-pitch feed, Constant speed control, Position follow-up control, Speed control with fixed position stop, Speed switching control, High-speed oscillation control, Synchronous control
Acceleration/ deceleration control	Automatic trapezoidal acceleration/deceleration, S-curve acceleration/deceleration
Compensation	Backlash compensation, Electronic gear, Phase compensation
Programming language	Motion SFC, Dedicated instruction, Mechanical support language
Servo program capacity	16k steps
Number of positioning points	3200 points (Positioning data can be designated indirectly)
Peripheral I/F	PERIPHERAL I/F
Home position return function	Proximity dog type (2 types), Count type (3 types), Data set type (2 types), Dog cradle type, Stopper type (2 types), Limit switch combined type (Home position return re-try function provided, home position shift function provided)
JOG operation function	Provided
Manual pulse generator operation function	Possible to connect 1 modules(Note-2)
Synchronous encoder operation function	Possible to connect 1 modules (incremental only) (Note-2)
M-code function	M-code output function provided M-code completion wait function provided
Limit switch output function	Number of output points 32 points Watch data: Motion control data/Word device
ROM operation function	Provided
Absolute position system	Made compatible by setting battery to servo amplifier. (Possible to select the absolute data method or incremental method for each axis)
Number of SSCNETⅢ systems (Note-1)	1 system
Motion related interface module	None
External input signal	The input signal of the servo amplifier is used.(FLS,RLS,DOG)
High-speed reading of Specified Data	Provided (Via internal I/F input module)
Number of I/O points	Input points 4 points/ Output points 2 points
Mark detection function	Provided

Motion control specifications (continued)

Item	Specifications
Clock Function	Provided
Security function	"Write Protection" or "Read/Write Protection" can be set for "Motion SFC program", "Servo program", "Mechanical system program" and "CAM data".
All clear function	Provided
Remote Operation	Remote RUN/STOP, Remote latch clear
Digital Oscilloscope function	Provided
Mixed Function of Virtual Mode/ Real Mode	None

(Note-1) : Only SSCNETⅢ based MR-J3 series servo amplifier can be used.

(Note-2) : Either a "Manual pulse generator" or "Incremental synchronous encoder" can be used.

(Note-3) : "CHANGE" signal of Speed-position control comes from the servo amplifier .

(2) Motion SFC performance specifications

Item				Specifications
Motion SFC program capacity	Code total (Motion SFC chart + Operation control + Transition)			543k bytes
	Text total (Operation control + Transition)			484k bytes
Motion SFC program	Number of Motion SFC programs			256 (No.0 to 255)
	Motion SFC chart size/program			Up to 64k bytes (Included Motion SFC chart comments)
	Number of Motion SFC steps/program			Up to 4094 steps
	Number of selective branches/branch			255
	Number of parallel branches/branch			255
	Parallel branch nesting			Up to 4 levels
Operation control program (F/FS) / Transition program (G)	Number of operation control programs			4096 with F(Once execution type) and FS(Scan execution type) combined. (F/FS0 to F/FS4095)
	Number of transition programs			4096(G0 to G4095)
	Code size/program			Up to approx. 64k bytes (32766 steps)
	Number of blocks(line)/program			Up to 8192 blocks (in the case of 4 steps(min)/blocks)
	Number of characters/block			Up to 128 (comment included)
	Number of operand/block			Up to 64 (operand: constants, word device, bit devices)
	( ) nesting/block			Up to 32 levels
	Descriptive expression	Operation control program		Calculation expression/bit conditional expression
		Transition program		Calculation expression/bit conditional expression/ comparison conditional expression
Execute specification	Number of multi execute programs			Up to 256
	Number of multi active steps			Up to 256 steps/all programs
	Executed task	Normal task		Execute in main cycle of Motion controller
		Event task (Execution can be masked.)	Fixed cycle	Execute in fixed cycle (0.44ms, 0.88ms, 1.77ms, 3.55ms, 7.11ms, 14.2ms)
I/O (X,Y) points				8192 points
I/O (PX, PY) points				Internal I/F (Input 4 points, Output 2 points)
Number of devices (Devices in the Motion controller only) (Positioning dedicated devices are included)	internal relays (M)			12288 points
	Link relays (B)			8192 points
	Annunciators relays (F)			2048 points
	Special relays (SM)			2256 points
	Data registers (D)			8192 points
	Link registers (W)			8192 points
	Special registers (SD)			2256 points
	Motion registers (#)			12288 points
	Coasting timers (FT)			1 point (888μs)
	Multiple CPU area device			None

(3) Mechanical system program specifications

<table>
<tr><th colspan="4">Item</th><th colspan="2">Specifications</th></tr>
<tr><td colspan="4">Number of control axes</td><td colspan="2">1 axis</td></tr>
<tr><td colspan="4">Control method</td><td colspan="2">Synchronous control, PTP (Point to Point) control, speed control, fixed-pitch feed, constant-speed control, position follow-up control, speed-switching control</td></tr>
<tr><td colspan="3" rowspan="5">Control units</td><td rowspan="2">Drive module</td><td>Virtual servomotor</td><td rowspan="2">PLS</td></tr>
<tr><td>Synchronous encoder</td></tr>
<tr><td rowspan="3">Output module</td><td>Roller</td><td rowspan="2">mm, inch</td></tr>
<tr><td>Ball screw</td></tr>
<tr><td>Rotary table</td><td>Fixed as "degree"</td></tr>
<tr><td colspan="3">Program language</td><td>Cam</td><td>mm, inch, PLS</td></tr>
<tr><td colspan="4">Program language</td><td colspan="2">Dedicated instructions (Servo program + mechanical system program)</td></tr>
<tr><td colspan="2" rowspan="2">Servo program</td><td>Capacity</td><td colspan="2">16k steps (14334 steps) (Note-1)</td></tr>
<tr><td>Number of positioning points</td><td colspan="2">Total of 3200 points (It changes with programs, indirect specification is possible.)</td></tr>
<tr><td rowspan="14">Mechanical system program</td><td colspan="3"></td><td colspan="2">Number of modules which can be set per CPU</td></tr>
<tr><td rowspan="2">Drive modules</td><td>Virtual module</td><td colspan="2">3 axes</td></tr>
<tr><td>Synchronous encoder</td><td colspan="2">1 axis</td></tr>
<tr><td rowspan="2">Virtual axes</td><td>Main shaft</td><td colspan="2">1</td></tr>
<tr><td>Auxiliary input axis</td><td colspan="2">1</td></tr>
<tr><td rowspan="4">Trans-mission modules</td><td>Gear</td><td colspan="2">2</td></tr>
<tr><td>Clutch</td><td colspan="2">2</td></tr>
<tr><td>Speed change gear</td><td colspan="2">2</td></tr>
<tr><td>Differential gear</td><td colspan="2">1</td></tr>
<tr><td colspan="2">Differential gear to main shaft</td><td colspan="2">1</td></tr>
<tr><td rowspan="4">Output modules</td><td>Roller</td><td>1</td><td rowspan="4">Total of 1</td></tr>
<tr><td>Ball screw</td><td>1</td></tr>
<tr><td>Rotary table</td><td>1</td></tr>
<tr><td>Cam</td><td>1</td></tr>
<tr><td rowspan="6">Cam</td><td colspan="3">Types</td><td colspan="2">Up to 256 (Note-2)</td></tr>
<tr><td colspan="3">Resolution per cycle</td><td colspan="2">256 • 512 • 1024 • 2048 (Note-2)</td></tr>
<tr><td colspan="3">Memory capacity</td><td colspan="2">132k bytes</td></tr>
<tr><td colspan="3">Storage memory for cam data</td><td colspan="2">CPU internal RAM memory</td></tr>
<tr><td colspan="3">Stroke resolution</td><td colspan="2">32767</td></tr>
<tr><td colspan="3">Control mode</td><td colspan="2">Two-way cam/feed cam</td></tr>
</table>

(3) Mechanical system program specifications (Continued)

<table>
<tr><th colspan="3">Item</th><th>Specifications</th></tr>
<tr><td rowspan="7">Virtual servomotor</td><td colspan="2">Control methods</td><td>PTP (Point to Point) control, speed control, fixed-pitch feed, constant-speed control,
position follow-up control</td></tr>
<tr><td rowspan="3">Positioning</td><td>Method</td><td>PTP control : Selection of absolute or incremental data method
Fixed-pitch feed : Incremental data method
Constant-speed control : Both absolute and incremental data method can be used together
Position follow-up control : Absolute data method</td></tr>
<tr><td>Position command</td><td>Address setting range : –2147483648 to 2147483647 [PLS]</td></tr>
<tr><td>Speed command</td><td>Speed setting range : 1 to 2147483647 [PLS/s]</td></tr>
<tr><td rowspan="2">Acceleration/
deceleration
control</td><td>Automatic
trapezoidal
acceleration/
deceleration</td><td><table><tr><th>Acceleration-fixed acceleration/deceleration</th><th>Time-fixed acceleration/deceleration</th></tr><tr><td>Acceleration time : 1 to 65535 [ms]</td><td rowspan="2">Acceleration/deceleration time:1 to 5000 [ms]
(Only constant-speed control is possible.)</td></tr><tr><td>Deceleration time : 1 to 65535 [ms]</td></tr></table></td></tr>
<tr><td>S-curve
acceleration/
deceleration</td><td>S-curve ratio : 0 to 100[%]</td></tr>
<tr><td colspan="2">JOG operation function</td><td>Provided</td></tr>
<tr><td colspan="2">M-function (with mode)</td><td>M-code output function provided, M-code complete wait function provided</td></tr>
<tr><td colspan="2">Manual pulse generator operation function
(Test mode only)</td><td>1 unit can be connected.
Setting of magnification : 1 to 10000
Setting of smoothing magnification provided.</td></tr>
</table>

(Note-1) : Capacity matching the servo program for real mode.

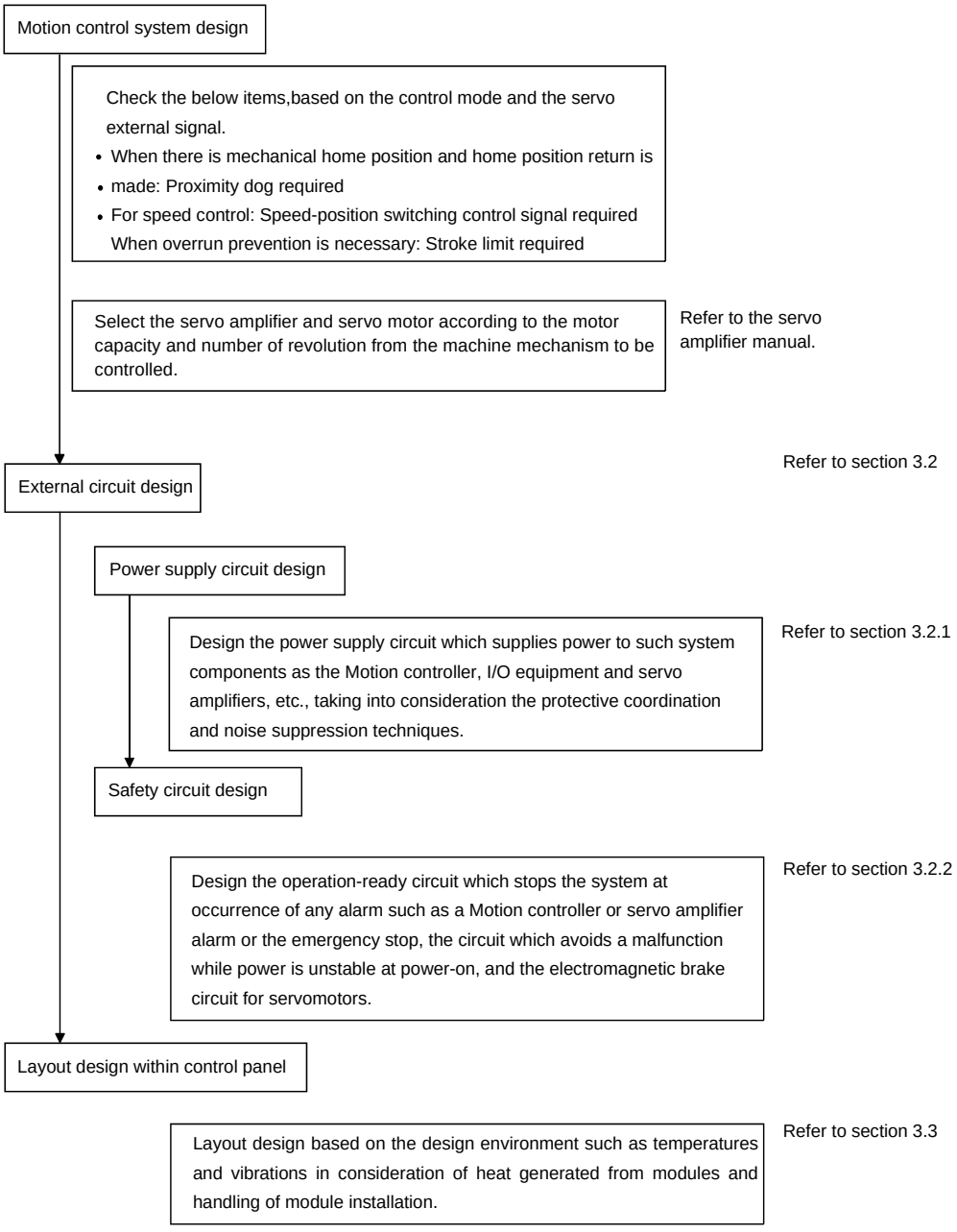
(Note-2) : Relation between a resolution per cycle of cam and type are shown below.

Resolution per cycle	256	512	1024	2048
Type	256	128	64	32

3. DESIGN

3.1 System Design Procedure

Design a system which uses the Motion controller using the following procedure.



⚠CAUTION

- Provide appropriate circuits external to the Motion controller to prevent cases where danger may result from abnormal operation of the overall system in the event of an external power supply fault or the Motion controller failure.
- Mount the Motion controller, servo amplifier, servomotor and regenerative resistor on incombustible material. Mounting them directly or close to combustibles will lead to fire.
- If a fault occurs in the Motion controller or servo amplifier, shut the power OFF at the servo amplifier's power source. If a large current continues to flow, fire may occur.
- When using a regenerative resistor, shut the power OFF with an error signal. The regenerative resistor may abnormally overheat due to a fault in the regenerative transistor, etc., and may lead to fire.
- Always take heat measures such as flame proofing for the inside of the control panel where the servo amplifier or regenerative resistor is mounted and for the wires used. Failing to do so may lead to fire.
- Do not apply a voltage other than that specified in the instruction manual on any terminal. Doing so may lead to destruction or damage.
- Do not mistake the polarity (+ / -), as this may lead to destruction or damage.

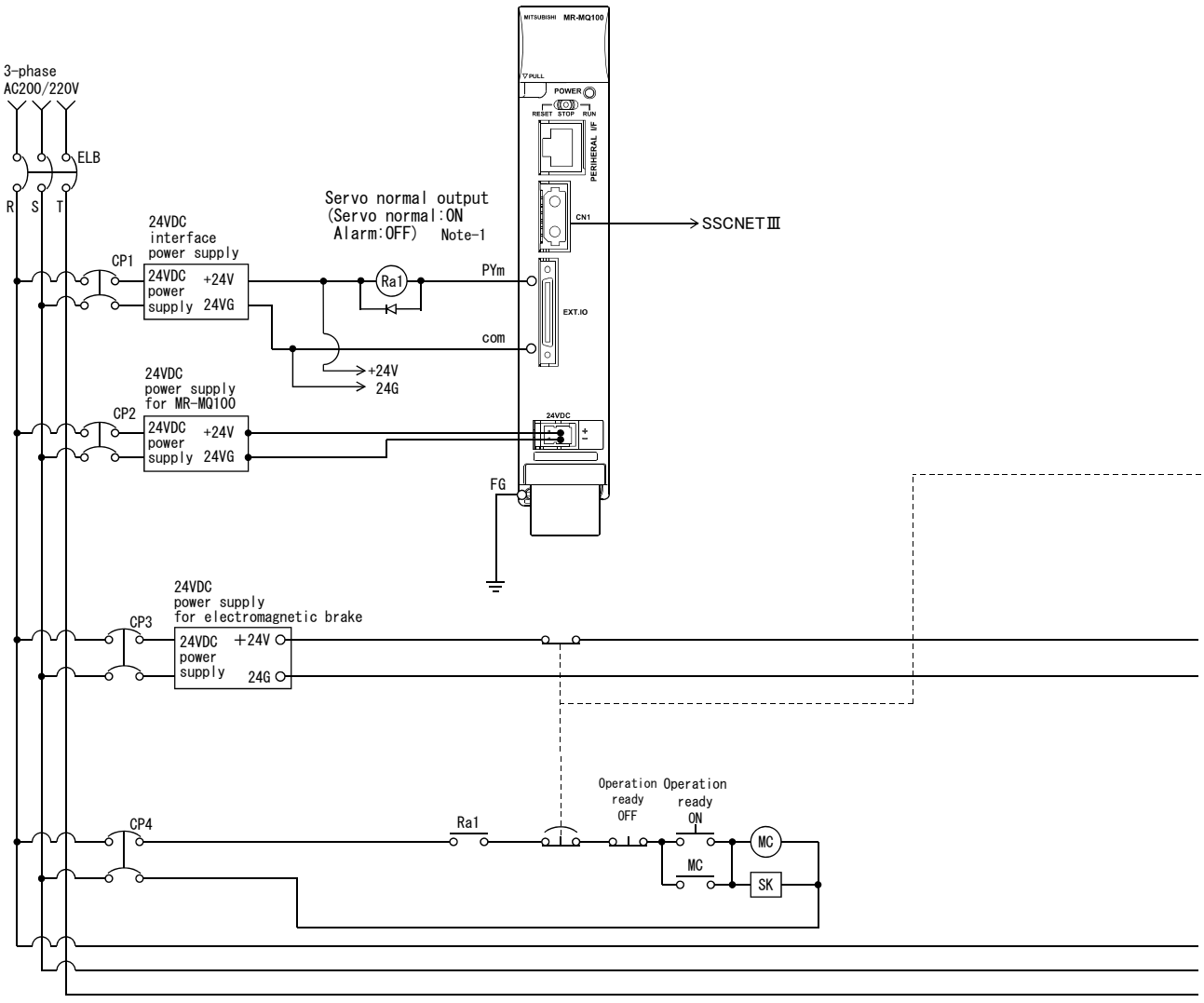
⚠CAUTION

- Do not touch the heat radiating fins of controller or servo amplifier, regenerative resistor and servomotor, etc. while the power is ON and for a short time after the power is turned OFF. In this timing, these parts become very hot and may lead to burns.
- Always turn the power OFF before touching the servomotor shaft or coupled machines, as these parts may lead to injuries.
- Do not go near the machine during test operations or during operations such as teaching. Doing so may lead to injuries.
- Always mount a leakage breaker on the Motion controller and servo amplifier power source.
- If mounting of an electromagnetic contactor for power shut off during an error, etc., is specified in the instruction manual for the servo amplifier, etc., always mount the electromagnetic contactor.
- Mount an emergency stop circuit externally so that the operation can be stopped immediately and the power shut off.
- Use the Motion controller, servo amplifier, servomotor and regenerative resistor with the correct combinations listed in the instruction manual. Other combinations may lead to fire or faults.
- If safety standards (ex., robot safety rules, etc.,) apply to the system using the Motion controller, servo amplifier and servomotor, make sure that the safety standards are satisfied.
- Construct a safety circuit externally of the Motion controller or servo amplifier if the abnormal operation of the Motion controller or servo amplifier differ from the safety directive operation in the system.
- In systems where coasting of the servomotor will be a problem during the forced stop, the emergency stop, servo OFF or when the power is shut OFF, use dynamic brakes.
- Make sure that the system considers the coasting amount even when using dynamic brakes.
- In systems where perpendicular shaft dropping may be a problem during the forced stop, the emergency stop, servo OFF or when the power is shut OFF, use both dynamic brakes and electromagnetic brakes.
- The dynamic brakes must be used only during the forced stop, the emergency stop and errors where servo OFF occurs. These brakes must not be used for normal braking.
- The brakes (electromagnetic brakes) assembled into the servomotor are for holding applications, and must not be used for normal braking.
- The system must have a mechanical allowance so that the machine itself can stop even if the stroke limits switch is passed through at the max. speed.
- Use wires and cables that have a wire diameter, heat resistance and bending resistance compatible with the system.
- Use wires and cables within the length of the range described in the instruction manual.
- The ratings and characteristics of the parts (other than Motion controller, servo amplifier, servomotor) used in a system must be compatible with the Motion controller, servo amplifier and servomotor.
- Install a cover on the shaft so that the rotary parts of the servomotor are not touched during operation.
- There may be some cases where holding by the electromagnetic brakes is not possible due to the life or mechanical structure (when the ball screw and servomotor are connected with a timing belt, etc.). Mount a stopping device to ensure safety on the machine side.

3.2 External Circuit Design

This section explains methods and instructions for designing the power supply circuits and safety circuits, etc.

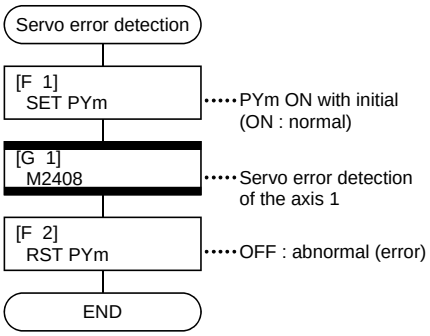
(1) Sample system circuit design for Motion controller



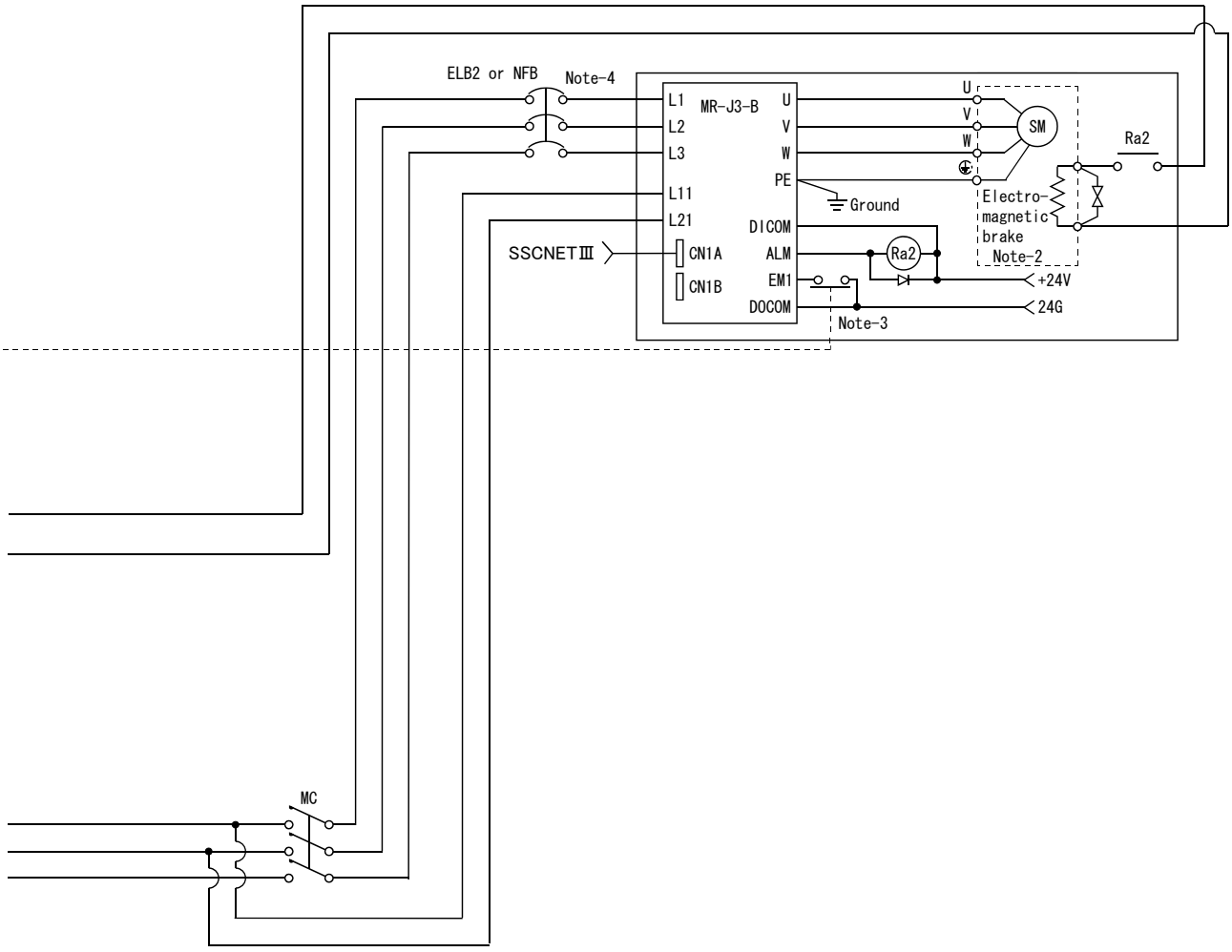
POINT

(1) (Note-1) : Motion SFC program example is shown in the right record.
(2) (Note-2) : It is also possible to use a full wave rectified power supply as the power supply for the electromagnetic brake.
(3) (Note-3) : It is also possible to use forced stop signal of the servo amplifier.
(4) (Note-4) : It is recommended to use one leakage breaker for one servo amplifier.
When electric power is supplied to multiple servo amplifiers for one leakage breaker, select the wire connected to the servo amplifier according to the capacity of the leakage breaker.

<Example> For control axis 1



(Note-5) : Be sure to shut off both the main circuit power supply L1/L2/L3 and control power supply L11/L21 at the time of exchange of servo amplifier. At this time, it is not possible to communicate between the servo amplifier and Motion controller. Therefore, be sure to exchange the servo amplifier after stopping the operating of machine beforehand.



3.2.1 Power supply circuit design

This section describes the protective coordination and noise suppression techniques of the power supply circuit.

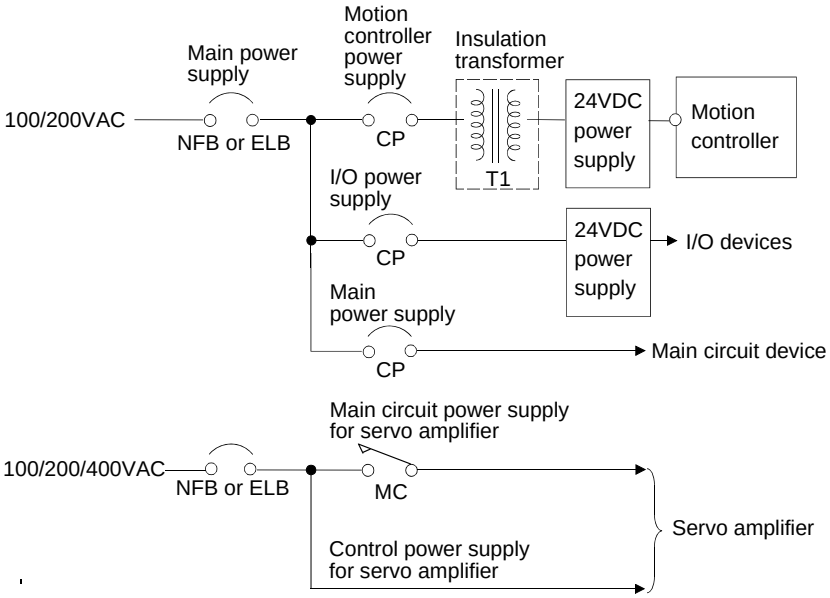
(1) Separation and protective coordination (leakage current protection, over current protection) of power supply lines

Separate the lines for Motion controller power supplies from the lines for I/O devices and servo amplifiers as shown below.

When there is much noise, connect an insulation transformer.

The Motion controller may malfunction as it is affected by various noises such as electric path noises from the power supply systems, and electromagnetic noises from conductors. To avoid such troubles, set the 24VDC power supply according to application.

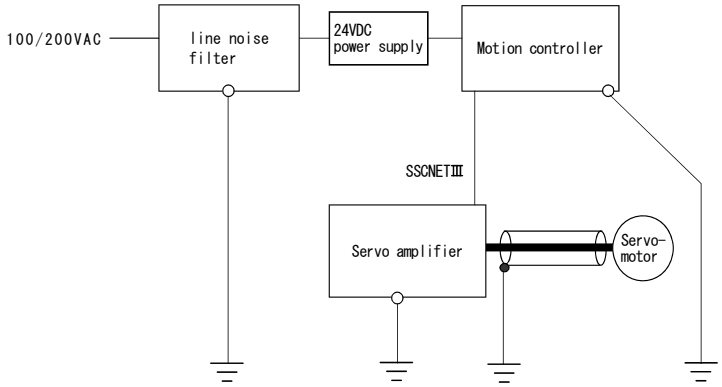
When there is much leakage current, connect a leakage current breaker.



(2) Grounding

Without proper grounding, the Motion controller may malfunction as it is affected by various noises such as electric path noises from the power supply systems, radiated and induced noises from other equipment, servo amplifiers and their cables, and electromagnetic noises from conductors. To avoid such troubles, connect the earthing ground of each equipment and the shield grounds of the shielded cables to the earth.

For grounding, use the exclusive ground terminal wire of each equipment or a single-point earth method to avoid grounding by common wiring, where possible, since noise interference may occur from other equipment due to common impedances.



(Note): Be sure to ground the line noise filter, Motion controller, servo amplifier and servomotor. (Ground resistance : 100 Ω or less)

3.2.2 Safety circuit design

(1) Concept of safety circuits

When the Motion controller is powered on and off, normal control output may momentarily not be possible due to a delay or startup time difference between the Motion controller power supply and the external power supply (DC in particular) for the control target.
Also, abnormal operation may occur if an external power supply fault or Motion controller failure takes place.
To prevent any of these abnormal operations from leading to the abnormal operation of the whole system, areas which can result in machine breakdown and accidents due to abnormal operations (e.g. emergency stop, protective and interlock circuits) should be constructed outside the Motion controller in a fail-safe method.

(2) Emergency stop circuit

The circuit should be constructed outside of the Motion controller or servo amplifier. Shutting off the power supply to the external servo amplifier using this circuit should turn on the electromagnetic brakes of the servomotor.

(3) Forced stop circuit

It is also possible to use the forced stop signal of the servo amplifier.
Refer to manual of the servo amplifier for detail.

Item	Operation of the signal ON	Remark
Emergency stop	Servo OFF	Shut off the power supply of the servo amplifier using an external circuit, and make the servomotor stop.
Forced stop		the "Forced stop" signal causes the servomotor to stop. (Refer to the instruction manual of the servo amplifier for further details.)

3.3 Control Panel Layout Design

3.3.1 Mounting environment

Mount the Motion controller system in the following environment conditions.

(1) Ambient temperature within the range of 0 to 55°C (32 to 131°F) .

(2) Ambient humidity within the range of 5 to 95[%]RH.

(3) No condensing due to sudden temperature changes.

(4) No corrosive or inflammable gases.

(5) There must not be excessive dust, iron filings, oil mist, salt, or organic solvents.

(6) No direct sunlight.

(7) No strong electrical or magnetic fields.

(8) No direct vibrations or shocks to the Motion controller.

3.3.2 Motion Controller Layout Design

This section describes the precautions related to mounting a Motion controller in an enclosure.

(1) To improve ventilation and permit easy replacement of the module, leave sufficient space between the top, bottom, side of the module and any other object (See below list).
(For details on layout design refer to section 4.1.3 "Motion Controller Mounting Instructions".)

- Top 40mm (1.57inch) or more
- Bottom 40mm (1.57inch) or more
- Front 100mm (3.94inch) or more
- Right side 1mm (0.04inch) or more
- Left side 30mm (1.18inch) or more

(2) Provide a wiring duct, if required.

⚠CAUTION

- Due to ventilation problems, do not mount the base units vertically or horizontally.
- Mount the base units on a flat surface. Unevenness or warping of the surface can apply undue force to printed circuit boards and lead to operation failures.
- Avoid mounting the base units close to a vibration source, such as a large electromagnetic contactor or no-fuse breaker. Mount them on a separate panel or at a safe distance.
- To limit the effects of reflected noise and heat, leave 100mm(3.94inch) or more clearance to instruments fitted in front of the Motion controller (on the rear of the door).
- Install the MR-MQ100 to the left of the servo amplifier.
- Separate the interval between MR-MQ100 and the servo amplifier by 1mm (0.04inch) or more.
- Leave at least 30mm (1.18inch) of space between the MR-MQ100 and any object to its left.

3.3.3 Calculating Motion Controller Heat Generation

The ambient temperature inside the panel storing the Motion controller must be suppressed to the specified ambient temperature of 55°C(131°F) or less.
For the design of a heat releasing panel, it is necessary to know the average power consumption (heating value) of the devices and instruments stored inside. "Use the "Power consumption" on section 2.5.2 "MR-MQ100 hardware and wiring" (1) Unit specification. From the power consumption, calculate a rise in ambient temperature inside the control panel.

3.4 Design Checklist

Copy the following table for use as a check sheet at the worksite.

Item	Sub Item	Design confirmation		Check
External circuit design	Fail-safe circuit design	Avoidance of operation failure at power-on		☐
		Avoidance of hazard at Motion controller failure		☐
Layout design	Module layout design	Conformance with general specifications such as ambient temperature, humidity, dust, etc.		☐
		Total power consumption of Motion controller (Calculate the heating value)	W	☐
		Layout in consideration of clearances between enclosure's inside walls, other structures and modules and heats generated by modules within the control panel.		☐

MEMO

4. INSTALLATION AND WIRING

4.1 Motion Controller Installation

4.1.1 Handling Instructions

⚠CAUTION

- Use the Motion controller in an environment that meets the general specifications contained in this manual. Using this Motion controller in an environment outside the range of the general specifications could result in electric shock, fire, operation failure, and damage to or deterioration of the product.
- Install the motion controller to the control panel with screws. The tightening torque should be within the specified range. If the screws are loose, the motion controller may drop or malfunction. Or if the screws are too tight, they may break, causing the motion controller to drop or malfunction.
- Lock the control panel and prevent access to those who are not certified to handle or install electric equipment.
- Do not touch the heat radiating fins of controller or servo amplifier's, regenerative resistor and servo motor, etc. while the power is ON and for a short time after the power is turned OFF. In this timing, these parts become very hot and may lead to burns.
  Remove the modules while paying attention.

This section describes instructions for handling the motion controller.

(1) Motion controller is made of resin, do not drop or subject to strong impact.

(2) In order to avoid changes in operation, do not remove the motion controller's printed circuit boards from the enclosure.

(3) Tighten the Motion controller's fixing screws and FG terminal screws within the tightening torque range specified below.

Location of screw	Tightening torque range
Motion controller FG terminal fixing screw (M4 × 12screw)	0.82 to 1.11 N•m
Motion controller fixing screw (M5 screw)	2.75 to 3.63 N•m (Note)

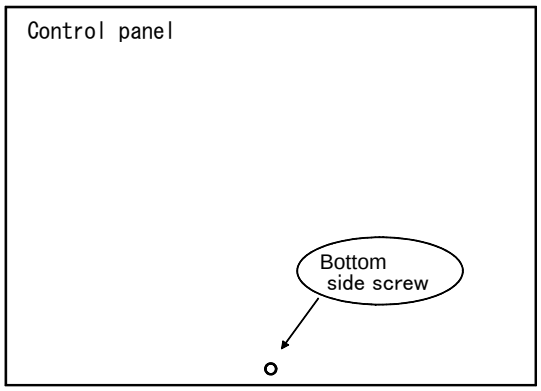
(Note) Torque range applies when the mounting panel is 2mm (0.88inch) thick and a fastening nut is used to secure the screw from the back side of the panel.

4.1.2 Motion Controller Installation

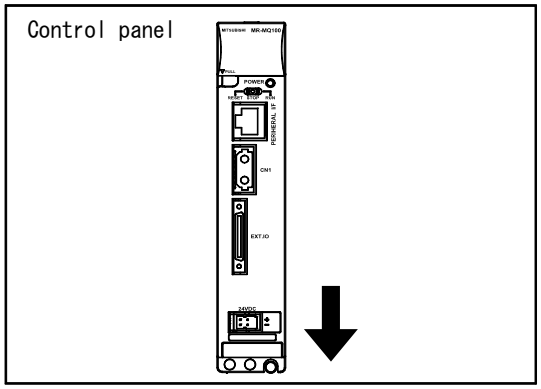
Be sure to fix the motion controller to the control panel using fixing screws. Not doing so could result in vibration that may cause erroneous operation.

Mount the motion controller in the following procedure.

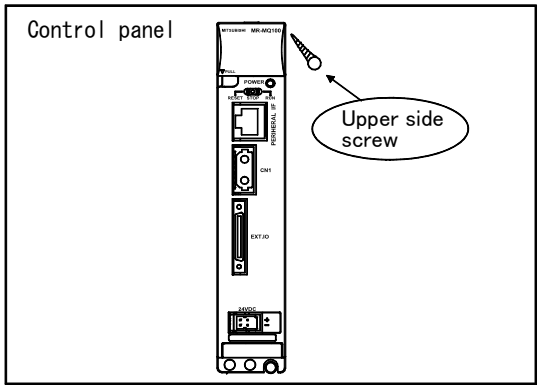
(a) Temporarily fasten the bottom side screw.



(b) Place the bottom side notch of the Motion controller onto the bottom side screw.



(c) Set a screw through the upper side hole of the motion controller to the control panel.

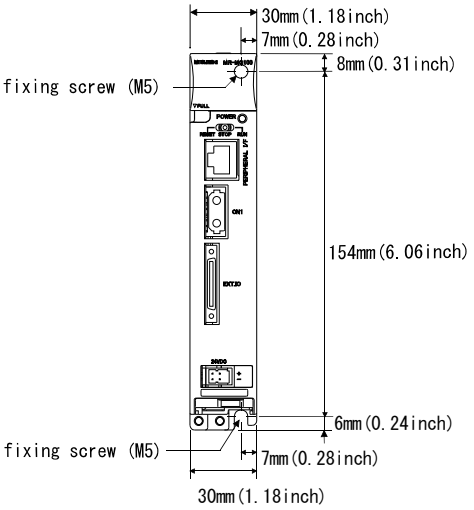


(d) Tighten both of the upper side screw and the bottom side screw.

4.1.3 Motion Controller Mounting Instructions

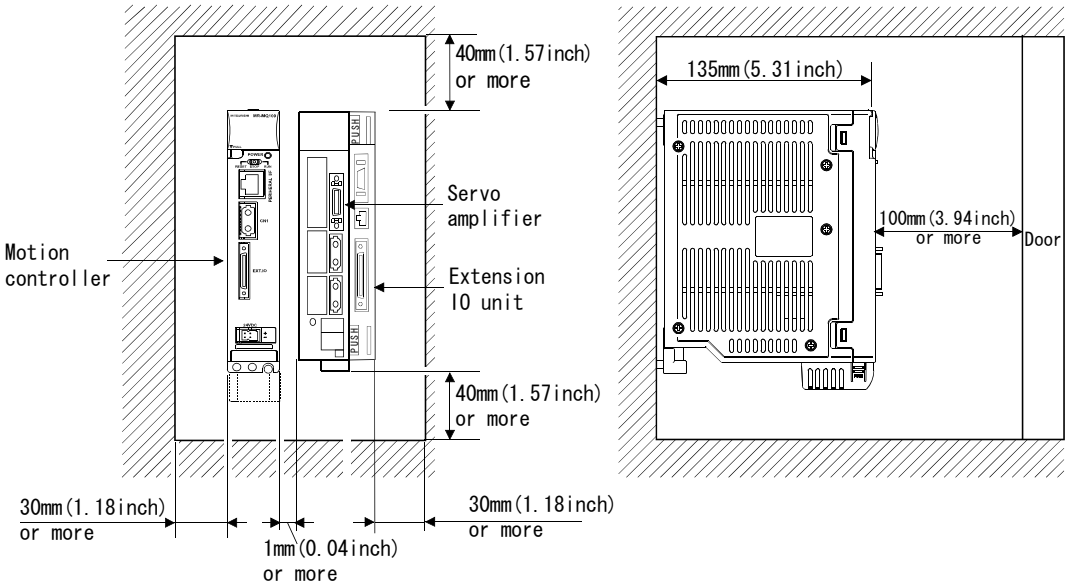
When mounting the Motion controller to an enclosure or similar, fully consider its operability, maintainability and environmental resistance.

(1) Fitting dimensions



(2) Motion controller mounting position

Make space for air flow between the upper side and bottom side of the control panel and the motion controller.

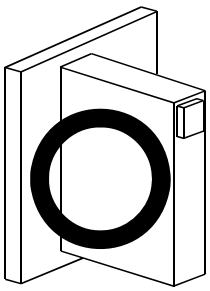


⚠CAUTION

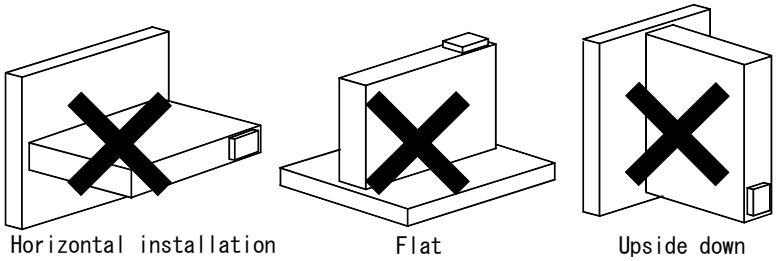
- Install the MR-MQ100 to the left of the servo amplifier.
- Separate the interval between MR-MQ100 and the servo amplifier by 1mm (0.04inch) or more.
- Leave at least 30mm (1.18inch) of space between the MR-MQ100 and any object to its left.

(3) Motion controller mounting orientation

(a) Mount the Motion controller in the orientation shown below to ensure good ventilation for heat release.



(b) Do not use it in any of the orientations shown below.



(4) Mounting surface

Mount the Motion controller on a flat surface. If the mounting surface is not even, this may strain the printed circuit boards and cause malfunctions.

(5) Mounting of unit in an area where other devices are mounted

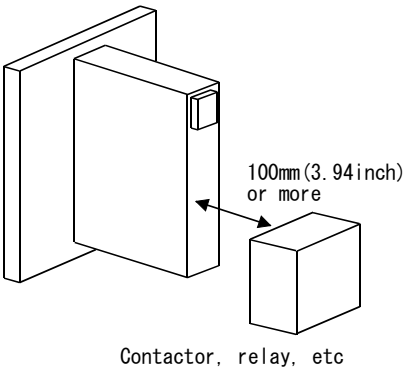
Avoid mounting the Motion controller in proximity to vibration sources such as large magnetic contactors and no-fuse circuit breakers, (Mount these on a separate panel or at a distance).

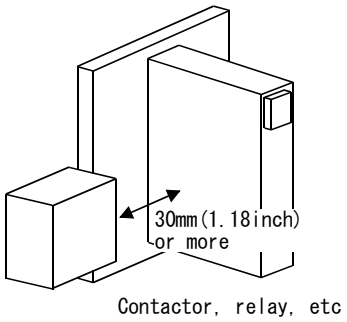
(6) Distances from other devices

In order to avoid the effects of radiated noise and heat, provide the clearances indicated below between the Motion controller and devices that generate noise or heat (contactors and relays).

• In front of the Motion controller : 100 mm (3.94 inch) or more

• On the left of the Motion controller : 30 mm (1.18 inch) or more





POINT

(1) Make sure to tighten both the upper side screw and the bottom side screw.

(2) Tighten the screws within the specified torque range.

(3) If the screws are loose, the motion controller may drop or malfunction.

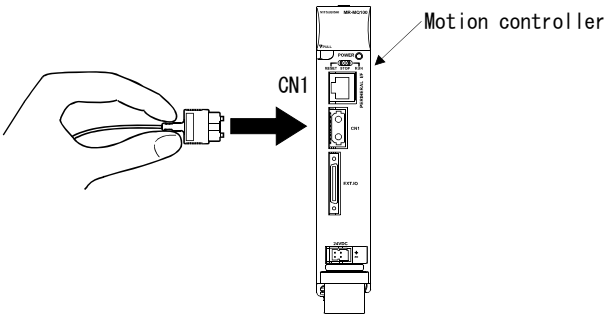
(4) If the screws are too tight, the screws or the unit may break and the motion controller may drop or malfunction.

4.2 Cable Connection and Disconnection

4.2.1 SSCNETⅢ cable

(1) Precautions for handling the SSCNETⅢ cable

- Do not stomp on the SSCNETⅢ cable.
- When laying the SSCNETⅢ cable, be sure to secure the minimum cable bend radius or more. If the bend radius is less than the minimum cable bend radius, it may cause malfunctions due to characteristic deterioration, wire breakage, etc.
- Hold the cable connector securely during connection and disconnection of the SSCNETⅢ cable.



(2) Connection of SSCNETⅢ cable

- For connection of SSCNETⅢ cable to the Motion controller, connect it to the SSCNETⅢ connector CN1 of the Motion controller while holding the SSCNETⅢ cable connector's tab. Be sure to insert it until it clicks.
- If the cord tip of the SSCNETⅢ cable is dirty, optical transmission may be interfered and may result in malfunctions. If it becomes dirty, wipe with a bonded textile or similar. Do not use solvent such as alcohol.

(3) Disconnection of SSCNETⅢ cable

- For disconnection of SSCNETⅢ cable, pull the cable out while holding the SSCNETⅢ cable connector's tab or the connector itself.
- After disconnection of SSCNETⅢ cable, be sure to replace the protective cap (attached to Motion controller or servo amplifier) to the Motion controller and servo amplifier.
- For SSCNETⅢ cable, attach the optical fiber protective tube to the end of the connector.

(4) Precautions of SSCNETⅢ cable wiring

The SSCNETⅢ cable is made from optical fiber. If the optical fiber undergoes major shock, lateral pressure, haul, sudden bending or twisting, its insides may distort or break, and optical transmission will not be possible. Since the optical fiber for MR-J3BUS□M, MR-J3BUS□M-A is made of synthetic resin, it may melt if left near fire or high temperature. Therefore, do not allow it to touch any part which can achieve high temperatures, such as radiators or the regenerative brake option of the servo amplifier.

Be sure to use the optical fiber within the range of operating temperature described in this manual.

Read described item of this section carefully and handle with caution.

(a) Minimum bend radius

Make sure to lay the cable with greater radius than the minimum bend radius. Do not press the cable to edges of the equipment or anything else. For SSCNET cable, the appropriate length should be selected with consideration of the dimensions and arrangement of the Motion controller or servo amplifier. When closing the door of control box, pay careful attention to avoid pinching the SSCNET Ⅲ cable with the case door or a situation where the cable bend becomes smaller than the minimum bend radius.

Model name of SSCNETⅢ cable	Minimum bend radius[mm(inch)]
MR-J3BUS□M	25(0.98)
MR-J3BUS□M-A	Enforced covering cord : 50 (1.97) Code : 25 (0.98)
MR-J3BUS□M-B	Enforced covering cord : 50 (1.97) Code : 30 (1.18)

(b) Tension

If tension is added to the SSCNETⅢ cable, the increase of transmission loss occurs due to external forces concentrated on attachment portion of the SSCNETⅢ cable or the connecting tab of SSCNETⅢ connector. At worst, breakage of the SSCNETⅢ cable or damage to the SSCNETⅢ connector may occur. For cable laying, handle without adding forced tension. (Refer to "APPENDIX1.1 SSCNETⅢ cables" for the tension strength.)

(c) Lateral pressure

If lateral pressure is applied to the SSCNETⅢ cable, the cable itself distorts and internal optical fiber becomes stressed. Then transmission loss increases. At worst, breakage of the optical cable may occur. As the same condition also occurs during cable laying, do not bundle or fasten the SSCNETⅢ cable with anything such as nylon bands (tie wrap), etc.

Do not stomp or tuck it down with the door of control box , etc.

(d) Twisting

If the SSCNETⅢ cable is twisted, it will have the same effect as when local lateral pressure or bending is applied. Consequently, transmission loss increases and breakage of the optical fiber may occur.

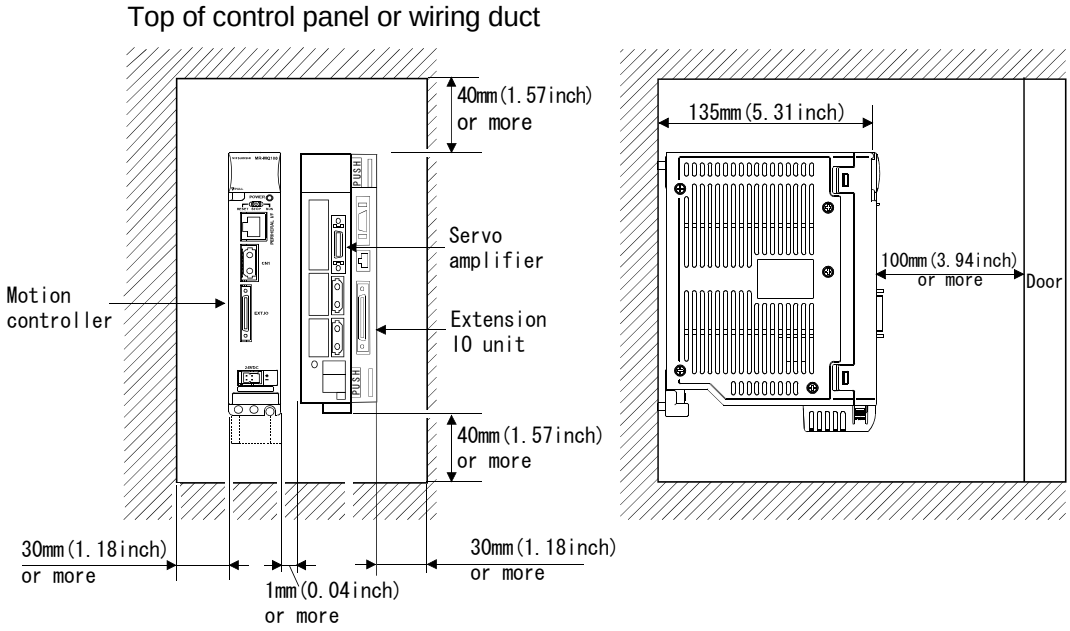
(e) Disposal

When incinerating optical cable (cord) used for SSCNET , hydrogen fluoride gas or hydrogen chloride gas which is corrosive and harmful may be generated. For disposal of optical fiber, request for specialized industrial waste disposal services which have an incineration facility for disposing hydrogen fluoride gas or hydrogen chloride gas.

(f) Wiring process of SSCNETⅢ cable

Put the SSCNETⅢ cable in the duct or fix the cable to the closest part of the Motion controller with bundle material in order to prevent the SSCNETⅢ cable from putting its own weight on SSCNETⅢ connector.
Leave the following space for wiring.

• Putting in the duct



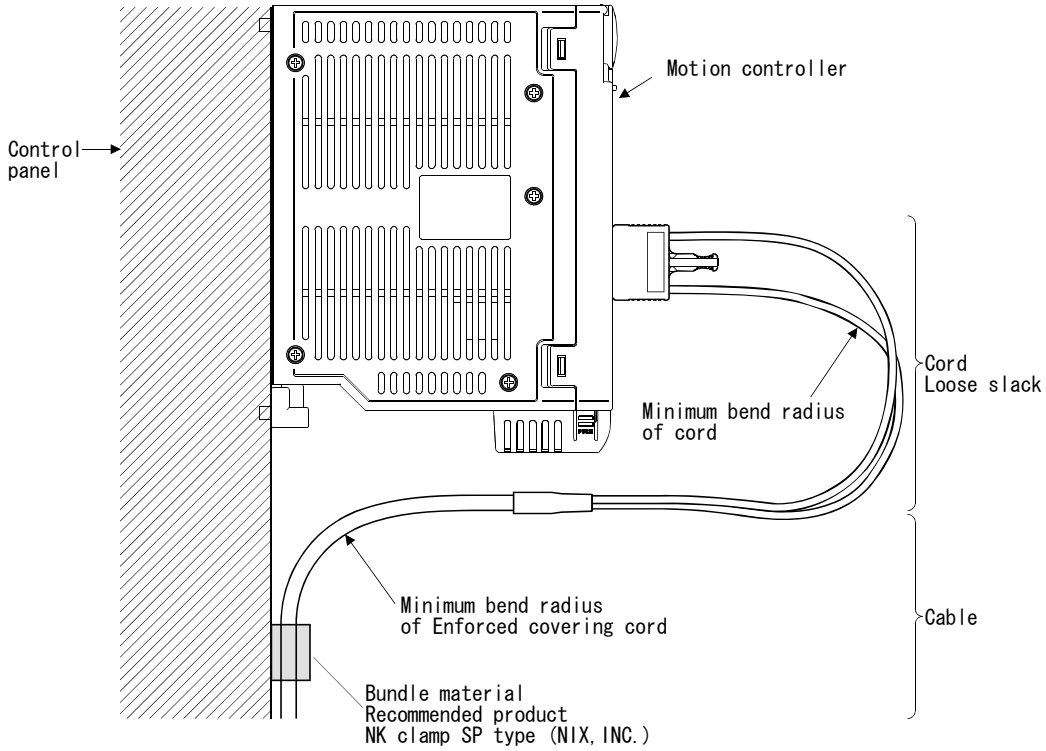
⚠CAUTION

- Install the MR-MQ100 to the left of the servo amplifier.
- Separate the interval between MR-MQ100 and the servo amplifier by 1mm (0.04inch) or more.
- Leave at least 30mm (1.18inch) of space between the MR-MQ100 and any object to its left.

• Bundle fixing

Optical cord should be given loose slack to avoid from becoming smaller than the minimum bend radius, and it should not be twisted. When laying cable, fix and hold it in position with using cushioning such as sponge or rubber which does not contain plasticizing material.

Model name of SSCNETⅢ cable	Minimum bend radius[mm(inch)]	
	Enforced covering cord	Code
MR-J3BUS□M	25(0.98)	25(0.98)
MR-J3BUS□M-A	50 (1.97)	25 (0.98)
MR-J3BUS□M-B	50 (1.97)	30 (1.18)



POINT

(1) Be sure to connect SSCNETⅢ cable with the above connector. If the connection is mistaken, between the Motion controller and servo amplifier cannot be communicated.

(2) Forcible removal the SSCNETⅢ cable from the Motion controller may damage the Motion controller and SSCNETⅢ cables.

(3) After removal of the SSCNETⅢ cable, be sure to replace the cap on the SSCNETⅢ connector. Otherwise, adhesion of dirt nay deteriorates the cable's characteristic and cause malfunctions.

(4) Do not remove the SSCNETⅢ cable with the power supply of Motion controller or servo amplifier turned on.
Do not look directly into the light generated from SSCNETⅢ connector of the Motion controller or servo amplifier or the end of SSCNETⅢ cable. The light can damage the eye (The light source of SSCNETⅢ cable complies with class1 defined in JISC6802 or IEC60825-1.)

(5) If the SSCNETⅢ cable undergoes major shock, lateral pressure, haul, sudden bending or twisting, or similar forces, the inside may distort or brake, and optical transmission will not be possible.
Be sure to take sufficient care so that the SSCNETⅢ cable can easily bend or twist without damage.

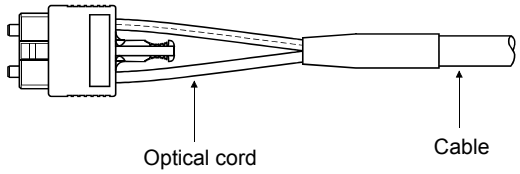
(6) Be sure to use the SSCNETⅢ cable within the range of operating temperature described in this manual. Especially, as optical fiber for MR-J3BUS□M and MR-J3BUS□M-A are made of synthetic resin, it may melt if left near a fire or high temperature. The cable portion and cord portion melt if left near the fire or high temperature. Therefore, do not allow either to touch any part which is high in temperature, such as radiators or the regenerative brake option of servo amplifier, or servomotor.

(7) When laying the SSCNETⅢ cable, be sure to secure the minimum cable bend radius or more.

(8) Put the SSCNETⅢ cable in a duct or fix the cable to the closest part of the Motion CPU module with bundle material in order to prevent the SSCNETⅢ cable from putting its own weight on SSCNETⅢ connector.
When laying cable, the optical cord should be given loose slack to avoid from becoming smaller than the minimum bend radius, and it should not be twisted. Also, fix and hold it in position with using cushioning such as sponge or rubber which does not contain plasticizing material.

POINT

(9) Migrating plasticizer is used for vinyl tape. Keep the MR-J3BUS□M, and MR-J3BUS□M-A cables away from vinyl tape because the optical characteristic may be affected.



SSCNETⅢ cable	Cord	Cable
MR-J3BUS□M	△	
MR-J3BUS□M-A	△	△
MR-J3BUS□M-B	○	○

○ Normally, cable is not affected by plasticizers.

△ Phthalate ester plasticizer such as DBP and DOP may affect optical characteristic of cable.

Generally, soft polyvinyl chloride (PVC), polyethylene resin (PE) and fluorine resin contain non-migrating plasticizer and they do not affect the optical characteristic of SSCNETⅢ cable. However, some wire sheaths and cable ties, which contain migrating plasticizer (phthalate ester), may affect MR-J3BUS□M and MR-J3BUS□M-A cables (made of plastic). In addition, MR-J3BUS□M-B cable (made of quartz glass) is not affected by plasticizer.

(10) The adhesion of solvent and oil to the cord part of SSCNETⅢ cable may lower the optical characteristic and machine characteristic. If used in such an environment, be sure to take protective measures for the cord portion.

(11) When storing the Motion CPU or servo amplifier, be sure to replace the protective cap on the connector so that dirt can not adhere to the end of SSCNETⅢ connector.

(12) The SSCNETⅢ connector connected to the SSCNETⅢ cable contains a cap to protect the light device inside the connector from dust. For this reason, do not remove the cap until just before connecting the SSCNETⅢ cable. Always replace the cap after removing the SSCNETⅢ cable.

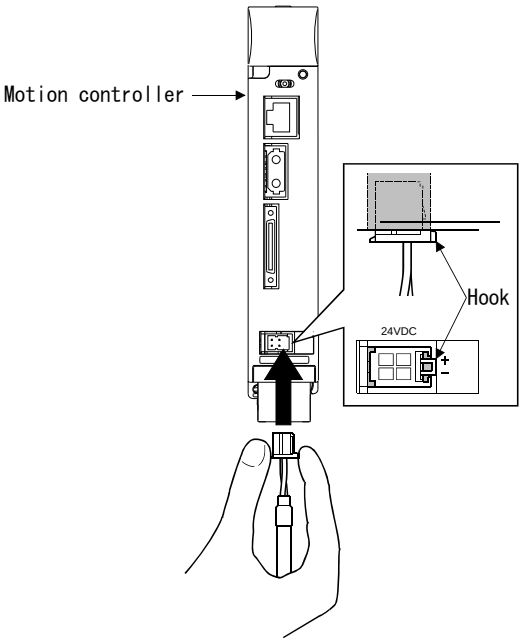
(13) Be sure to keep the fiber optic protective cap and tube for the SSCNETⅢ cable in a sealed plastic bag to prevent them from becoming dirty.

(14) When exchanging the Motion controller or servo amplifier, be sure to replace the cap on SSCNETⅢ connector. When sending a Motion controller or servo amplifier in for repair, also be sure to replace the cap on the SSCNETⅢ connector. Without the cap, the light device may be damaged during transit. In this case, exchange and repair of light device is required.

4.2.2 24VDC power supply cable

(1) Precautions for handling the 24VDC power supply cable

• For connection or removal of the 24VDC power supply cable, do it surely while holding a connector of 24VDC power supply cable.



(2) Connection of the 24VDC power supply cable

• For connection of a 24VDC power supply cable to the Motion controller connect it surely to a 24VDC power supply connector of Motion controller while holding a connector. Be sure to insert it until it clicks.

(3) Removal of the 24VDC power supply cable

• For removal of the 24VDC power supply cable, push a tab and pull out the cable while holding a connector.

POINT
Forcibly removal the 24VDC power supply cable from the Motion controller will damage the Motion controller or 24VDC power supply cable.

4.3 Wiring

4.3.1 Wiring Instructions

⚠DANGER

- Completely turn off the externally supplied power used in the system before installation or removal of the module. Not doing so could result in electric shock or damage to the product.
- When turning on the power supply or operating the module after wiring, be sure that the module's terminal covers are correctly attached. Not attaching the terminal cover could result in electric shock.

⚠CAUTION

- Be sure to ground the earth terminal FG to avoid an electric shock or operation failure. (Ground resistance: 100Ω or less)
- When wiring in the Motion controller, be sure that it is done correctly by checking the product's rated voltage and the terminal layout. Connecting a power supply that is different from the rating or incorrectly wiring the product could result in fire or damage.
- External connections shall be crimped or pressure welded with the specified tools, or correctly soldered. Imperfect connections could result in short circuit, fire, or operation failure.
- Be sure there are no foreign matters such as sawdust or wiring debris inside the module. Such debris could cause fire, damage, or operation failure.

This section describes the power supply wiring instructions.
Refer to the "15 EMC directives" for grounding method and measure against noise

(1) Power supply wiring

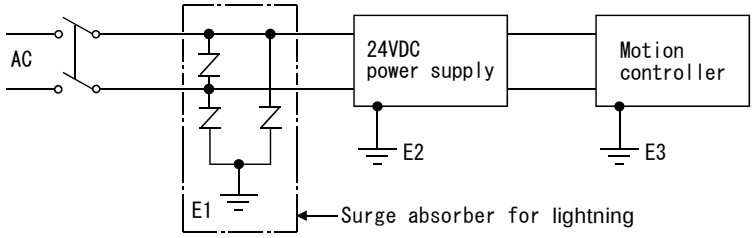
(a) 24VDC power supply wires should be twisted as dense as possible.
Connect the modules using the shortest distance possible.
Use wires with the following conductor sizes.

Application	Recommended core size	AWG (Note)
24VDC power supply wire	0.34 to 0.37 mm^2	AWG22
External I/O signal wire	0.3 to 0.75mm^2	AWG22 to AWG18
Ground wire	2.0 mm^2 or more	AWG14 or less

(Note): AWG stands for "American Wire Gauge".

(b) Do not bundle the 24VDC power supply wire with, or run them close to, the main circuit (high voltage, large current) or I/O signal lines (including common line).
Reserve a distance of at least 100mm (3.94inch) from adjacent wires.

(c) Noise due to a lightning surge may cause an instantaneous power failure or reset of the motion controller.
As a counter-measures to lightning surges, connect a surge absorber as shown below.
Using the surge absorber for lightening can reduce the influence of lightening.



POINT

(1) "E1: earth of surge suppressor for lightning", "E2: earth of the 24VDC power supply" and "E3: the motion controller's earth" must be grounded separately.

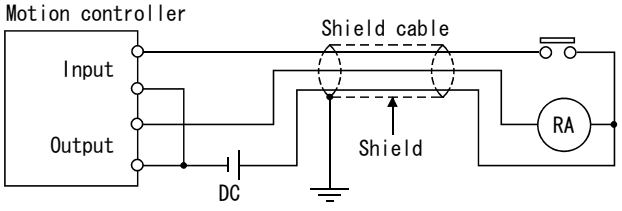
(2) Select a surge absorber for lightning whose power supply voltage does not exceed the maximum allowable circuit voltage even at the time of maximum power supply voltage elevation.

(2) Wiring of I/O equipment

(a) The wires used for connection to external I/O signals should contain 0.3 to 0.75mm^2 (AWG22 to AWG18) conductors and 2.8mm (0.11inch) or less in outside diameter.

(b) Do not run the input and output lines close to each other.

(c) When the wiring cannot be run away from the main circuit and power lines, use a batch-shielded cable and ground it on the Motion controller side.
In some cases, ground it in the opposite side.



(d) Whenever wiring runs through piping, be sure to ground the piping without fail.

(e) Run the 24VDC input line away from the 100VAC and 200VAC lines.

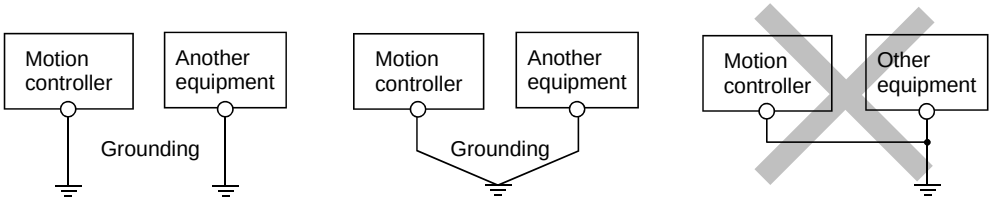
(f) As a countermeasure against a power surge due to lightning, separate the AC wiring and DC wiring and connect a surge absorber (Refer to Section 4.3.1(1)).
Failure to do so increases the risk of I/O device failure due to lightning.

(3) Grounding

For grounding, follow the steps (a) to (c) shown below.

(a) Use dedicated grounding wire as much as possible.
(Ground resistance: 100Ω or less)

(b) When dedicated grounding cannot be used, use (2) Common Grounding shown below.

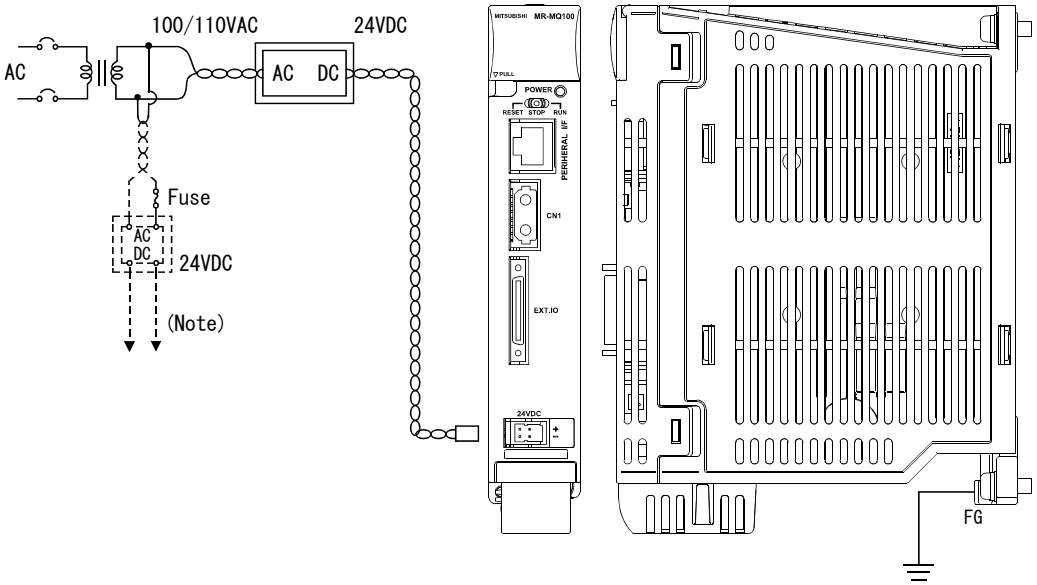


(1) Independent grounding…..Best (2) Common grounding….Good (3) Joint Grounding….Not allowed

(c) For grounding cable, use cable of 2 mm^2 or thicker.
Position the ground-contact point as close to the Motion controller as possible, and reduce the length of the grounding cable as much as possible.

4.3.2 Connecting to the power supply module

The following diagram shows the wiring example of power lines, grounding lines, etc. to the Motion controller.



(Note) : Connect to power input terminals of I/O signals that require 24VDC.

POINT

(1) Use a different 24VDC power supply for MR-MQ100 and for I/O components.

(2) Use different 24VDC power supplies for the MR-MQ100 and the electromagnetic brake of the servomotor.

(3) Refer to "Wiring of 24VDC power supply connector of MR-MQ100" chapter 2.

(4) Motion controller and 24VDC power supply are an open type device and must be installed inside a control panel for use.
This not only ensures safety but also ensures effective shielding of the Motion controller and 24VDC power supply electromagnetic noise.

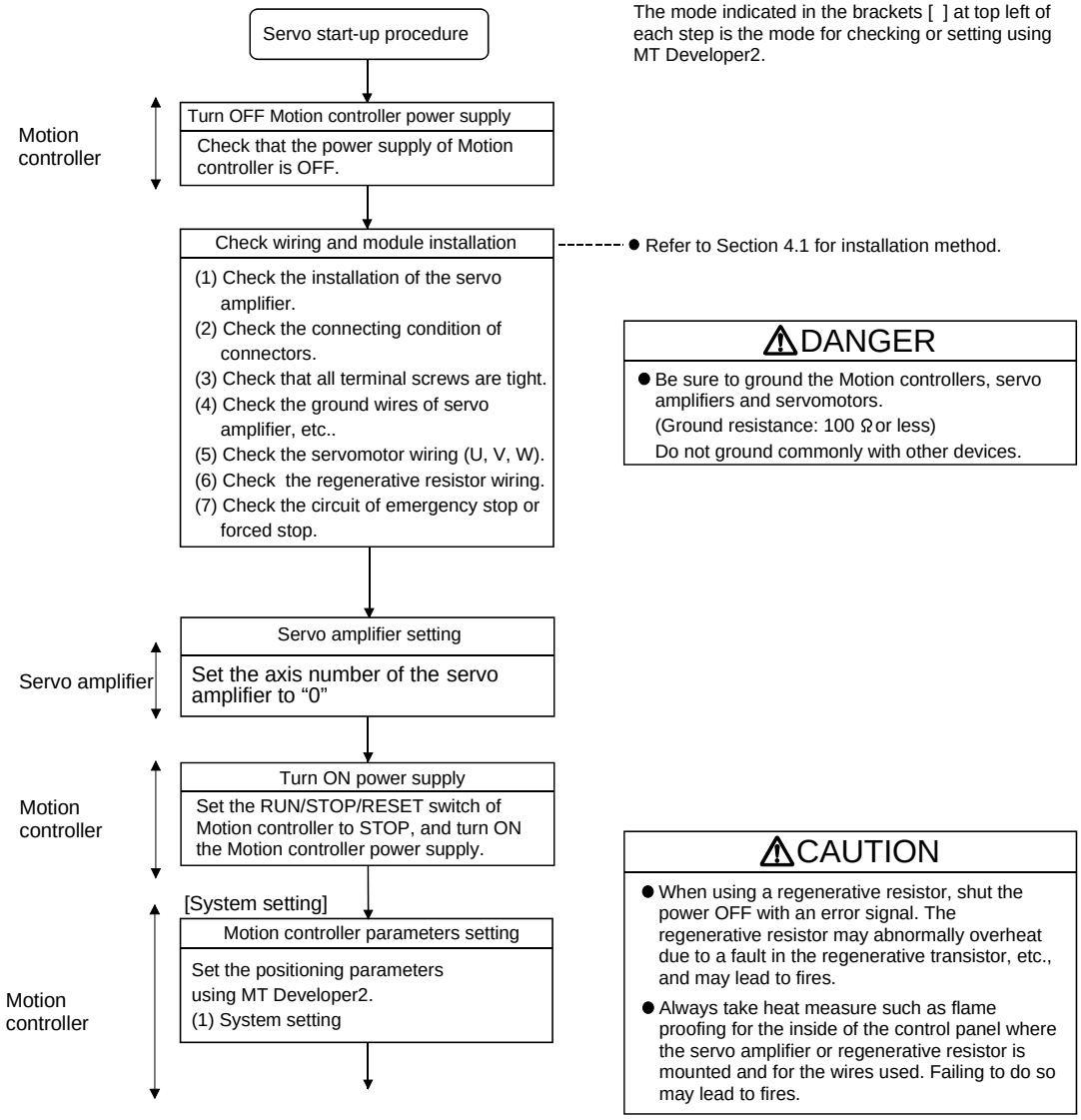
5. TRIAL OPERATION AND ADJUSTMENT

5.1 Checklist before Trial Operation

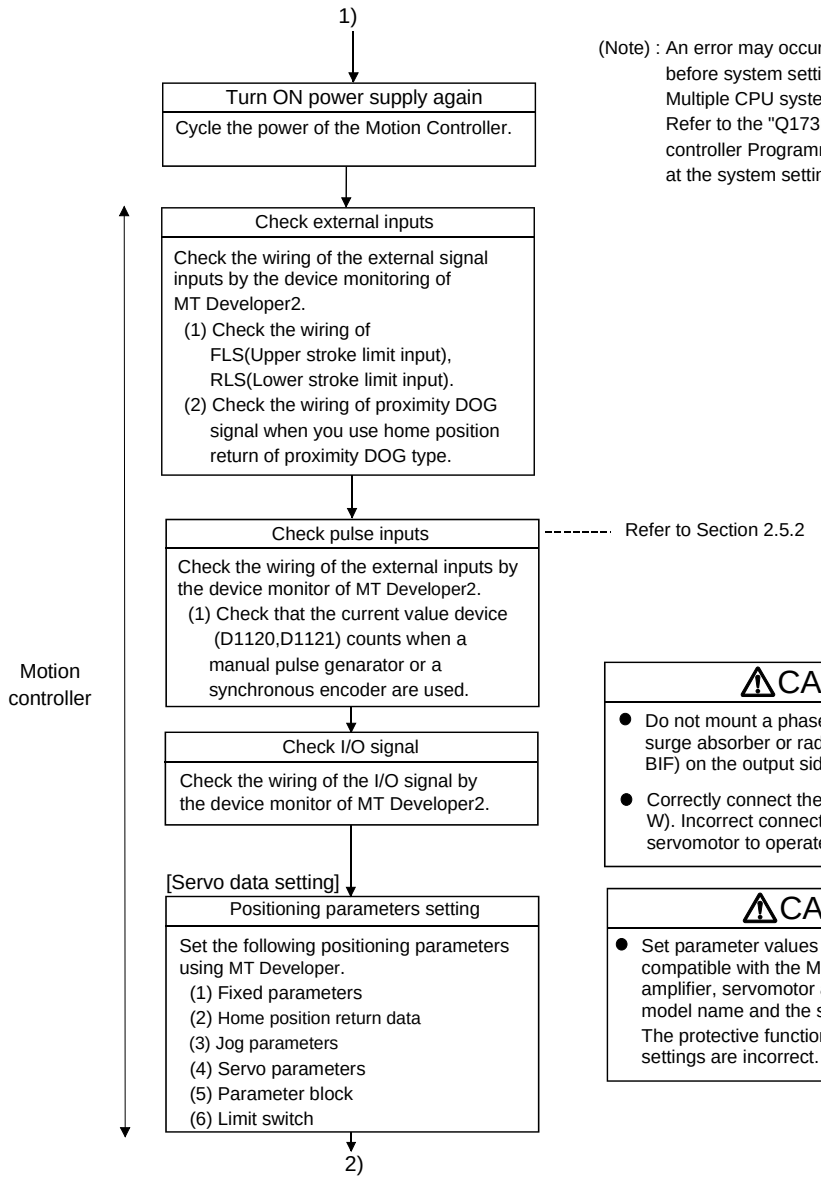
Table 5.1 Checklists before Trial Operation

Model name	Confirmation Items	Check	Reference
MR-MQ100 Motion controller	(1) Check for looseness, rattling or incorrect installation.	☐	4.1.1
	(2) Check that the module fixing screw tightening torque is as specified.	☐	4.1.1
	(3) Check that the wire sizes of cables are correct.	☐	4.3.1
	(4) Check that the power line is wired correctly.	☐	4.3.1, 2.5.3
	(5) Check that the polarity of power supply line is corrected.	☐	2.5.3
	(6) Check that FG is wired correctly.	☐	4.3.1
	(7) Check that the FG terminal screws are tightened correctly.	☐	
	(8) Check that the FG terminal screws are tightening torque is as specified.	☐	4.1.1
	(9) Check that the 24VDC power supply wire is twisted as tightly as possible and run in the shortest distance.	☐	4.3.1
	(10) Check that the 24VDC power supply wire is not bound to or runs close to the power wires.	☐	4.3.1
	(11) Check for grounding of the earth terminal FG .	☐	4.3.1
	(12) Check that the battery is connected correctly.		2.5.5
	(13) Check that the internal I/F are wired correctly.		2.5.2
	(14) Check that the Manual pulse generator or INC synchronous encoder is wired correctly.		2.5.2
MR-J3-☐B Servo amplifier	(1) Check that the rotary switch is set to "0".	☐	2.5.4
	(2) Check that the connection with the main circuit power supply is correct.	☐	3.2
SSCNETⅢ cable	(1) Check that the model name of SSCNETⅢ cables is correct.	☐	2.5.4
	(2) Check that the SSCNETⅢ cables are connected to the correct location.	☐	
	(3) Check that the SSCNETⅢ cables are connected properly.	☐	4.2.1
	(4) Check for looseness, rattling or incorrect connection.	☐	4.2.1
	(5) Check that the bend radius meets the minimum requirement or more.	☐	4.2.1
	(6) Check that the MR-J3BUS☐M or MR-J3BUS☐M-A do not come in contact with wires/cables that use materials with the plasticizing material.	☐	4.2.1

5.2 Trial Operation and Adjustment Procedure



1)



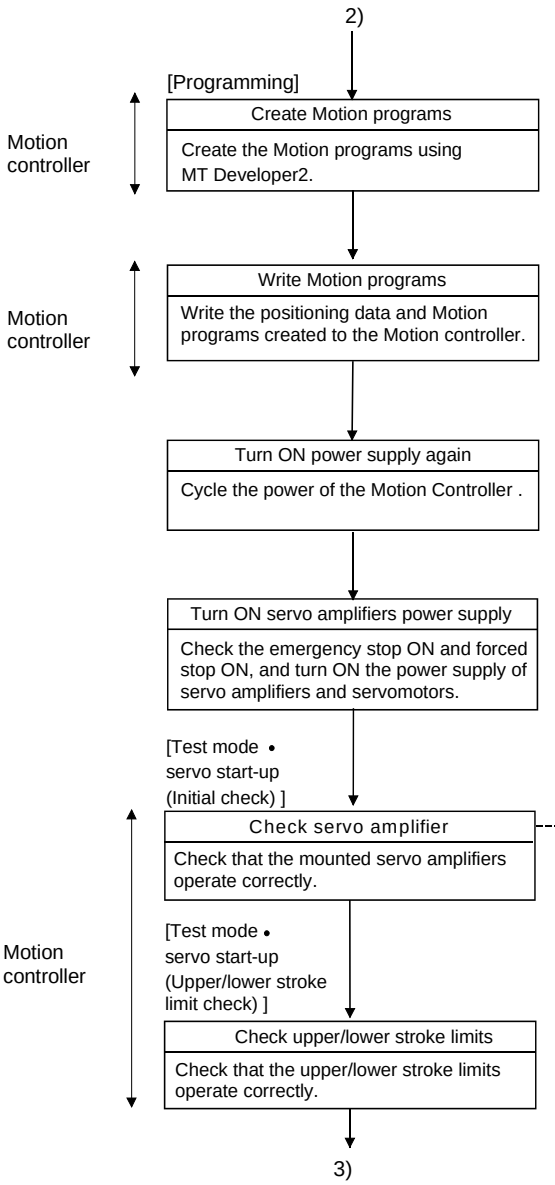
(Note) : An error may occur if the power is turned on before system setting. In the case, reset the Multiple CPU system after system setting. Refer to the "Q173DCPU/Q172DCPU Motion controller Programming Manual (COMMON)" at the system setting error occurrence.

⚠CAUTION

- Do not mount a phase advancing capacitor, surge absorber or radio noise filter (option FR-BIF) on the output side of the servo amplifier.
- Correctly connect the output side (terminal U, V, W). Incorrect connections will lead the servomotor to operate abnormally.

⚠CAUTION

- Set parameter values to those that are compatible with the Motion controller, servo amplifier, servomotor and regenerative resistor model name and the system name application. The protective functions may not function if the settings are incorrect.



⚠DANGER

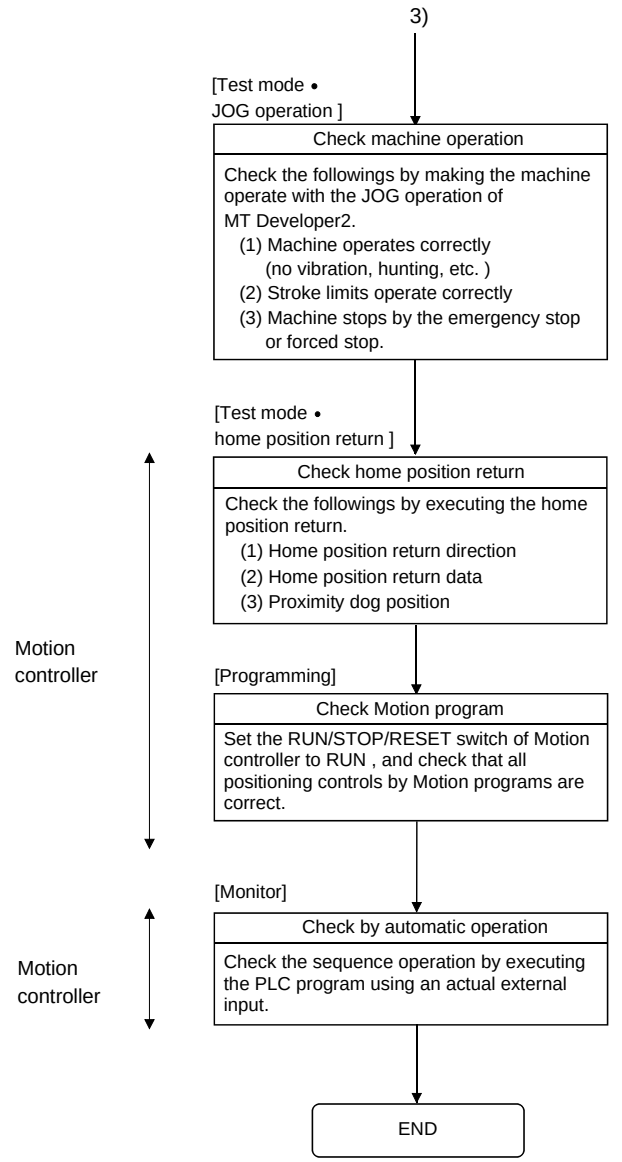
- When performing wiring work or inspections, turn the power OFF, wait at least ten minutes, and then check the voltage with a tester, etc.. Failing to do so may lead to electric shocks.
- Wire the units after mounting the Motion controller, servo amplifier and servomotor. Failing to do so may lead to electric shocks or damage.

⚠CAUTION

- Always mount a leakage breaker on the Motion controller and servo amplifier power source.
- Install emergency stop circuit externally so that operation can be stopped immediately and the power shut off.
- Use the program commands for the program with the conditions specified in the instruction manual.
- Some devices used in the program have fixed applications, so use these with the conditions specified in the programming manual.

⚠CAUTION

- If safety standards (ex., robot safety rules, etc.,) apply to the system using the Motion controller, servo amplifier and servomotor, make sure that the safety standards are satisfied.
- Construct a safety circuit externally of the Motion controller or servo amplifier if the abnormal operation of the Motion controller or servo amplifier differ from the safety directive operation in the system.



⚠CAUTION

- The system must have a mechanical allowance so that the machine itself can stop even if the stroke limits switch is passed through at the max. speed.
- Execute the test operation in the system that it is low-speed as much as possible and put forced stop, and confirm the operation and safety.

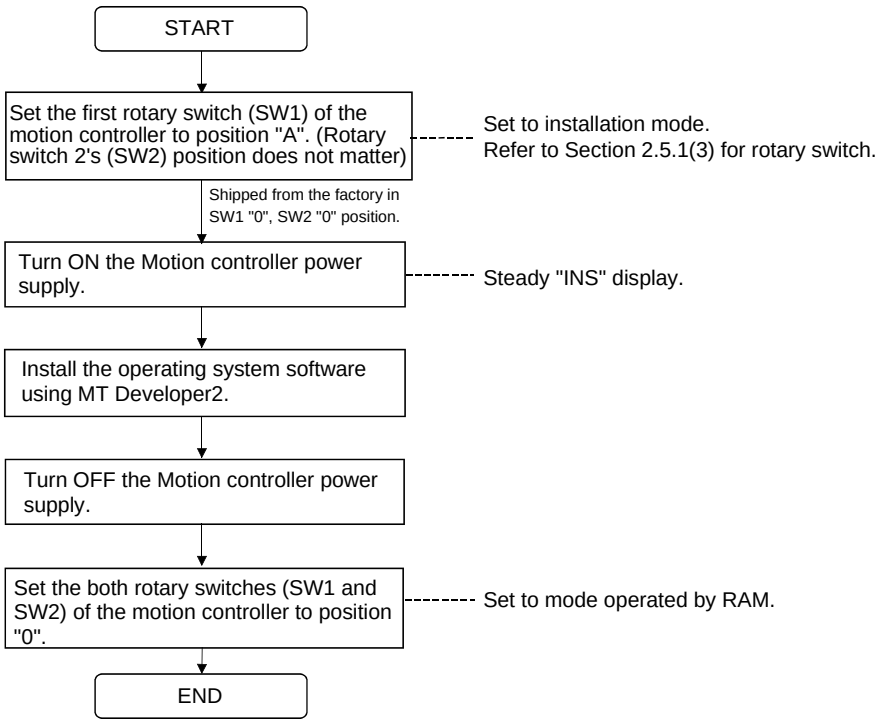
POINT

(1) Make a note of the series name of the motor before mounting to a machine. The servo motor name plate may not be visible after the servo motor is mounted.

(2) When the servo amplifier, servomotor is first turned on, check the operation before mounting them to a machine in order to avoid unexpected accidents such as machine damage.

5.3 Operating System Software Installation Procedure

The operating system software can be installed to the Motion controller from a computer running MT Developer2.
The installation procedure is shown below.



POINT

(1) The operating system software is installed at the time of Motion controller purchase. It is necessary to install operating system software again after any upgrades.

(2) Be sure to change the rotary switches only after first turning off the power supply.

(3) Even if the operating system software is installed, the programs, parameters and absolute position data written to the Motion controller is not overwritten.

(4) Do not do any of the following while installing operating system software. Doing so could result damage the Motion controller.
- Turn off the motion controller's power supply.
- Change the RUN/STOP/RESET switch of Motion controller to RESET.
- Turn off the power supply of the personal computer.
- Pull out the personal computer’s communications cable.

5.4 Trial Operation and Adjustment Checklist

At the worksite, copy the following table for use as a check sheet.

Work Step	Item	Trial Operation and Adjustment Confirmation	Check
Before power supply ON	Installation of unit/module and basic wiring	Check that each module is installed correctly.	☐
		Check that each connector is connected correctly.	☐
		Check each terminal screw for looseness.	☐
		Check that the earth wires of Motion controller or servo amplifiers, etc. are correct.	☐
		Check that the servomotor wiring is correct.	☐
		Check that the regenerative option wiring is correct.	☐
		Check that the circuit of emergency stop and forced stop are correct.	☐
		Check that the wiring of each power supply and I/O are correct.	☐
		Check that the rotary switch settings are correct.	☐
Power supply ON, Motion controller in STOP status	System setting	Check that the system setting is correct.	☐
	External signal	Check that the upper/lower stroke limit inputs are correct.	☐
		Check that the proximity dog and speed-position switching signal input are correct.	☐
	Program/ positioning data	Check that the Motion program, PLC program and positioning data are stored in the motion controller correctly.	☐
	Basic axis operations	Check communications with servo amplifiers.	☐
		Check that the rotation direction for JOG operation is correct.	☐
		Check that the upper/lower limit switches operate correctly.	☐
		Check that the maximum commanded rotation speed is within the motor's rating	☐
		Check that the machine operates correctly by the JOG operation.	☐
		Check that the machine stops by the upper/lower stroke limit.	☐
		Check that the machine stops by the emergency stop or forced stop.	☐
		Check that the home position return is executed correctly.	☐
		Check that each positioning control of the motion program operates correctly.	☐
Motion controller in RUN status	Manual operation	Checks for each operation in manual operation mode during Motion program execution.	☐
		Check that the machine operation stops immediately by the emergency stop or forced stop.	☐
		Check the operation of each actuator and confirm limit switch operation.	☐
		Check that the emergency stop, forced stop and equipment alarm signals are correct.	☐
		Check for compliance with control specifications specific to system and equipment.	☐
	Automatic operation	Checks for each operation in automatic operation mode during Motion program execution.	☐
		Check that the automatic operation works.	☐
		Check that the machine operation stops immediately by the emergency stop or forced stop.	☐
		Check that the module or equipment alarm causes an immediate stop or cycle stop.	☐
		Check that restoring operations can be performed after an alarm stop.	☐
		Make other checks in compliance with control specifications specific to system and equipment.	☐
	Torque check	Check that the acceleration/deceleration torque is maximum torque or less.	☐
		Check that the continuous effective load torque is rated torque or less.	☐

MEMO

6. INSPECTION AND MAINTENANCE

In order that you can use the motion controller in normal and optimal conditions at all times, this section describes those items that must be maintained or inspected daily or at regular intervals.

⚠DANGER

- Do not touch the terminals while power is on. Doing so could cause electric shock.
- Correctly connect the battery. Also, do not charge, disassemble, heat, place in fire, short circuit, or solder the battery.
  Mishandling of a battery may cause overheating, cracks or ignition which could result in injury and fire.
- Switch off all phases of the externally supplied power used in the system when cleaning the module or retightening the terminal or Motion controller's mounting screws.
  Not doing so could result in electric shock.
  Under tightening of terminal screws can cause a short circuit or malfunction.
  Over tightening of screws can cause damages to the screws and the Motion controller, resulting in fallout, short circuits, or malfunction.
- The capacitors are mounted on the Motion controller. Do not incinerate the Motion controller so that the incineration of capacitor may cause a burst.

⚠CAUTION

- Read the manual carefully and pay careful attention to safety for the on-line operation (especially program change, forced stop or operation change) performed by connecting peripheral devices to the Motion controller during operation.
  Erroneous operation may cause machine breakage or accident.
- Never try to disassemble or modify Motion controller. It may cause product failure, operation failure, injury or fire.
- Use any radio communication device such as a cellular phone or a PHS phone more than 25cm (9.85 inch) away in all directions of the Motion controller.
  Failure to do so may cause a malfunction.
- Completely turn off the externally supplied power used in the system before installation or removing the Motion controller. Not doing so could result in damage to the product.
- Do not drop or impact the battery installed to the Motion controller. Doing so may damage the battery, causing battery liquid to leak in the battery.
  Do not use the dropped or impacted battery, but dispose of it.
- Before touching the Motion controller, always touch grounded metal, etc. to discharge static electricity from human body. Failure to do so may cause the Motion controller to fail or malfunction.
- Do not directly touch the Motion controller's conductive parts and electronic components. Touching them could cause an operation failure or give damage to the Motion controller.

6.1 Maintenance

6.1.1 Inspection Instructions

In order to ensure safe and normal operation of the Motion controller, the below items must be inspected.

⚠DANGER

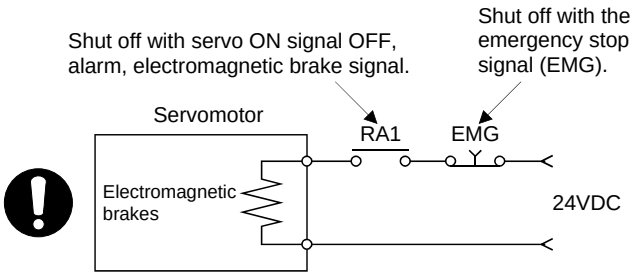
- Never open the front case while the power is ON or the unit is running, as this may lead to electric shocks.
- Never run the unit with the front case cover removed. The high voltage terminal and charged sections will be exposed and may lead to electric shocks.
- Never remove the front case at times other than wiring work or periodic inspections even if the power is OFF. The insides of the Motion controller and servo amplifier are charged and may lead to electric shocks.
- When performing wiring work or inspections, turn the power OFF, wait at least ten minutes, and then check the voltage with a tester, etc.. Failing to do so may lead to electric shocks.
- Never operate the switches with wet hands, as this may lead to electric shocks.
- Do not damage, apply excessive stress, place heavy things on or sandwich the cables, as this may lead to electric shocks or fire.
- Do not touch the Motion controller, servo amplifier or servomotor terminal blocks while the power is ON, as this may lead to electric shocks.
- Do not touch the built-in power supply, built-in grounding or signal wires of the Motion controller and servo amplifier, as this may lead to electric shocks.

⚠CAUTION

- Be sure to ground the Motion controller, servo amplifier and servomotor. Do not ground commonly with other devices. (Ground resistance : 100 Ω or less)
- The wiring work and inspections must be done by a qualified technician.
- Wire the units after mounting the Motion controller, servo amplifier and servomotor. Failing to do so may lead to electric shocks or damage.
- Perform the daily and periodic inspections according to the instruction manual.
- Perform maintenance and inspection after backing up the program and parameters for the Motion controller and servo amplifier.
- Do not place fingers or hands in the clearance when opening or closing any opening.
- Periodically replace consumable parts such as batteries according to the instruction manual.
- Do not touch the lead sections such as ICs or the connector contacts.
- Do not place the Motion controller or servo amplifier on metal that may cause a power leakage or wood, plastic or vinyl that may cause static electricity buildup.
- Do not perform a megger test (insulation resistance measurement) during inspection.
- When replacing the Motion controller or servo amplifier, always set the new unit settings correctly.
- After maintenance and inspections are completed, confirm that the position detection of the absolute position detector function is correct.

⚠CAUTION

- Do not short circuit, charge, overheat, incinerate or disassemble the batteries.
- The electrolytic capacitor will generate gas during a fault, so do not place your face near the Motion controller or servo amplifier.
- The electrolytic capacitor and fan will deteriorate. Periodically change these to prevent secondary damage from faults. Replacements can be made by our sales representative.
- If an error occurs in the self diagnosis of the Motion controller or servo amplifier, confirm the check details according to the instruction manual, and restore the operation.
- If a dangerous state is predicted in case of a power failure or product failure, in order to prevent that state, use a servomotor with electromagnetic brakes for maintenance or mount a brake mechanism externally.
- Use a double circuit construction so that the electromagnetic brake operation circuit can be operated by emergency stop signals set externally.



- If an error occurs, remove the cause, secure the safety and then resume operation after alarm release.
- The unit may suddenly restart after a power failure is restored, so do not go near the machine. (Design the machine so that personal safety can be ensured even if the machine restarts suddenly.)
- Confirm and adjust the program and each parameter before operation. Unpredictable movements may occur depending on the machine.
- Extreme adjustments and changes may lead to unstable operation, so never make them.
- Do not apply a voltage other than that specified in the instruction manual on any terminal. Doing so may lead to destruction or damage.
- Do not mistake the terminal connections, as this may lead to destruction or damage.
- Do not mistake the polarity (+ / -), as this may lead to destruction or damage.
- Do not touch the heat radiating fins of controller or servo amplifier, regenerative resistor and servomotor, etc., while the power is ON and for a short time after the power is turned OFF. In this timing, these parts become very hot and may lead to burns.
- Always turn the power OFF before touching the servomotor shaft or coupled machines, as these parts may lead to injuries.
- Do not go near the machine during test operations or during operations such as teaching. Doing so may lead to injuries.
- Do not bunch the control wires or communication cables with the main circuit or power wires, or lay them closely. They should be installed 100 mm (3.94 inch) or more from each other. Trying to bunch or install could result in noise that would cause operation failure.

6.2 Daily Inspection

The items that must be inspected daily are shown below.

Table 6.1 Daily Inspection

Item	Inspection item			Inspection	Criterion	Action
1	Mounting of Motion controller			Check that the fixing screws are not loose and the cover is not dislocated.	The screws and cover must be mounted securely.	Retighten the screws.
2	Connecting conditions			Check for loose FG terminal screws.	Screws should not be loose.	Retighten the FG terminal screws.
				Check for distance between solder-less terminals.	The proper clearance should be provided between solder-less terminals.	Correct.
				Check the connector part of the cable.	Connections should not be loose.	Retighten the connector fixing screws.
3	Module indication LED	Motion controller	[POWER] LED	Check that the LED is ON.	The LED should be ON (red). (The LED off with power supplied is an abnormal situation).	Refer to Section 2.5.1
			Normal		Steady "RUN" display. (Abnormal if "RUN" is not displayed or is incorrectly displayed.)	Refer to Section 2.5.1(2)
					Steady "STP" display. (Abnormal if "STP" is not displayed or incorrectly displayed.)	
			Battery error warning (2.7V or less)		"BT1" should not be displayed. (Abnormal if steady "BT1" is displayed.)	Refer to Section 6.5
			Battery error warning (2.5V or less)		"BT2" should not be displayed. (Abnormal if steady "BT2" is displayed.)	
			WDT error		" . . . " should not be displayed. (Abnormal if steady " . . ." is displayed.)	Refer to Section 2.5.1(2)
			Others		" AL" should not flash. (Abnormal if " . . ." is flashing.)	

6.3 Periodic Inspection

The items that must be inspected one or two times every 6 months to 1 year are listed below. When the equipment is moved or modified, or layout of the wiring is changed, also implement this inspection.

Table 6.2 Periodic Inspection

Item	Inspection item		Inspection	Judgment criteria	Remedy
1	Ambient environment	Ambient temperature	Measure with a thermometer and a hygrometer. Measure corrosive gas.	0 to 55 °C (32 to 131 °F)	When the controller is used in an enclosure, the ambient environment in the enclosure becomes the operating environment.
		Ambient humidity		5 to 95 % RH	
		Atmosphere		No corrosive gases	
2	Power voltage		Measure the voltage across the terminals of 24VDC.	21.6 to 26.4VDC	Change the power supply.
3	Installation	Looseness, rattling	Move the Motion controller to check for looseness and rattling.	The module must be installed securely.	Retighten the screws.
		Adhesion of dirt and foreign matter	Check visually.	Dirt and foreign matter must not be present.	Remove and clean.
4	Connection	Looseness of FG terminal screws	Try to further tighten screws with a screwdriver.	Screws must not be loose.	Retighten the terminal screws.
		Looseness of connectors	Check visually.	Connectors must not be loose.	Retighten the connector fixing screws.
5	Battery		Check the 7-segment LED on the front side of MR-MQ100.	"BT1" or "BT2" must not be displayed.	Even if the lowering of a battery capacity is not shown, replace the battery with a new one if the service life time of the battery is exceeded.
			Check the length of term after purchasing the battery	Must not be used for more than 5 years.	
			Check that SM51 or SM58 is turned OFF using MT Developer2 monitor.	Must be turned OFF.	Replace the battery with a new one when SM51 or SM58 is ON.

6.4 Life

The following parts must be changed periodically as listed below.
However, if any part is found faulty, it must be changed immediately even when it has not yet reached the end of its life, which depends on the operating method and environmental conditions.
For parts replacement, please contact a local sales representative.

Table 6.3 Life

Module name	Part name	Life guideline	Remark
Motion controller	Capacitor	10 years	Life guideline a reference only. If any abnormality is discovered, the capacitor must be changed immediately even if it has not yet reached the life guideline.
	Electrolytic capacitor		

(1) Capacitor
The life of the capacitor greatly depends on ambient temperature and operating conditions. The capacitor will reach the end of its in 10 years of continuous operation in normal air-conditioned environment.

6.5 Battery

The battery installed in the Motion controller is used for data retention of the program memory and latch device during a power failure.
Special relays SM51, SM52, SM58, or SM59 turn on due to a decrease in battery voltage. Even if the special relays turn on, the program and retained data are not erased immediately.
However, if these relays are overlooked, the contents may be erased.
After relay SM51 or SM58 turns on, replace the battery quickly within the data retention time for power failure (3 minutes).

POINT

(1) SM51 or SM58 turns on when the battery voltage falls below the specified value, and remains ON even after the voltage is recovered to the normal value. SM51 or SM58 turns off after a power supply cycle or reset.
(2) After SM51 or SM58 turns on, replace the battery immediately.
  • SM51 or SM52 turns on if the battery voltage becomes 2.5V or less.
  • SM58 or SM59 turns on if the battery voltage becomes 2.7V or less.
(3) If SM51 turns on, the details of the programs, parameters and absolute position and latch data cannot be guaranteed.
  It is recommended to back-up the battery periodically.
(4) The data stored in the SRAM built-in Motion controller are shown below.
  Programs, Parameters, Motion devices (#), Devices of latch range, and Absolute position data

6.5.1 Battery life

The battery life is shown below.

Module type	Battery life (Total power failure time) [h] (Note-1)				
	Power-on time ratio (Note-2)	Guaranteed value (Note-3) (MIN) (75°C (167°F))	Guaranteed value (Note-4) (TYP) (40°C (104°F))	Actual service value (Note-5) (Reference value) (TYP) (25°C (77°F))	Backup time after alarm (Note-6)
Q6BAT (note-7)	0%	20000	43800	43800	90 (After SM51/SM52ON)
	30%	27000			
	50%	31000			
	70%	36000			
	100%	43800			
Q7BAT (note-7)	0%	39000	43800	43800	90 (After SM51/SM52ON)
	30%	43800			
	50%				
	70%				
	100%				

(Note-1) : The actual service value indicates the average value, and the guaranteed time indicates the minimum time.

(Note-2) : The power-on time ratio indicates the ratio of Motion controller power-on time to one day (24 hours).

$$\text{Power-on time ratio} = \frac{17}{24} \times 100 = 70[\%]$$

(When the total power-on time is 17 hours and the total power-off time is 7 hours, the power-on time ratio is 70%.)

(Note-3) : The guaranteed value (MIN) ; equivalent to the total power failure time that is calculated based on the characteristics value of the memory (SRAM) supplied by the manufacturer and under the storage ambient temperature range of -25°C to 75°C (-13 to 167°F) (operating ambient temperature of 0°C to 55°C (32 to 131°F)).

(Note-4) : The guaranteed value (TYP) ; equivalent to the total power failure time that is calculated based on the normal air-conditioned environment (40°C (104°F)).

(Note-5) : The actual service value (Reference value) ; equivalent to the total power failure time that is calculated based on the measured value and under the storage ambient temperature of 25°C (77°F). This value is intended for reference only, as it varies with characteristics of the memory.

(Note-6) : In the following status, the backup time after power OFF is 3 minutes.

- The Q6BAT lead connector/ Q7BAT lead connector is disconnected.
- Lead wire of Q6BAT/Q7BAT is broken.

(Note-7) : Set the battery (Q6BAT/Q7BAT) to battery holder .

POINT

(1) Do not use any battery having exceeded its guaranteed life.

(2) When the battery hours (total power failure time) may exceed its guaranteed value, take the following measure.
- Perform ROM operation to protect a program even if the battery dies at the Motion controller power-OFF.
- If SM51 turns on, the contents for the data (Refer to Section 6.5.) of SRAM built-in Motion controller cannot be guaranteed.
  It is recommended to back-up the data periodically.

(3) When the total power failure time exceeds its guaranteed value, and SM51, SM52, SM58 and SM59 turns on, immediately change the battery. Even if the alarm has not yet occurred, it is recommended to replace the battery periodically according to operating conditions.

(4) Even when not connect to a motion controller, self-discharge influences the life of the battery. The battery should be exchanged approximately every 4 or 5 years even if the total power failure time is within the guaranteed value.

6.5.2 Battery replacement procedure

(1) Battery replacement procedure of the Battery holder unit

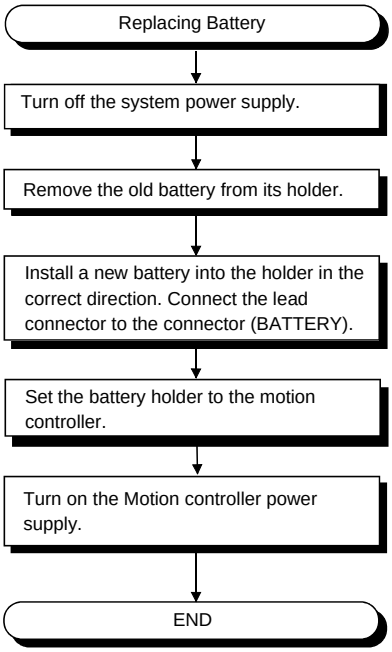
When the battery has been exhausted, replace the battery with a new one in accordance with the procedure shown below.

POINT

When replacing the battery, pay attention to the following.

(1) Back up the data using MT Developer2 before starting replacement.

(2) First back up data stored in the Motion controller using a personal computer with MT Developer2 installed. Then replace the battery with a new one. After setting the battery in the Battery holder unit, use the MT Developer2 "verify" function to confirm the data on the motion controller has not changed.
In the following status, the backup time after power OFF is 3 minutes.
- The lead connector of Q6BAT/Q7BAT is disconnected.
- The lead wire of Q6BAT/Q7BAT is broken.



6.5.3 Resuming operation after storing the Motion controller

When operation is to be resumed after the Motion controller has been in storage with the battery removed or if the battery has died during storage, the contents of programs, parameters, absolute position data and latch data cannot be guaranteed. Before resuming operation, write the contents of programs, parameters, absolute position data and latch data which were backed-up to the motion controller's SRAM prior to storage.

POINT
Before placing the motion controller into storage, always back up the contents of programs, parameters, absolute position data and latch data to the Motion controller's SRAM.

6.5.4 Symbol for the new EU Battery Directive

This section describes a symbol for the new EU Battery Directive (2006/66/EC) that is labeled batteries.

Note: This symbol mark is for EU countries only

This symbol mark is according to the directive 2006/66/EC Article 20 Information for end-users and Annex II.
Your MITSUBISHI ELECTRIC product is designed and manufactured with high quality materials and components which can be recycled and/or reused.
This symbol means that batteries and accumulators, at their end-of-life, should be disposed of separately from your household waste.
If a chemical symbol is printed beneath the symbol shown above, this chemical symbol means that the battery or accumulator contains a heavy metal at a certain concentration.
This will be indicated as follows:
Hg: mercury (0.0005%), Cd: cadmium (0.002%), Pb: lead (0.004%)
In the European Union there are separate collection systems for used batteries and accumulators.
Please, dispose of batteries and accumulators correctly at your local community waste collection/recycling centre.
Please, help us to conserve the environment we live in!

6.6 Troubleshooting

This section describes the various types of trouble that occur when the system is operated, and causes and corrective actions of these troubles.

6.6.1 Troubleshooting basics

The basic three points that must be followed in the troubleshooting are as follows.

(1) Visual inspection

Visually check the following.

(a) Movement of machine (stopped condition, operating condition)
(b) Power supply on/off
(c) Status of input/output devices
(d) Installation condition of the Motion controller, SSCNETⅢ cable, synchronous encoder cable.
(e) State of wiring (I/O cables, cables)
(f) Display states of various types of indicators
Motion controller : 7-segment LED (Installation mode, Operation mode, Battery error, STOP/RUN/RESET, etc.)
(g) Status of setting of various types of switches (Setting of No. of stages of extension base unit, power interrupt hold-on status).

After checking (a) to (g), monitor the operating conditions of servomotors and error code using MT Developer2.

(2) Error Check

Check to see how the operating condition varies while the Motion controller is operated as follows.

(a) Set the RUN/STOP/RESET switch of the Motion controller to STOP.
(b) Reset the system with the RUN/STOP/RESET switch of Motion controller.
(c) Cycle the Motion controller power supply.

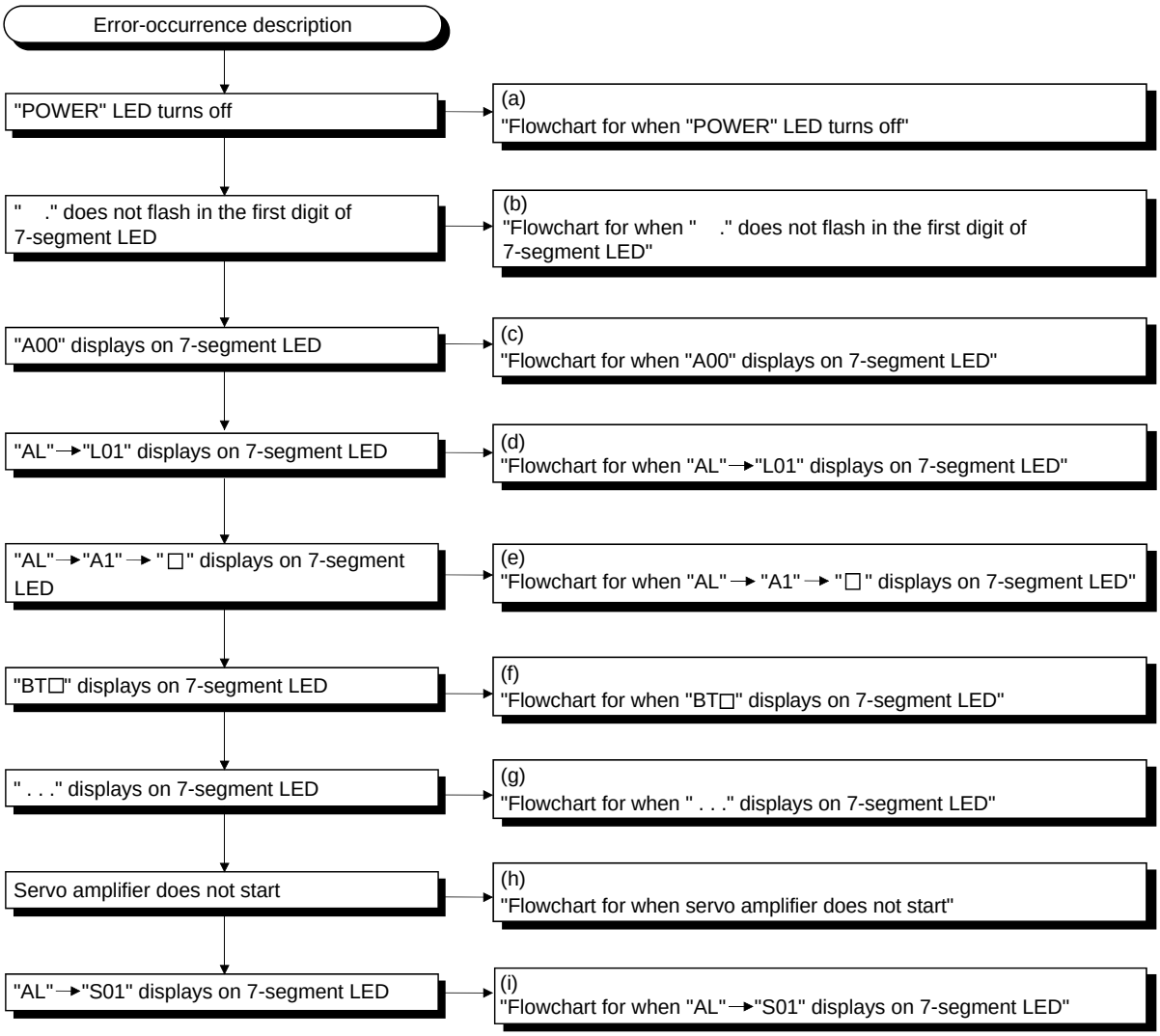
(3) The above two steps help determine if it is the servo programs or SFC programs that contain the error.

6.6.2 Motion Controller Troubleshooting

This section gives error code descriptions and details corrective actions.

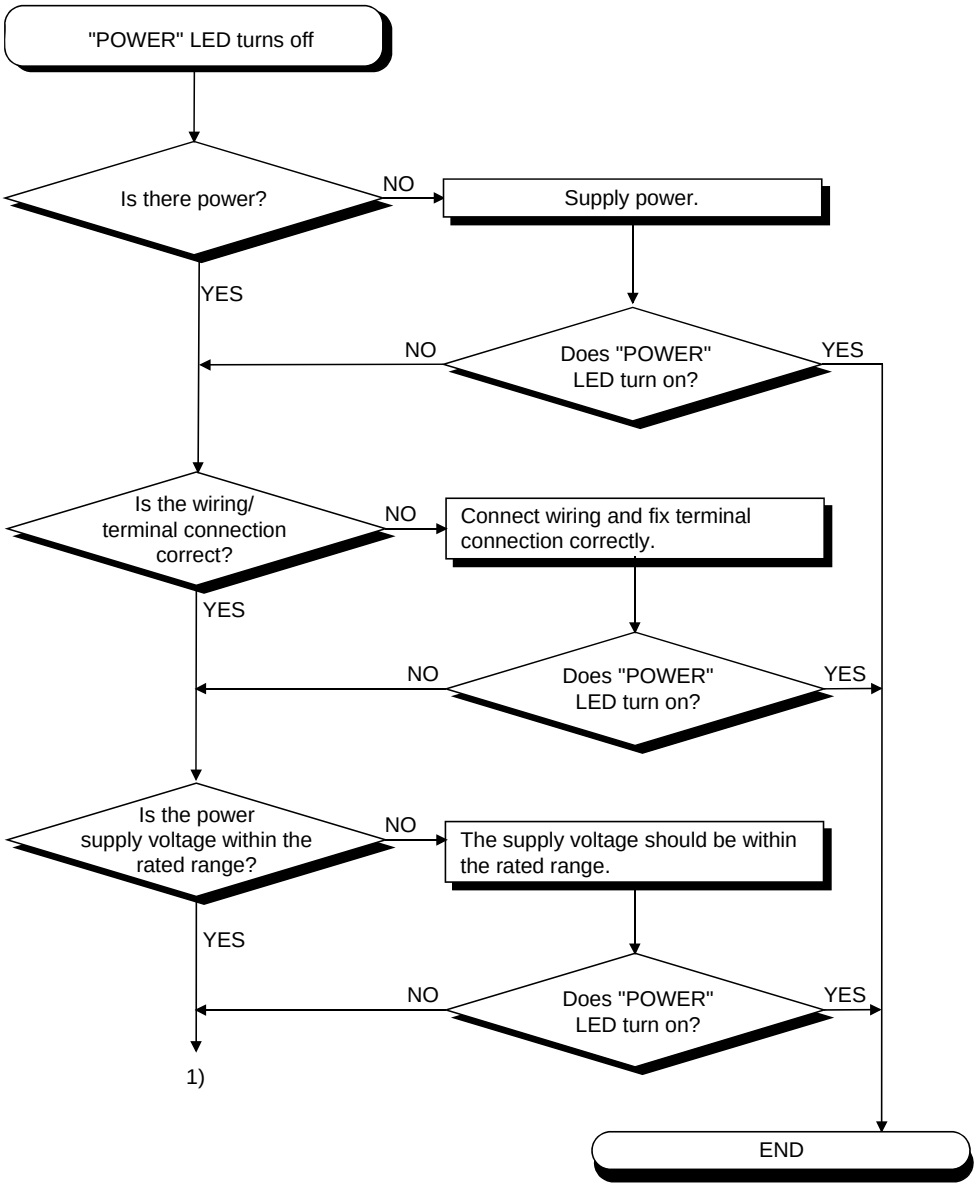
(1) Troubleshooting flowchart

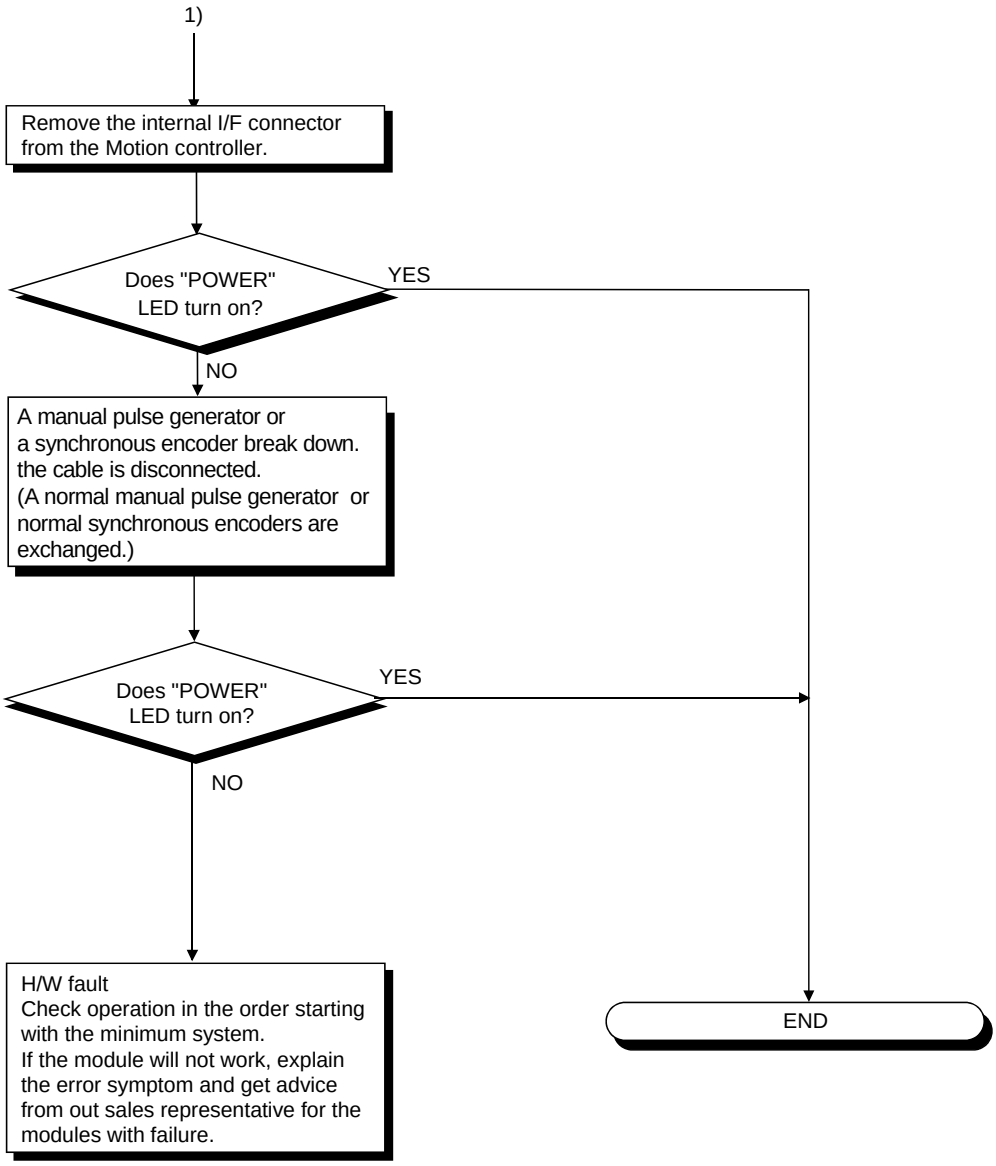
The following shows the issues classified into a variety of groups according to the types of events.



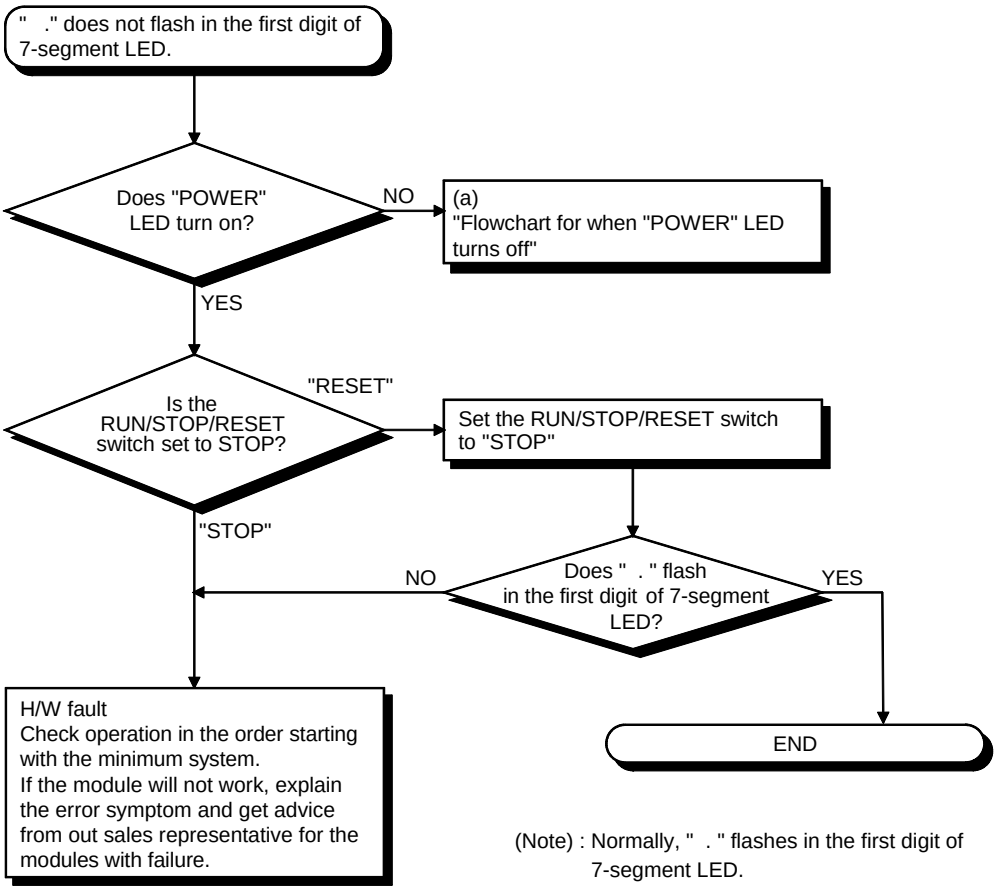
(a) Flowchart for when the "POWER" LED turns off

The following shows the flowchart when the "POWER" LED turns off while turning on the or during operation.




1)
Remove the internal I/F connector from the Motion controller.
Does "POWER" LED turn on?
YES
NO
A manual pulse generator or a synchronous encoder break down. the cable is disconnected. (A normal manual pulse generator or normal synchronous encoders are exchanged.)
Does "POWER" LED turn on?
YES
NO
H/W fault
Check operation in the order starting with the minimum system.
If the module will not work, explain the error symptom and get advice from out sales representative for the modules with failure.
END

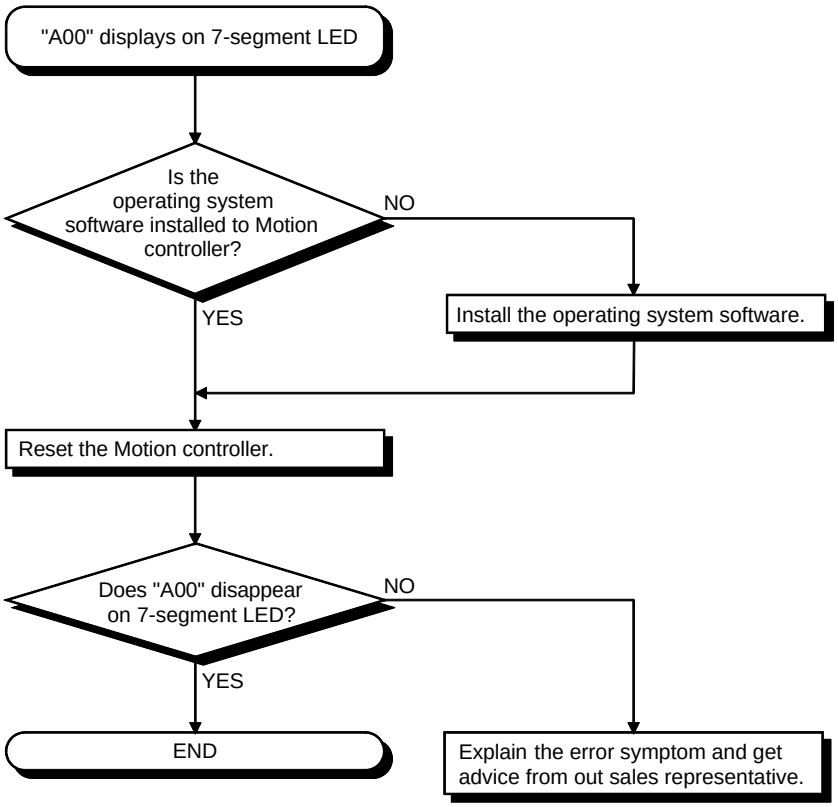
(b) Flowchart for when " ." does not flash in the first digit of 7-segment LED



(Note) : Normally, " . " flashes in the first digit of 7-segment LED.

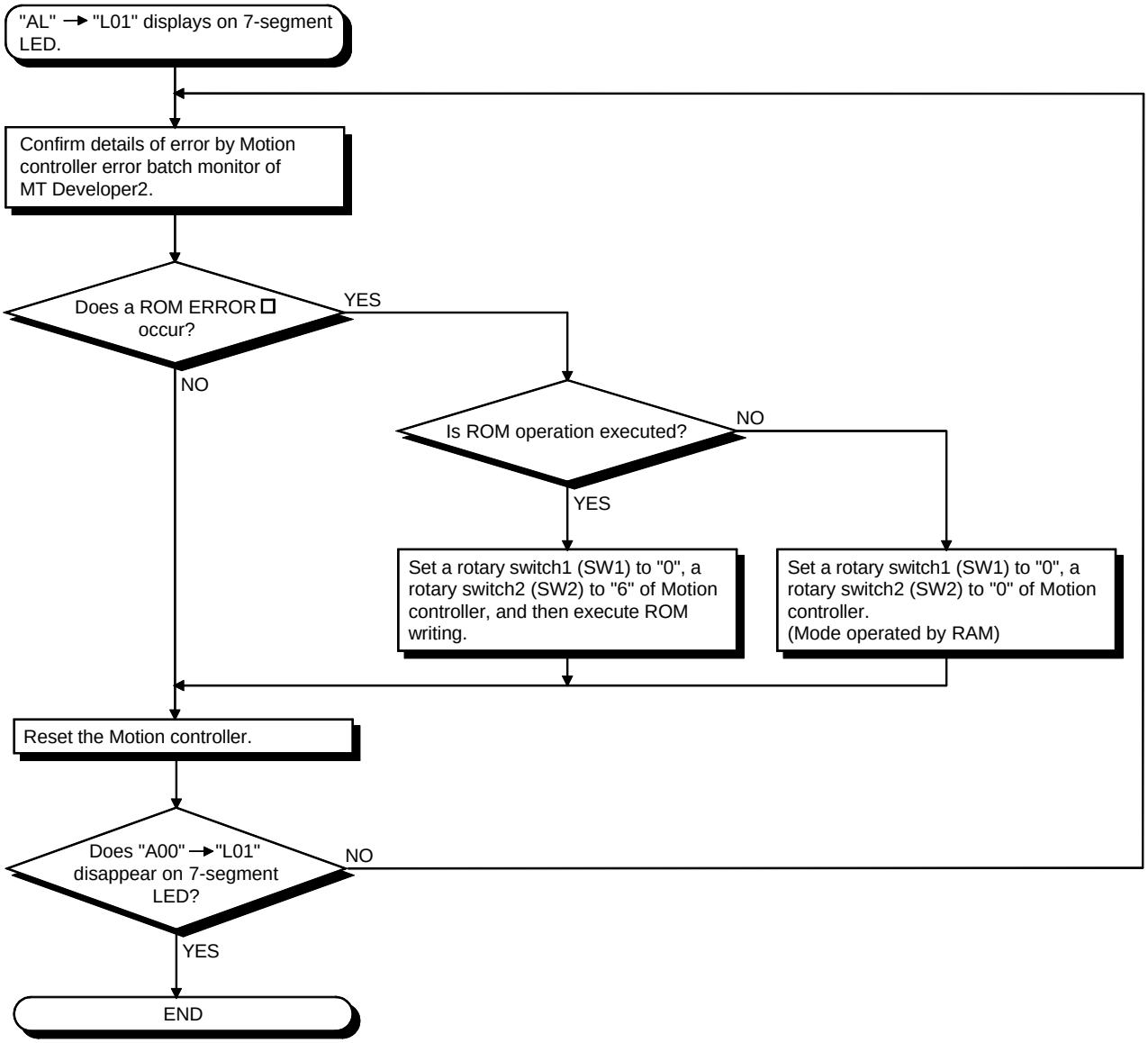
(c) Flowchart for when "A00" displays on 7-segment LED

"A00" displays when the operating system software is not installed.
The following shows the flowchart when the "A00" displays at the power supply ON or operation start.



(d) Flowchart for when "AL" → "L01" displays on 7-segment LED

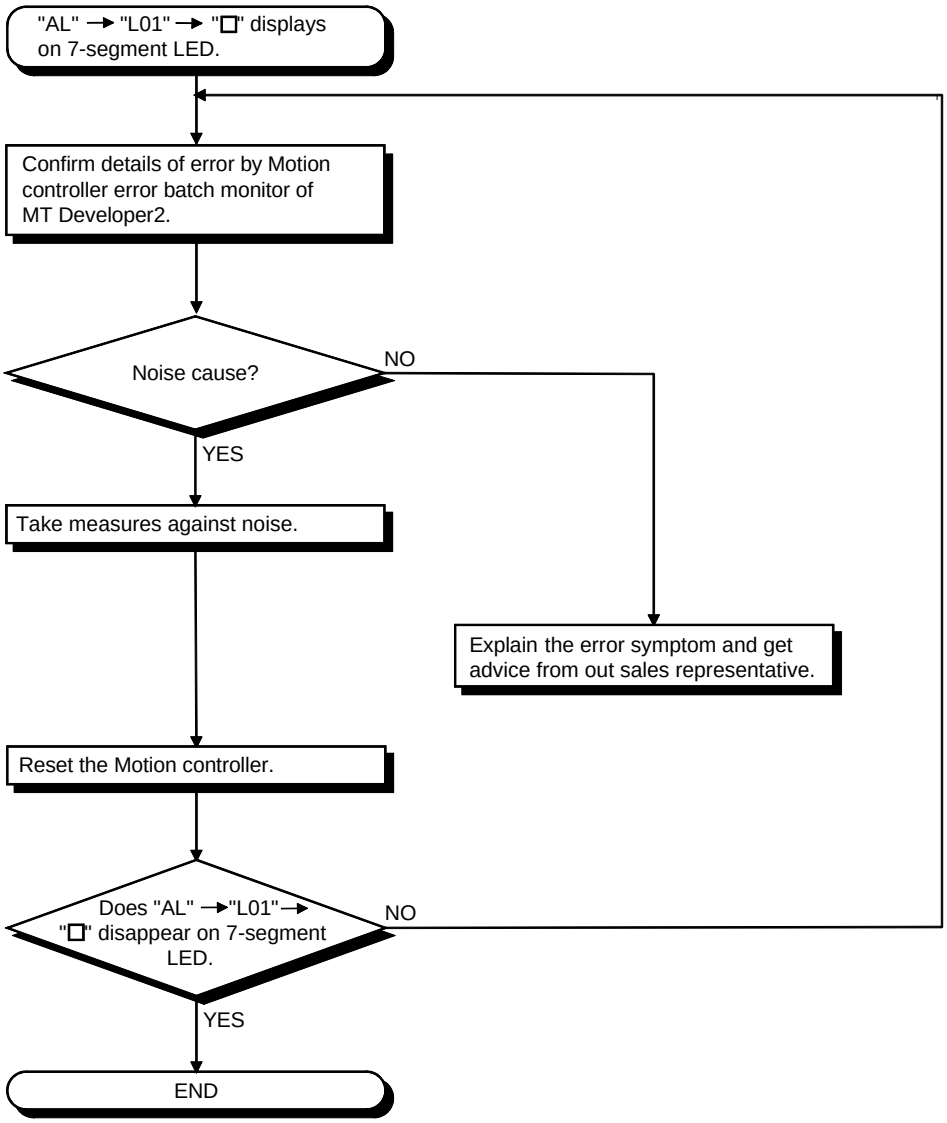
"AL" (flashes 3 times) → Steady "L01" display" displays at the system setting error occurrence.
The following shows the flowchart when the "AL" (flashes 3 times) → Steady "L01" display" displays during operation.



(e) Flowchart for when "AL" → "A1" → "□" displays on 7-segment LED.

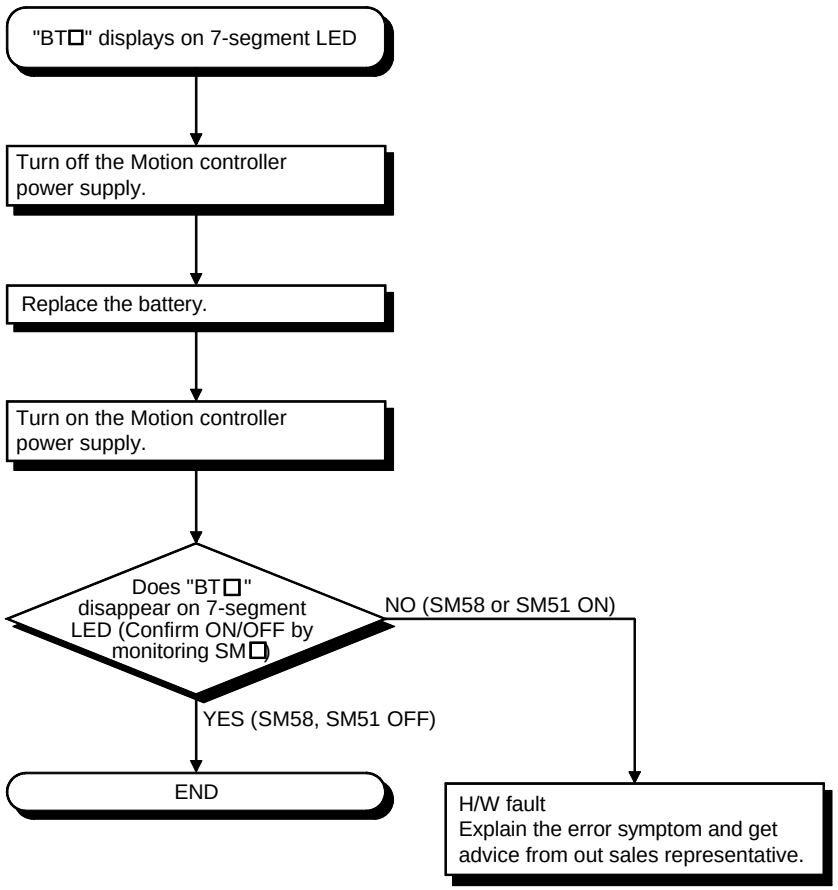
""AL" (flashes 3 times) → Steady "A1" display → "□"" displays at the self-diagnosis error occurrence.

□: 4-digits error code is displayed in two sequential flashes of 2-digits each.



(f) Flowchart for when "BT□" displays on 7-segment LED

"BT1" or "BT2" displays when the battery voltage is lowered.
"BT1" or "BT2" displays at the following cases.
• BT1: Battery voltage 2.7V or less
• BT2: Battery voltage 2.5V or less
The following shows the flowchart for when "BT□ " displays.

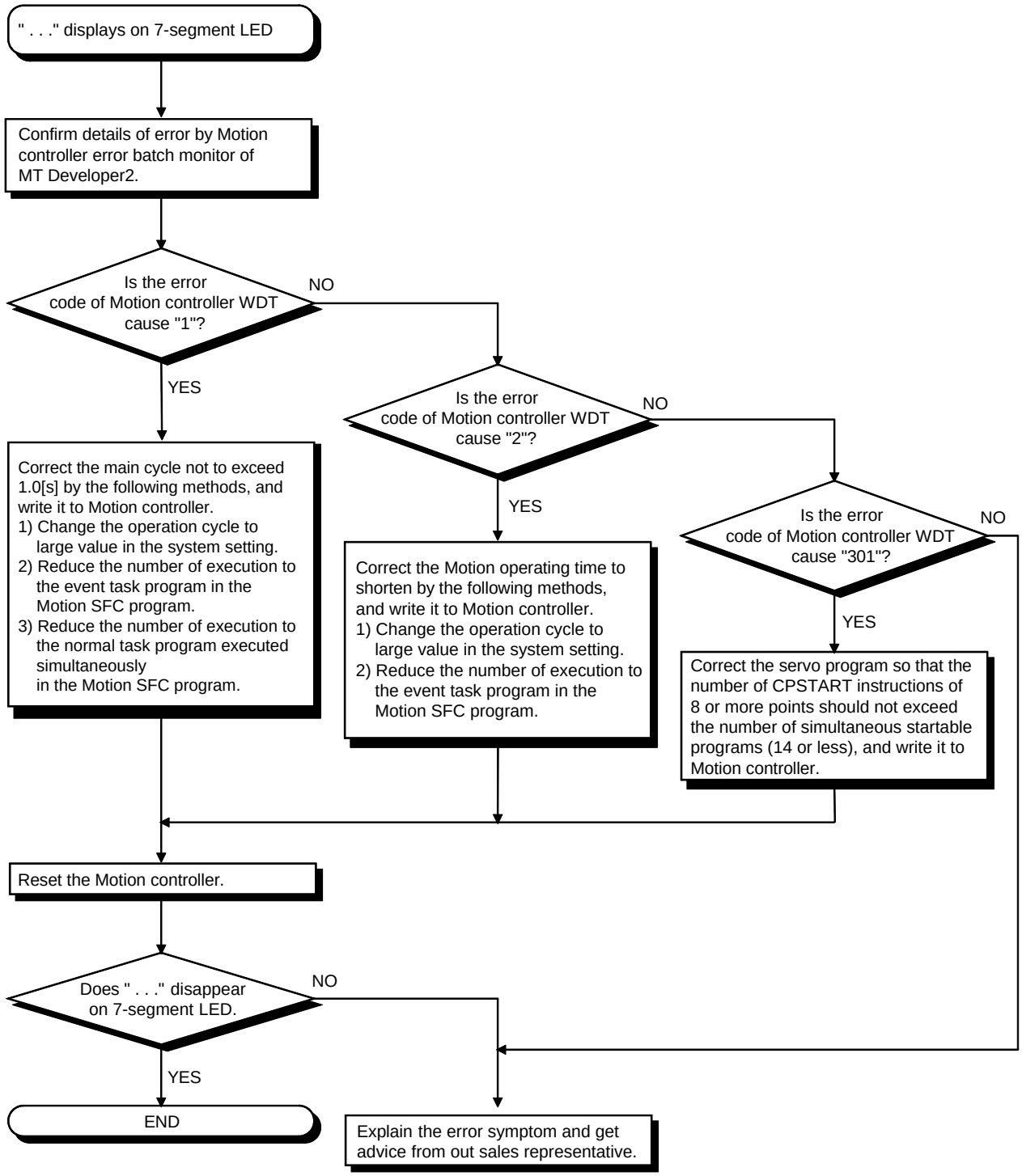


REMARK

If SM51,SM58 turns on, the contents for the data (Refer to Section 6.5.) of SRAM built-in Motion controller cannot be guaranteed.
It is recommended to back-up the battery periodically.

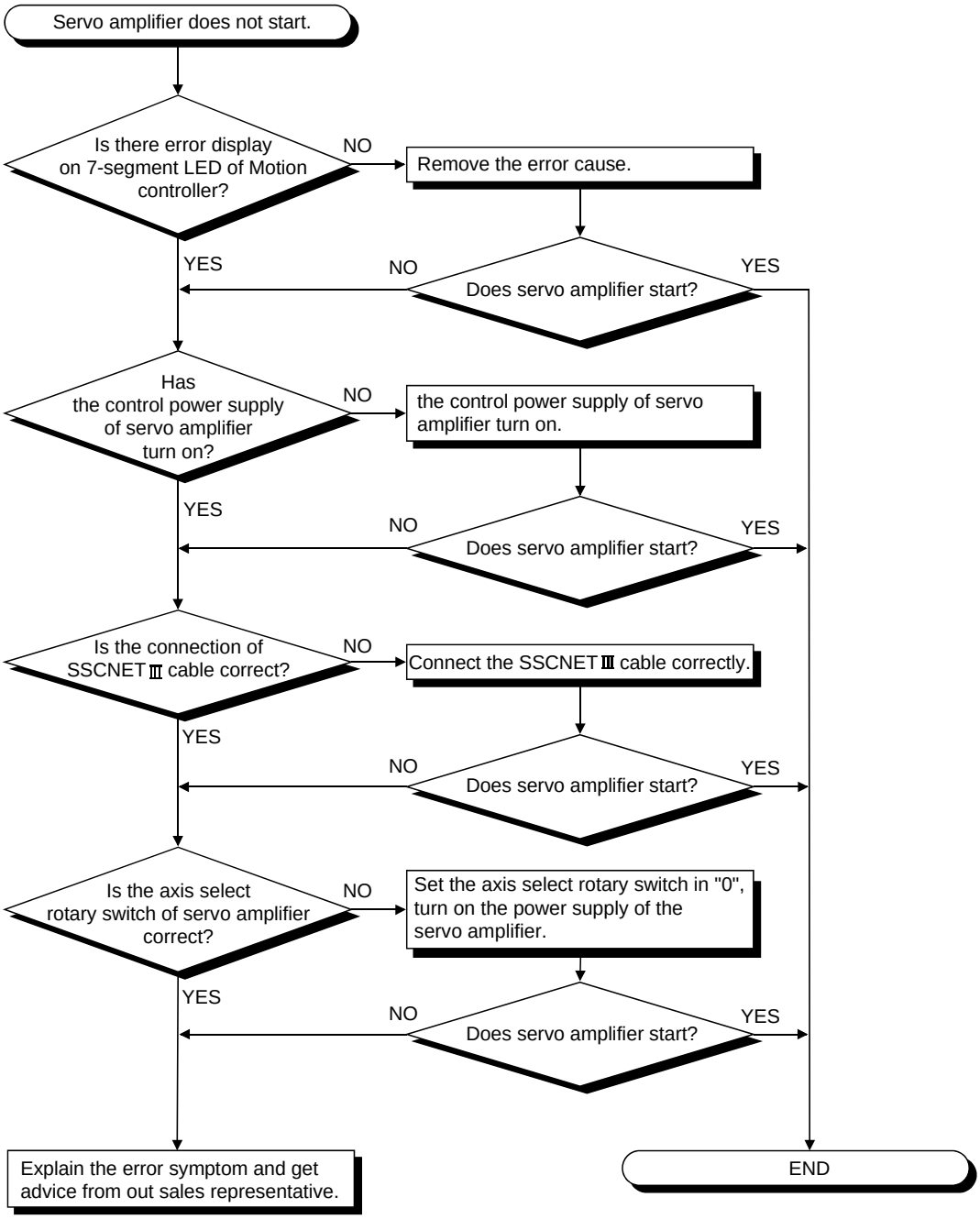
(g) Flowchart for when " . . ." displays on 7-segment LED

" . . ." displays at the WDT error occurrence.
The following shows the flowchart for when " . . ." displays on 7-segment LED during operation.



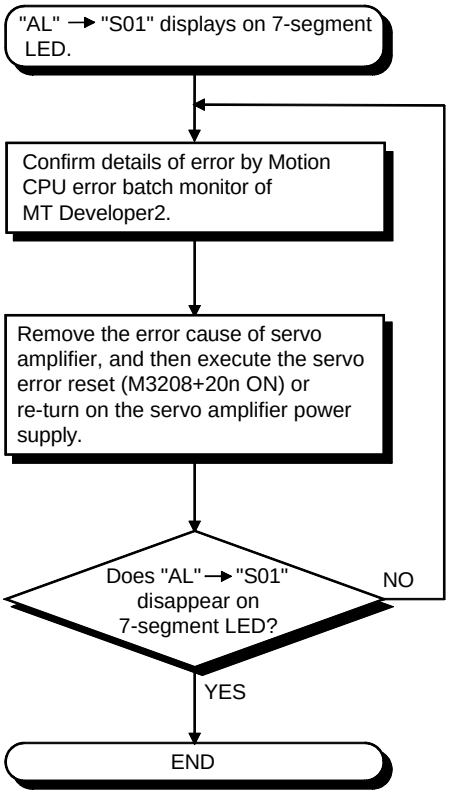
(h) Flowchart for when servo amplifier does not start

The following shows the flowchart for when servo amplifier does not start.



(i) Flowchart for when "AL" → "S01" displays on 7-segment LED

""AL" (flashes 3 times) → Steady "S01" display" displays at the servo error occurrence.
The following shows the flowchart for when "AL" (flashes 3 times) → Steady "S01" display" displays on 7-segment LED during operation.



6.6.3 Confirming error code

The error code and error message can be read using MT Developer2.
The procedure for reading error is as follows.

(1) Connect a computer to the PERIPHERAL I/F of the Motion controller.
(2) Start MT Developer2.
(3) Select [Online] - [Read from CPU] Menu of MT Developer2, and read the project data from Motion controller.
(4) Start the monitor screen of MT Developer2 and select [Motion CPU error batch monitor] menu.
(5) Confirm the error codes and error messages displayed on screen.

Refer to help of MT Developer2 for details of operating method.

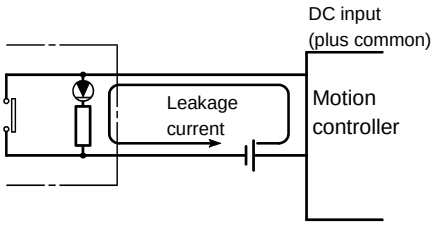
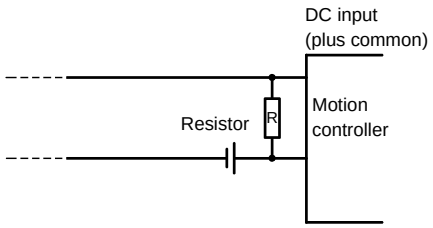
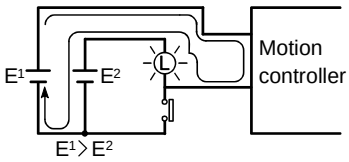
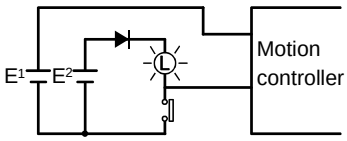
6.6.4 I/O circuit troubleshooting

This section describes possible problems with I/O circuits and their corrective actions.

(1) Input circuit troubleshooting

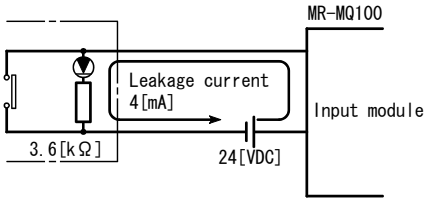
The following describes possible problems with input circuits and their corrective actions.

Input Circuit Troubleshooting and Corrective Action

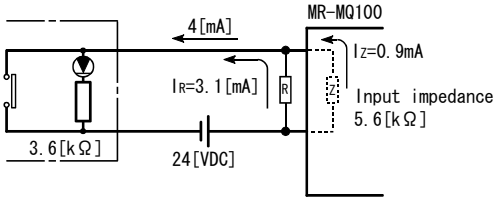
	Condition	Cause	Corrective action
Example 1	Input signal is not turned OFF.	• Drive by switch with LED indicator. 	• Connect an appropriate resistor so that the current across the Motion controller becomes lower than the off current.  (Note-1) : A calculation example of the resistance to be connected is shown below.
Example 2	Input signal is not turned OFF.	• Sneak path due to the use of two power supplies. 	• Use only one power supply. • Connect a sneak path prevention diode. (Figure below) 

<Calculation example of Example 1>

If a switch with LED display is connected to MR-MQ100, and current of 4 [mA] is leaked.



(a) Because the condition for OFF voltage (0.9[mA]) of MR-MQ100 is not satisfied. Connect a resistor as shown below.



(b) Calculate the connecting resistor value R as indicated below.
To satisfy the 0.9 [mA] OFF current of the MR-MQ100, the resistor R to be connected may be the one where 3.1 [mA] or more will flow.
$I_R : I_Z$=Z(Input impedance):R

$$R \leq \frac{I_Z}{I_R} \times Z(\text{Input impedance}) = \frac{0.9}{3.1} \times 5.6 \times 10^3 = 1625[\Omega]$$

R<1625 [Ω].
Assuming that resistor R is 1500 [Ω], the power capacity W of resistor R is:

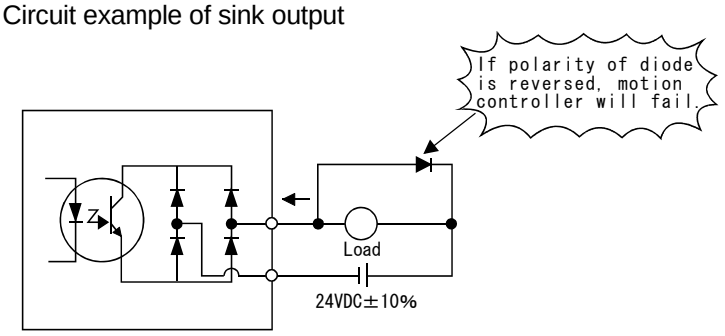
W = (Input voltage)^2 ÷ R = 26.4^2 ÷ 1500 = 0.464 [W]

(c) The power capacity of the resistor selected is 3 to 5 times greater than the actual current consumption. 1.5K [Ω], 2 to 3 [W] resistor may therefore be connected to the terminal in question.

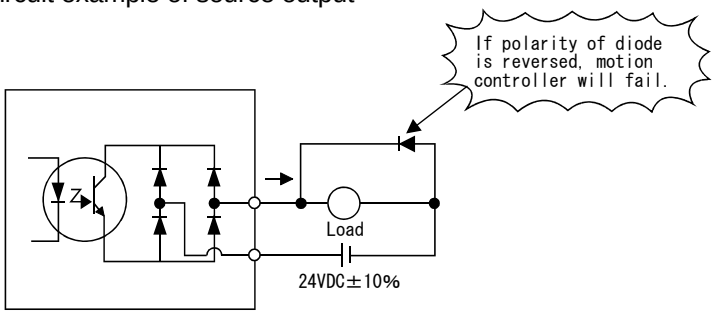
(2) Output circuit troubleshooting

The following describes possible problems with output circuits and their corrective actions.
It can drive lamp, relay or photo coupler. Install a diode (D) for an inductive load (relay etc.), or install an inrush current suppressing resistor (R) for a lamp load. (Permissible current: 40mA or less, inrush current: 100mA or less) A maximum of 2.6V voltage drop occurs in the Motion controller.

(a) Circuit example of sink output



(b) Circuit example of source output



⚠CAUTION

● Do not mistake the polarity and " + / - " of diode, as this may lead to destruction or damage.

7. POSITIONING DEDICATED SIGNALS

The device list that can be used with the Motion controller is shown below.

7.1 Device List

The range of devices that can be used is shown below.

Class	Type	Device Name	Device Code	Numeric Expressions	Points	Setting range	Latch
Internal device	Bit device	Input	X	16	8192	X0 to X1FFF	Not available
		Output	Y	16	8192	Y0 to Y1FFF	Not available
		Actual input	PX	16	4 (Note-1)	PX0 to PXFFF	Not available
		Actual output	PY	16	2 (Note-2)	PY0 to PYFFF	Not available
		internal relay (User area)	M	10	8192 (Note-3)	M0 to M8191	Latch range setting
		internal relay (System area)	M	10	4096	M8192 to M12287	Not available
		Link relay	B	16	8192	B0 to B1FFF	Latch range setting
		Annunciator	F	10	2048	F0 to F2047	Latch range setting
	Word device	Data register	D	10	8192 (Note-3)	D0 to D8191	Latch range setting (Motion dedicated device)
		Link register	W	16	8192	W0 to W1FFF	Latch range setting
		Motion register (User area)	#	10	7912	#0 to #7911	Available
		Motion register (System area) (Note-4)	#	10	4376	#7912 to #12287	Not available (Note-5)
System device	Bit device	Special relay	SM	10	2256 (Note-6)	SM0 to SM2255	Not available
	Word device	Special register	SD	10	2256 (Note-7)	SD0 to SD2255	Not available
		Coasting Timer	FT	-	1	FT (888μs)	Not available

(Note-1): Actual input (PX) is every 16 points. Actual input (X) is 4 points, and the dummy is 12 points.
Dummy devices cannot be used. These are fixed as "0".

(Note-2): Actual output (PY) is every 16 points. Actual output (Y) is 2 points, and the dummy is 14 points.
Dummy devices cannot be used. These are fixed as "0".
<example>
When starting I/O number is 10(H) : PX10 to PX13 Actual input, PX14 to PX1F (Not Available).
PY10 to PY11 Actual output, PY12 to PY1F (Not Available).

(Note-3): Including Motion dedicated devices.

(Note-4): These devices are used by the system.

(Note-5): The latch of "Motion device(#8640 to #8735)" is available.

(Note-6): SM2000 to SM2255 : Not available

(Note-7): SD2000 to SD2255 : Not available

7.2 Internal relays

The available numbers of axes are below.
Real mode : 1 axis
Virtual mode: Virtual axes=8, Output axis=1, Synchronous encoder=1

7.2.1 Internal relay list

Device No.	Purpose	Remark
M0 to	User device (2000 points)	
M2000 to	Common device (320 points)	
M2320 to	Not available (80 points)	
M2400 to	Axis status (20 points × 1 axis)	Real mode : Axis status Virtual mode : Output module
M2420 to	Not available (652 points)	
M3072 to	Common device (64 points)	
M3136 to	Not available (64 points)	
M3200 to	Axis command signal (20 points × 1 axis)	Real mode : Axis status Virtual mode : Output module
M3220 to	Not available (780 points)	
M4000 to	Virtual servomotor axis status (20 points × 8 axes)	(Note-1),(Note-2),(Note-4)
M4160 to	Not available (480 points)	
M4640 to	Synchronous encoder axis status (4 points × 1 axis)	(Note-2)
M4644 to	Not available (156 points)	
M4800 to	Virtual servomotor axis command signal (20 points × 8 axes)	(Note-1),(Note-2),(Note-4)
M4960 to	Not available (480 points)	
M5440 to	Synchronous encoder axis command signal (4 points × 1 axis)	(Note-2)
M5444 to	Not available (44 points)	
M5488 to M8191	User device (2704 points)	

Device No.	Purpose	Remark
M8192 to M12287	Not available (4096 points)	

□ It can be used as an user device.

(Note-1) : It can be used as a user device in real mode only.
(Note-2) : Do not set "M4000 to M5487" as the latch range in Virtual mode.
(Note-3) : "Cam axis command signals" and "Smoothing clutch complete signals" can be set to the parameters of any device.
(Note-4) : Only the area of the axis set in Mechanical System Program is occupied. The area which is not used in Mechanical System Program can be used by users.

POINT

(1) Total number of user device points.
4704 points
(2) This manual explains only the data registers that are used in Virtual mode.
Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for information regarding other data registers.

7.2.2 Axis status list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Axis No.	Device No.	Signal name
1	M2400 to M2419	

	Signal name		Refresh cycle	Fetch cycle	Signal direction
0	Positioning start complete		Operation cycle		Status signal
1	Positioning complete				
2	In-position				
3	Command in-position				
4	Speed controlling				
5	Speed/position switching latch				
6	Zero pass				
7	error detection		Immediate		
8	Servo error detection		Operation cycle		
9	Home position return request		Main cycle		
10	Home position return complete		Operation cycle		
11	External signals	FLS	Main cycle		
12		RLS			
13		Unusable	—	—	—
14		DOG/CHANGE	Main cycle		Status signal
15	Servo ready		Operation cycle		
16	torque limiting				
17	Unusable		—	—	—
18	Virtual mode continuation operation disable warning signal (Note-1)		At virtual mode transition		Status signal
19	M-code outputting signal		Operation cycle		

(Note-1) : It is unusable in the real mode.

7.2.3 Axis command signal list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Axis No.	Device No.	Signal name
1	M3200 to M3219	

	Signal name	Refresh cycle	Fetch cycle	Signal direction
0	Stop command		Operation cycle	Command signal
1	Rapid stop command			
2	Forward rotation JOG start command		Main cycle	
3	Reverse rotation JOG start command			
4	Complete signal OFF command			
5	Speed/position switching enable command		Operation cycle	
6	Unusable	—	—	—
7	Error reset command		Main cycle	Command signal
8	Servo error reset command			
9	External stop input disable at start command		At start	
10	Unusable	—	—	—
11				
12	Feed current value update request command		At start	Command signal
13	Address clutch reference setting command (SV22 only) (Note-1)		At virtual mode transition	
14	Cam reference position setting command (SV22 only) (Note-1)			
15	Servo OFF command		Operation cycle	
16	Gain changing command		Operation cycle (Note-2)	
17	Unusable	—	—	—
18	Control loop changing command		Operation cycle	Command signal
19	FIN signal			

(Note-1): It is unusable in the real mode.

(Note-2): Operation cycle 7.1[ms] or more: Every 3.5[ms]

7.2.4 Virtual servomotor axis status list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (VIRTUAL MODE)" for details.

Axis No.	Device No.
1	M4000 to M4019
2	M4020 to M4039
3	M4040 to M4059
4	M4060 to M4079
5	M4080 to M4099
6	M4100 to M4119
7	M4120 to M4139
8	M4140 to M4159

Signal name

	Signal name	Real	Virtual				Refresh cycle	Fetch cycle	Signal direction
			Roller	Ball screw	Rotary table	Cam			
0	Positioning start complete	Backup	○				Operation cycle		Status signal
1	Positioning complete								
2	Unusable	—	—				—	—	—
3	Command in-position	Backup	○				Operation cycle		Status signal
4	Speed controlling								
5	Unusable	—	—				—	—	—
6									
7	Error detection	Backup	○				Immedi-ately		Status signal
8	Unusable	—	—				—	—	—
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19	M-code outputting signal	Backup	○				Operation cycle		Status signal

○ : Valid

POINT

(1) Axes 1 to 8 can be set as a Virtual axis. (Up to 3 axes can be used)

REMARK

In the positioning dedicated signals, "n" in "M4007+20n", etc. indicates a value corresponding to axis No. such as the following table.

Axis No.	n	Axis No.	n	Axis No.	n
1	0	2	1	3	2

• Calculate as follows for the device No. corresponding to each axis.
M4007+20n (error detection)=M4007+20×2=M4047

7.2.5 Virtual servomotor axis command signal list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (VIRTUAL MODE)" for details.

Axis No.	Device No.
1	M4800 to M4819
2	M4820 to M4839
3	M4840 to M4859
4	M4860 to M4879
5	M4880 to M4899
6	M4900 to M4919
7	M4920 to M4939
8	M4940 to M4959

Signal name

	Signal name	Real	Virtual				Refresh cycle	Fetch cycle	Signal direction
			Roller	Ball screw	Rotary table	Cam			
0	Stop command	×	○					Operation cycle	
1	Rapid stop command								
2	Forward rotation JOG start command							Main cycle	
3	Reverse rotation JOG start command								
4	Complete signal OFF command								
5	Unusable	—	—				—	—	—
6									
7	Error reset command	×	○					Main cycle	Command signal
8	Unusable	—	—				—	—	—
9	External stop input disable at start command	×	○					At start	Command signal
10	Unusable	—	—				—	—	—
11									
12									
13									
14									
15									
16									
17									
18									
19	FIN signal	×	○					Operation cycle	Command signal

○ : Valid, × : Invalid

POINT

(1) Axes 1 to 8 can be set as a Virtual axis. (Up to 3 axes can be used)

7.2.6 Synchronous encoder axis status list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (VIRTUAL MODE)" for details.

Axis No.	Device No.	Signal name
1	M4640 to M4643	

	Signal name	Real	Virtual	Refresh cycle	Fetch cycle	Signal direction
0	Error detection	○	○	Immediately		Status
1	Unusable	—	—	—	—	—
2	Virtual mode continuation operation disable warning	○	○	Main cycle		Status signal
3	Unusable	—	—	—	—	—

○ : Valid

7.2.7 Synchronous encoder axis command signal list

Axis No.	Device No.	Signal name
1	M5440 to M5443	

	Signal name	Real	Virtual	Refresh cycle	Fetch cycle	Signal direction
0	Error reset	○	○		Main cycle	Status signal
1	Unusable	—	—	—	—	—
2						
3						

○ : Valid, × : Invalid

7.2.8 Common device list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Device No.	Signal name	Refresh cycle	Fetch cycle	Signal direction	Remark (Note-4)
M2000	PLC ready flag		Main cycle	Command signal	M3072
M2001	Axis 1	Operation cycle		Status signal (Note-1), (Note-2)	
M2002	Axis 2				
M2003	Axis 3				
M2004	Axis 4				
M2005	Axis 5				
M2006	Axis 6				
M2007	Axis 7				
M2008	Axis 8				
M2009	Unusable (24 points)	—	—	—	
M2010					
M2011					
M2012					
M2013					
M2014					
M2015					
M2016					
M2017					
M2018					
M2019					
M2020					
M2021					
M2022					
M2023					
M2024					
M2025					
M2026					
M2027					
M2028					
M2029					
M2030					
M2031					
M2032					
M2033	Unusable (2 points)	—	—	—	—
M2034					
M2035	Motion error history clear request flag		Main cycle	Command signal	M3080
M2036	Unusable (2 points)	—	—	—	—
M2037					
M2038	Motion SFC debugging flag	At debugging mode transition		Status signal	
M2039	Motion error detection flag		Immediate		
M2040	Speed switching point specified flag		At start	Command signal	M3073
M2041	System setting error flag	Operation cycle		Status signal	
M2042	All axes servo ON command		Operation cycle	Command signal	M3074
M2043	Real mode/virtual mode switching request (SV22)		At virtual mode transition		M3075
M2044	Real mode/virtual mode switching status (SV22)	At virtual mode transition		Status signal	
M2045	Real mode/virtual mode switching error detection signal (SV22)				
M2046	Out-of-sync warning (SV22)				
M2047	Motion slot fault detection flag	Operation cycle			
M2048	JOG operation simultaneous start command		Main cycle	Command signal	M3076
M2049	All axes servo ON accept flag	Operation cycle		Status signal	
M2050	Unusable	—	—	—	—
M2051	Manual pulse generator 1 enable flag		Main cycle	Command signal	M3077
M2052	Unusable	—	—	—	—

Device No.	Signal name	Refresh cycle	Fetch cycle	Signal direction	Remark (Note-4)
M2053	Unusable	—	—	—	—
M2054	Operation cycle over flag	Operation cycle		Status signal	
M2055	Unusable (6 points)	—	—	—	—
M2056					
M2057					
M2058					
M2059					
M2060					
M2061	Axis 1 Speed changing accepting flag	Operation cycle		Status signal (Note-1), (Note-2)	
M2062	Axis 2				
M2063	Axis 3				
M2064	Axis 4				
M2065	Axis 5				
M2066	Axis 6				
M2067	Axis 7				
M2068	Axis 8				
M2069	Unusable (24 points)	—	—	—	—
M2070					
M2071					
M2072					
M2073					
M2074					
M2075					
M2076					
M2077					
M2078					
M2079					
M2080					
M2081					
M2082					
M2083					
M2084					
M2085					
M2086					
M2087					
M2088					
M2089					
M2090					
M2091					
M2092					
M2093	Unusable (8 points)	—	—	—	—
M2094					
M2095					
M2096					
M2097					
M2098					
M2099					
M2100					
M2101	Axis 1 Synchronous encoder current value changing flag (Note-3) (12 axes)	Operation cycle		Status signal (Note-1), (Note-2)	
M2102	Axis 2				
M2103	Axis 3				
M2104	Axis 4				
M2105	Axis 5				
M2106	Axis 6				
M2107	Axis 7				
M2108	Axis 8				
M2109	Unusable (4 Points)	—	—	—	—
M2110					
M2111					
M2112					
M2113	Unusable (6 points)	—	—	—	—
M2114					
M2115					
M2116					
M2117					
M2118					

Common device list (Continued)

Device No.	Signal name		Refresh cycle	Fetch cycle	Signal direction	Remark (Note-4)
M2119	Unusable (9 points)		—	—	—	—
M2120						
M2121						
M2122						
M2123						
M2124						
M2125						
M2126						
M2127						
M2128	Axis 1	Automatic decelerating flag	Operation cycle		Status signal (Note-1), (Note-2)	
M2129	Axis 2					
M2130	Axis 3					
M2131	Axis 4					
M2132	Axis 5					
M2133	Axis 6					
M2134	Axis 7					
M2135	Axis 8					
M2136	Unusable (24 Points)		—	—	—	—
M2137						
M2138						
M2139						
M2140						
M2141						
M2142						
M2143						
M2144						
M2145						
M2146						
M2147						
M2148						
M2149						
M2150						
M2151						
M2152						
M2153						
M2154						
M2155						
M2156						
M2157						
M2158						
M2159						
M2160	Unusable (28 points) (Note-5)		—	—	—	—
M2161						
M2162						
M2163						
M2164						
M2165						
M2166						
M2167						
M2168						
M2169						
M2170						
M2171						
M2172						
M2173						
M2174						
M2175						
M2176						
M2177						
M2178						
M2179						
M2180						
M2181						
M2182						
M2183						
M2184						
M2185						
M2186						
M2187						

Device No.	Signal name		Refresh cycle	Fetch cycle	Signal direction	Remark (Note-4)
M2188	Unusable (36 points) (Note-5)		—	—	—	—
M2189						
M2190						
M2191						
M2192						
M2193						
M2194						
M2195						
M2196						
M2197						
M2198						
M2199						
M2200						
M2201						
M2202						
M2203						
M2204						
M2205						
M2206						
M2207						
M2208						
M2209						
M2210						
M2211						
M2212						
M2213						
M2214						
M2215						
M2216						
M2217						
M2218						
M2219						
M2220						
M2221						
M2222						
M2223						
M2224	Unusable (16 points)		—	—	—	—
M2225						
M2226						
M2227						
M2228						
M2229						
M2230						
M2231						
M2232						
M2233						
M2234						
M2235						
M2236						
M2237						
M2238						
M2239						
M2240	Axis 1	Speed change "0" accepting flag	Operation cycle		Status signal (Note-1), (Note-2)	
M2241	Axis 2					
M2242	Axis 3					
M2243	Axis 4					
M2244	Axis 5					
M2245	Axis 6					
M2246	Axis 7					
M2247	Axis 8					
M2248	Unusable (9 points)		—	—	—	—
M2249						
M2250						
M2251						
M2252						
M2253						
M2254						
M2255						
M2256						

Common device list (Continued)

Device No.	Signal name	Refresh cycle	Fetch cycle	Signal direction	Remark (Note-4)
M2257	Unusable (9 points)	—	—	—	—
M2258					
M2259					
M2260					
M2261					
M2262					
M2263					
M2264					
M2265					
M2266					
M2267					
M2268					
M2269					
M2270					
M2271					
M2272	Axis 1 Control loop monitor status	Operation cycle		Status signal (Note-2)	
M2273	Unusable (16 points)	—	—	—	—
M2274					
M2275					
M2276					
M2277					
M2278					
M2279					
M2280					
M2281					
M2282					
M2283					
M2284					
M2285					
M2286					
M2287					
M2288					

Device No.	Signal name	Refresh cycle	Fetch cycle	Signal direction	Remark (Note-4)
M2289	Unusable (15 points)	—	—	—	—
M2290					
M2291					
M2292					
M2293					
M2294					
M2295					
M2296					
M2297					
M2298					
M2299					
M2300					
M2301					
M2302					
M2303					
M2304	Unusable (16 points)	—	—	—	—
M2305					
M2306					
M2307					
M2308					
M2309					
M2310					
M2311					
M2312					
M2313					
M2314					
M2315					
M2316					
M2317					
M2318					
M2319					

(Note-1): Axes 1 to 8 can be set as a Virtual axis. (Up to 3 axes can be used).
Axis 1 can be set as a Real axis.
(Note-2): Device areas for axis9 or larger cannot be used with the MR-MQ100 .
(Note-3): This signal is unusable in real mode.
(Note-4): The device shown in the remark column can also be used.
(Note-5): These devices can be used for clutch statuses.
The clutch status can also be set as the optional device at the clutch parameter.
(Note-6): The devices in the shaded region cannot be used.

7.2.9 Common device list (Command device)

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Device No.	Signal name	Refresh cycle	Fetch cycle	Signal direction	Remark (Note-1), (Note-2)
M3072	PLC ready flag		Main cycle	Command signal	M2000
M3073	Speed switching point specified flag		At start		M2040
M3074	All axes servo ON command		Operation cycle		M2042
M3075	Real mode/virtual mode switching request (SV22)		At virtual mode transition		M2043
M3076	JOG operation simultaneous start command		Main cycle		M2048
M3077	Manual pulse generator 1 enable flag				M2051
M3078 M3079	Unusable (2 points)	—	—	—	—
M3080	Motion error history clear request flag		Main cycle	Command signal	M2035
M3081 to M3135	Unusable (Note-3) (55 points)	—	—	—	—

(Note-1): The state of a device is not in agreement when the device of a remark column is turned ON/OFF directly. In addition, when the request from a data register and the request from the above device are performed simultaneously, the request from the above device becomes effective.

(Note-2): Refer to the explanation of the point column.

(Note-3): Do not use as a user device. It can be used as a device that performs automatic refresh because of area for the reserve of command signal.

POINT

When the common devices (M3072 to M3080) turn to ON (OFF), the devices in REMARKS will turn to ON (OFF).
And, it can also be turned ON/OFF by the data register.

7.3 Data Registers

7.3.1 Data register list

Device No.	Purpose	Remark	Real mode	Virtual mode
D0 to	Axis monitor device (20 points)	Real mode : Axis status Virtual mode : Output module	○	○
D20 to	Not available (620 points)		—	—
D640 to	Control change register (2 points × 8 axes)	Real mode : Axis status Virtual mode : Output module	○	○
D656 to	Not available (48 points)		—	—
D704 to	Common device (54 points)		○	○
D758 to	Not available (42 points)		—	—
D800 to	Virtual servomotor axis monitor device (6 points × 8 axes) + (6 points × 24 axes) Not available		Back up	○
	Current value after virtual servomotor axis main shafts differential gear (4 points × 8 axes)			
D880 to	Not available (240 points)		—	—
D1120 to	synchronous encoder axis monitor device (6 points)		○ (Note-1)	○
	Synchronous encoder axis Current value after synchronous encoder axis main shafts differential gear (4 points)		Back up	○
D1130 to	Not available (110 points)		—	—
D1240 to	CAM axis monitor device (10 points × 1 axis)		Back up	○
D1250 to	Not available (310 points)		—	—
D1560 to D8191	User device (6632 points)			

○ : Valid

POINT

(1) Total number of points for the user devices
6632 points

(2) (Note-1) : Current value of synchronous encoder is updated in Real mode.

(3) This manual describes only details for data registers used in the virtual mode. If it is required, refer to the "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)".

7.3.2 Axis monitor device list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Axis No.	Device No.	Signal name
1	D0 to D19	

	Signal name	Real	Virtual	Refresh cycle	Unit	Signal direction
0	Feed current value/ roller cycle speed	○	○	Operation cycle	Command unit	Monitor device
1						
2	Real current value					
3						
4	Deviation counter value				PLS	
5						
6	Minor error code			Immediate	—	
7	Major error code					
8	Servo error code			Main cycle		
9	Home position return re-travel value		Backup	Operation cycle	PLS	
10	Travel value after proximity dog ON				Command unit	
11						
12	Execute program No.		×	At start	—	
13	M-code			Operation cycle		
14	Torque limit value		○		%	
15	Data set pointer for constant-speed control		×	At start/during start	—	
16	Unusable (Note-1)	—	—	—	—	—
17						
18	Real current value at stop input	○	Backup	Operation cycle	Command unit	Monitor device
19						

○ : Valid, × : Invalid

(Note-1): It can be used as the travel value change register. The travel value change register can be set to the device optionally in the servo program.

7.3.3 Control change register list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Axis No.	Device No.	Signal name
1	D640, D641	
2	D642, D643	
3	D644, D645	
4	D646, D647	
5	D648, D649	
6	D650, D651	
7	D652, D653	
8	D654, D655	

	Signal name	Real	Virtual	Fetch cycle	Unit	Signal direction
0 1	JOG speed setting	○	○	At start	Command unit	Command device

○ : Valid, × : Invalid

POINT

(1) Only axis 1 can be set as a real mode. Axes 1 to 8 can be set as a virtual servo motor axis. (Up to 3 axes can be used)

7.3.4 Virtual servomotor axis monitor device list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (VIRTUAL MODE)" for details.

Axis No.	Device No.	Signal name
1	D800 to D809	
2	D810 to D819	
3	D820 to D829	
4	D830 to D839	
5	D840 to D849	
6	D850 to D859	
7	D860 to D869	
8	D870 to D879	

	Signal name	Real	Virtual	Refresh cycle	Fetch cycle	Signal direction
0	Feed current value	Backup	○	Operation cycle		Monitor device
1						
2	Minor error code			Immediately		
3	Major error code					
4	Execute program No.			At start		
5	M-code			Operation cycle		
6	Current value after virtual servomotor axis main shaft's differential gear					
7						
8	Error search output axis No.					
9	Data set pointer for constant-speed control					

○ : Valid, × : Invalid

POINT

(1) Axes 1 to 8 can be set as a virtual servo motor axis. (Up to 3 axes can be used)

7.3.5 Synchronous encoder axis monitor device list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (VIRTUAL MODE)" for details.

Axis No.	Device No.	Signal name
1	D1120 to D1129	

	Signal name	Real	Virtual	Refresh cycle	Fetch cycle	Signal direction
0 1	Current value	○	○	Operation cycle		Monitor device
2 3	Minor error code Major error code	Backup		Immediately		
4 5	Unusable	—	—	—	—	—
6 7	Current value after synchronous encoder axis main shaft's differential gear	Backup	○	Operation cycle		Monitor device
8	Error search output axis No.					
9	Unusable	—	—	—	—	—

○ : Valid

7.3.6 Cam axis monitor device list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (VIRTUAL MODE)" for details.

Axis No.	Device No.	Signal name
1	D1240 to D1249	

	Signal name	Real	Virtual	Refresh cycle	Fetch cycle	Signal direction
0	Unusable	—	—	—	—	—
1	Execute cam No.	Backup	○	Operation cycle		Monitor device
2 3	Execute stroke amount					
4 5	Current value within 1 cam shaft revolution					
6 7 8 9	Unusable	—	—	—	—	—

○ : Valid

POINT

(1) Axes 1 to 8 can be set as a virtual servo motor axis. (Up to 3 axes can be used)

7.3.7 Common device list

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Device No.	Signal name	Refresh cycle	Fetch cycle	Signal direction
D704	PLC ready flag request		Main cycle	Command device
D705	Speed switching point specified flag request			
D706	All axes servo ON command request			
D707	Real mode/virtual mode switching request (SV22)			
D708	JOG operation simultaneous start command request			
D709	Unusable	—	—	—
D710	JOG operation simultaneous start axis setting register		At start	Command device
D711				
D712				
D713				
D714	Manual pulse generator axis 1 No. setting register		At the manual pulse generator enable flag	
D715				
D716	Unusable	—	—	—
D717				
D718				
D719				
D720	Axis 1 Manual pulse generators 1 pulse input magnification setting register (Note-1), (Note-2)		At the manual pulse generator enable flag	Command device
D721	Unusable	—	—	—
D722				
D723				
D724				
D725				
D726				
D727				
D728				
D729				
D730				
D731				
D732				
D733				
D734				
D735				
D736				
D737				
D738				
D739				
D740				
D741				
D742				
D743				
D744				
D745				
D746				
D747				
D748				
D749				
D750				
D751				

Device No.	Signal name	Refresh cycle	Fetch cycle	Signal direction
D752	Manual pulse generator 1 smoothing magnification setting register		At the manual pulse generator enable flag	Command device
D753	Unusable	—	—	—
D754				
D755	Manual pulse generator 1 enable flag request		Main cycle	
D756	Unusable	—	—	—
D757				
D758	Unusable (42 points)	—	—	—
D759				
D760				
D761				
D762				
D763				
D764				
D765				
D766				
D767				
D768				
D769				
D770				
D771				
D772				
D773				
D774				
D775				
D776				
D777				
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D779				
D780				
D781				
D782				
D783				
D784				
D785				
D786				
D787				
D788				
D789				
D790				
D791				
D792				
D793				
D794				
D795				
D796				
D797				
D798				
D799				

7.4 Motion registers

The motion registers (#0 to #12287) are available as the Motion controller-dedicated devices.
they can be used in operation control(F/FS) program or transition (G) programs.

Motion device	Item	Specifications
Motion register (#)	Number of points	12288 points (#0 to #12287)
	Data size	16-bit/points
	Latch	Only a user device is latched.
	Usable tasks	Normal, event
	Access	Read and write enabled in whole range

7.4.1 Motion registers list

Device No.	Purpose
#0 to	User devices (7912 points)
#7912 to	Mark detection setting devices (88 points)
#8000 to	Monitor devices2 (20 points × 1 axis)
#8020 to	Not available (620 points)
#8640 to	Motion error history devices (96 points)
#8736 to	Analog output devices for extension IO unit (2 points × 1 axis)
#8738 to	Not available (62 points)
#8800 to	Analog input devices for extension IO unit (2 points × 1 axis)
#8802 to	Not available (94 points)
#8896 to	Mark detection monitor devices (320 points)
#9216 to #12287	Not available (3072 points)

7.4.2 Axis monitor device 2

Information for the axis is stored in the monitor devices.
Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Axis No.	Device No.	Signal name
1	#8000 to #8019	

	Signal name	signal description	Refresh cycle	Signal direction
0	Servo amplifier type	0 : Unused 256 : MR-J3-B 257 : MR-J3-B (Fully closed loop control) 258 : MR-J3-B (Linear) 263 : MR-J3-B (DD motor)	When the servo amplifier power-on	Monitor device
1	Motor current	×0.1[%]	Operation cycle 1.7[ms] or less: Operation cycle Operation cycle 3.5[ms] or more: 3.5[ms]	
2 3	Motor speed	×0.1[r/min]		
4 5	Command speed	[PLS/s]	Operation cycle	
6 7	Home position return re-travel value (Real mode only)	—	At home position return re-travel	
8 9 10 11 12 13 14 15 16 17 18 19	Unusable	—	—	—

7.4.3 Motion error history devices

The Motion error history devices are shown below.
Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Device No.	Signal name		Signal direction		Refresh cycle	Fetch cycle
			Status	Command		
#8640 to #8651	Seventh error information in past (oldest error information)	Motion error history (8 errors) (96 points)	○	—	At error occurrence	—
#8652 to #8663	Sixth error information in past					
#8664 to #8675	Fifth error information in past					
#8676 to #8687	Fourth error information in past					
#8688 to #8699	Third error information in past					
#8700 to #8711	Second error information in past					
#8712 to #8723	First error information in past					
#8724 to #8735	Latest error information					

Error information								Signal name
Seventh in past	Sixth in past	Fifth in past	Fourth in past	Third in past	Second in past	First in past	Latest	
#8640	#8652	#8664	#8676	#8688	#8700	#8712	#8724	Error Motion SFC program No.
#8641	#8653	#8665	#8677	#8689	#8701	#8713	#8725	Error type
#8642	#8654	#8666	#8678	#8690	#8702	#8714	#8726	Error program No.
#8643	#8655	#8667	#8679	#8691	#8703	#8715	#8727	Error block No./Motion SFC list/ Line No./Axis No.
#8644	#8656	#8668	#8680	#8692	#8704	#8716	#8728	Error code
#8645	#8657	#8669	#8681	#8693	#8705	#8717	#8729	Error occurrence time (Year/month)
#8646	#8658	#8670	#8682	#8694	#8706	#8718	#8730	Error occurrence time (Day/hour)
#8647	#8659	#8671	#8683	#8695	#8707	#8719	#8731	Error occurrence time (Minute/second)
#8648	#8660	#8672	#8684	#8696	#8708	#8720	#8732	Error setting data information
#8649	#8661	#8673	#8685	#8697	#8709	#8721	#8733	Unusable
#8650	#8662	#8674	#8686	#8698	#8710	#8722	#8734	Error setting data
#8651	#8663	#8675	#8687	#8699	#8711	#8723	#8735	

7.4.4 Mark detection devices

(1) Mark detection monitor devices

Mark detection function No.	Device No.	Signal name
1	#8896 to #8975	
2	#8976 to #9055	
3	#9056 to #9135	
4	#9136 to #9215	

	Signal name	Refresh cycle	Signal direction
0 1	Mark detection data current monitor	Operation cycle	Monitor device
2	Number of marks detected	At mark detection	
3	Mark detection settings verification flag	Main cycle	
4 5 6 7 8 9 10 11 12 13 14 15	Not available	—	
16 17	Latch data storage area 1	At mark detection	
18 19	Latch data storage area 2		
20 21	Latch data storage area 3		
22 23	Latch data storage area 4		
to	to		
78 79	Latch data storage area 32		

(2) Mark detection setting devices

Mark detection function No.	Device No.	Signal name
	#7912 to #7919	

	Signal name	Fetch cycle	Signal direction
0	Registration code	Main cycle	Command device
1			
2			
3			
4			
5			
6			
7			

Mark detection function No.	Device No.	Signal name
1	#7920 to #7939	
2	#7940 to #7959	
3	#7960 to #7979	
4	#7980 to #7999	

	Signal name	Fetch cycle	Signal direction
0	Marl detection signal allocation devices	At Registration code setting	Command device
1	Mark detection signal compensation time	Operation cycle	
2	Latch data type	At Registration code setting	
3	Mark detection axis number		
4	Not available	—	—
5			
6	Latch data upper limit	Operation cycle	Command device
7			
8	Latch data lower limit		
9			
10	Mark detection mode		
11	Not available	—	—
12			
13			
14			
15			
16			
17			
18			
19			

7.4.5 Devices for extension IO unit

(1) Analog output devices

Axis No.	Device No.	Signal name
1	#8736 to #8737	

	Signal name	Pin No. of MR-J3-D01	Fetch cycle	Signal direction
0	Analog output ANO1	CN20-4	Operation cycle 0.8 [ms] or less : 0.8 [ms] Operation cycle 1.7 [ms] : 1.7 [ms] Operation cycle 3.5 [ms] or more : 3.5 [ms]	Command device
1	Analog output ANO2	CN20-14		

POINT

(1) The analog output voltage instruction is specified within the range of -10000～10000 mV. When a value outside of the range is specified, the output voltage may not be correct.

(2) When the motion controller's power supply is turned on, the content of the analog output instruction device is cleared to 0.

(2) Analog input devices

Axis No.	Device No.	Signal name
1	#8800 to #8801	

	Signal name	Pin No. of MR-J3-D01	Fetch cycle	Signal direction
0	Analog input ANI1	CN20-2	Operation cycle 0.8 [ms] or less : 0.8 [ms] Operation cycle 1.7 [ms] : 1.7 [ms] Operation cycle 3.5 [ms] or more : 3.5 [ms]	Monitor device
1	Analog input ANI2	CN20-12		

POINT

(1) Analog input voltage is stored in units of mV. However, 0 is always stored in the channel due to improper usage as per the restrictions described in section 13.5.

(2) When the motion controller's power supply is turned on, the content of the analog input instruction device is cleared to 0.

7.5 Special relays/Special registers

7.5.1 Special relays

Special relays are internal relays whose applications are fixed in the Motion controller. For this reason, they cannot be used in the same way as the normal internal relays by the Motion SFC programs.
However, they can be turned ON/OFF as needed in order to control the Motion controller.

Explanation of headings used in the table on the next page.

Item	Explanation
No.	• Indicates the device No. of the special relay.
Name	• Indicates the name of the special relay.
Meaning	• Indicates the nature of the special relay.
Details	• Indicates detailed information about the nature of the special relay.
Set by (When set)	• Indicates whether the relay is set by the system or user, and, if it is set by system, when setting is performed. <Set by> S: Set by system (Motion controller) U: Set by user (Motion SFC program or test operation using MT Developer2) S/U: Set by both system (Motion controller) and user <When set> Indicated only if setting is done by system (Motion controller). Main process: Set during each main processing (free time processing of the CPU) Initial process: Set only during initial processing (when power supply is turned ON, or when executed the reset) Status change : Set only when there is a change in status Error : Set when error is occurred. Request : Set only when there is a user request (Special relay, etc.) Operation cycle : Set during each operation cycle of the Motion controller.

Special relay list

No.	Name	Meaning	Details	Set by (When set)	Remark
SM0	Diagnostic error	OFF : No error ON : Error	• Turns ON if an error occurs as a result of diagnosis. • Remains ON even if the condition is restored to normal thereafter. • Turns ON when the Motion error detection flag (M2039) goes from ON to OFF except in the case of a stop error after confirming the error content.	S (Occur an error)	
SM1	Self-diagnostic error	OFF : No self-diagnostic error ON : Self-diagnostic error	• Turns ON if an error occurs as a result of self-diagnosis. • Remains ON even if the condition is restored to normal thereafter. • Turns ON when the Motion error detection flag (M2039) goes from ON to OFF except when a stop error occurs after confirming the error content.		
SM51	Battery low latch	OFF : Normal ON : Battery low	• Turns ON if the voltage of external battery reduces to less than 2.5[V]. • Remains ON even if the condition is restored to normal thereafter.		
SM52	Battery low	OFF : Normal ON : Battery low	• Turns on when the voltage of the external battery reduces to less than 2.5[V]. • Turns OFF when the voltage of external battery returns to normal.		
SM53	AC/DC DOWN detection	OFF : AC/DC DOWN not detected ON : AC/DC DOWN detected	• Turns ON if an instantaneous power failure of 10[ms] or less occurs during use of the AC power supply module. Resets after the power supply is cycled.		
SM58	Battery low warning latch	OFF : Normal ON : Battery low	• Turns ON if the voltage of external battery reduces to less than 2.7[V]. • Remains ON even if the condition is restored to normal thereafter.		
SM59	Battery low warning	OFF : Normal ON : Battery low	• Turns on when the voltage of the external battery reduces to less than 2.7[V]. • Turns OFF when the voltage of external battery returns to normal.		
SM211	Clock data error	OFF : No error ON : Error	• Turns ON if an error occurs in the clock data (SD210 to SD213) value, and turns OFF if no error is detected.	S (Request)	
SM400	Always ON	ON ——— OFF	• Normally ON. signal	S (Main processing)	
SM401	Always OFF	ON OFF ———	• Normally OFF signal.		

Special relay list (Continued)

No.	Name	Meaning	Details	Set by (When set)	Remark
SM500	PCPU READY complete	ON : PCPU READY completion OFF : PCPU READY incompletion	• When the PLC ready flag (M2000) turns from OFF to ON, the fixed parameters, servo parameters and limit switch output data, etc., are checked, and if no error is detected, this flag turns ON. • Turns OFF with PLC ready flag (M2000) OFF.	S (Request)	
SM501	Test mode ON	ON : TEST mode ON OFF : Except TEST mode	• Judge whether TEST mode ON or not using MT Developer2. • If the TEST mode is not established by TEST mode request using MT Developer2, the TEST mode request error flag (SM510) turns ON.		
SM502	External forced stop input	ON : Forced stop OFF OFF : Forced stop ON	• Confirms forced stop ON/OFF.	S (Operation cycle)	
SM503	Digital oscilloscope executing	ON : Digital oscilloscope is stop OFF : Digital oscilloscope is executing	• Confirms the execution of digital oscilloscope using MT Developer2.	S (Change status)	
SM510	TEST mode request error	ON : Abnormal OFF : Normal	• Turns ON if the TEST mode is not established by TEST mode request using MT Developer2. • When this relay is ON, the error content is stored in the TEST mode request error register (SD510, SD511).	S (Occur an error)	
SM512	Motion controller WDT error	ON : Abnormal OFF : Normal	• Turns ON when a "watchdog timer error" is detected by the Motion controller self-diagnosis function. When the Motion CPU detects a WDT error, it executes an immediate stop without deceleration of the operating axes. • The error cause is stored in the "Motion controller WDT error cause (SD512)".		
SM513	Manual pulse generator axis setting error	ON : At least one D714 to D715 setting is abnormal. OFF : All D714 to D715 settings are normal.	• Judges whether the register for the manual pulse generator axis setting (D714 to D715) is normal/abnormal. • When this relay is ON, the error content is stored in the manual pulse generator axis setting error register (SD513 to SD514).		
SM516	Servo program setting error	ON : Abnormal OFF : Normal	• Judges whether the positioning data of servo program(K) specified with the Motion SFC program is normal/abnormal, and if an error is detected turns ON. • The content of a servo program setting error is stored at SD516, SD517.		
SM526	Over heat warning latch	OFF : Normal ON : Abnormal	• Turns ON when the temperature of Motion controller becomes specified value 85[°C] (185[°F]) or more. Remains ON even if normal status is restored.		
SM527	Over heat warning	OFF : Normal ON : Abnormal	• Turn ON when the temperature of Motion controller becomes specified value 85[°C] (185[°F]) or more. Turn OFF when the temperature of Motion controller returns to normal.		
SM800	Clock data set request	OFF : Ignored ON : Set request	• When this relay turns ON, the clock data stored in SD210 – SD213 is written to the clock element.	U	
SM801	Clock data read request	OFF : Ignored ON : Read request	• When this relay is ON, clock data is read to SD210 to SD213 as BCD values.	U	

7.5.2 Special registers

Special registers are internal registers whose applications are fixed in the Motion controller. For this reason, it is not possible to use these registers in Motion SFC programs in the same way that normal registers are used. However, data can be written as needed in order to control the Motion controller.
Data stored in the special registers are stored as BIN values if no special designation has been made to the contrary.

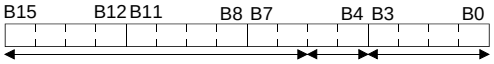
Explanation of headings used in the table on the next page.

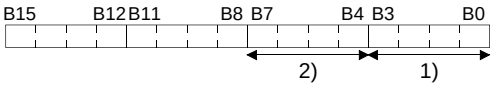
Item	Explanation
Number	• Indicates the No. of the special register.
Name	• Indicates the name of the special register.
Meaning	• Indicates the nature of the special register.
Details	• Indicates detailed information about the nature of the special register.
Set by (When set)	• Indicates whether the register is set by the system or user, and, if set by system, when setting is performed. <Set by> S: Set by system (Motion controller) U: Set by user (Motion SFC program or test operation using MT Developer2) S/U: Set by both system (Motion controller) and user <When set> Indicated only if setting is done by system (Motion controller). Main process: Set during each main processing (free time processing of the CPU) Initial process: Set only during initial processing (when power supply is turned ON, or when executed the reset) Status change : Set only when there is a change in status Error : Set when error is occurred. Request : Set only when there is a user request (Special relay, etc.) Operation cycle : Set during each operation cycle of the Motion controller.

Special register list

<table>
<tr><th>No.</th><th>Name</th><th>Meaning</th><th>Details</th><th>Set by
(When set)</th><th>Remark</th></tr>
<tr><td>SD0</td><td>Diagnostic errors</td><td>Diagnostic error code</td><td>• Error codes for any errors discovered during diagnosis are stored as BIN data.
• Refer to "APPENDIX 3" for details of the error code.
• After confirming the error content (except a stop error) it is possible to clear turning the Motion error detection flag (M2039) from ON to OFF.
• Clear SD0 to SD26 by switching the Motion error detection flag (M2039) from ON to OFF, except in the case of a stop error after confirming the error content.</td><td rowspan="15">S (Occur an error)</td><td rowspan="15"></td></tr>
<tr><td>SD1</td><td rowspan="3">Clock time for diagnostic error occurrence</td><td rowspan="3">Clock time for diagnostic error occurrence</td><td>• The year (last two digits) and month that SD0 data was updated is stored as BCD 2-digit code.
B15 to B8 B7 to B0 Example : January 2006
Year(0 to 99) | Month(1 to 12) H0601</td></tr>
<tr><td>SD2</td><td>• The day and hour that SD0 data was updated is stored as BCD 2-digit code.
B15 to B8 B7 to B0 Example : 25st, 10 a.m
Day(1 to 31) | Hour(0 to 23) H2510</td></tr>
<tr><td>SD3</td><td>• The minute and second that SD0 data was updated is stored as BCD 2-digit code.
B15 to B8 B7 to B0 Example : 35min., 48 sec.
Minute(0 to 59) | Second(0 to 59) H3548</td></tr>
<tr><td>SD4</td><td>Error information categories</td><td>Error information category code</td><td>• Category codes which help indicate what type of information is being stored in the error common information areas (SD5 to SD15) and error individual information areas (SD16 to SD26) are stored. The category code for judging the error information type is stored.
B15 to B8 B7 to B0
Individual information category codes | Common information category codes
• The common information category codes store the following codes.
0: No error
1: Module No./CPU No./Base No.
• The individual information category codes store the following codes.
0: No error
5: Parameter No.
13:Parameter No./CPU No.</td></tr>
<tr><td>SD5
SD6
SD7
SD8
SD9
SD10
SD11
SD12
SD13
SD14
SD15</td><td>Error common information</td><td>Error common information</td><td>• Common information corresponding to the diagnostic error (SD0) is stored.
• The error common information type can be judged by SD4 (common information category code).
1: Module No./CPU No./Base No.
• For the Multiple CPU system, Module No. or CPU No. is stored depending on the error that occurred.
(Refer to corresponding error code for which No. has been stored.)
CPU No.1: 1, CPU No.2: 2, CPU No.3: 3, CPU No.4: 4
<table><tr><th>No.</th><th>Meaning</th></tr><tr><td>SD5</td><td>Module No./CPU No./Base No.</td></tr><tr><td>SD6</td><td>I/O No.</td></tr><tr><td>SD7 to SD15</td><td>Empty</td></tr></table></td></tr>
</table>

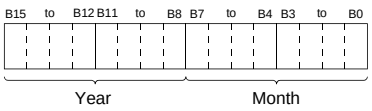
Special register list (Continued)

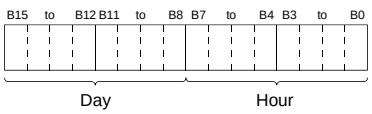
<table>
<tr><th>No.</th><th>Name</th><th>Meaning</th><th>Details</th><th>Set by
(When set)</th><th>Remark</th></tr>
<tr><td>SD16
SD17
SD18
SD19
SD20
SD21
SD22
SD23
SD24
SD25
SD26</td><td>Error individual information</td><td>Error individual information</td><td>—</td><td rowspan="3">S (Occur an error)</td><td rowspan="3"></td></tr>
<tr><td>SD53</td><td>AC/DC DOWN counter No.</td><td>Number of times for AC/DC DOWN</td><td>• Every time the input voltage falls to or below 85[%] of the rating (DC power) while the Motion controller is performing calculations, the value is incremented by 1 and stored in BIN code.</td></tr>
<tr><td>SD60</td><td>Fuse blown No.</td><td>Module No. with blown fuse</td><td>• The lowest station I/O No. of the module with the blown fuse is stored.</td></tr>
<tr><td>SD200</td><td>Status of switch</td><td>Status of CPU switch</td><td>• The CPU switch status is stored in the following format.
 

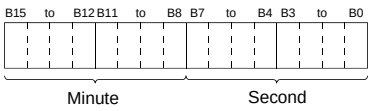
1) CPU switch status: 0: RUN, 1: STOP
2) Memory card switch: Always OFF</td><td rowspan="2">S (Main processing)</td><td rowspan="2"></td></tr>
<tr><td>SD203</td><td>Operating status of CPU</td><td>Operating status of CPU</td><td>• The CPU operating status is stored as indicated in the following figure.
 

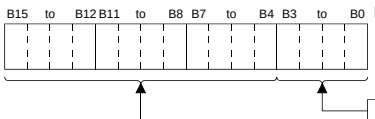
1) Operating status of CPU: 0: RUN, 2: STOP
2) STOP cause: 0: RUN/STOP switch
(Note) Priority is earliest first: 4: Error</td></tr>
</table>

Special register list (Continued)

<table>
<tr><th>No.</th><th>Name</th><th>Meaning</th><th>Details</th><th>Set by
(When set)</th><th>Remark</th></tr>
<tr><td>SD210</td><td rowspan="4">Clock data</td><td>Clock data
(Year, Month)</td><td>• The year (last two digits) and month are stored as BCD code.
 

Example : July, 2006
H0607</td><td rowspan="4">S/U (Request)</td><td rowspan="18"></td></tr>
<tr><td>SD211</td><td>Clock data
(Day, Hour)</td><td>• The day and hour are stored as BCD code.
 

Example : 31st, 10 a.m.
H3110</td></tr>
<tr><td>SD212</td><td>Clock data
(Minute, Second)</td><td>• The minutes and seconds are stored as BCD code.
 

Example : 35 min., 48 sec.
H3548</td></tr>
<tr><td>SD213</td><td>Clock data
(Day of week)</td><td>• The day of week is stored as BCD code.
 

Example : Friday
H0005
<table>
<tr><th colspan="2">Day of week</th></tr>
<tr><td>0</td><td>Sunday</td></tr>
<tr><td>1</td><td>Monday</td></tr>
<tr><td>2</td><td>Tuesday</td></tr>
<tr><td>3</td><td>Wednesday</td></tr>
<tr><td>4</td><td>Thursday</td></tr>
<tr><td>5</td><td>Friday</td></tr>
<tr><td>6</td><td>Saturday</td></tr>
</table></td></tr>
<tr><td>SD290</td><td rowspan="14">Device
assignment</td><td>Number of points
assigned for X</td><td>• Stores the number of points currently set for X devices.</td><td rowspan="14">S (Initial processing)</td></tr>
<tr><td>SD291</td><td>Number of points
assigned for Y</td><td>• Stores the number of points currently set for Y devices.</td></tr>
<tr><td>SD292</td><td>Number of points
assigned for M</td><td>• Stores the number of points currently set for M devices.</td></tr>
<tr><td>SD293</td><td>Number of points
assigned for L</td><td>• Stores the number of points currently set for L devices.</td></tr>
<tr><td>SD294</td><td>Number of points
assigned for B</td><td>• Stores the number of points currently set for B devices.</td></tr>
<tr><td>SD295</td><td>Number of points
assigned for F</td><td>• Stores the number of points currently set for F devices.</td></tr>
<tr><td>SD296</td><td>Number of points
assigned for SB</td><td>• Stores the number of points currently set for SB devices.</td></tr>
<tr><td>SD297</td><td>Number of points
assigned for V</td><td>• Stores the number of points currently set for V devices.</td></tr>
<tr><td>SD298</td><td>Number of points
assigned for S</td><td>• Stores the number of points currently set for S devices.</td></tr>
<tr><td>SD299</td><td>Number of points
assigned for T</td><td>• Stores the number of points currently set for T devices.</td></tr>
<tr><td>SD300</td><td>Number of points
assigned for ST</td><td>• Stores the number of points currently set for ST devices.</td></tr>
<tr><td>SD301</td><td>Number of points
assigned for C</td><td>• Stores the number of points currently set for C devices.</td></tr>
<tr><td>SD302</td><td>Number of points
assigned for D</td><td>• Stores the number of points currently set for D devices.</td></tr>
<tr><td>SD303</td><td>Number of points
assigned for W</td><td>• Stores the number of points currently set for W devices.</td></tr>
<tr><td>SD304</td><td>Number of points
assigned for SW</td><td>• Stores the number of points currently set for SW devices.</td></tr>
</table>

Special register list (Continued)

No.	Name	Meaning	Details	Set by (When set)	Remark
SD502 SD503	Servo amplifier loading information	Servo amplifier loading information	• The loading status (loading: 1/non-loading: 0) of the servo amplifier checked in initial process, and stored as the bit data. SD502 : b0 (Axis 1) • The axis which turned from non-loading to loading status after power-on is handled as loaded. (However, the axis which turned from loading to non-loading status remains as loaded.)	S (Initial processing)	
SD504 SD505 SD506	Real mode/virtual mode switching error information	Real mode /virtual mode switching error code	• When a mode switching error occurs in real-to-virtual or virtual-to-real mode switching, or a mode continuation error occurs in the virtual mode, its error information is stored.	S (Occur an error)	
SD510 SD511	Test mode request error	It is operating in requirement error occurrence of the test mode, axis information	• Each axis is stopping: 0/Operating: 1, information is stored as a bit data. SD510 : b0 (Axis 1)		
SD512	Motion CPU WDT error cause	Error meaning of WDT error occurs	• The following error codes are stored in SD512. 1: S/W fault 1 2: Operation cycle over 3: — 4: WDT error 201 to 215: — 250 to 253: Servo amplifier interface H/W fault 300: S/W fault 3 301: 15 CPSTART instructions of 8 or more points were started simultaneously. 303: S/W fault 4	S (Occur an error)	
SD513 SD514 SD515	Manual pulse generator axis setting error	Manual pulse generator axis setting error information	• Contents of the manual pulse generator axis setting error is stored when the manual pulse generator axis setting error flag (SM513) turns on. (Normal: 0/Setting error: 1) SD513 : The manual pulse generator axis setting error is stored in b0 (P1). The smoothing magnification setting is stored in b3 (P1). SD514 : One pulse input magnification setting error is stored in b0 (axis 1).		
SD516	Error program No.	Error program No. of servo program	• When the servo program setting error flag (SM516) turns on, the erroneous servo program No. will be stored.		
SD517	Error item information	Error code of servo program	• When the servo program setting error flag (SM516) turns on, the error code corresponding to the erroneous setting item will be stored.		
SD520	Scan time	Scan time (1ms units)	• Main cycle is stored in the 1ms units. Setting range (0 to 65535[ms])	S (Main processing)	
SD521	Maximum scan time	Maximum scan time (1ms units)	• The maximum value of the main cycle is stored in the 1ms units. Setting range (0 to 65535[ms])		
SD522	Motion operation cycle	Motion operation cycle	• The time required for motion operation cycle is stored in the [μs] unit.	S (Operation cycle)	
SD523	Operation cycle of the Motion CPU setting	Operation cycle of the Motion CPU setting	• The setting operation cycle is stored in the [μs] unit.	S (Initial processing)	
SD700	allocated devices	allocated number	• The number of # devices that are set is stored.	S (Initial processing)	
SD720 SD721	444μs Coasting Timer	444μs Coasting Timer	• It is counting up "1" each 444us. (No latch device. When power is on, it will be "0" and then it starts counting up.	S (by 1 per 444μs)	

7.6 I/O devices

7.6.1 Input device list

Device No.	Purpose
X0 to	User devices [PX assignment] (4096 points)
X1000 to	Not available (3584 points)
X1E00 to	Input devices for extension IO unit (16 points × 1 axis)
X1E10 to X1FFF	Not available (496 points)

7.6.2 Output device list

Device No.	Purpose
Y0 to	User devices [PY assignment] (4096 points)
Y1000 to	Not available (3584 points)
Y1E00 to	Output devices for extension IO unit (16 points × 1 axis)
Y1E10 to Y1FFF	Not available (496 points)

7.6.3 Input device

Axis No.	Device No.	Signal name
1	X1E00 to X1E0F	

	Signal name	Pin No. of MR-J3-D01	Fetch cycle	Signal direction
0	Input signal DI0	CN10-1	Operation cycle 0.8 [ms] or less : 0.8 [ms] Operation cycle 1.7 [ms] : 1.7 [ms] Operation cycle 3.5 [ms] or more : 3.5 [ms]	Status signal
1	Input signal DI1	CN10-2		
2	Input signal DI2	CN10-3		
3	Input signal DI3	CN10-4		
4	Input signal DI4	CN10-5		
5	Input signal DI5	CN10-6		
6	Input signal DI6	CN10-7		
7	Input signal DI7	CN10-8		
8	Input signal DI8	CN10-9		
9	Input signal DI9	CN10-10		
A	Input signal DI10	CN10-11		
B	Input signal DI11	CN10-12		
C	Input signal DI12	CN10-15		
D	Input signal DI13	CN10-16		
E	Input signal DI14	CN10-17		
F	Input signal DI15	CN10-18		

7.6.4 Output device

Axis No.	Device No.	Signal name
1	Y1E00 to Y1E0F	

	Signal name	Pin No. of MR-J3-D01	Fetch cycle	Signal direction
0	Output signal DO0	CN10-22	Operation cycle 0.8 [ms] or less : 0.8 [ms] Operation cycle 1.7 [ms] : 1.7 [ms] Operation cycle 3.5 [ms] or more : 3.5 [ms]	Command signal
1	Output signal DO1	CN10-23		
2	Output signal DO2	CN10-24		
3	Output signal DO3	CN10-25		
4	Output signal DO4	CN10-38		
5	Output signal DO5	CN10-39		
6	Output signal DO6	CN10-40		
7	Output signal DO7	CN10-41		
8	Output signal DO8	CN10-42		
9	Output signal DO9	CN10-43		
A	Output signal DO10	CN10-44		
B	Output signal DO11	CN10-45		
C	Output signal DO12	CN10-46		
D	Output signal DO13	CN10-47		
E	Output signal DO14	CN10-48		
F	Output signal DO15	CN10-49		

MEMO

8. PARAMETERS FOR POSITIONING CONTROL

8.1 Fixed Parameters

(1) The user sets the fixed parameters for each axis based on the mechanical system requirements, etc.
(2) Fixed parameters are set using MT Developer2.
(3) Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Table 8.1 Fixed parameter list

No.	Item	Setting range								Initial value	Units	Remarks
		mm		inch		degree		PLS				
		Setting range	Units	Setting range	Units	Setting range	Units	Setting range	Units			
1	Unit setting	0	—	1	—	2	—	3	—	3	—	• Set the command value for each axis at the positioning control.
2	Travel value per pulse (A): Number of pulses per rotation (AP)	1 to 2147483647[PLS]								20000	PLS	• Set the number of feedback pulses per motor rotation based on the mechanical system.
3	Travel value per pulse (A): Travel value per rotation (AL)	0.1 to 214748364.7	μm	0.00001 to 21474.83647	inch	0.00001 to 21474.83647	degree	1 to 2147483647	PLS	20000		• Set the travel value per motor based on the mechanical system.
4	Backlash compensation amount (Note)	0 to 6553.5		0 to 0.65535		0 to 0.65535		0 to 65535		0		• Set the backlash amount of the machine. • Every time the direction changes during positioning, backlash compensation is executed with the set value. The expression below shows the setting range. 0 ≦ (backlash compensation amount) × AP/AL ≦ 65535
5	Upper stroke limit (Note)	-214748364.8 to 214748364.7		-21474.83648 to 21474.83647		0 to 359.99999		-2147483648 to 2147483647		2147483647		• Set the upper limit for the machine travel range. The expression below shows the setting range.
6	Lower stroke limit (Note)	-214748364.8 to 214748364.7		-21474.83648 to 21474.83647		0 to 359.99999		-2147483648 to 2147483647		0		• Set the lower limit for the machine travel range. The expression below shows the setting range.
7	Command in-position range (Note)	0.1 to 214748364.7		0.00001 to 21474.83647		0.00001 to 359.99999		1 to 2147483647		100		• Set the position at which the command in-position signal (M2403+20n) turns on [(positioning address) - (current value)]. The expression below shows the setting range. 1 ≦ (command in-position range) × AP/AL ≦ 32767
8	Speed control 10×multiplier setting for degree axis	—	—	—	—	Invalid/Valid	—	—	—	Invalid	—	• When the control unit is set to degrees, set whether the positioning control is executed based on a 10× multiplier of the command speed setting.

(Note): The display of the possible setting range changes according to the electronic gear value.

8.2 Parameter Block

(1) Parameter blocks allow for easy setting changes by allowing data such as acceleration/deceleration control to be set once and then reused for multiple positioning processes.
(2) A maximum of 64 parameter blocks can be created.
(3) Parameter blocks can be set using MT Developer2.
(4) Parameter block parameters available are shown in Table 8.2.
(5) Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Table 8.2 Parameter Block Setting List

No.	Item	Setting range								Initial value	Units	Remarks
		mm		inch		degree		PLS				
		Setting range	Units	Setting range	Units	Setting range	Units	Setting range	Units			
1	Interpolation control unit (Note-2)	0	—	1	—	2	—	3	—	3	—	• Set the units for compensation control. • It can be also used as the units for the command speed and allowable error range for circular interpolation set in the servo program.
2	Speed limit value	0.01 to 6000000.00	mm/min	0.001 to 600000.000	inch/min	0.001 to 2147483.647 (Note-1)	degree/min	1 to 2147483647	PLS/s	200000	PLS/s	• Set the maximum speed for positioning/home position return. • If the positioning speed or home position return speed setting exceeds the speed limit value, control is executed at the speed limit value.
3	Acceleration time	1 to 65535[ms]								1000	ms	• Set the time taken to reach the speed limit value from the start of motion.
4	Deceleration time	1 to 65535[ms]								1000	ms	• Set the time taken to stop from the speed limit value.
5	Rapid stop deceleration time	1 to 65535[ms]								1000	ms	• Set the time taken to stop from the speed limit value when a rapid stop is executed.
6	S-curve ratio	0 to 100[%]								0	%	• Set the S-curve ratio for S-pattern processing. • When the S-curve ratio is 0[%], trapezoidal acceleration/deceleration processing is executed.
7	Torque limit value	1 to 1000[%]								300	%	• Set the torque limit value in the servo program.
8	Deceleration processing on STOP input	0 : Deceleration stop is executed based on the deceleration time. 1 : Deceleration stop is executed based on the rapid stop deceleration time.								0	—	• Set the deceleration processing when external signals (STOP, FLS, RLS) are input.
9	Allowable error range for circular interpolation (Note-2)	0 to 10000.0	μm	0 to 1.00000	inch	0 to 1.00000	degree	0 to 100000	PLS	100	PLS	• Set the permissible range for the locus of the arc and the set end point coordinates.

(Note-1): When the "speed control 10×multiplier setting for degree axis" is set to "valid", the setting range is 0.01 to 21474836.47[degree/min]. However, setting range of 0.001 to 2147483.647[degree/min] is displayed in the parameter block setting screen of programming software.
(Note-2): The setting value is invalid in Real mode.

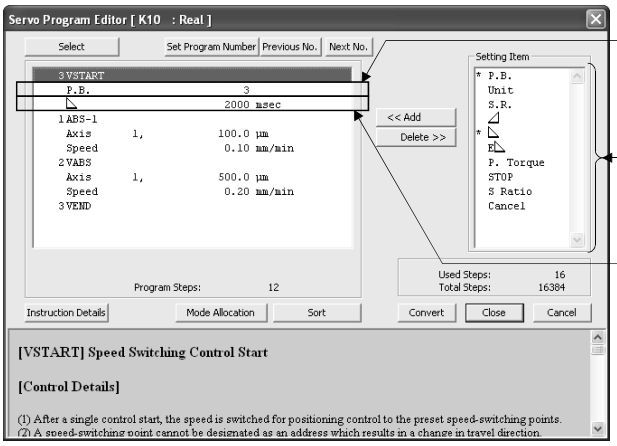
POINT

(1) Parameter blocks are specified in the home position return data, JOG operation data or servo program.
(2) The various parameter block data can be changed using the servo program.

POINT

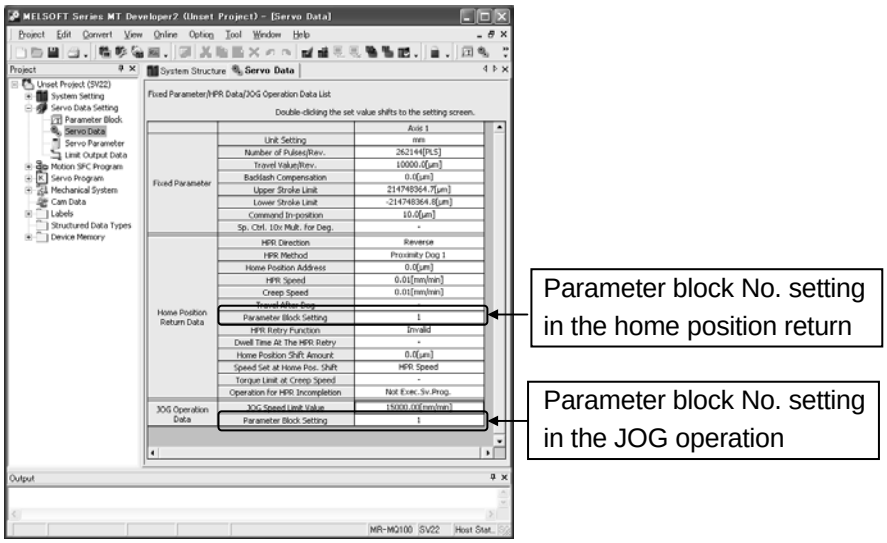
The data set in the parameter block is used in positioning control, home position return and JOG operation.

(1) The parameter block No. used in the positioning control is set using MT Developer2 during creation of the servo program. If it is not set, control is executed with the contents of parameter block No.1.
Also, it is possible to set parameter block data individually in the servo program.
[Servo program creation screen]



UNIT	: Interpolation control unit	S.R.	: Speed limit value
◿	: Acceleration time	◺	: Deceleration time
E◺	: Rapid stop deceleration time,	P.TORQ	: Torque limit value
STOP	: Deceleration processing on STOP input	◠	: Allowable error range for circular interpolation
S RATIO	: S-curve ratio when S-pattern processing is executed		

(2) The parameter block No. used in the home position return or JOG operation is set in the "home position return data" or "JOG operation data" setting areas of MT Developer2.
[Home position return data setting screen]



8.3 JOG Operation Data

(1) The settings for JOG operation is executed.
(2) Individual start or simultaneous start can be used in JOG operation.
(3) JOG operation can be executed using the Motion SFC program or test mode of MT Developer2.
(Refer to the help of MT Developer2 for JOG operation method in the test mode of MT Developer2.)
(4) Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Table 8.3 JOG operation data list

No.	Item	Setting range								Initial value	Units	Remarks
		mm		inch		degree		PLS				
		Setting range	Units	Setting range	Units	Setting range	Units	Setting range	Units			
1	JOG speed limit value	0.01 to 6000000.00	mm /min	0.001 to 600000.000	inch /min	0.001 to 2147483.647 (Note-1)	degree/ min	1 to 2147483647	PLS /s	20000	PLS/s	• Sets the maximum speed at the JOG operation. • If JOG speed setting exceeds the JOG speed limit value, it is controlled with JOG speed limit value.
2	Parameter block setting	1 to 64								1	—	• Sets the parameter block No. to be used at the JOG operation.

(Note-1): When the "speed control 10×multiplier speed setting for degree axis" is set to "valid", the setting range is 0.01 to 21474836.47[degree/min].

8.4 Home Position Return

(1) Use home position return immediately after power supply ON or at other times when confirmation of axis location is required.

(2) Six methods for home position return are as follows.
- Proximity dog type
- Count type
- Data set type
- Dog cradle type
- Stopper type
- Limit switch combined type

(3) Select the optimal home position return method based on the system configuration and application with reference to the following.

(4) Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Home position return methods		Contents	Applications
Proximity dog type	Proximity dog type 1	• Home position is zero point of servomotor. • When the proximity dog is ON, it cannot be started.	• It is used in the system which can surely pass a zero point from the home position return start to proximity dog ON → OFF.
	Proximity dog type 2	• Home position is zero point of servomotor. • When the proximity dog is ON, it can be started.	• This method is valid when the stroke range is short and "proximity dog type 1" cannot be used.
Count type	Count type 1	• Home position is zero point of servomotor.	• It is used in systems which will always pass a zero point while travelling the set distance from the home position return start point based on the "travel value after proximity dog ON" setting.
	Count type 2	• Zero point is not used in the home position return.	• This method is used when the proximity dog is near the stroke end and the stroke range is narrow.
	Count type 3	• Home position is zero point of servomotor.	• This method is valid when the stroke range is short and "count type 1" cannot be used.
Data set type	Data set type 1	• Home position is the commanded position of Motion controller.	• External input signals such as dog signal are not used in an absolute position system. • This method is valid for the data set independent of a deviation counter value.
	Data set type 2	• Home position is real position of servomotor.	• External input signals such as dog signal are not used in an absolute position system.
Dog cradle type		• Home position is zero point of servomotor immediately after the proximity dog signal ON.	• It is easy to set the position of the proximity dog, because it is near the same position used for homing.
Stopper type	Stopper type 1	• Home position is set at the point where further motion is prevented by a physical stopper. • Proximity dog is used.	• This method is useful for improving accuracy of home position return when the physical stopper of a machine is used as the home position.
	Stopper type 2	• Home position is set at the point where further motion is prevented by a physical stopper. • Proximity dog is not used.	
Limit switch combined type		• Home position is zero point of servomotor. • Proximity dog is not used. • External limit switch is used.	• It is used in the system that the proximity dog signal cannot be used and only external limit switch can be used.

Table 8.4 Home position return data list

No.	Item	Setting range								Initial value	Units	Indirect setting	
		mm		inch		degree		PLS					
		Setting range	Units	Setting range	Units	Setting range	Units	Setting range	Units			Valid/ invalid	Number of words
1	Home position return direction	0: Reverse direction (Address decrease direction) 1: Forward direction (Address increase direction)								0	—	—	—
2	Home position return method	0: Proximity dog type 1 4: Proximity dog type 2 1: Count type 1 5: Count type 2 6: Count type 3 2: Data set type 1 3: Data set type 2 7: Dog cradle type 8: Stopper type 1 9: Stopper type 2 10: Limit switch combined type								0	—	—	—
3	Home position address	-214748364.8 to 214748364.7	μm	-21474.83648 to 21474.83647	inch	0 to 359.99999	degree	-2147483648 to 2147483647	PLS	0	PLS	○	2
4	Home position return speed	0.01 to 6000000.00	mm/min	0.001 to 600000.000	inch/min	0.001 to 2147483.647 (Note-1)	degree/min	1 to 10000000	PLS/s	1	PLS/s	○	2
5	Creep speed	0.01 to 6000000.00	mm/min	0.001 to 600000.000	inch/min	0.001 to 2147483.647 (Note-1)	degree/min	1 to 10000000	PLS/s	1	PLS/s	○	2
6	Travel value after proximity dog ON	0.0 to 214748364.7	μm	0.00000 to 21474.83647	inch	0.00000 to 21474.83647	degree	0 to 2147483647	PLS	0	PLS	○	2
7	Parameter Block setting	1 to 64								1	—	—	—
8	Home position return retry function	0: Invalid (Do not execute the home position return retry by limit switch.) 1: Valid (Execute the home position return retry by limit switch.)								0	—	—	—
9	Dwell time at the home position return retry	0 to 5000 [ms]								0	ms	○	1
10	Home position shift amount	-214748364.8 to 214748364.7	μm	-21474.83648 to 21474.83647	inch	-21474.83648 to 21474.83647	degree	-2147483648 to 2147483647	PLS	0	PLS	○	2
11	Speed set at the home position shift	0: Home position return speed 1: Creep speed								0	—	—	—
12	Torque limit value at the creep speed	1 to 1000 [%]								300	%	○	1
13	Operation setting for incompletion of home position return	0: Execute a servo program 1: Not execute a servo program								1	—	—	—

	No.	Item	Remarks
	1	Home position return direction	• The home position return direction is set.
	2	Home position return method	• The home position return method is set. • The proximity dog type or count type are recommended for servo amplifier's/systems which do not support absolute value.
	3	Home position address	• The current value of home position after the home position return is set.
	4	Home position return speed	• The home position return speed is set.
	5	Creep speed	• The creep speed (low speed immediately before stopping after deceleration from home position return speed) after the proximity dog ON is set.
	6	Travel value after proximity dog ON	• The travel value after the proximity dog ON for the count type is set. • More than the deceleration distance at the home position return speed is set.
	7	Parameter Block setting	• The parameter block (Refer to Section 4.3) No. to use for home position return is set.
	8	Home position return retry function	• Valid/invalid of home position return retry is set.
	9	Dwell time at the home position return retry	• The stop time at the deceleration stop during the home position return retry is set.
	10	Home position shift amount	• The shift amount at the home position shift is set.
	11	Speed set at the home position shift	• The operation speed which set the home position shift amount except "0" is set.
	12	Torque limit value at the creep speed	• The torque limit value with creep speed at the stopper type home position return is set.
	13	Operation setting for incompletion of home position return	• When the home position return request signal is ON, it set whether a servo program can be executed or not.

MEMO

9. SERVO PROGRAMS FOR POSITIONING CONTROL

Servo programs specify the type of the positioning data required to execute positioning control in the Motion controller.
This chapter describes the configuration and setting method of the servo programs.

9.1 Servo Program Composition Area

This section describes the composition of servo programs and the area in which they are stored.

9.1.1 Servo Program Composition

A servo program is composed of a program number, servo instructions and positioning data.
When a program number and the required servo instructions are specified using MT Developer2, the positioning data required to execute the specified servo instructions can be set.

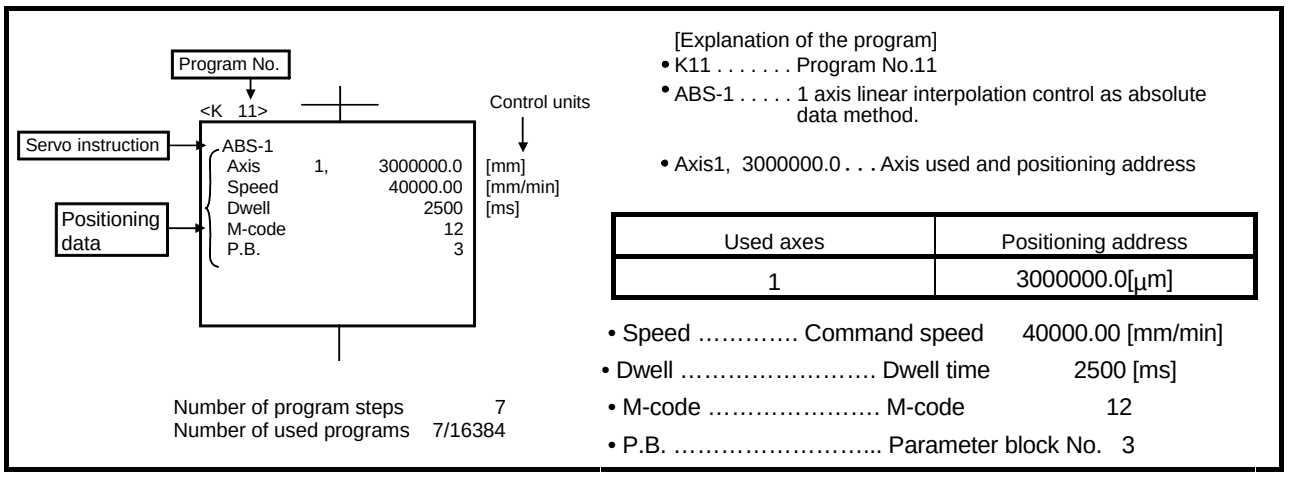


Fig. 9.1 Composition example of servo program

(1) Program No. ..... This number is specified using the Motion SFC program. Any number in the range of 0 to 4095 can be set.

(2) Servo instruction …. Type of positioning control is indicated.

(3) Positioning data ..... This is the required data for executing servo instructions.
The data required is fixed for each servo instruction.
The following applies for the servo program shown in Figure 9.1:

- Axis used and positioning address
- Command speed

} Data which must be set in order to execute the servo instruction.

- Dwell time
- M-code

} Data which will be set to default values for control if not set.

- P.B. (parameter block)

} Control is executed using the data of parameter block 3 (P.B.3).

9.1.2 Servo program area

(1) Servo program area

Internal RAM memory of the Motion controller which stores the servo program created using MT Developer2.

(2) Servo program capacity

The servo program area has a capacity of 16384 steps.

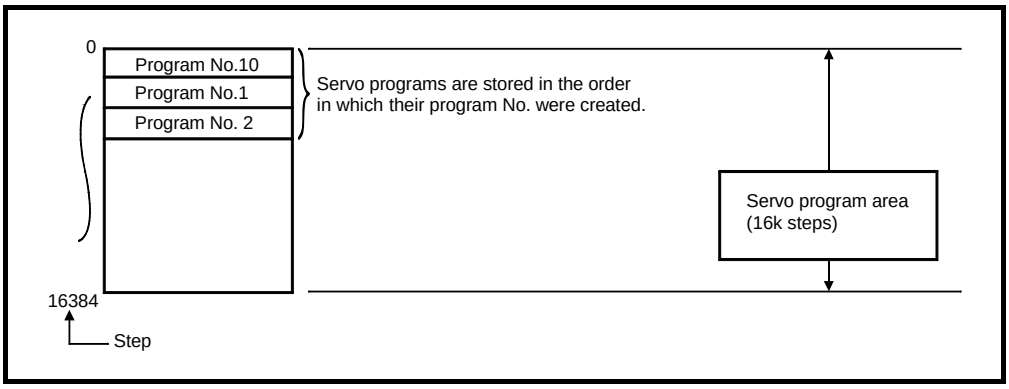


Fig. 9.2 Servo program area

POINT

If the servo program area has insufficient capacity, execute multiple positioning control operations with one program using indirect setting of the servo program's positioning data.

9.2 Servo Instructions

The servo instructions used in the servo programs are shown below.
Refer to the "Q173DCPU/Q172DCPU Motion Controller (SV13/SV22) Programming Manual (Motion SFC)" for details of the current value change control (CHGA, CHGA-E, CHGA-C).

(1) Guide to servo instruction list

Table 9.1 Guide to Servo Instruction List

Positioning control	Instruction symbol	Processing	Positioning data: Common: Parameter block No.	Axis	Address/travel	Command speed	Dwell time	M-code	Torque limit value	Arc/Helical: Auxiliary point	Radius	Central point	Pitch	OSC: Starting angle	Amplitude	Frequency	Reference axis No.	Parameter block: Control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing at stop input	Allowable error range for circular interpolation	S-curve ratio	Other: Repeat condition	Program No.	Command speed (constant speed)	Cancel	Skip	FIN acceleration/deceleration	WAIT-ON/OFF	Fixed position stop acceleration /deceleration time	Fixed position stop	Number of steps
		Virtual enable	○	○	○	○	○	○	—	○	○	○	○	—	—	—	○	—	○	○	○	○	—	—	○	○	○	○	○	○	○	○	○	—	—	
		Number of step	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	
		Number of indirect words	1	—	2	2	1	1	1	2	2	2	1	2	2	2	1	1	2	1	1	1	1	1	2	1	1/1(B)	—	2	1(B)	1(B)	1	1(B)	1	1(B)	
1 axis	ABS-1	Absolute 1-axis positioning	△	○	○	○	△	△											△	△	△	△	△	△			△				△					4 to 17
1 axis	INC-1	Incremental 1-axis positioning	△	○	○	○	△	△											△	△	△	△	△	△			△				△					
2 axes	ABS-2	Absolute 2-axes linear															○	△	△	△	△	△	△	△			△				△					

1) 2) 3) 4) 5) 6) 7) 8)

Number	Description	
1)	Instruction symbol	Lists the servo instructions usable in servo programs.
	Processing	Lists the processing outlines of the servo instructions.
2)	(a) Indicates positioning data which can be set in servo instructions. 1) ○: Item which must be set by the user (The servo instruction can not execute unless this data is set by the user.) 2) △: Item which is set when required by user (Data is set to the default value unless otherwise set by user.)	
	(b) Allows direct or indirect designation (except axis No.) 1) Direct designation : Set with numerical value. 2) Indirect designation : Set with word device. • Servo program execution is controlled using the preset word device contents. • Each setting item may either be 1 or 2 word data. • For 2 word data, set the start device No..	
	(c) Number of steps The more set items there are, the more the number of instruction steps. (The number of steps is displayed when the servo program is created.) (The instruction + ○ item comprise the minimum steps, and one △ item increases the number of steps by 1.)	
3)	Items common to the servo instructions	
4)	Items set in circular interpolation servo programs	
5)	Items set for high-speed oscillation	
6)	Set when wishing to deviate from data set in the parameter block used in the servo program (left at default parameter block value when not set) (The parameter block data remains unchanged in other servo programs.)	
7)	Setting items other than the common, circular and parameter block items (Items to be set vary with the servo instruction.)	
8)	Indicates the number of steps of each servo instruction.	

(2) Servo instruction list

The servo program servo instructions and available positioning data used are shown in Table 9.2. Refer to Section 9.3 for details of the servo instruction positioning data.

Table 9.2 Servo instruction list

Positioning control		Instruction symbol	Processing	Positioning data: Common: Parameter block No.	Common: Axis	Common: Address/travel value	Common: Command speed	Common: Dwell time	Common: M -code	Common: Torque limit value	Arc/Helical: Auxiliary point	Arc/Helical: Radius	Arc/Helical: Central point	Arc/Helical: Pitch
			Virtual enable	○	○	○	○	○	○	—	○	○	○	○
			Number of steps	1	1	1	1	1	1	1	1	1	1	1
			Number of indirect words	1	—	2	2	1	1	1	2	2	2	1
Linear interpolation control	1 axis	ABS-1	Absolute 1-axis positioning	△	○	○	○	△	△					
		INC-1	Incremental 1-axis positioning	△	○	○	○	△	△					
	2 axes	ABS-2	Absolute 2-axes linear interpolation	△	○	○	○	△	△					
		INC-2	Incremental 2-sxes linear interpolation	△	○	○	○	△	△					
	3 axes	ABS-3	Absolute 3-axes linear interpolation	△	○	○	○	△	△					
		INC-3	Incremental 3-axes linear interpolation	△	○	○	○	△	△					
	4 axes	ABS-4	Absolute 4-axes linear interpolation	△	○	○	○	△	△					
		INC-4	Incremental 4-axes linear interpolation	△	○	○	○	△	△					
Circular interpolation control	Auxiliary point-specified	ABS	Absolute auxiliary point-specified circular interpolation	△	○	○	○	△	△		○			
		INC	Incremental auxiliary point-specified circular interpolation	△	○	○	○	△	△		○			
	Radius-specified	ABS	Absolute radius-specified circular interpolation less than CW 180°	△	○	○	○	△	△			○		
		ABS	Absolute radius-specified circular interpolation CW 180° or more	△	○	○	○	△	△			○		
		ABS	Absolute radius-specified circular interpolation less than CCW 180°	△	○	○	○	△	△			○		
		ABS	Absolute radius-specified circular interpolation CCW 180° or more	△	○	○	○	△	△			○		
		INC	Incremental radius-specified circular interpolation less than CW 180°	△	○	○	○	△	△			○		
		INC	Incremental radius-specified circular interpolation CW 180° or more	△	○	○	○	△	△			○		
		INC	Incremental radius-specified circular interpolation less than CCW 180°	△	○	○	○	△	△			○		
		INC	Incremental radius-specified circular interpolation CCW 180° or more	△	○	○	○	△	△			○		

Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.
Servo instructions which need multiple axes like "Linear Interpolation control" and "Circular Interpolation control" are set in Virtual mode.

Positioning data																						Number of steps
OSC				Parameter block									Others (Note-2)									
Starting angle	Amplitude	Frequency	Reference axis No.(Note-1)	Control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing at stop input	Allowable error range for circular interpolation	S-curve ratio	Repeat condition	Program No.	Command speed (constant speed)	Cancel	Skip	FIN acceleration/deceleration	WAIT-ON/OFF	Fixed position stop acceleration /deceleration time	Fixed position stop	
—	—	—	○	—	○	○	○	○	—	—	○	○		○	○	○	○	○	○	—	—	
1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	
2	2	2	1	1	2	1	1	1	1	1	2	1	Note-2 1/ 1(B)	—	2	Note-2 1(B)	Note-2 1(B)	1	Note-2 1(B)	1	Note-2 1(B)	
					△	△	△	△	△	△		△				△						4 to 17
					△	△	△	△	△	△		△				△						
			○	△	△	△	△	△	△	△		△				△						5 to 20
			○	△	△	△	△	△	△	△		△				△						
			○	△	△	△	△	△	△	△		△				△						7 to 21
			○	△	△	△	△	△	△	△		△				△						
			○	△	△	△	△	△	△	△		△				△						8 to 22
			○	△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△	△	△				△						7 to 22
				△	△	△	△	△	△	△	△	△				△						
				△	△	△	△	△	△	△	△	△				△						6 to 21
				△	△	△	△	△	△	△	△	△				△						
				△	△	△	△	△	△	△	△	△				△						
				△	△	△	△	△	△	△	△	△				△						
				△	△	△	△	△	△	△	△	△				△						
				△	△	△	△	△	△	△	△	△				△						

○ : Must be set. △ : Set if required.
(Note-1) : Only reference axis speed specification.
(Note-2) : (B) indicates a bit device.

Table 9.2 Servo Instruction List (continued)

Positioning control		Instruction symbol	Processing	Positioning data										
				Common							Arc/Helical			
				Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	Pitch
			Virtual enable	○	○	○	○	○	○	—	○	○	○	○
			Number of steps	1	1	1	1	1	1	1	1	1	1	1
			Number of indirect words	1	—	2	2	1	1	1	2	2	2	1
Circular interpolation control	Central point-specified	ABS	Absolute central point-specified circular interpolation CW	△	○	○	○	△	△				○	
		ABS	Absolute central point-specified circular interpolation CCW	△	○	○	○	△	△				○	
		INC	Incremental central point-specified circular interpolation CW	△	○	○	○	△	△				○	
		INC	Incremental central point-specified circular interpolation CCW	△	○	○	○	△	△				○	
Helical interpolation control	Auxiliary point-specified	ABH	Absolute auxiliary point- specified helical interpolation	△	○	○	○	△	△		○			○
		INH	Incremental auxiliary point- specified helical interpolation	△	○	○	○	△	△		○			○
	Radius-specified	ABH	Absolute radius-specified helical interpolation less than CW 180°	△	○	○	○	△	△			○		○
		ABH	Absolute radius-specified helical interpolation CW 180° or more	△	○	○	○	△	△			○		○
		ABH	Absolute radius-specified helical interpolation less than CCW 180°	△	○	○	○	△	△			○		○
		ABH	Absolute radius-specified helical interpolation CCW 180° or more	△	○	○	○	△	△			○		○
		INH	Incremental radius-specified helical interpolation less than CW 180°	△	○	○	○	△	△			○		○
		INH	Incremental radius-specified helical interpolation CW 180° or more	△	○	○	○	△	△			○		○
		INH	Incremental radius-specified helical interpolation less than CCW 180°	△	○	○	○	△	△			○		○
		INH	Incremental radius-specified helical interpolation CCW 180° or more	△	○	○	○	△	△			○		○
	Central point-specified	ABH	Absolute central point-specified helical interpolation CW	△	○	○	○	△	△				○	○
		ABH	Absolute central point-specified helical interpolation CCW	△	○	○	○	△	△				○	○
		INH	Incremental central point-specified helical interpolation CW	△	○	○	○	△	△				○	○
		INH	Incremental central point-specified helical interpolation CCW	△	○	○	○	△	△				○	○

Positioning data																						Number of steps
OSC			Reference axis No. (Note-1)	Parameter block									Others (Note-2)									
Starting angle	Amplitude	Frequency		Control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing at stop input	Allowable error range for circular interpolation	S-curve ratio	Repeat condition	Program No.	Command speed (constant speed)	Cancel	Skip	FIN acceleration/deceleration	WAIT-ON/OFF	Fixed position stop acceleration /deceleration time	Fixed position stop	
—	—	—	○	—	○	○	○	○	—	—	○	○	○	○	○	○	○	○	○	—	—	
1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	
2	2	2	1	1	2	1	1	1	1	1	2	1	Note-2 1/ 1(B)	—	2	Note-2 1(B)	Note-2 1(B)	1	Note-2 1(B)	1	Note-2 1(B)	
				△	△	△	△	△	△	△	△	△				△						7 to 22
				△	△	△	△	△	△	△	△	△				△						
				△	△	△	△	△	△	△	△	△				△						
				△	△	△	△	△	△	△	△	△				△						
				△	△	△	△	△	△	△		△				△						10 to 27
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						9 to 26
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						10 to 27
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						
				△	△	△	△	△	△	△		△				△						

○ : Must be set. △ : Set if required.
(Note-1) : Only reference axis speed specification.
(Note-2) : (B) indicates a bit device.

Table 9.2 Servo Instruction List (continued)

Positioning control		Instruction symbol	Processing	Positioning data: Common: Parameter block No.	Common: Axis	Common: Address/travel value	Common: Command speed	Common: Dwell time	Common: M-code	Common: Torque limit value	Arc/Helical: Auxiliary point	Arc/Helical: Radius	Arc/Helical: Central point	Arc/Helical: Pitch
			Virtual enable	○	○	○	○	○	○	—	○	○	○	○
			Number of steps	1	1	1	1	1	1	1	1	1	1	1
			Number of indirect words	1	—	2	2	1	1	1	2	2	2	1
Fixed-pitch feed	1 axis	FEED-1	1-axis fixed-pitch feed start	△	○	○	○	△	△					
	2 axes	FEED-2	2-axes linear interpolation fixed-pitch feed start	△	○	○	○	△	△					
	3 axes	FEED-3	3-axes linear interpolation fixed-pitch feed start	△	○	○	○	△	△					
Speed control (Ⅰ)	Forward rotation	VF	Speed control (Ⅰ) forward rotation start	△	○		○		△					
	Reverse rotation	VR	Speed control (Ⅰ) reverse rotation start	△	○		○		△					
Speed control (Ⅱ)	Forward rotation	VVF	Speed control (Ⅱ) forward rotation start	△	○		○		△	△				
	Reverse rotation	VVR	Speed control (Ⅱ) reverse rotation start	△	○		○		△	△				
Speed-position control (Note-3)	Forward rotation	VPF	Speed-position control forward rotation start	△	○	○	○	△	△	△				
	Reverse rotation	VPR	Speed-position control reverse rotation start	△	○	○	○	△	△	△				
	Restart	VPSTART	Speed-position control restart		○									
Speed-switching control		VSTART	Speed-switching control start	△										
		VEND	Speed-switching control end											
		ABS-1	Speed-switching control end point address		○	○	○	△	△	△				
		ABS-2			○	○	○	△	△	△				
		ABS-3			○	○	○	△	△	△				
		INC-1	Travel value up to speed-switching control end point		○	○	○	△	△	△				
		INC-2			○	○	○	△	△	△				
		INC-3			○	○	○	△	△	△				
		VABS	Speed-switching point absolute specification			○	○		△	△				
		VINC	Speed-switching point incremental specification			○	○		△	△				

Positioning data																						
OSC				Parameter block									Others (Note-2)									
Starting angle	Amplitude	Frequency	Reference axis No. (Note-1)	Control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing at stop input	Allowable error range for circular interpolation	S-curve ratio	Repeat condition	Program No.	Command speed (constant speed)	Cancel	Skip	FIN acceleration/deceleration	WAIT-ON/OFF	Fixed position stop acceleration /deceleration time	Fixed position stop	Number of steps
—	—	—	○	—	○	○	○	○	—	—	○	○	○	○	○	○	○	○	○	—	—	
1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	
2	2	2	1	1	2	1	1	1	1	1	2	1	Note-2 1/ 1(B)	—	2	Note-2 1(B)	Note-2 1(B)	1	Note-2 1(B)	1	Note-2 1(B)	
					△	△	△	△	△	△		△				△						4 to 17
				△	△	△	△	△	△	△		△				△						5 to 19
				△	△	△	△	△	△	△		△				△						7 to 21
					△	△	△	△	△	△		△				△						3 to 15
					△	△	△	△	△	△		△				△						
					△	△	△	△	△	△		△				△						3 to 16
					△	△	△	△	△	△		△				△						
					△	△	△	△	△	△		△				△						4 to 18
					△	△	△	△	△	△		△				△						
																△						2 to 4
				△	△	△	△	△	△	△		△				△						1 to 13
																						1
																△						4 to 9
																△						5 to 10
																△						7 to 12
																△						4 to 9
																△						5 to 10
																△						7 to 12
																						4 to 6

○ : Must be set. △ : Set if required.
(Note-1) : Only reference axis speed specification.
(Note-2) : (B) indicates a bit device.
(Note-3) : The DOG signal of a servo amplifier is used for CHANGE (Speed/position switching) signal of “Speed/position switching control).

Table 9.2 Servo Instruction List (continued)

Positioning control	Instruction symbol	Processing	Positioning data										
			Common							Arc/Helical			
			Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	Pitch
		Virtual enable	○	○	○	○	○	○	—	○	○	○	○
		Number of steps	1	1	1	1	1	1	1	1	1	1	1
		Number of indirect words	1	—	2	2	1	1	1	2	2	2	1
Speed control with fixed position stop (Forward rotation)	PVF	Speed control with fixed position stop absolute specification	△	○	○	○	△	△					
Speed control with fixed position stop (Reverse rotation)	PVR		△	○	○	○	△	△					
Position follow-up control	PFSTART	Position follow-up control start	△	○	○	○		△					
Constant-speed control	CPSTART1	1-axis constant-speed control start	△	○		○							
	CPSTART2	2-axes constant-speed control start	△	○		○							
	CPSTART3	3-axes constant-speed control start	△	○		○							
	CPSTART4	4-axes constant-speed control start	△	○		○							
	ABS-1	Constant-speed control passing point absolute specification		○	○			△	△				
	ABS-2			○	○			△	△				
	ABS-3			○	○			△	△				
	ABS-4			○	○			△	△				
	ABS			○	○			△	△	○			
	ABS			○	○			△	△		○		
	ABS			○	○			△	△		○		
	ABS			○	○			△	△		○		
	ABS			○	○			△	△		○		
	ABS			○	○			△	△			○	
	ABS			○	○			△	△			○	
	ABH	Constant-speed control passing point helical absolute specification		○	○			△	△	○			○
	ABH			○	○			△	△		○		○
	ABH			○	○			△	△		○		○
	ABH			○	○			△	△		○		○
	ABH			○	○			△	△		○		○
	ABH			○	○			△	△			○	○
	ABH			○	○			△	△			○	○

Positioning data																						Number of steps
OSC				Parameter block									Others (Note-2)									
Starting angle	Amplitude	Frequency	Reference axis No. (Note-1)	Control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing at stop input	Allowable error range for circular interpolation	S-curve ratio	Repeat condition	Program No.	Command speed (constant speed)	Cancel	Skip	FIN acceleration/deceleration	WAIT-ON/OFF	Fixed position stop acceleration /deceleration time	Fixed position stop	
—	—	—	○	—	○	○	○	○	—	—	○	○	○	○	○	○	○	○	○	—	—	
1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	
2	2	2	1	1	2	1	1	1	1	1	2	1	Note-2 1/ 1(B)	—	2	Note-2 1(B)	Note-2 1(B)	1	Note-2 1(B)	1	Note-2 1(B)	
					△		△	△	△	△		△				△				○	○	6 to 19
					△		△	△	△	△		△				△				○	○	
					△	△	△	△	△	△		△				△						4 to 16
					△	△	△	△	△	△		△				△		△				3 to 15
				△	△	△	△	△	△	△	△	△				△		△				3 to 17
				△	△	△	△	△	△	△	△	△				△		△				4 to17
				△	△	△	△	△	△	△	△	△				△		△				
															△		△		△			2 to 10
															△		△		△			3 to 11
															△		△		△			4 to 12
															△		△		△			5 to 13
															△		△		△			5 to 14
															△		△		△			4 to 13
															△		△		△			
															△		△		△			
															△		△		△			
															△		△		△			5 to 14
															△		△		△			
															△		△		△			9 to 14
															△		△		△			8 to 13
															△		△		△			
															△		△		△			
															△		△		△			
															△		△		△			9 to 14
															△		△		△			

○ : Must be set. △ : Set if required.
(Note-1) : Only reference axis speed specification.
(Note-2) : (B) indicates a bit device.

Table 9.2 Servo Instruction List (continued)

Positioning control	Instruction symbol	Processing		Positioning data										
				Common							Arc/Helical			
				Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	Pitch
			Virtual enable	○	○	○	○	○	○	—	○	○	○	○
			Number of steps	1	1	1	1	1	1	1	1	1	1	1
			Number of indirect words	1	—	2	2	1	1	1	2	2	2	1
Constant-speed control	INC-1	Constant-speed control passing point incremental specification			○	○			△	△				
	INC-2				○	○			△	△				
	INC-3				○	○			△	△				
	INC-4				○	○			△	△				
	INC				○	○			△	△	○			
	INC				○	○			△	△		○		
	INC				○	○			△	△		○		
	INC				○	○			△	△		○		
	INC				○	○			△	△		○		
	INC				○	○			△	△			○	
	INC				○	○			△	△			○	
	INH	Constant-speed control passing point helical incremental specification			○	○			△	△	○			○
	INH				○	○			△	△		○		○
	INH				○	○			△	△		○		○
	INH				○	○			△	△		○		○
	INH				○	○			△	△		○		○
	INH				○	○			△	△			○	○
	INH				○	○			△	△			○	○
	CPEND	Constant-speed control end						△						

Positioning data																						Number of steps
OSC				Parameter block									Others (Note-2)									
Starting angle	Amplitude	Frequency	Reference axis No. (Note-1)	Control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing at stop input	Allowable error range for circular interpolation	S-curve ratio	Repeat condition	Program No.	Command speed (constant speed)	Cancel	Skip	FIN acceleration/deceleration	WAIT-ON/OFF	Fixed position stop acceleration /deceleration time	Fixed position stop	
—	—	—	○	—	○	○	○	○	—	—	○	○	○	○	○	○	○	○	○	—	—	
1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	
2	2	2	1	1	2	1	1	1	1	1	2	1	Note-2 1/ 1(B)	—	2	Note-2 1(B)	Note-2 1(B)	1	Note-2 1(B)	1	Note-2 1(B)	
															△		△		△			2 to 10
															△		△		△			3 to 11
															△		△		△			4 to 12
															△		△		△			5 to 13
															△		△		△			5 to 14
															△		△		△			4 to 13
															△		△		△			
															△		△		△			
															△		△		△			
															△		△		△			5 to 14
															△		△		△			
															△		△		△			9 to 14
															△		△		△			8 to 13
															△		△		△			
															△		△		△			
															△		△		△			
															△		△		△			9 to 14
															△		△		△			
																						1 to 2

○ : Must be set. △ : Set if required.
(Note-1) : Only reference axis speed specification.
(Note-2) : (B) indicates a bit device.

Table 9.2 Servo Instruction List (continued)

Positioning control	Instruction symbol	Processing	Positioning data										
			Common							Arc/Helical			
			Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	Pitch
		Virtual enable	○	○	○	○	○	○	—	○	○	○	○
		Number of steps	1	1	1	1	1	1	1	1	1	1	1
		Number of indirect words	1	—	2	2	1	1	1	2	2	2	1
Repetition of same control (used in speed switching control, constant-speed control)	FOR-TIMES	Repeat range start setting											
	FOR-ON												
	FOR-OFF												
	NEXT	Repeat range end setting											
Simultaneous start	START	Simultaneous start											
Home position return	ZERO	Home position return start		○									
High speed oscillation	OSC	High-speed oscillation	△	○				△					
Current Value change	CHGA	Servomotor/Virtual Servomotor Shaft Current Value Change		○	○								
	CHGA-E	Encoder current value change		○	○								
	CHGA-C	CAM shaft current value change		○	○								

Positioning data																						
OSC				Parameter block									Others (Note-2)									
Starting angle	Amplitude	Frequency	Reference axis No. (Note-1)	Control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing at stop input	Allowable error range for circular interpolation	S-curve ratio	Repeat condition	Program No.	Command speed (constant speed)	Cancel	Skip	FIN acceleration/deceleration	WAIT-ON/OFF	Fixed position stop acceleration /deceleration time	Fixed position stop	Number of steps
—	—	—	○	—	○	○	○	○	—	—	○	○	○	○	○	○	○	○	○	—	—	
1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	1	2	1	1	
2	2	2	1	1	2	1	1	1	1	1	2	1	Note-2 1/ 1(B)	—	2	Note-2 1(B)	Note-2 1(B)	1	Note-2 1(B)	1	Note-2 1(B)	
													○									2
													○									
													○									
																						3
														○								2 to 3
																						2
○	○	○							△							△						5 to 10
																						3

○ : Must be set. △ : Set if required.
(Note-1) : Only reference axis speed specification.
(Note-2) : (B) indicates a bit device.

9.3 Positioning Data

The positioning data set in the servo programs is shown in Table 9.3.
Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (REAL MODE)" for details.

Table 9.3 Positioning data

Name				Explanation	Default value	Setting value using MT Developer2			
						Setting range			
						mm	inch	degree	PLS
Common Settings	Parameter block No.			• Set based on which parameter block to use during both acceleration/ deceleration processing and STOP input.	1	1 to 64			
	Axis			• Set the starting axis. • The interpolation starting axis No. during interpolation.	—	1 to 32 (Note-6)			
	Address/travel value	Absolute data method	Address	Set the positioning address as an absolute address.	—	-214748364.8 to 214748364.7 [μm]	-21474.83648 to 21474.83647	0 to 359.99999	-2147483648 to 2147483647
		Incremental data method	Travel value	Set the positioning address as an incremental travel value. Travel direction is indicated by the sign. Only positive settings can be made during speed/position control. Positive : Forward rotation (address increase direction) Negative: Reverse rotation (address decrease direction)	—	Expect for the speed/position switching control 0 to 0 to ±2147483647 Speed/position switching control 0 to 214748364.7 [μm]	0 to 21474.83647	0 to 21474.83647	0 to 2147483647
	Command speed			• Sets the positioning speed. • Units for speed are the "control units" set in the parameter block. • Becomes either vector speed long-axis reference speed or reference axis speed during interpolation moves. (PTP control only)	—	0.01 to 6000000.00 [mm/min]	0.001 to 600000.000 [inch/min]	0.001 to 2147483.647 [degree/min] (Note-5)	1 to 2147483647 [PLS/s]
	Dwell time			• The time until the positioning complete signal (M2401+20n) is output after reaching the positioning address.	0[ms]	0 to 5000[ms]			
	M-code			• Set the M-code. • Set for each point at the speed-switching control and constant-speed control. • Updated it at the start or at a specified point.	0	0 to 32767			
	Torque limit value			• Set the torque limit value. • The torque limit is performed based on the starting parameter block data. Speed-switching control can be set for each point and torque limit values can be set at specific points.	Torque limit setting valued [%] in the parameter block	1 to 1000[%]			

	Setting value using the Motion SFC program (Indirect setting)				Indirect setting		Processing at the setting error		
	Setting range				Possible/ not possible	Number of used words	Error item information (Stored in SD517) (Note-4)	Control using default value	Not start
	mm	inch	degree	PLS					
	1 to 64				○	1	1	○	
	–				×	–	–		○
	-2147483648 to 2147483647 ($\times 10^{-1}$[μm])	-2147483648 to 214748647 ($\times 10^{-5}$[inch])	0 to 35999999 ($\times 10^{-5}$[degree])	-2147483648 to 2147483647	○	2	n03 (Note-1)		
	Except for speed/position switching control 0 to ±214783647 Speed/position switching control						–		
	0 to 2147483647 ($\times 10^{-1}$[μm])	0 to 2147483647 ($\times 10^{-5}$[inch])	0 to 2147483647 ($\times 10^{-5}$[degree])	0 to 2147483647					
	1 to 600000000 ($\times 10^{-2}$ [mm/min])	1 to 600000000 ($\times 10^{-3}$ [inch/min])	1 to 2147483647 ($\times 10^{-3}$ [degree/min]) (Note-5)	1 to 2147483647 [PLS/s]	○	2	4	○ (Note-2)	○ (Note-3)
	0 to 5000[ms]				○	1	5	○	
	0 to 32767				○	1	6	○	
	1 to 1000[%]				○	1	7	○	

(Note-1): The "n" in n03, n08, n09 and n10, indicates the axis No. (1 to 32).
(Note-2): When an error occurs because the speed limit value is exceeded, it is controlled at the speed limit value.
(Note-3): Applies when the command speed is "0".
(Note-4): If there are multiple errors in the same program, the latest error item information is stored.
(Note-5): When the "speed control 10 × multiplier setting for degree axis" is set to "valid", the setting range is 0.01 to 21474836.47 [degree/min].
(Note-6): If 2 axes are set, an error will be happened when the servo program starts.

Table 9.3 Positioning data (Continued)

Name			Explanation	Setting value using MT Developer2				
				Default value	Setting range			
					mm	inch	degree	PLS
Circular Interpolation	Auxiliary point	Absolute data method	• Set at the auxiliary point-specified circular interpolation.	—	-214748364.8 to 214748364.7 [μm]	-21474.83648 to 21474.83647	0 to 359.99999	-2147483648 to 2147483647
		Incremental data method			0 to ±2147483647			
	Radius	Absolute data method	• Set at the radius-specified circular interpolation. • The sitting ranges depending on the positioning method is shown to the right.	—	0.1 to 429496729.5 [μm]	0.00001 to 42949.67295	0 to 359.99999	1 to 4294967295
		Incremental data method			0.1 to 214748364.7 [μm]	0.00001 to 21474.83647	0.00001 to 21474.83647	1 to 2147483647
	Central point	Absolute data method	• Set at the central point-specified circular interpolation.	—	-214748364.8 to 214748364.7 [μm]	-21474.83648 to 21474.83647	0 to 359.99999	-2147483648 to 2147483647
		Incremental data method			0 to ±2147483647			
	Number of pitches		• Set at the helical interpolation.	—	0 to 999			
Parameter block	Control unit(Note-7)		• Can only be set to items of the specified parameter block which are to be changed. • Refer to Section 4.3 "Parameter Block" for details of each data.	3	0	1	2	3
	Speed limit value			200000 [PLS/s]	0.01 to 6000000.00 [mm/min]	0.001 to 600000.000 [inch/min]	0.001 to 2147483.647 [degree/min] (Note-5)	1 to 2147483647 [PLS/s]
	Acceleration time			1000[ms]	1 to 65535[ms]			
	Deceleration time			1000[ms]	1 to 65535[ms]			
	Rapid stop deceleration time			1000[ms]	1 to 65535[ms]			
	S-curve ratio			0[%]	0 to 100[%]			
	Torque limit value			300[%]	1 to 1000[%]			
	Deceleration processing on STOP input			0	0: Deceleration stop based on the deceleration time 1: Deceleration stop based on the rapid stop deceleration time			
	Allowable error range for circular interpolation(Note-7)			100[PLS]	0 to 10000.0 [μm]	0 to 1.00000	0 to 1.00000	0 to 100000

	Setting value using the Motion SFC program (Indirect setting)				Indirect setting		Processing at the setting error		
	Setting range				Possible/ not possible	Number of used words	Error item information (Stored in SD517) (Note-4)	Control using default value	Not start
	mm	inch	degree	PLS					
	-2147483648 to 2147483647 ($\times 10^{-1}$[μm])	-2147483648 to 2147483647 ($\times 10^{-5}$[inch])	0 to 35999999 ($\times 10^{-5}$[degree])	-2147483648 to 2147483647	○	2×2	n08 (Note-1)		
	0 to ±2147483647								
	1 to 4294967295 ($\times 10^{-1}$[μm])	1 to 4294967295 ($\times 10^{-5}$[inch])	0 to 35999999 ($\times 10^{-5}$[degree])	1 to 4294967295	○	2	n09 (Note-1)		○
	1 to 2147483647 ($\times 10^{-1}$[μm])	1 to 2147483647 ($\times 10^{-5}$[inch])	1 to 2147483647 ($\times 10^{-5}$[degree])	1 to 2147483647	○				
	-2147483648 to 2147483647 ($\times 10^{-1}$[μm])	-2147483648 to 2147483647 ($\times 10^{-5}$[inch])	0 to 35999999 ($\times 10^{-5}$[degree])	-2147483648 to 2147483647	○	2×2	n10 (Note-1)		
	0 to ±2147483647				○				
	0 to 999				○	1	28		
	0	1	2	3	○	1	11	○	
	1 to 600000000 ($\times 10^{-2}$ [mm/min])	1 to 600000000 ($\times 10^{-3}$ [inch/min])	1 to 2147483647 ($\times 10^{-3}$ [degree/min]) (Note-5)	1 to 2147483647 [PLS/s]	○	2	12		
	1 to 65535[ms]				○	1	13		
	1 to 65535[ms]				○	1	14		
	1 to 65535[ms]				○	1	15		
	0 to 100[%]				○	1	21		
	1 to 1000[%]				○	1	16		
	0: Deceleration to a stop in accordance with the deceleration time 1: Deceleration to a stop in accordance with the rapid stop deceleration time				○	1	−		
	1 to 100000 ($\times 10^{-1}$[μm])	1 to 100000 ($\times 10^{-5}$[inch])	1 to 100000 ($\times 10^{-5}$[degree])	1 to 100000 [PLS]	○	2	17		

(Note-1): The "n" in n03, n08, n09 and n10, indicates the axis No. (1 to 32).
(Note-4): If there are multiple errors in the same program, the latest error item information is stored.
(Note-5): When the "speed control 10× multiplier setting for degree axis is set to "valid", is 0.01 to 21474836.47 [degree/min].
(Note-7): The setting value is invalid in Real mode.

Table 9.3 Positioning data (Continued)

	Name	Explanation	Setting value using MT Developer					
			Default value	Setting range				
				mm	inch	degree	PLS	
Others	Repeat condition (Number of repetitions)	Set the repeat conditions between FOR-TIMES instruction and NEXT instruction.	—	1 to 32767				
	Repeat condition (ON/OFF)	Set the repeat conditions between FOR-ON/OFF instruction and NEXT instruction.	—	X, Y, M, B, F, U□\G				
	Program No.	Set the program No. for simultaneous start.	—	0 to 4095				
	Command speed (constant-speed)	Set the speed for points on the way in the servo program.	—	0.01 to 6000000.00 [mm/min]	0.001 to 600000.000 [inch/min]	0.001 to 2147483.647 [degree/min] (Note-5)	1 to 2147483647 [PLS/s]	
	Cancel	Set to stop execution of a servo program by deceleration stop by turning on the specified bit device in the servo program.	—	X, Y, M, B, F, U□\G				
	Skip	Set to cancel positioning to pass point and execute the positioning to the next point by turning on the specified bit device during positioning at each pass point for constant-speed control instruction.	—	X, Y, M, B, F, U□\G				
	FIN acceleration/ deceleration	Set to execute positioning to each pass point for constant-speed control instruction by turning on the FIN signal.	—	1 to 5000[ms]				
	WAIT-ON/OFF	Set to make state of the waiting for execution by constant-speed control and execute the positioning immediately by turning on/off the command bit device.	—	X, Y, M, B, F, U□\G				
	Fixed position stop acceleration/ deceleration time	Acceleration/deceleration time used in the starting of speed control with fixed position stop, speed change request (CHGV) or fixed position stop command ON.	—	1 to 65535[ms]				
	Fixed position stop	Command bit device of fixed position stop is set.	—	X, Y, M, B, F, U□\G				

Table 9.3 Positioning data (Continued)

	Setting value using the Motion SFC program (Indirect setting)				Indirect setting		Processing at the setting error		
	Setting range				Possible/ not possible	Number of used words	Error item information (Stored in SD517) (Note-4)	Control using default value	Not start
	mm	inch	degree	PLS					
	1 to 32767				○	1	18	Control by K1	
	–				–	–	–		
	0 to 4095				○	1	19		○
	1 to 600000000 ($\times 10^{-2}$ [mm/min])	1 to 600000000 ($\times 10^{-3}$ [inch/min])	1 to 2147483647 ($\times 10^{-3}$ [degree/min]) (Note-5)	1 to 2147483647 [PLS/s]	○	2	4	○ (Note-2)	○ (Note-3)
	–				–	–	–		
	–				–	–	–		
	1 to 5000[ms]				○	1	13	Control by 1000[ms]	
	–				–	–	–		
	1 to 65535[ms]				○	1	13	Control by 1000[ms]	
	–				–	–	–		

(Note-2): When an error occurs because the speed limit value is exceeded, it is controlled at the speed limit value.
(Note-3): Applies when the command speed is "0".
(Note-4): If there are multiple errors in the same program, the latest error item information is stored.
(Note-5): When the "speed control 10 × multiplier setting for degree axis is set to "valid", is 0.01 to 21474836.47 [degree/min].

MEMO

10. MOTION SFC PROGRAMS

10.1 Motion SFC Performance Specifications

This chapter describes the Motion SFC program.
Refer to "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (Motion SFC)" for details.

(a) Motion SFC Performance Specifications

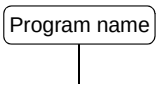
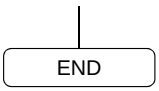
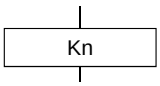
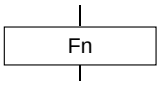
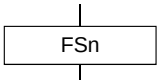
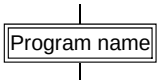
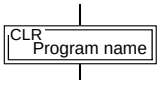
Item				Specifications
Motion SFC program capacity	Code total (Motion SFC chart + Operation control + Transition)			543k bytes
	Text total (Operation control + Transition)			484k bytes
Motion SFC program	Number of Motion SFC programs			256 (No.0 to 255)
	Motion SFC chart size/program			Up to 64k bytes (Included Motion SFC chart comments)
	Number of Motion SFC steps/program			Up to 4094 steps
	Number of selective branches/branch			255
	Number of parallel branches/branch			255
	Parallel branch nesting			Up to 4 levels
Operation control program (F/FS) / Transition program (G)	Number of operation control programs			4096 with F(Once execution type) and FS(Scan execution type) combined. (F/FS0 to F/FS4095)
	Number of transition programs			4096(G0 to G4095)
	Code size/program			Up to approx. 64k bytes (32766 steps)
	Number of blocks(line)/program			Up to 8192 blocks (in the case of 4 steps(min)/blocks)
	Number of characters/block			Up to 128 (comment included)
	Number of operand/block			Up to 64 (operand: constants, word device, bit devices)
	( ) nesting/block			Up to 32 levels
	Descriptive expression	Operation control program		Calculation expression/bit conditional expression
		Transition program		Calculation expression/bit conditional expression/ comparison conditional expression
Execute specification	Number of multi execute programs			Up to 256
	Number of multi active steps			Up to 256 steps/all programs
	Executed task	Normal task		Execute in main cycle of Motion CPU
		Event task (Execution can be masked.)	Fixed cycle	Execute in fixed cycle (0.44ms, 0.88ms, 1.77ms, 3.55ms, 7.11ms, 14.2ms)
			External interrupt	None
			PLC interrupt	None
		NMI task		None

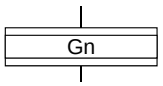
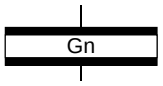
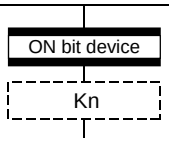
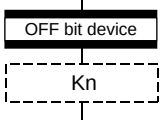
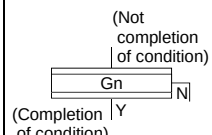
(a) Motion SFC Performance Specifications(continued)

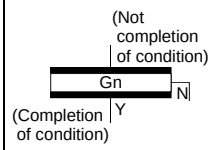
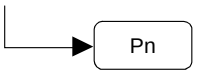
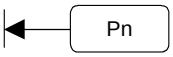
Item			Specifications
I/O (X/Y) points			8192 points
I/O (PX/ PY) points			Internal I/F (Input 4 points/ Output 2 points)
Number of devices (Device in the Motion controller only) (included the positioning dedicated device)	internal relays	(M)	12288 points
	Link relays	(B)	8192 points
	Annunciators relays	(F)	2048 points
	Special relays	(SM)	2256 points
	Data registers	(D)	8192 points
	Link registers	(W)	8192 points
	Special registers	(SD)	2256 points
	Motion registers	(#)	12288 points
	Coasting timers	(FT)	1 point (888μs)
	Multiple CPU area device		None

10.2 Motion SFC Chart Symbol List

Motion SFC program components are shown below. The operation sequence or transition control is expressed by connecting these symbols with directed lines in the Motion SFC program.

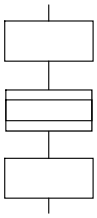
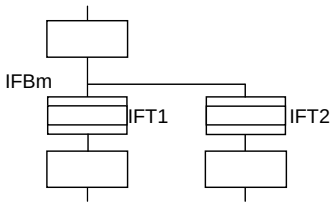
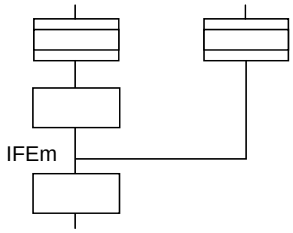
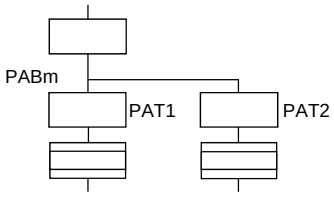
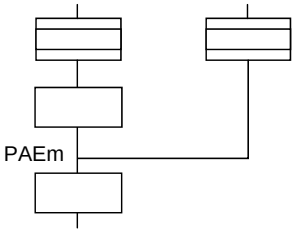
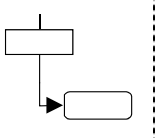
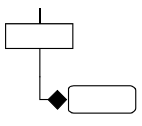
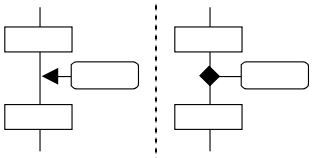
Classification	Name	Symbol (Code size (byte))	List Representation	Function
Program start/end	START	 (0)	Program name	• Indicates a program entry an its name. • Specify this program name with a subroutine call. • Only one program name per program.
	END	 (8)	END	• Indicates a program end (exit). • When a subroutine call is carried out, returns to the call source program. • It is possible to use one, multiple or zero END commands in a single program.
Step	Motion control step	 (8)	CALL Kn	• Starts a servo program Kn (K0 to K4095).
	Single execution type operation control step	 (8)	CALL Fn	• Executes the operation control program Fn a single time (F0 to F4095).
	Scan execution type operation control step	 (8)	CALL FSn	• Repeats an operation control program FSn (FS0 to FS4095) until the next transition condition enables.
	Subroutine call/start step	 (8)	GSUB program name	• When a WAIT command comes after GSUB , performs a "subroutine call" and transfers control to the specified program. Control returns to the call source program at END execution. • When anything other than WAIT comes after GSUB, performs "subroutine start", starts the specified program and transitions to the next (below) command in the current program. The start source and destination programs are executed simultaneously, and the call destination program ends at END execution.
	Clear step	 (8)	CLR program name	• Stops and ends the specified running program. After an end, the program is started from its initial (start) step upon a program restart. • When the specified program is in a "subroutine call", the subroutine program's execution is also stopped. • When the specified program is after a "subroutine start", the subroutine program is not stopped. • When clearing a "subroutine call", the specified subroutine's execution is stopped, the program returns to the call source program, and then transitions to the next step.

Classification	Name	Symbol (Code size (byte))	List representation	Function
Transition	Shift (Pre-read transition)	 (8)	SFT Gn	• If preceded by a motion control step, transitions to the next step after meeting transition condition Gn (G0 to G4095) without waiting for the motion operating completion. • If preceded by an operation control step, transitions to the next step after meeting the transition condition and completing the operation execution. • If preceded by a subroutine call or starting step, transitions to the next step after meeting transition condition without waiting for the completion of subroutine operation.
	WAIT	 (8)	WAIT Gn	• If preceded by a motion control step, waits for completion of the motion operation and then transitions to the next step after meeting the transition condition Gn (G0 to G4095). • If preceded by an operation control step, transitions to the next step after meeting the transition condition and after operation execution. (Same operation as Shift.) • If preceded by a subroutine call or starting step, waits for subroutine operation completion and then transitions to the next step after meeting transition condition.
	WAITON	 (14)	WAITON bit device	• Prepares start conditions of the next motion control step and issues an instruction immediately when the specified bit device turns ON. • Always pair this transition with the motion control step one-for-one.
	WAITOFF	 (14)	WAITOFF bit device	• Prepares start conditions of the next motion control step and issues an instruction immediately when the specified bit device turns OFF. • Always pair this transition with the motion control step one-for-one.
	Shift Y/N		IFBm IFT1 SFT Gn : JMP IFEm IFT2 SFT Gn+? : JMP IFEm IFEm	• If preceded by a motion control step, transitions to the next step after meeting transition condition Gn (G0 to G4095) without waiting for the motion operation completion. If transition condition is not met, transitions to the right-connected step. • If preceded by an operation control step, transitions to the next step after both meeting the transition condition operation execution completion. If the transition condition is not met, transitions to the right-connected step. • If preceded by a "subroutine call" or "starting step", transitions to the next step after meeting the transition condition without waiting for subroutine operation completion. If transition condition is not met, transitions to the right-connected step.

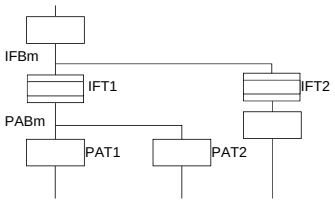
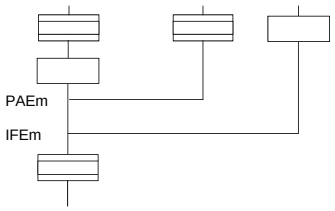
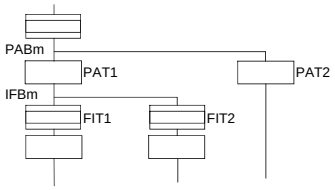
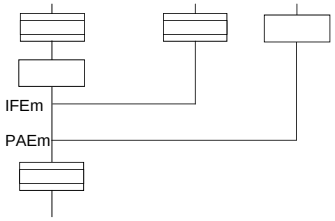
Classification	Name	Symbol (Code size (byte))	List representation	Function
Transition	WAIT Y/N		IFBm IFT1 WAIT Gn : JMP IFEm IFT2 WAIT Gn+? : JMP IFEm IFEm	• If preceded by a motion control step, waits for motion operation completion and then transitions to the next step after meeting transition condition Gn (G0 to G4095). If transition condition is not met, transitions to the right-connected step. • If preceded by an operation control step, transitions to the next step after meeting the transition condition and after operation execution. If transition condition is not met, transitions to the right-connected step. (Same operation as Shift.) • If preceded by a subroutine call or starting step, waits for the subroutine operation completion, and then transitions to the next step after meeting the transition condition. If the transition condition is not met, transitions to the right-connected step.
Jump	Jump	 (14)	JMP Pn	• Jumps to the specified pointer Pn (P0 to P16383) contained within the same program.
Pointer	Pointer	 (8)	Pn	• Indicates a jump destination pointer (label). • This pointer can be set at a step, transition, branch point or coupling point. • P0 to P16383 can be set in one program. The same number may also be reused in other programs without causing any conflicts.

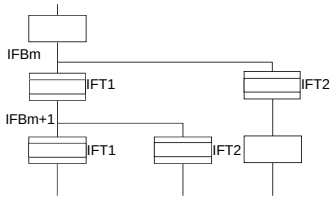
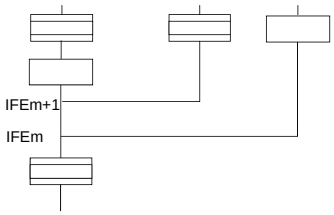
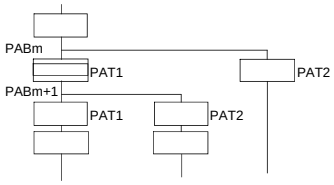
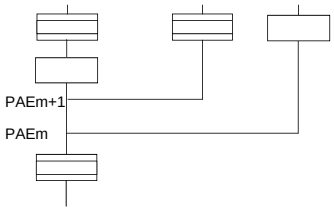
10.3 Branch and Coupling Chart List

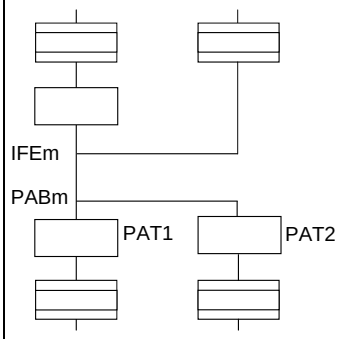
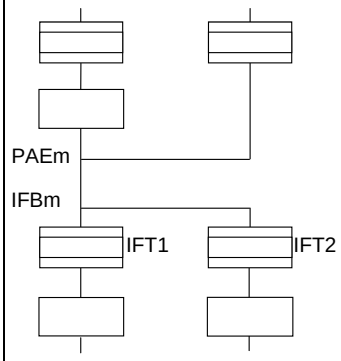
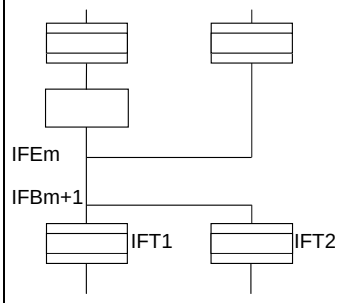
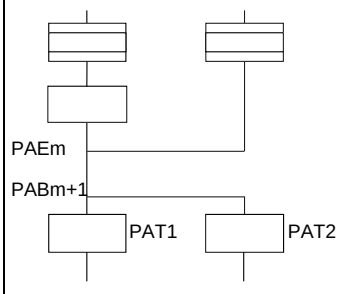
Branch and coupling patterns which specify step and transition sequences in the Motion SFC charts are shown below.

	Name (Code size (byte))	Motion SFC chart symbol	List representation	Function
Basic type	Series transition (Corresponding symbol size)		List representation corresponding to the Motion SFC chart symbols shown in Section 4.2.	• Steps and transitions connected in series are processed in order from top to bottom. • Steps and transitions need not be lined up alternately. • When a transition is omitted, unconditional shift processing is performed.
	Selective branch ((Number of branches + 2) × 10)		CALL Kn IFBm IFT1 SFT Gn CALL Fn : JMP IFEm IFT2 SFT Gn' CALL Fn' : (JMP IFEm) IFEm CALL Fn''	• The first route to meet the transition condition is executed after executing the step or transition preceding the branch. • Selective branch destinations should always be started by transitions which must be either all Shift's or all WAIT's. (Mixed use of Shift and WAIT together will cause a parallel branch.)
	Selective coupling (8)			• After the route branched by a selective branch has been processed, execution shifts to a coupling point. • A coupling may be preceded and followed by either a step or a transition.
	Parallel branch (Number of branches × 22 + number of coupling points × 2 + 12)		CALL Kn PABm PAT1 CALL Fn SFT Gn' : JMP PAEm PAT2 CALL Fn' SFT Gn'' : (JMP PAEm) PAEm CALL Fn'' :	• Multiple routes (steps) connected in parallel are executed simultaneously. • Each parallel branch destination may be started by either a step or transition.
	Parallel coupling (8)			• Execution waits at the coupling point of the parallel branch output and shifts to the next step after all routes in the parallel branch have been completed. • A coupling may be preceded and followed by either a step or a transition. • When this coupling is preceded by an FS step, scans are executed while waiting for the parallel branch to complete. After completed, scans are no longer executed.
	Jump transition (Corresponding symbol size)	<Normal jump> <Coupling jump>  	CALL Fn JMP Pn	1) Normal jump • After the step or transition preceding this jump transition is executed, execution shifts to the pointer Pn specified within its own program. • The jump destination may either be a step or transition. • When a jump takes place from an FS step to a transition, scans are executed while waiting for the completion of transition condition of the jump destination. 2) Coupling jump • When a jump to another route within a parallel branch takes place after a parallel branch, a "coupling jump" occurs and execution waits at the jump destination.
			CALL Fn' Pn CALL Kn	

Combining basic type branches/couplings provides the following application types.

	Name	Motion SFC chart symbol	List representation	Function
Application type	Selective branch | Parallel branch		CALL Kn IFBm IFT1 SFT Gn PABm PAT1 CALL Fn : JMP PAEm PAT2 CALL Fn' : (JMP PAEm) PAEm JMP IFEm IFT2 SFT Gn' CALL Fn'' : (JMP IFEm) IFEm SFT Gn''	• After a selective branch, a parallel branch can be performed.
	Parallel coupling | Selective coupling			• The selective coupling point can be the same as the coupling point of a parallel coupling for selective branch → parallel branch. Note that in the Motion SFC chart, this type is displayed in order of a parallel coupling → a selective coupling, as shown on the left. • In this case, a pointer (Pn) cannot be set between the parallel coupling point (PAEm) and the selective coupling point (IFEm).
	Parallel branch | Selective branch		SFT Gn PABm PAT1 CALL Fn IFBm IFT1 SFT Gn' CALL Fn' : JMP IFEm IFT2 SFT Gn'' CALL Fn'' : (JMP IFEm) IFEm JMP PAEm PAT2 CALL Fn''' : CALL Kn (JMP PAEm) PAEm SFT Gn'''	• After a parallel branch, a selective branch can be performed.
	Selective coupling | Parallel coupling			• The parallel coupling point can be the same as the coupling point of a selective coupling for parallel branch → selective branch. Note that in the Motion SFC chart, this type is displayed in order of a selective coupling → a parallel coupling, as shown on the left. • In this case, a pointer (Pn) cannot be set between the selective coupling point (IFEm) and the parallel coupling point (PAEm).

	Name	Motion SFC chart symbol	List representation	Function
Application type	Selective branch | Selective branch		CALL Kn IFBm IFT1 SFT Gn IFBm+1 IFT1 SFT Gn' : JMP IFEm+1 IFT2 SFT Gn'' : (JMP IFEm+1) IFEm+1 JMP IFEm IFT2 SFT Gn''' CALL Fn' : (JMP IFEm) IFEm SFT Gn'''' :	• After a selective branch, a selective branch can be performed.
	Selective coupling | Selective coupling			• The two selective coupling points for selective branch → selective branch can be the same. Note that in the Motion SFC chart, this type is displayed in order of a selective coupling → selective coupling, as shown on the left. • In this case, a pointer (Pn) cannot be set between the selective coupling point (IFEm+1) and the selective coupling point (IFEm).
	Parallel branch | Parallel branch		CALL Kn PABm PAT1 SFT Gn PABm+1 PAT1 CALL Fn' : JMP PAEm+1 PAT2 CALL Fn'' : (JMP PAEm+1) PAEm+1 JMP PAEm PAT2 CALL Fn''' : CALL Kn JMP PAEm PAEm SFT Gn''' :	• After a parallel branch, a parallel branch can be performed. • A parallel branch can be nested up to four levels.
	Parallel coupling | Parallel coupling			• The two parallel coupling points for parallel branch parallel branch can be the same. Note that in the Motion SFC chart, this type is displayed in order of a parallel coupling → parallel coupling, as shown on the left. • In this case, a pointer (Pn) cannot be set between the parallel coupling point (PAEm+1) and the parallel coupling point (PAEm).

	Name	Motion SFC chart symbol	List representation	Function
Application type	Selective coupling | Parallel branch		: (JMP IFEm) IFEm PABm PAT1 CALL Fn : JMP PAEm PAT2 CALL Fn' : (JMP PAEm) PAEm :	• The selective coupling point and parallel branch point can be the same. Note that in the Motion SFC chart, this type is displayed in order of a selective coupling → parallel branch, as shown on the left. • In this case, a pointer (Pn) cannot be set between the selective coupling point (IFEm) and the parallel branch point (PABm).
	Parallel coupling | Selective branch		: JMP PAEm PAEm IFBm IFT1 SFT Gn : JMP IFEm IFT2 SFT Gn' : (JMP IFEm) IFEm :	• The parallel coupling point and selective branch point can be the same. Note that in the Motion SFC chart, this type is displayed in order of a parallel coupling → selective branch, as shown on the left. • Execution waits at the parallel coupling point and shifts to the selective branch. • In this case, a pointer (Pn) cannot be set between the parallel coupling point (PAEm) and the selective branch point (IFBm).
	Selective coupling | Selective branch		: (JMP IFEm) IFEm IFBm+1 IFT1 SFT Gn : JMP IFEm+1 IFT2 SFT Gn' : (JMP IFEm+1) IFEm+1	• The selective coupling point and selective branch point can be the same. Note that in the Motion SFC chart, this type is displayed in order of a selective coupling → selective branch, as shown on the left. • In this case, a pointer (Pn) cannot be set between the selective coupling point (IFEm) and the selective branch point (IFBm+1).
	Parallel coupling | Parallel branch		: (JMP PAEm) PAEm PABm+1 PAT1 CALL Fn : JMP PAEm+1 PAT2 CALL Fn' : (JMP PAEm+1) PAEm+1 :	• The parallel coupling point and parallel branch point can be the same. Note that in the Motion SFC chart, this type is displayed in order of a parallel coupling → parallel branch, as shown on the left. • Execution waits at the parallel coupling point and shifts to the parallel branch. • In this case, a pointer (Pn) cannot be set between the parallel coupling point (PAEm) and the parallel branch point (PABm+1).

10.4 Operation/Transition Control Specifications

(1) Table of Operation/Transition Control Specifications

<table>
<tr><th>Item</th><th colspan="3">Specifications</th><th>Remark</th></tr>
<tr><td rowspan="3">Expression</td><td colspan="2">Calculation expression</td><td>Returns a numeric result.
Expressions for calculating indirectly specified data using constants and word devices.</td><td>D100+1,SIN(D100), etc.</td></tr>
<tr><td rowspan="2">Conditional expression</td><td>Bit conditional expression</td><td>Returns a true or false result.
Expression for judging ON or OFF of bit device.</td><td>M0, !M0, M1*M0,
(M1+M2)*(!M3+M4), etc.</td></tr>
<tr><td>Comparison conditional expression</td><td>Expressions for comparing indirectly specified data and calculation expressions using constants and word devices.</td><td>D100==100
D10<D102+D10, etc.</td></tr>
<tr><td>Bit devices</td><td colspan="3">
<table>
<tr><th colspan="2" rowspan="2">Device</th><th rowspan="2">Symbol</th><th colspan="2">Accessibility</th><th colspan="2">Usable tasks</th><th rowspan="2">Description example</th></tr>
<tr><th>Read</th><th>Write</th><th>Normal</th><th>Event</th></tr>
<tr><td rowspan="2">Input</td><td>Input</td><td>X</td><td>○</td><td>○</td><td rowspan="8">○</td><td rowspan="8">○</td><td>X100</td></tr>
<tr><td>Actual Input</td><td>PX</td><td>○</td><td>×</td><td>PX180</td></tr>
<tr><td rowspan="2">Output</td><td>Output</td><td>Y</td><td>○</td><td>○</td><td>Y100</td></tr>
<tr><td>Actual Output</td><td>PY</td><td>○</td><td>○</td><td>PY1E0</td></tr>
<tr><td colspan="2">Internal relay</td><td>M</td><td>○</td><td>○</td><td>M20</td></tr>
<tr><td colspan="2">Link relay</td><td>B</td><td>○</td><td>○</td><td>B3FF</td></tr>
<tr><td colspan="2">Annunciator</td><td>F</td><td>○</td><td>○</td><td>F0</td></tr>
<tr><td colspan="2">Special relay</td><td>SM</td><td>○</td><td>○</td><td>SM0</td></tr>
</table>
○: usable
×: unusable

CAUTION
<Restrictions on write-enabled bit devices>
1) "X Devices" except " Actual inputs" can be written .
2) Special relay has predetermined applications in the system.
Do not perform write to other than the user setting device.
</td><td>The input X/output Y are written with the actual input PX/actual output PY.
Set the I/O number of "Actual inputs/ Actual outputs (PX/PY)" to "First I/O No" in "System Structure" of MT Developer2
DI : PX0 to PXFFF
DO : PY0 to PYFFF</td></tr>
<tr><td>Word devices</td><td colspan="3">
<table>
<tr><th rowspan="2">Devices</th><th rowspan="2">Symbol</th><th colspan="2">Accessibility</th><th colspan="2">Usable tasks</th><th rowspan="2">Description example</th></tr>
<tr><th>Read</th><th>Write</th><th>Normal</th><th>Event</th></tr>
<tr><td>Data register</td><td>D</td><td>○</td><td>○</td><td rowspan="5">○</td><td rowspan="5">○</td><td>DOL</td></tr>
<tr><td>Link register</td><td>W</td><td>○</td><td>○</td><td>W1F : F</td></tr>
<tr><td>Special register</td><td>SD</td><td>○</td><td>○</td><td>SD0</td></tr>
<tr><td>Motion register</td><td>#</td><td>○</td><td>○</td><td>#0F</td></tr>
<tr><td>Coasting timer</td><td>FT</td><td>○</td><td>×</td><td>FT</td></tr>
</table>
○: usable
×: unusable

CAUTION
<Restrictions on write-enabled word devices>
1) Special register has predetermined applications in the system.
Do not perform write to other than the user-set device.
</td><td></td></tr>
</table>

Table of the operation control/transition control specification (continued)

<table>
<tr><th>Item</th><th colspan="4">Specifications</th><th>Remark</th></tr>
<tr><td rowspan="6">Data type</td><td rowspan="2">(None)</td><td colspan="2">16-bit integer type (signed)</td><td>-32768 to 32767</td><td rowspan="2">K10, D100, etc.</td></tr>
<tr><td colspan="2">16-bit integer type (unsigned)</td><td>0 to 65535</td></tr>
<tr><td rowspan="2">L</td><td colspan="2">32-bit integer type (signed)</td><td>-2147483648 to 2147483647</td><td rowspan="2">2000000000, W100L, etc.</td></tr>
<tr><td colspan="2">32-bit integer type (unsigned)</td><td>0 to 4294967295</td></tr>
<tr><td>F</td><td colspan="2">64-bit floating-point type
(double precision real number type)</td><td>IEEE format</td><td>1.23, #10F, etc.</td></tr>
<tr><td rowspan="2">Constant</td><td>K</td><td>Decimal constant</td><td colspan="2" rowspan="2">The above data type symbol 'L' or '. (decimal point)' provided at the end indicates the data type. The constant without the data type is regarded as the applicable minimum type.</td><td rowspan="2">K-100, H0FFL, etc.
'K' may be omitted.</td></tr>
<tr><td>H</td><td>Hexadecimal constant</td></tr>
<tr><td rowspan="11">Number of instructions</td><td colspan="2">Binary operation</td><td>6</td><td rowspan="11">59 in total</td><td rowspan="11"></td></tr>
<tr><td colspan="2">Bit operation</td><td>6</td></tr>
<tr><td colspan="2">Sign</td><td>1</td></tr>
<tr><td colspan="2">Standard function</td><td>15</td></tr>
<tr><td colspan="2">Type conversion</td><td>6</td></tr>
<tr><td colspan="2">Bit device status</td><td>2</td></tr>
<tr><td colspan="2">Bit device control</td><td>5</td></tr>
<tr><td colspan="2">Logical operation</td><td>4</td></tr>
<tr><td colspan="2">Comparison operation</td><td>6</td></tr>
<tr><td colspan="2">Motion dedicated function</td><td>2</td></tr>
<tr><td colspan="2">Others</td><td>6</td></tr>
<tr><td rowspan="2">Read/write response of input PX, output PY</td><td colspan="2">Input response</td><td colspan="3">Direct read control at instruction execution.</td><td rowspan="2"></td></tr>
<tr><td colspan="2">Output response</td><td colspan="3">Direct write control at instruction execution.</td></tr>
</table>

⚠CAUTION

● If " Multi CPU common devices" are set, a SFC error will occur. (The error code depends on the instructions, so refer to "Motion SFC error code list".)

(2) Table of the operation control/transition instruction

Classification	Symbol	Function	Format	Basic steps	Usable step		Y/N transition's conditional expression
					F/FS	G	
Binary operation	=	Substitution	(D)=(S)	4	○	○	—
	+	Addition	(S1)+(S2)	4	○	○	—
	-	Subtraction	(S1)-(S2)	4	○	○	—
	*	Multiplication	(S1)*(S2)	4	○	○	—
	/	Division	(S1)/(S2)	4	○	○	—
	%	Remainder	(S1)%(S2)	4	○	○	—
Bit operation	~	Bit inversion (complement)	~(S)	2	○	○	—
	&	Bit logical AND	(S1)&(S2)	4	○	○	—
	|	Bit logical OR	(S1)|(S2)	4	○	○	—
	^	Bit exclusive logical OR	(S1)^(S2)	4	○	○	—
	>>	Bit right shift	(S1)>>(S2)	4	○	○	—
	<<	Bit left shift	(S1)<<(S2)	4	○	○	—
Sign	-	Sign inversion (complement of 2)	-(S)	2	○	○	—
Standard function	SIN	Sine	SIN(S)	2	○	○	—
	COS	Cosine	COS(S)	2	○	○	—
	TAN	Tangent	TAN(S)	2	○	○	—
	ASIN	Arcsine	ASIN(S)	2	○	○	—
	ACOS	Arccosine	ACOS(S)	2	○	○	—
	ATAN	Arctangent	ATAN(S)	2	○	○	—
	SQRT	Square root	SQRT(S)	2	○	○	—
	LN	Natural logarithm	LN(S)	2	○	○	—
	EXP	Exponential operation	EXP(S)	2	○	○	—
	ABS	Absolute value	ABS(S)	2	○	○	—
	RND	Round-off	RND(S)	2	○	○	—
	FIX	Round-down	FIX(S)	2	○	○	—
	FUP	Round-up	FUP(S)	2	○	○	—
	BIN	BCD ⟶ BIN conversion	BIN(S)	2	○	○	—
	BCD	BIN ⟶ BCD conversion	BCD(S)	2	○	○	—
Type conversion	SHORT	Convert into 16-bit integer type (signed)	SHORT(S)	2	○	○	—
	USHORT	Convert into 16-bit integer type (unsigned)	USHORT(S)	2	○	○	—
	LONG	Convert into 32-bit integer type (signed)	LONG(S)	2	○	○	—
	ULONG	Convert into 32-bit integer type (unsigned)	ULONG(S)	2	○	○	—
	FLOAT	Regard as signed data and convert into 64-bit floating point type	FLOAT(S)	2	○	○	—
	UFLOAT	Regard as unsigned data and convert into 64-bit floating point type	UFLOAT(S)	2	○	○	—
Bit device status	(None)	ON (normally open contact)	(S)	2	○	○	○
	!	OFF (normally closed contact)	!(S)	2	○	○	○
Bit device control	SET	Device set	SET(D)	3	○	○	—
			SET(D)= (conditional expression)	4	○	○	—
	RST	Device reset	RST(D)	3	○	○	—
			RST(D)=(conditional expression)	4	○	○	—
	DOUT	Device output	DOUT(D),(S)	4	○	○	—
	DIN	Device input	DIN(D),(S)	4	○	○	—
	OUT	Bit device output	OUT(D)=(conditional expression)	4	○	○	—

Table of the operation control/transition instruction (continued)

Classification	Symbol	Function	Format	Basic steps	Usable step		Y/N transition's conditional expression
					F/FS	G	
Logical operation	(None)	Logical acknowledgment	(Conditional expression)	0	○	○	○
	!	Logical negation	!(Conditional expression)	2	○	○	○
	*	Logical AND	(Conditional expression) * (conditional expression)	4	○	○	○
	+	Logical OR	(Conditional expression) + (conditional expression)	4	○	○	○
Comparison operation	==	Equal to	(Conditional expression) == (conditional expression)	4	○	○	○
	!=	Not equal to	(Conditional expression) != (conditional expression)	4	○	○	○
	<	Less than	(Conditional expression) < (conditional expression)	4	○	○	○
	<=	Less than or equal to	(Conditional expression) <= (conditional expression)	4	○	○	○
	>	More than	(Conditional expression) > (conditional expression)	4	○	○	○
	>=	More than or equal to	(Conditional expression) >= (conditional expression)	4	○	○	○
Motion dedicated function	CHGV	Speed change request	CHGV((S1),(S2))	4	○	○	—
	CHGT	Torque limit value change request	CHGT((S1),(S2))	4	○	○	—
Others	EI	Event task enable	EI	1	○	○	—
	DI	Event task disable	DI	1	○	○	—
	NOP	No operation	NOP	1	○	○	—
	BMOV	Block transfer	BMOV(D),(S),(n)	6	○	○	—
	FMOV	Same data block transfer	FMOV(D),(S),(n)	6	○	○	—
	MULTW	Write device data to CPU shared memory of the self CPU	MULTW(D),(S),(n),(D1)	8	○	○	—
	MULTR	Read device data from CPU shared memory of the other CPU	MULTR(D),(S1),(S2),(n)	7	○	○	—
	TO	Write device data to intelligent function module.	TO(D1),(D2),(S),(n)	7	○	○	—
	FROM	Read device data from intelligent function module.	FROM(D),(S1),(S2),(n)	7	○	○	—
	TIME	Time to wait	TIME(S)	7	—	○	—

⚠CAUTION

● If an unavailable "Operation control" or "Transition instruction" is set, a "Motion SFC program start error" will occur.

(3) Rough calculation expression of single program for operation control/transition program

2 + (1 + Total number of basic steps in 1 block
+ Number of 32-bit constants/1 block × 1
+ Number of 64-bit constants/1 block × 3) × Number of blocks (steps)
(1 step = 2 bytes)

10.5 Program Parameters

Set the following parameters for every Motion SFC program.

No.	Item	Setting range	Initial value	Remark
1	Start setting	Automatically started or not	Not setting	These parameters are imported at leading edge of PLC ready flag (M2000) and used for control thereafter. When setting/changing the values of these parameters, turn PLC ready flag (M2000) off.
2	Execute task	Can be either a normal, event or NMI task.	Normal task	
		When you have set the event task, further set the event. 1. Fixed cycle Can be either 0.44ms, 0.88ms, 1.77ms, 3.55ms, 7.11ms,14.2ms or none. The same event can be shared among multiple Motion SFC programs.	None	
3	Number of consecutive transitions	1 to 10 Set the number of consecutive transitions toward the program set to the event .	1	
4	END operation	End/continue Set the operation mode of the END step toward the program set to the event .	End	
5	Executing flag	None/Bit device Set the bit device turned ON while executing Motion SFC program. X0 to X1FFF Y0 to Y1FFF M0 to M8191 B0 to B1FFF	None	

10.6 Device Descriptions

Word and bit device descriptions are shown below.

(1) Word device descriptions

	Device descriptions			Device No. (n) specified ranges
	16-bit integer type	32-bit integer type ("n" is even No.)	64-bit floating-point type ("n" is even No.)	
Data register	Dn	DnL	DnF	0 to 8191
Link register	Wn	WnL	Wn:F	0 to 1FFF
Special register	SDn	SDnL	SDnF	0 to 2255
Motion device	#n	#nL	#nF	0 to 12287
Coasting timer	—	FT	—	—

(a) For differentiation, the 32-bit floating-point type is ended by L and the 64-bit floating-point type by F (F for the link register).

(b) For the 32-bit integer type and 64-bit floating-point type, specify the device number with an even number. (It cannot be set as an odd number).

(c) The coasting timer FT is incremented per 888[μs]. (The coasting timer is a 32-bit integer type.)

(2) Bit device descriptions

	Device description	Device No. (n) specified ranges
Input relay	Xn PXn	Xn : 0 to 1FFF PXn : 0 to FFF
Output relay	Yn PYn	Yn : 0 to 1FFF PYn : 0 to FFF
Internal relay	Mn	0 to 12287
Link relay	Bn	0 to 1FFF
Annunciator	Fn	0 to 2047
Special relay	SMn	0 to 2255

(a) When using the device in DIN or DOUT as batch bit data, specify "n" as a multiple of 16.

MEMO

11. MECHANICAL SYSTEM PROGRAM

This section describes virtual mode of the mechanical system program.

In the mechanical system program (Mechanical support language), mechanical hardware that historically has been used to perform synchronous control such as gears, shafts, belts, pulleys, cams and variable speed changers, etc. are transposed to software and the same operational control can be performed.
The mechanical system program consists of mechanical module connection diagrams and mechanical module parameters.

- Mechanical module connection diagrams show a virtual mechanical system consisting of multiple connected virtual mechanical modules.
- The mechanical module parameters are used to control of the mechanical modules used at the mechanical module connection diagram.

Refer to the "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (VIRTUAL MODE)" for specifics of the mechanical module parameters.

11.1 Mechanical Module Connection Diagram

The mechanical module connection diagram depicts a virtual system composed of user arranged mechanical modules.
Configuration of the mechanical module connection is shown in Fig. 11.1 below.

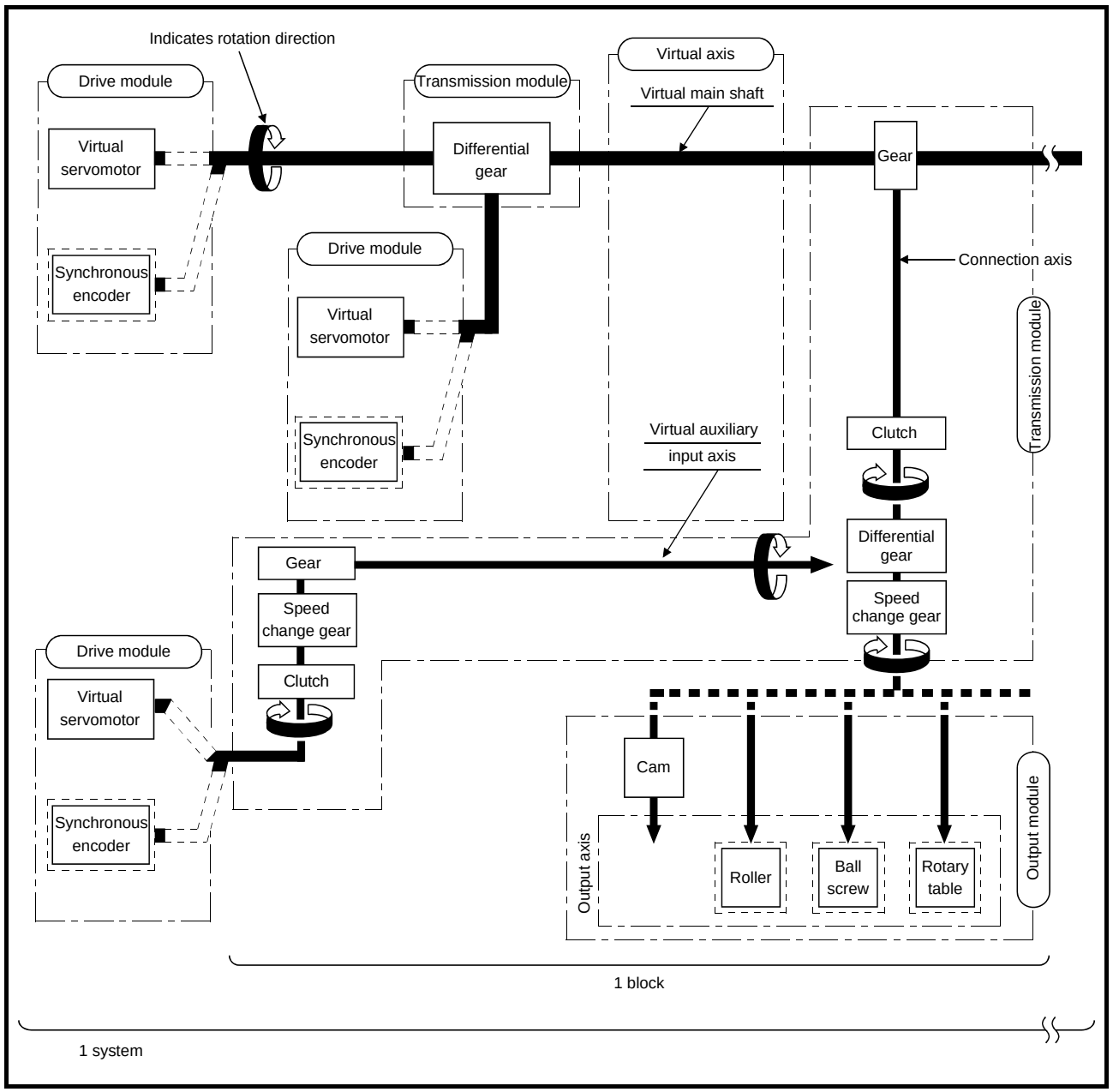


Fig. 11.1 Configuration of the Mechanical Module Connection

POINT

(1) Either a virtual servomotor or a synchronous encoder can be connected to the drive shaft.
(2) Either a cam, roller, ball screw or rotary table can be connected to the output shaft.

(1) Block

The term "block" is one set of mechanical modules beginning after a virtual transmission module (gear) connected to the virtual main shaft and ending at the output module.

Refer to Section 11.2 for the number of mechanical modules which can be connected in a single block.

(2) System

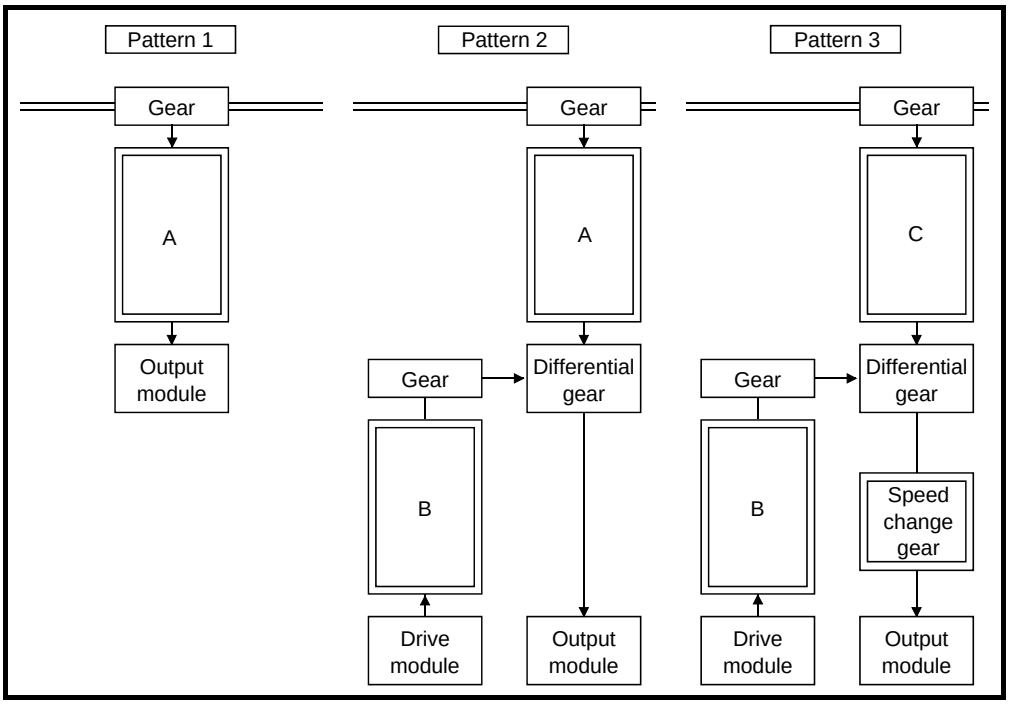
The term "system" is a generic term of multiple blocks connected to one virtual main shaft.

The maximum number of blocks allowable in a single system is 32.

(3) Transmission module connections

There are 3 transmission module connection patterns:

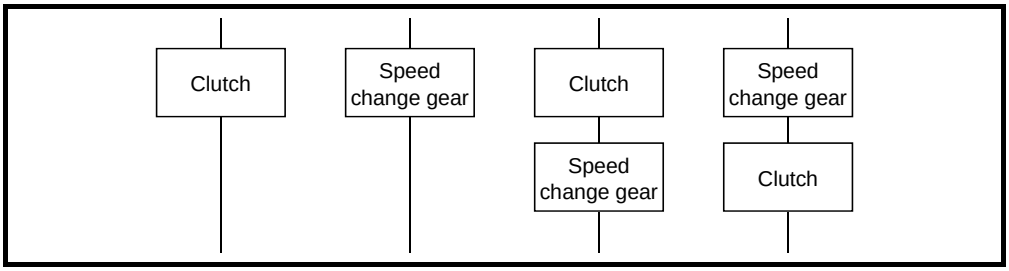
- Pattern 1..... Straight connection to output (i.e. no differential gear).
- Pattern 2..... Differential gear connection directly connected to the output module (i.e. no speed change gear).
- Pattern 3..... Differential gear connection with a speed change gear on the output side.



(a) Transmission modules which can be used in the above "A" and "B"

1) A clutch, speed change gear, and "clutch + speed change gear" can be used in "A" and "B".

2) There are no restrictions on connection constraints if a "clutch + speed change gear" combination is used.



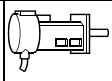
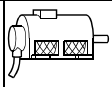
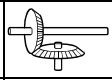
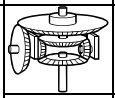
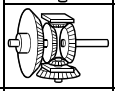
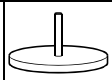
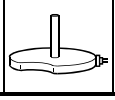
(b) Transmission module which can be used in above "C" (pattern 3)

Only a clutch can be used in location "C".

11.2 Mechanical Module List

An overview of the mechanical modules used in the virtual mode connection diagram is shown in Table 11.1.
Refer to the "Q173DCPU/Q172DCPU Motion controller (SV13/SV22) Programming Manual (VIRTUAL MODE)" for details of the mechanical modules.

Table 11.1 Mechanical Module List

Classification	Mechanical Module		Maximum Number of Usable						Function Description
			Number Per Motion CPU module		Number Per System		Number Per Block		
	Name	Appearance					Connection Shaft Side	Auxiliary Input Axis Side	
Drive module	Virtual servomotor		3	Total 4	3	Total 3	—	—	• Drives the virtual axis of the mechanical system program using the servo program or a JOG operation . • Axes 1 to 8 can be set as a Virtual axis.
	Synchronous encoder		1		1		—	—	• Drives the virtual axis using input pulses from an external synchronous encoder..
Virtual axis	Virtual main shaft	—	1	Total 1	1		—	—	• This is a virtual "link shaft". • Drive module rotation is transferred to the transmission module.
	Virtual auxiliary input axis	—	1		1		—	—	• This is the auxiliary input axis to the transmission module's differential gear . • Automatically displayed when a differential gear and standard gear are connected .
Transmission module	Gear		2		2		1	1	• Drive module rotation is transmitted to the output axis. • The travel value (pulse) input from the drive module is transmitted to the output axis as a function of the gear ratio and rotation direction defined by the user in the module's settings.
	Direct clutch		2		2		1	1	• Transmits or disconnects the drive module rotation to the output module. • Direct clutches transmit directly to the output shaft while smoothing clutches perform an acceleration/deceleration profile during ON/OFF operation based on a set smoothing time-constant setting. • ON/OFF mode, address mode can be selected to suit the application. (The external input mode can not be selected to suit the application.) • The smoothing clutch can be set to use a time-constant method or slippage method.
	Smoothing clutch								
	Speed change gear		2		2		1	1	• Changes the speed of an output module (roller). • The setting speed change ratio is applied to input axis speed, and transmits to the output axis.
	Differential gear		1		1		1	—	• Auxiliary input axis rotation is subtracted from the virtual main shaft rotation and the result is transmitted to the output axis.
			1		1		—		• Auxiliary input axis rotation is subtracted from the virtual main shaft rotation and the result is transmitted to the output axis. (Connected to the virtual main shaft)
Output module	Roller		1	Total 1	1	Total 1	1	1	• Used to perform speed control.
	Ball screw		1		1				• Used to perform linear positioning control.
	Rotary table		1		1				• Used to perform angle control.
	Cam		1		1				• Position control executed based on cam pattern data setting. • There are 2 cam control modes: two-way cam and feed cam.

11.3 Device range

The below devices can be used for "Indirect setting" of "Transmission module" and "Output module" in Mechanical support language.

(1) Bit devices

Table 11.2 Bit devices List

Name	Setting range
Input relay	X0000 to X1FFF
Output relay	Y0000 to Y1FFF
Internal relay	M0 to M8191
Link relay	B0000 to B1FFF
Annunciator	F0 to F2047

(2) Word devices

Table 11.3 Word devices List

Name	Setting range
Data register	D0 to D8191
Link register	W0 to W1FFF
Motion register	#0 to #12287

Remark

An error will occur if the multi-CPU common devices (for Q172DCPU/Q173DCPU) are set.

12. COMMUNICATION

Connection compatibility of the Motion controller with the dedicated software and GOT is shown below.

Peripheral device interface \ Transfer		MT Developer2	GOT
RS-422 communication I/F		X	○(Note-1)
PERIPHERAL I/F	Direct connection	○	○
	Connection via HUB	○	○

○:Possible X: Impossible

Note-1: Functionality varies by version. Please see Section 1.3 for details.

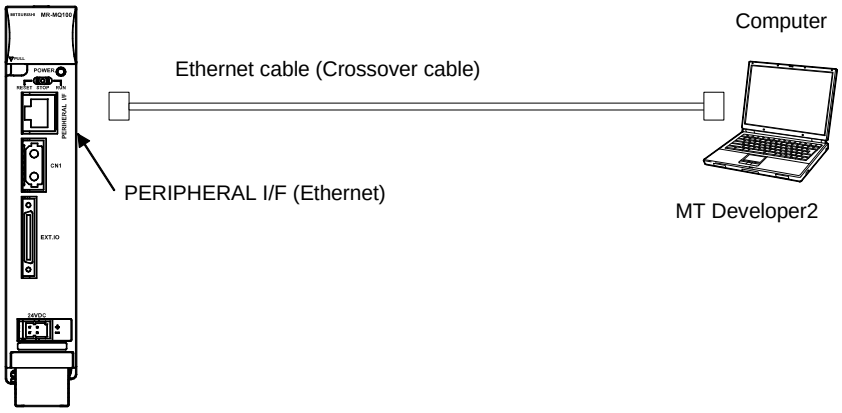
12.1 Connection to peripheral devices

There are two ways to communicate between the Motion controller and a computer: "Direct connection" and "Hub Connection".
Ethernet cables and parameters are different for "Direct connection" and "Hub Connection".
Please note there are two types of Ethernet cables: "Crossover cable" and "Straight cable". Refer to the section 2.1(2).

12.1.1 Direct connection

"Direct connection" uses an Ethernet cable between the Motion controller and a computer.
Select "Direct connection" on the "Transfer Setup" screen of MT Developer2.

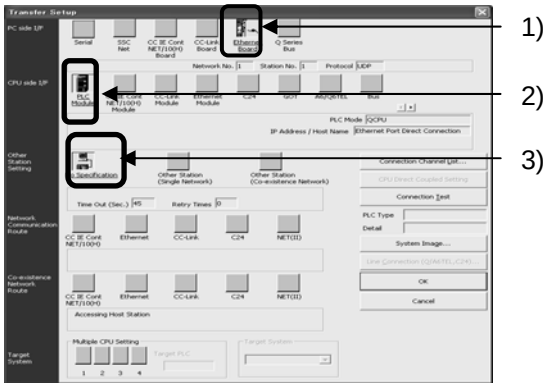
* No need to set "IP address", "IP Input Format" or "Protocol".



(1) Direct connection settings

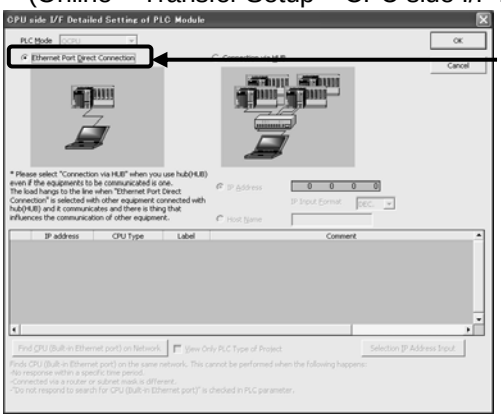
Select "Ethernet Port Direct connection" on the Transfer Setup screen.

Transfer Setup
(Online > Transfer Setup)



1) Select "Ethernet Board" for PC side I/F.
2) Select "CPU Module" for CPU side I/F.
   Select the "Ethernet Port Direct Connection" on the CPU side I/F Detail Setting of PLC Module screen.
3) Choose this setting for Other Station Setting.

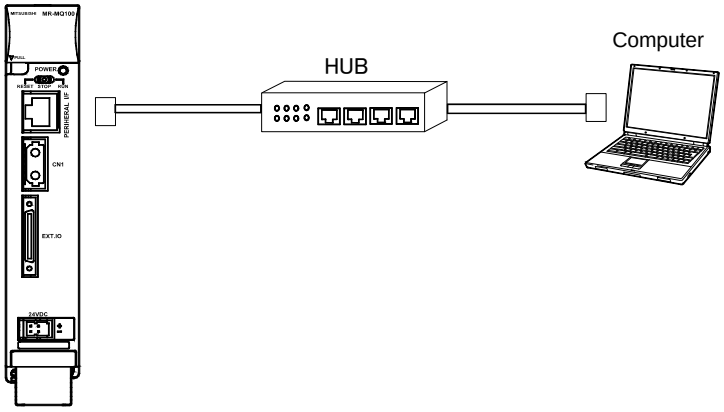
CPU side I/F Detailed Setting of PLC Module
(Online > Transfer Setup > CPU side I/F Detailed Setting of PLC Module)



Select "Ethernet Port Direct connection"

(2) Note

(a) When you want to use a hub, refer to next section "Hub Connection"



(b) Do not connect to a LAN with "Direct connection" setting. The LAN line will become busy and may effect communication of other equipment on the LAN.

(c) IP address setting does not matter when using a direct connection. However, communication may fail with the below conditions.

•In the Motion controller IP address, bits corresponding to "0" in the computer subnet mask are all ON (255) or all OFF (0).

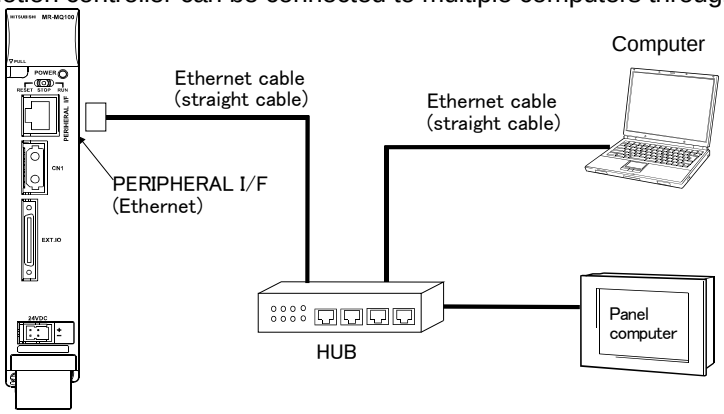
[Example] Motion controller IP address: 64. 64.255.255
Personal computer IP address: 64. 64. 1. 1
Personal computer subnet mask: 255.255. 0. 0

•In the Motion controller IP address, bits corresponding to the computer IP address for each class in the personal computer IP address are all ON (255) or all OFF (0).

[Example] Motion controller IP address: 64. 64.255.255
Personal computer IP address: 192.168. 0. 0
Personal computer subnet mask: 255. 0. 0. 0

12.1.2 Hub Connection

The Motion controller can be connected to multiple computers through a hub.



(1) Hub connection settings

Before connection with a hub can be made, the Motion controller's settings must be changed using a direct connection method.

(a) Connecting an Ethernet cable (Crossover cable)

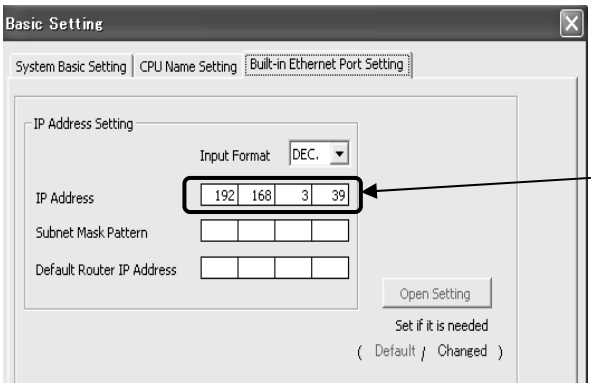
Connect an Ethernet cable (Crossover cable) between the Motion controller and a computer.

(b) Setting IP address of the Motion controller

Set the IP address located in the "Built-in Ethernet Port Setting" tab.
The default IP address value is [192.168.3.39]
Refer to (2)Note about IP address value setting.
No need to set "Subnet Mask Pattern" or "Default Router IP Address".

"Built-in Ethernet Port Setting"

(System Setting > Basic Setting > Built-in Ethernet Port Setting)

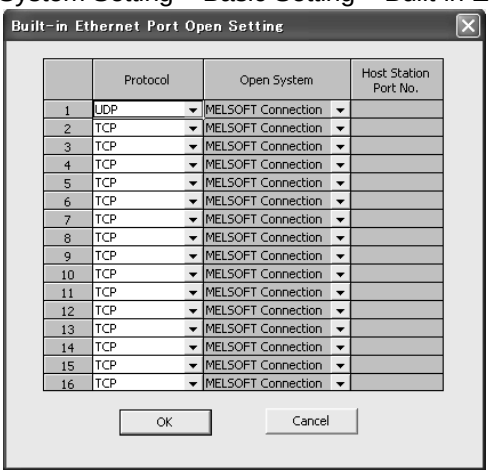


Set IP address
Refer to (2) Note

(c) "Open Setting" of the Motion controller

Select TCP or UDP to correspond to current setting of the computer.
TCP is recommended, because of the quality of the communication.

"Open Setting"
(System Setting > Basic Setting > Built-in Ethernet Port Setting > Open Setting)



(d) Writing parameters

Write parameters to the Motion controller.
(Crossover cable must be used for this step.)

(e) Changing cables

Power off the Motion controller, then change the Ethernet cable from a crossover cable to a straight cable.

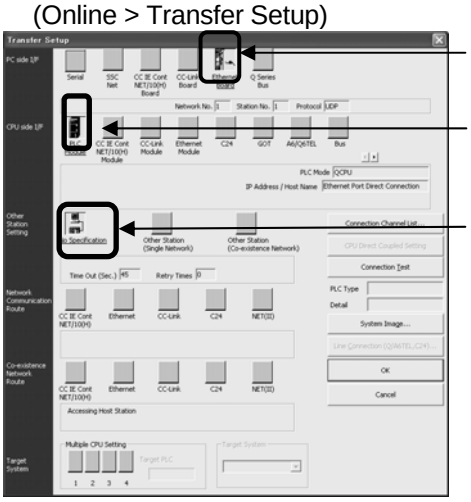
Equipment	Ethernet cable
The Motion controller — Hub	Straight cable
All Computers — Hub	Straight cable

(f) Enabling the parameters of the Motion controller

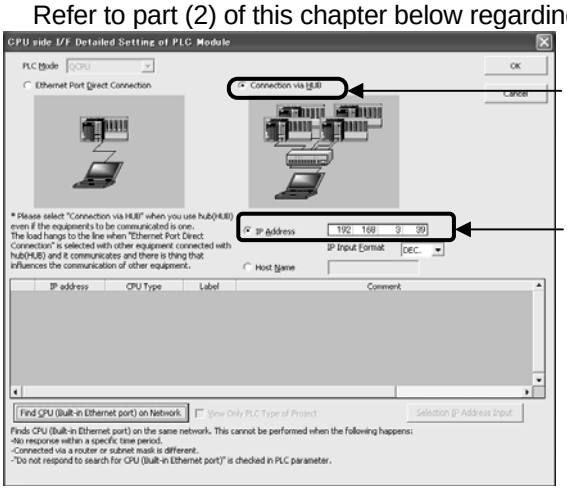
Once power returns to the Motion controller, the "Open Setting" IP address and parameters will become enabled.

(g) Transfer Setup of the computer (MT Developer2)
Select "Connection via Hub" on the Transfer Setup screen.

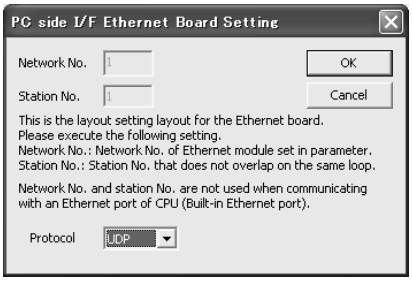
Transfer Setup
(Online > Transfer Setup)



"CPU side I/F Detailed Setting of PLC Module"
Select "Connection via Hub"
Set the IP address to the same value as the IP address of the Motion controller.
The default value of the IP address is [192.168.3.39]
Refer to part (2) of this chapter below regarding the IP address setting.



"PC side I/F Ethernet Board Setting"
Select TCP or UDP to be same as "Open Setting"

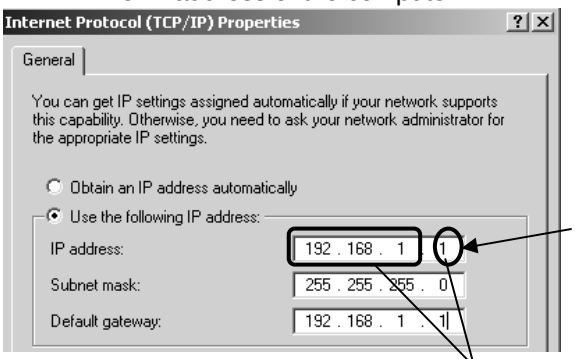


(2) Hub connection setting

(a) IP Address

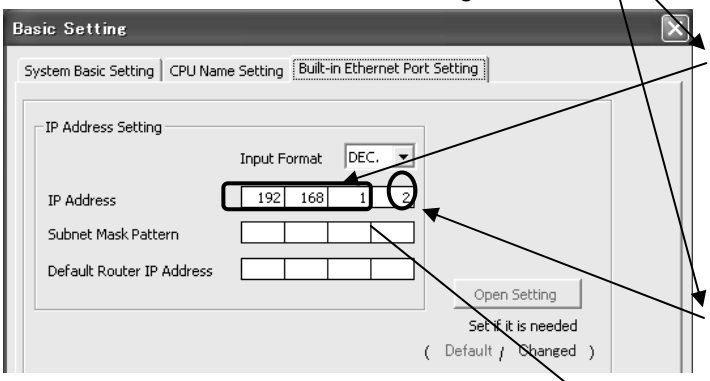
The IP address of the Motion controller has to be considered when the IP address of the computer is already set. The below setting is one example. (For instance, the IP address of the computer is [192.168.1.1])

The IP address of the computer



For instance
[192.168.1.1] is already set as the IP address of the computer.

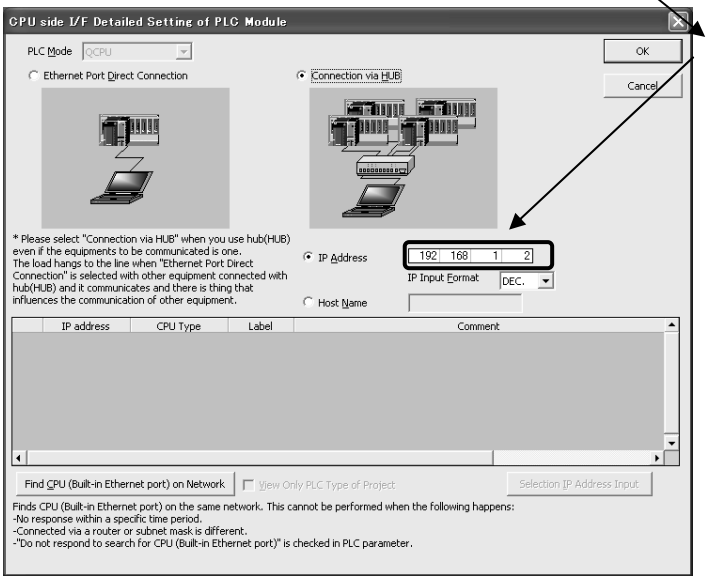
"Built-in Ethernet Port Setting"



Set the values of these 3 columns to the same value as the computer's setting.

Be sure this column has a different value than the computer's setting.

For example, [192.168.1.2] on the controller when [192.168.1.1] is set on the computer side.



Set this value to be the same as the "Built-in Ethernet Port Setting.
In this example, [192.168.1.2]

(b) Up to 16 different equipment can access the Motion controller.

(c) Hub
The hub can be either a 10BASE-T or 100BASE-TX port.
(It has to meet IEEE802.3 100BASE-TX or IEEE802.3 10BASE-T)

(d) The Ethernet cables must to be installed away from power cabling lines.

(e) The connections cannot be guaranteed under below conditions:
- Any connection made over the internet.
- Any connection made through a fire wall.
- Any connection made through a broadband router.
- Any connection made through a wireless LAN.

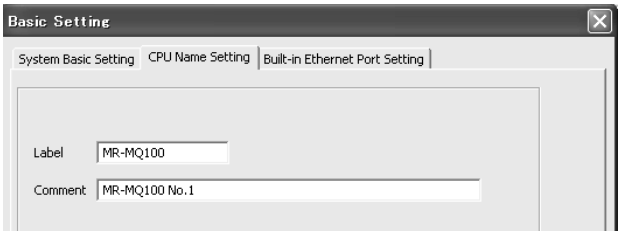
(f) When multiple Motion controllers are connected to MT Developer2, beware of the below cautions:
- IP addresses must be different for each Motion controller.
- Different projects must be used for each Motion controllers on MT Developer2.
- Only one instance each of the "Digital oscilloscope function" and "Test mode function" can be used on a single computer at a time.

12.1.3 Setting CPU name

(1) HUB connection setting

When setting up a connection to a hub, a label and comments can be added to each controller in the CPU Name Setting tab of the Basic Settings window. (Communication is still available even without defining a Label and/or Comment.)

"CPU Name Setting"
(System Setting > Basic Setting > CPU Name Setting)



Item	Contents	Length
Label	Enter a label (name and/or purpose) of the Motion controller.	Up to 10 characters.
Comment	Enter comments regarding the Motion controller.	Up to 64 characters.

The "Find CPU (Built-in Ethernet port) on Network" function in the "CPU side I/F Detailed Setting of PLC Module" conveniently shows the below information when MT Developer2 and the Motion controller are connected via the PERIPHERAL I/F (Ethernet).

- IP address .
- CPU type.
- Label.
- Comment.

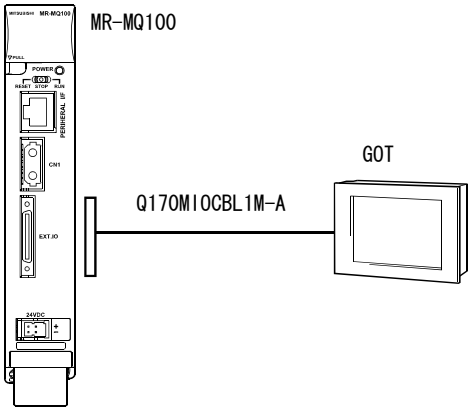
12.2 Connection with GOT

The Motion controller can connect GOT with using the RS-422 communication interface.

Item	Model	Remark
Internal I/F connector cable (GOT communication I/F)	Q170MIOCBL1M-A	The GOT side is a pigtail cable.
	Q170MIOCBL1M-B	The GOT side is D-SUB (9pin).

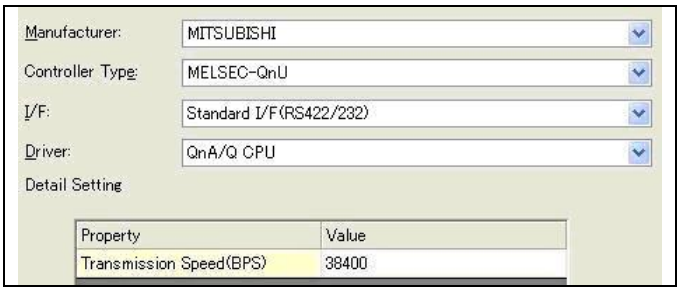
(1) Connection between the MR-MQ100 and GOT

Diagram of the connection between the MR-MQ100 and GOT (GT1020) is shown below.



(2) Controller setting with the GOT device

Set the parameter with the GOT device in [Controller Setting] of GT Designer3. Example for setting GOT1020 is shown below.



(3) Precautions

(a) Communication with RS-422 can be performed only when the motion controller is starting in the normal mode.
When a system setting error etc. occurs, it is possible to communicate only if the motion controller is in the normal mode.

(b) It is not possible to communicate in the installation mode.

(c) When a rate faster than 38400bps is specified, say when 57600/115200 bps is set, the speed is automatically set to 38400bps.

13. AUXILIARY FUNCTION

13.1 Mark detection function

The mark detect function latches various data such as "real current value", etc. when a mark sensor (Digital input signal) input changes state.

Items	Specification
Digital input signals	DI1, DI2, DI3 and DI4
Input Module Detect Direction	Valid on leading (rising) edge, Valid on trailing (falling) edge. (Selectable in "System Structure" of MT Developer2)
Mark input signal compensation time	-32768 to 32767μs
Mark input accuracy	30μs
Latch data	Total 7 types Real current value, Feed current value, Position feed back, Feed current value of virtual servomotor, Current value of synchronous encoder, Current value within 1 cam shaft revolution, (Real current value) Current value within 1 cam shaft revolution, (Feed current value)
Number of continuous latch data that can be stored	Up to 32
Range of latch data	-2147483648 to 2147483647

[Feature]

One type of data can be selected out of a total of 7 types.
Real current value, Feed current value, Position feed back,
Feed current value of virtual servomotor,
Current value of synchronous encoder
Current value within 1 cam shaft revolution. (Real current value)
Current value within 1 cam shaft revolution. (Feed current value)

[Detailed function]

It is possible store latch data to a device continuously.
The number of stored latch data can be set by the user. This is useful when latch data is continuously input into the system.

<Example> One work /process has several marks. Every 4th mark is used by the system.

(a) Set the value “4” to the "Specified number method" parameter and clear the value of "Number of mark detection" so that it returns to "0".
(b) The system will wait until "Number of mark detection" reaches "4".
(c) Then the latch data relating to the mark input will be saved to the data storage device.

[Devices list]

	Items	Contents	Value	Taking cycle	Unit
Setting device	#7912,#7913 #7914,#7915 #7916,#7917 #7918,#7919	Registration codes These devices make the "Mark detection function" valid	#7912=H434D #7913=H414D #7914=H4B52 #7915=H4544 #7916=H4554 #7917=H5443 #7918=H4144 #7919=H4154	Main cycle	-

	Mark detection function				Contents	Setting range /Monitor value	Fetch cycle/ Refresh cycle	Unit
	1	2	3	4				
Setting device	#7920	#7940	#7960	#7980	Mark detection signal allocation devices	1 to 4	At setting of registration code	—
	#7921	#7941	#7961	#7981	Mark detection signals compensation time	-32768 to 32767	Operation cycle	[μs]
	#7922	#7942	#7962	#7982	Latch data type	0 to 6	At setting of registration code	—
	#7923	#7943	#7963	#7983	Mark detection data axis number	1 to 8(Note-1)	At setting of registration code	(Note-2)
	#7926 #7927	#7946 #7947	#7966 #7967	#7986 #7987	Latch data upper limit	-2147483648 to 2147483647	Operation cycle	(Note-2)
	#7928 #7929	#7948 #7949	#7968 #7969	#7988 #7989	Latch data lower limit	-2147483648 to 2147483647	Operation cycle	—
	#7930	#7950	#7970	#7990	Mark detection mode	0 to 32	Operation cycle	(Note-2)
Monitor device	#8896 #8897	#8976 #8977	#9056 #9057	#9136 #9137	Mark detection data current monitor	-2147483648 to 2147483647	Operation cycle	(Note-2)
	#8898	#8978	#9058	#9138	Number of marks detected	0 to 65535(Note-3)	Upon detection of mark signals	—
	#8899	#8979	#9059	#9139	Mark detection settings verification flag	0 to 1	Main cycle	—
	#8912 #8913 to #8974 #8975	#8992 #8993 to #9054 #9055	#9072 #9073 to #9134 #9135	#9152 #9153 to #9214 #9215	Latch data storage area	-2147483648 to 2147483647	Upon detection of mark signals	(Note-2)

(Note-1): Refer to "(e) Mark detection data axis number"

(Note-2): It depends on the axis to which data is latched. $\times 10^{-1}$[μm], $\times 10^{-5}$[degree], $\times 10^{-5}$[inch],[PLS]

(Note-3): It depends on "Mark detection mode (#7930+20m)"

POINT

If the setting values are out of range, the mark detection functions are invalid.

[Data setting]

(1) Mark detection device settings

Up to 4 mark detection functions can be set.

(a) Registration code

(#7912,#7913,#7914,#7915,#7916,#7917,#7918,#7919)

When the specified data are set to "#7912 to #7919", the mark detection functions become valid.

If anything other than the specified data is set, the mark detection functions are invalid and at next power on, this incorrect data in "#7912 to #7919" is cleared.

Below is an example of motion SFC.

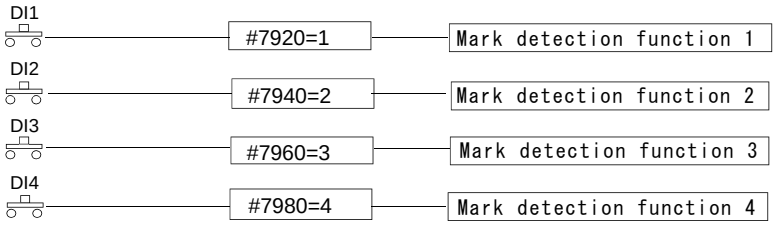
```
#7912L=H414D434D
#7914L=H45444B52
#7916L=H54434554
#7918L=H41544144
```

(b) Mark detection signals allocation devices (#7920+20m)

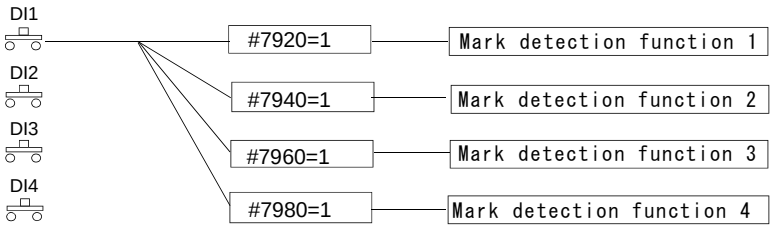
These devices allocate between the digital inputs (DI1 to DI4) to the mark detection functions.

Setting value	Contents
1	The mark detection signal is allocated to DI1.
2	The mark detection signal is allocated to DI2.
3	The mark detection signal is allocated to DI3
4	The mark detection signal is allocated to DI4.

<Ex1> Each mark detection functions is allocated to a different digital inputs.



<Ex2> All mark detection functions are allocated to a digital input (DI1).



(c) Mark detection signal compensation time (#7921+20m) [Unit : μs]
Use these devices to compensate delay of sensors and so on.

Setting values	Contents
-32768 to -1	Decrease in sensor delay. [μs]
0 to 32767	Increase in sensor delay. [μs]

(d) Latch data type (#7922+20m)
Select data type to latch, at the mark sensors are detected.

Setting values	Contents	Unit	Mark detection data axis number
0	Real current value	(Note-1)	1
1	Feed current value	(Note-1)	1
2	Position feed back	[PLS]	1
3	Feed current value of virtual servomotor	(Note-1)	1 to 8
4	Current value of synchronous encoder	(Note-1)	1
5	Current value within 1 cam shaft revolution. (Real current value)	(Note-1)	1
6	Current value within 1 cam shaft revolution. (Feed current value)	(Note-1)	1

(Note-1): It depends on the axis whose data is latched. $\times 10^{-1}$[μm], $\times 10^{-5}$[degree], $\times 10^{-5}$[inch],[PLS]

(e) Mark detection data axis number (#7923+20m)
Select the axis number for mark detection function.
With the exception of "Feed current value of virtual servomotor", only axis 1 can be selected. Please refer to the above table.

(f) Latch data upper limit (#7926+20m, #7927+20m)
Set the upper limit of latch data during mark detection.
Depends upon the relation of the upper limit and the lower limit.

Setting values	Contents
Upper limit > Lower limit	All data greater than "Lower limit" and smaller than "Upper limit" can be latched.
Upper limit = Lower limit	All data can be latched.
Upper limit < Lower limit	Mark detection function will not work.

(g) Latch data lower limit (#7928+20m, #7929+20m)
Set the lower limit of latch data during mark detection.
See the above table.

(h) Mark detection mode (#7930+20m)
Select the mark detection mode.
See the below table.

Setting values	Contents
0	Continuous detection mode.
1 to 32	Specified number of detections mode. The data continues to be latched until the specified number of detections (#8898+80m) is reached.

(2) Mark detection monitor devices

These monitor devices show the status of the mark detection function.

(a) Mark detection data current monitor (#8896+80m, #8897+80m)
The current data selected can be monitored.

(b) Number of marks detected (#8898+80m)
Running count of each mark detected. The range depends upon the "Mark detection mode (#7930+20m)"

• Continuous detection mode (#7930+20m= 0 to 65535)
After "65535" is reached, the count returns to "0". (Ring counter)
The latch data is always stored to #8912,#8913+80m.

• Specified number of detections mode (#7930+20m= 0 to 32)
Until "Number of marks detected (#8898+80m)" reaches the value of #7930+20m, the latch data is stored to the "Latch data storing area".
Clear "Number of marks detected (#8898+80m)" before starting the mark detection function.

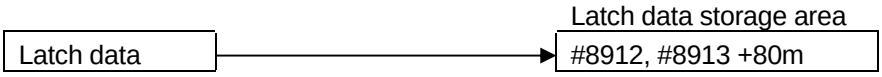
POINT

(1) When "specified number of detections mode" is set as the "Mark detection mode (#7930+20m)", clear "Number of marks detected (#8898+80m)" set to "0". Otherwise mark detection will not work correctly.

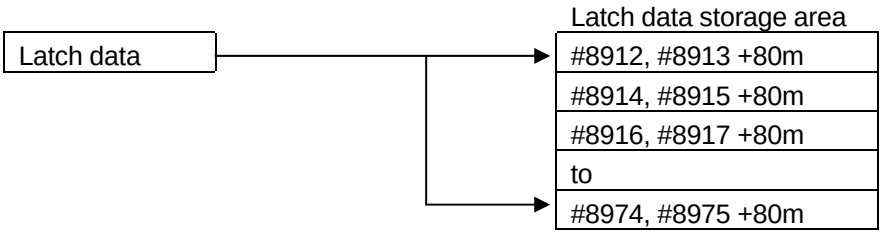
(c) Mark detection settings verification flag (#8899+80m)
When "Mark detection signals allocation devices (#7920+20m)", "Latch data type (#7922+20m)" and "Mark detection data axis number (#7923+20m)" are all correct, the verification flag (#8899+80m) will become "1".
If even one of the above three settings is incorrect, the verification flag becomes "0".

(d) Latch data storage area (#8912,#8913+80m to #8974,#8975+80m)
There are 32 storage areas for detection.

• Continuous detection mode (#7930+20m=0)
The latch data is stored to #8912, #8913+80m upon every mark detection.



• Specified number of detections mode (#7930+20m=1 to 32)
Latch data is stored to the corresponding area up to the maximum number specified by "Mark detection mode (#7930+20m)".



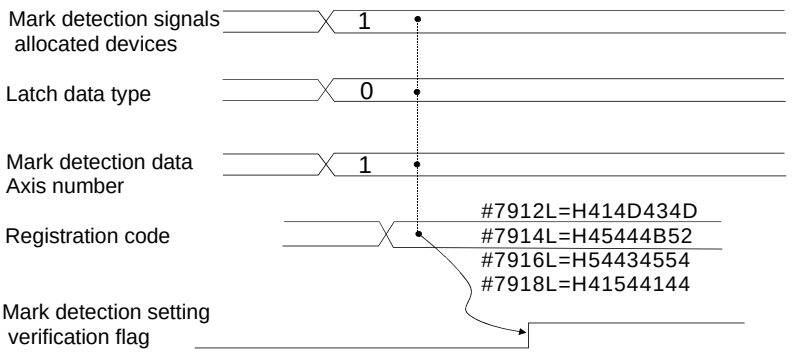
Remark

"m" (for example in #7920+20m) corresponds to the Mark detection function number.

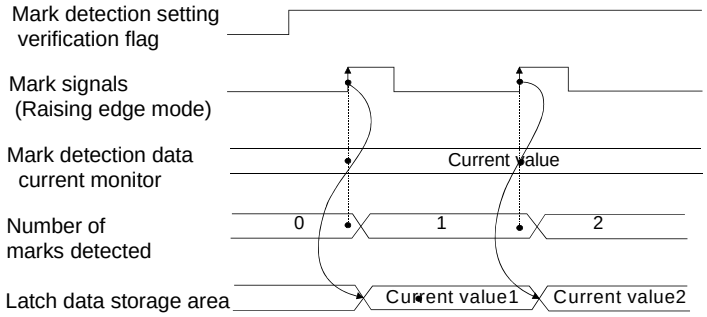
Mark detection function number	1	2	3	4
m	0	1	2	3

[Timing chart]

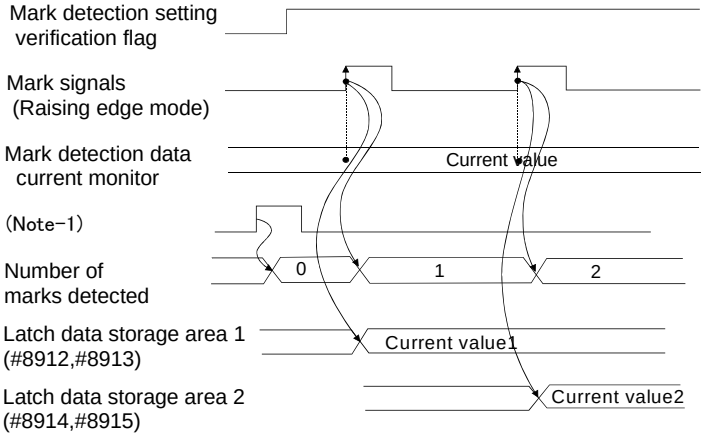
(1) Timing of mark detection function verification.
When "Registration code (#7912 to #7919)" is set, and "Mark detection signal allocation devices (#7920+20m)", "Latch data type (#7922+20m)" and " Mark detection data axis number (#7923+20m)" are all correct, "Mark detection settings verification flag (#8899+80m)" will be "1" and the mark detection functions become valid.



(2) Timing of the mark detection function (Continuous detection mode).
Latch data is stored to "Latch data storage area" upon mark detection.
"Number of Marks detected" is incremented by 1.



(3) Timing of the Mark detection function (Specified number of detections mode) .
For Mark detection function, first the "Number of marks detected(#8898+80m)" should be cleared to "0".
When a mark detection signal turns on, "Latch data" will be stored to the first "Latch data storage area" (#8912+80m, #8913+80m), and then the "Number of marks detected" will be incremented by "+1".
The next mark detection signal stores the "Latch data" to the second "Latch data storage area" (#8914+80m, #8915+80m), and then increments the "Number of marks detected" by "+1" again.



(Note-1) : Clear "Number of marks detected (#8898+80m)" to "0"

13.2 High-Speed Reading of Specified Data

This function is used to store specified positioning data in a specified device (D,W) The input signal of the Motion controller is used as a trigger and can be set in the system settings of MT Developer2.

(1) Position data that can be set

Setting data	Word No.	Unit	Remark
Position command (Feed current value)	2	10^{-1}[μm],10^{-5}[inch],10^{-5}[degree],[PLS]	
Actual current value(Real current value)	2	10^{-1}[μm],10^{-5}[inch],10^{-5}[degree],[PLS]	
Position droop (Deviation counter value)	2	[PLS]	
M-code	1	-	
Torque limit value	1	[%]	
Motor current	1	[%]	
Motor speed	2	[r/min]	
Servo command value	2	[PLS]	
Virtual servomotor feed current value	2	[PLS]	Valid in virtual mode only
Synchronous encoder current value	2	[PLS]	
Virtual servo M-code	1	-	
Current value after main shaft differential gear	2	[PLS]	
Current value within one revolution of cam axis	2	[PLS]	
Execute cam No.	1	-	
Execute stroke amount	2	10^{-1}[μm],10^{-5}[inch],[PLS]	
Optional address (Fixed to 4 bytes)	2	-	

(2) Signals used

Signals	Read timing	Number of setting points
PX devices (MR-MQ100)	0.4[ms]	4

(3) Devices that can be assigned

Word devices	Devices
D	0 to 8191
W	0 to 1FFF

POINT

(1) When using 2 words of data, assign to an even number device.
(2) If wrong address is assigned, the motion controller will issue a "watch dog timer error".

13.3 MC Protocol Communication

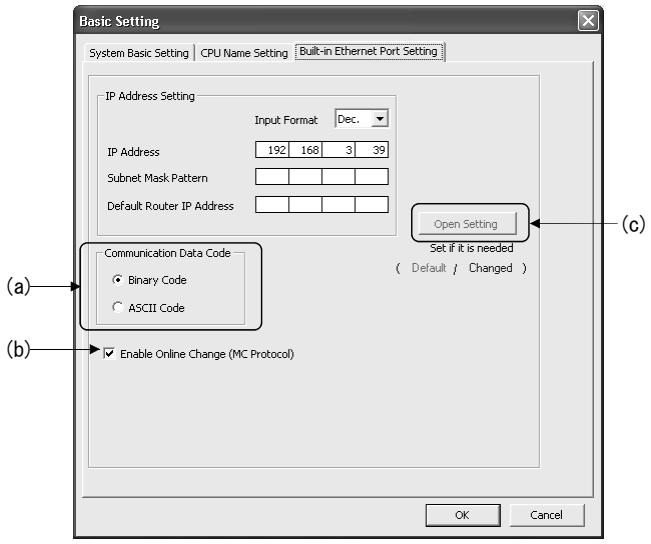
PERIPHERAL I/F of the Motion controller enables communication using the MC protocol (Note-1).
External devices such as personal computers and display devices read/write device data from/to the Motion controller using the MC protocol.
External devices monitor the operation of the Motion controller, analyze data, and manage production by reading/writing device data.

REMARK

(Note-1): The MC protocol is an abbreviation for the MELSEC communication protocol.
The MELSEC communication protocol is a name of the communication method used to access CPU modules from external devices in accordance with the communication procedure of Q-series programmable controllers (such as serial communication modules, Ethernet modules).
For details on the MC protocol, refer to the "Q Corresponding MELSEC Communication Protocol Reference Manual".

(1) Setting for MC protocol communication

Setting for communication using the MC protocol is described below.
Set the items of following (a) to (c) in the Built-in Ethernet Port Setting of the Basic Setting of MT Developer2.



(a) Communication data code

Select a communication data code used for the MC protocol, "Binary code" or "ASCII code".

(b) Enable online change (MC protocol)

Check the checkbox to enable online change when writing data to the Motion controller from the external device that communicates using the MC protocol.

For details on the available functions with this setting, refer to this section (2).

(c) Open Setting

Set the following items.

1) Protocol

Select a connection used as MC protocol. (Up to 16 CPU modules can be connected.)

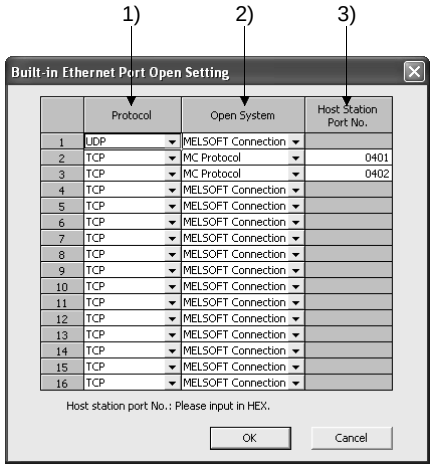
2) Open System

Select "MC protocol".

3) Host Station Port No. (Required)

Set the host station port number (in hexadecimal).

• Setting range : 0401H to 1387H, 1392H to FFFEH



POINT

When the "Enable online change (MC protocol)" box is unchecked, if a data write request is sent from an external device to the Motion controller which is in the RUN status, data will not be written to the Motion controller and the module returns the NAK message.

(2) Command list

When the PERIPHERAL I/F of the Motion controller communicates using the MC protocol, commands listed in table below can be executed.

Function			Command (Subcommand) (Note-1)	Description	Number of processed points	Status of Motion controller		
						STOP	RUN	
							Write enabled	Write disabled
Device memory	Batch read	In units of bits	0401 (0001)	Reads bit devices in units of one point.	ASCII: 3584 points BIN : 7168 points	○	○	○
		In units of words	0401 (0000)	Reads bit devices in units of 16 points.	960 words (15360 points)			
				Reads word devices in units of one point.	960 points			
	Batch write	In units of bits	1401 (0001)	Writes bit devices in units of one point.	ASCII: 3584 points BIN : 7168 points	○	○	×
		In units of words	1401 (0000)	Writes bit devices in units of 16 points.	960 words (15360 points)			
				Writes word devices in units of one point.	960 points			
	Random read (Note-2)	In units of words	0403 (0000)	Reads bit devices in units of 16 or 32 points by randomly specifying a device or device number.	192 points	○	○	○
				Reads word devices in units of one or two points by randomly specifying a device or device number.				
	Test (Random write)	In units of bits	1402 (0001)	Sets/resets bit devices in units of one point by randomly specifying a device or device number.	188 points	○	○	×
		In units of words (Note-2)	1402 (0000)	Sets/resets bit devices in units of 16 or 32 points by randomly specifying a device or device number.	(Note-5)			
				Writes word devices in units of one or two points by randomly specifying a device or device number.				
	Monitor registration (Note-2), (Note-3), (Note-4)	In units of words	0801 (0000)	Registers bit devices to be monitored in units of 16 or 32 points.	192 points	○	○	○
				Registers word devices to be monitored in units of one or two points.				
	Monitor	In units of words	0802 (0000)	Monitors devices registered.	Number of registered points	○	○	○

○: Available, ×: Not available

(Note-1): Subcommand is for the QnA-compatible 3E frame.

(Note-2): Devices such as TS, TC, SS, SC, CS, and CC cannot be specified in units of words.
For the monitor registration, an error (4032H) occurs during the monitor operation.

(Note-3): During monitor registration, monitor condition cannot be set.

(Note-4): Do not execute monitor registration from multiple external devices. If executed, the last monitor registration becomes valid.

(Note-5): Set the number of processed points so that the following condition is satisfied.
(Number of word access points) × 12 + (Number of double-word access points) × 14 ≦ 1920
• Bit devices are regarded as 16 bits during word access and 32 bits during double-word access.
• Word devices are regarded as one word during word access and two words during double-word access.

(3) Available devices

The devices available in commands used in the MC protocol communication function is shown below.

Classification	Device	Device code		Device number range		Remarks
		ASCII code (Note-1)	Binary code			
Internal system device	Special relay	SM	91h	000000 to 002255	Decimal	—
	Special register	SD	A9h	000000 to 002255	Decimal	
Internal user device	Input	X ✻	9Ch	000000 to 001FFF	Hexadecimal	Including actual input device PX.
	Output	Y ✻	9Dh	000000 to 001FFF	Hexadecimal	Including actual input device PY.
	Internal relay	M ✻	90h	000000 to 012287	Decimal	—
	Annunciator	F ✻	93h	000000 to 002047	Decimal	
	Link relay	B ✻	A0h	000000 to 001FFF	Hexadecimal	
	Data register	D ✻	A8h	000000 to 008191	Decimal	
	Link register	W ✻	B4h	000000 to 001FFF	Hexadecimal	
	Motion register	# ✻	E0h	000000 to 012287	Decimal	

(Note-1): When data is communicated in ASCII code, the second character " ✻ " can be designated a blank space (code: 20H).

(4) Precautions

(a) Number of connected modules

In the connection with external devices using the MC protocol, the number of Motion controllers set as "MELSOFT connection" in the Open Settings on Built-in Ethernet Port setting of Basic Setting can be connected simultaneously.

(b) Data communication frame

Table below shows the frames available in the communication function using the MC protocol with PERIPHERAL I/F.

Communication frame	Communication function using the MC protocol with PERIPHERAL I/F
4E frame	×
QnA-compatible 3E frame	○
A-compatible 1E frame	×

○: Available, ×: Not available

(c) Access range

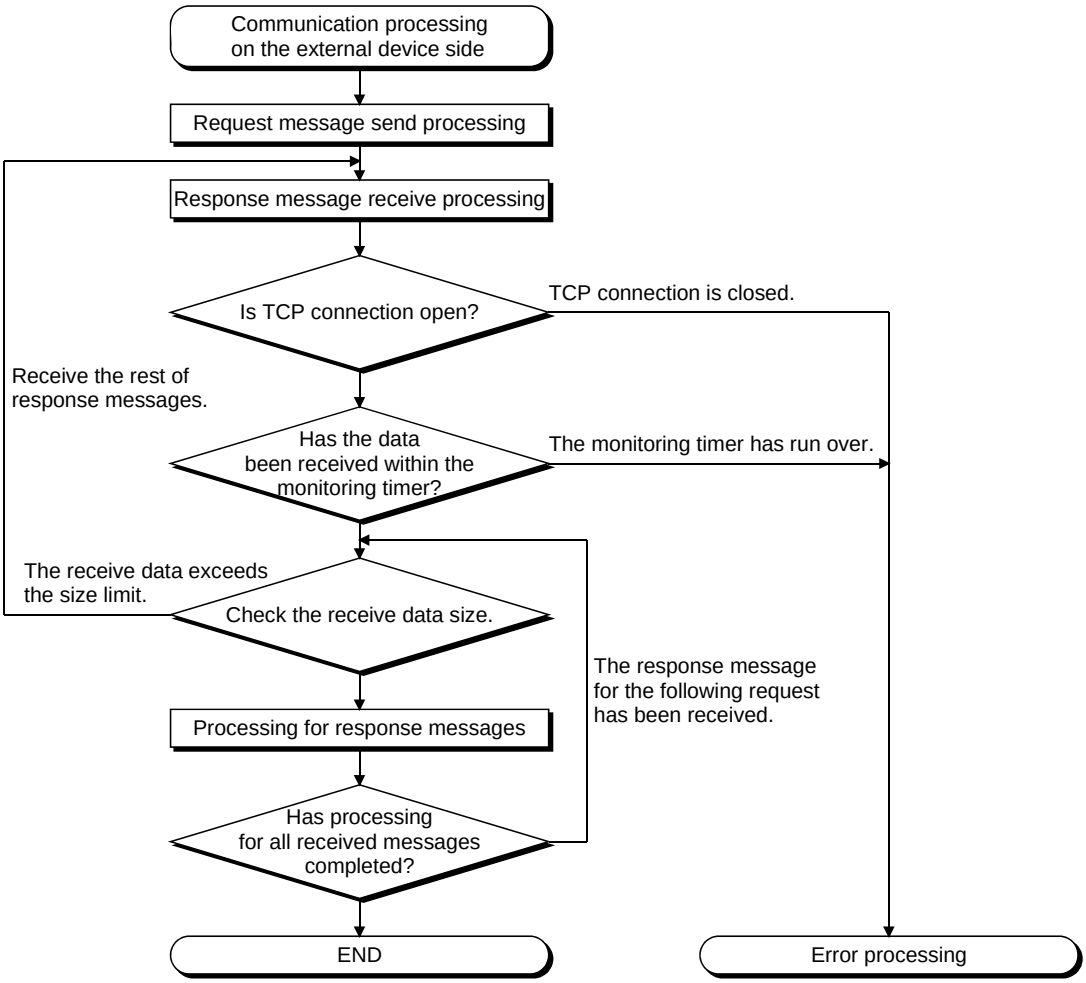
1) Only Motion controller connected by Ethernet can be accessed. Accessing a Motion controller not connected by Ethernet results in an error.

(d) Precautions when UDP protocol is selected

1) If a new request message is sent to the same UDP port while the port waits for a response message, the new request message is discarded.
2) Setting same host station port number to multiple UDP ports is regarded as one setting. When communicating with multiple external devices using the same host station port number, select TCP protocol.

(e) Response message receive processing

Figure below shows an example of the response message receive processing on the external device side.



REMARK

Personal computers use the TCP socket functions internally for Ethernet communication.
These functions do not have boundary concept. Therefore, when data is sent by executing the "send" function once, the "recv" function needs to be executed once or more to receive the same data.
(One execution of the "send" function does not correspond to one execution of the "recv" function.)
For this reason, receive processing described above is required on the external device side.
If the "recv" function is used in blocking mode, data may be read by executing the function once.

(5) Error codes for communication using MC protocol

Table below shows the error codes, error descriptions, and corrective actions that will be sent from the Motion contrller to an external device when an error occurs during communication using the MC protocol.

No.	Error code (Hexadecimal)	Description	Corrective action
1	4000H to 4FFFH	Motion controller detected error (Error that occurred in other than communication using the MC protocol)	Refer to the QCPU User's Manual (Hardware Design, Maintenance and Inspection) and take corrective action.
2	0055H	When the setting for online change is disabled on the Built-in Ethernet Port Setting of Basic Setting in MT Developer2, an external device requested online change to the Motion controller.	• When enabling online change, write data. • Change the status of the Motion controller to STOP and write data.
3	C050H	When the communication data code setting is set to ASCII code in the Built-in Ethernet Port Setting, ASCII code data that cannot be converted to binary code was received.	• Set the communication data code to binary code and restart the Motion controller for communication. • Correct the send data on the external device side and resend the data.
4	C051H to C054H	The number of device points for reading/writing is outside the allowable range.	Correct the number of device points for reading/writing and resend the data to the Motion controller.
5	C056H	The read/write request data exceeds the allowable address range.	Correct the start address or the number of device points for reading/writing, and resend the data to the Motion controller. (Do not exceed the allowable address range.)
6	C058H	The request data length after the ASCII to binary conversion does not match the data size of the character area (a part of text data).	Correct the text data or the request data length of the header data, and resend the data to the Motion controller.
7	C059H	• The command and/or subcommand are specified incorrectly. • The command and/or subcommand not supported in the Motion controller are specified.	• Check the request data. • Use commands and/or subcommands supported in the Motion controller.
8	C05BH	The Motion controller cannot read/write data from/to the specified device.	Check the device for reading/writing data.
9	C05CH	The request data is incorrect. (ex. specifying data in units of bits for reading/writing of word devices)	Correct the request data (such as subcommand correction) and resend the data to the Motion controller.
10	C05DH	Monitor registration is not performed.	Perform the monitor registration before monitor operation.
11	C05FH	The external device sent a request that cannot be executed in the Motion controller.	• Correct the network number, PC number, request destination module I/O number, and request destination module station number. • Correct the read/write request data.
12	C060H	The request data is incorrect. (ex. incorrect specification of data for bit devices)	Correct the request data and resend the data to the Motion controller.
13	C061H	The request data length does not match the data size of the character area (a part of text data)	Correct the text data or the request data length of the header data, and resend the data to the Motion controller.
14	C070H	The device memory extension cannot be specified for the target station.	Read/Write data to the device memory without specifying the extension.
15	C0B5H	Data that cannot communicate in the Motion controller or Ethernet module is specified.	• Check the request data. • Stop the current request.

13.4 Synchronous encoder for drive module

The synchronous encoder is used to operate the virtual axis (virtual main shaft, virtual auxiliary input axis) with the external input pulse.

Item		MR-MQ100
Current value storage register (D1120, D1121)	Power cycle	The current value immediately before power supply OFF is stored. (The travel value is not added in power supply OFF.)
	Real mode	Updated
	Virtual mode	Updated (Updated with clutch ON, and stopped with clutch OFF.)
Current value after synchronous encoder axis main shaft's differential gear storage registers (D1126, D1127)	Power cycle	"0" is stored
	Real mode	Backup
	Virtual mode	Updated
Error reset command (M5440)	Real mode	All errors can be reset regardless of the error type.
	Virtual mode	Errors can be reset according to the mechanical system configuration.
Synchronous encoder current value change (CHGA-E)	Real mode	Executable
	Virtual mode	Executable

(1) Synchronous encoder current value monitor in real mode

The synchronous encoder set in the system setting is updated for every operation cycle in the current value storage register (D1120, D1121) regardless of whether or not the synchronous encoder is set in the mechanical program. However, the current value after synchronous encoder axis main shaft's differential gear storage registers (D1126, D1127) is updated in only virtual mode.

(2) Error reset of the synchronous encoder axis

The error reset command (M5440) can be executed in both of the real mode and virtual mode.

If the error reset command (M5440) is turned ON when the synchronous encoder and output module are normal, the minor error code storage register (D1122) and major error code storage register (D1123) are cleared, and the error detection signal (M4640) is reset.

(3) Synchronous encoder current value change (CHGA-E)

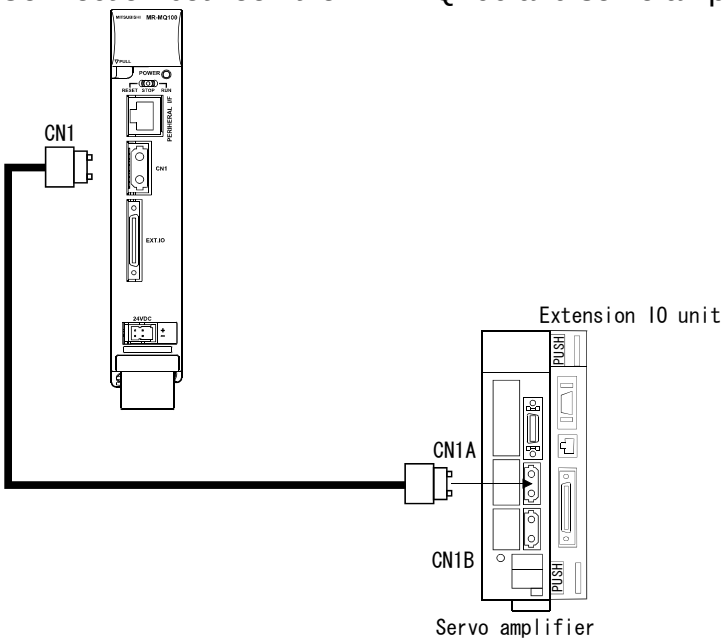
The synchronous encoder current value change (CHGA-E) of the synchronous encoder set in the system setting can be changed regardless of whether or not the synchronous encoder is set in the mechanical program.

13.5 Connection of extension IO unit (MR-J3-D01)

The extension IO unit (MR-J3-D01) for digital I/O signal, and analog I/O can be controlled by the motion controller.
Contact your local sales office for more details.

13.5.1 Connection of extension IO unit (MR-J3-D01)

(1) Connection between the MR-MQ100 and servo amplifiers



(2) Connection Equipment

Compatibility of servo amplifier models and software versions is as follows.

Model name	Connection with MR-J3-D01	Software version of servo amplifier
MR-J3- □B	×	-
MR-J3- □B-RJ004	×	-
MR-J3- □B-RJ006	○	C5 or later
MR-J3- □B-RJ080W	×	-
MR-J3- □S	○	C5 or later

○ : Possible × : Impossible

(3) I/O Specifications

The I/O points and the signal update cycle of extension IO unit (MR-J3-D01) are as follows.

Item	Number of devices	Update Cycle
Analog Input	2 Points (word)	Operation cycle 0.8 [ms] or less : 0.8 [ms] Operation cycle 1.7 [ms] : 1.7 [ms] Operation cycle 3.5 [ms] or more : 3.5 [ms]
Analog Output	2 Points (word)	
Input signal	16 Points (bit)	
Output signal	16 Points (bit)	

(4) Restrictions on the extension IO unit

When the extension IO unit (MR-J3-D01) is used, it is not necessary to set from MT Works2. However, when using the servo amplifier's data monitor function, the following restrictions should be noted for the I/O expansion unit.

Number of optional data monitor	Input signal	Output signal	Analog output ANO1	Analog output ANO2	Analog input ANI1	Analog input ANI2
0	○	○	○	○	○	○
1	○	○	○	○	○	○
2	○	○	○	○	○	×
3	○	○	○	○	×	×

○ : Use × : No use

13.5.2 I/O devices

(1) Analog output

Device No.	Signal name	Pin No. of MR-J3-D01
#8736	Analog output ANO1	CN20-4
#8737	Analog output ANO2	CN20-14

POINT

(1) The analog output voltage instruction is specified within the range of -10000 to 10000 mV. When a value outside of the range is specified, the output voltage may not be correct.

(2) When the motion controller's power supply is turned on, the content of the analog output instruction device is cleared to 0.

(2) Analog input

Device No.	Signal name	Pin No. of MR-J3-D01
#8800	Analog input ANI1	CN20-2
#8801	Analog input ANI2	CN20-12

POINT

(1) Analog input voltage is stored in units of mV. However, 0 is always stored in the channel due to improper usage as per the restrictions.

(2) When the motion controller’s power supply is turned on, the content of the analog input instruction device is cleared to 0.

(3) Input signal

Device No.	Signal name	Pin No. of MR-J3-D01
X1E00	Input signal DI0	CN10-1
X1E01	Input signal DI1	CN10-2
X1E02	Input signal DI2	CN10-3
X1E03	Input signal DI3	CN10-4
X1E04	Input signal DI4	CN10-5
X1E05	Input signal DI5	CN10-6
X1E06	Input signal DI6	CN10-7
X1E07	Input signal DI7	CN10-8
X1E08	Input signal DI8	CN10-9
X1E09	Input signal DI9	CN10-10
X1E0A	Input signal DI10	CN10-11
X1E0B	Input signal DI11	CN10-12
X1E0C	Input signal DI12	CN10-15
X1E0D	Input signal DI13	CN10-16
X1E0E	Input signal DI14	CN10-17
X1E0F	Input signal DI15	CN10-18

POINT

(1) When the motion controller's power supply is turned on, the input device is cleared to 0.

(4) Output signal

Device No.	Signal name	Pin No. of MR-J3-D01
Y1E00	Output signal DO0	CN10-22
Y1E01	Output signal DO1	CN10-23
Y1E02	Output signal DO2	CN10-24
Y1E03	Output signal DO3	CN10-25
Y1E04	Output signal DO4	CN10-38
Y1E05	Output signal DO5	CN10-39
Y1E06	Output signal DO6	CN10-40
Y1E07	Output signal DO7	CN10-41
Y1E08	Output signal DO8	CN10-42
Y1E09	Output signal DO9	CN10-43
Y1E0A	Output signal DO10	CN10-44
Y1E0B	Output signal DO11	CN10-45
Y1E0C	Output signal DO12	CN10-46
Y1E0D	Output signal DO13	CN10-47
Y1E0E	Output signal DO14	CN10-48
Y1E0F	Output signal DO15	CN10-49

POINT

(1) When the motion controller's power supply is turned on, the output device is cleared to 0.

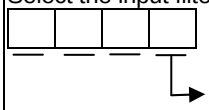
13.5.3 Related servo amplifier parameters

The relevant servo amplifier parameters are shown below.

POINT

- For any parameter whose symbol is preceded by *, set the parameter value and switch power off once, then switch it on again to make that parameter setting valid.

(1) I/O Setting parameter

No.	Symbol	Name and function	Initial value	Unit	Setting range
PD11	*DIF	Input filter setting Select the input filter.  Input signal filter 0 : None 1 : 0.88ms 2 : 1.77ms 3 : 2.66ms 4 : 3.55ms	4	-	0 to 4

(2) Option card parameter

No.	Symbol	Name and function	Initial value	Unit	Setting range
PO06	D1AD1	Analog input (ANI1) offset of the extension IO unit Set the offset voltage of the analog input in hexadecimal.	0000h	mV	0000h to 0FFFFh (Note-1)
PO07	D1AD2	Analog input (ANI2) offset of the extension IO unit Set the offset voltage of the analog input in hexadecimal.	0000h	mV	0000h to 0FFFFh (Note-1)
PO08	D1DA1	Analog output (ANO1) offset of the extension IO unit Set the offset voltage of the analog output in hexadecimal.	0000h	mV	0000h to 0FFFFh (Note-1)
PO09	D1DA2	Analog output (ANO2) offset of the extension IO unit Set the offset voltage of the analog output in hexadecimal.	0000h	mV	0000h to 0FFFFh (Note-1)

Note-1 : The setting range is -9999mV to 9999mV. If set to outside the range, servo amplifier rounds it to within the range.

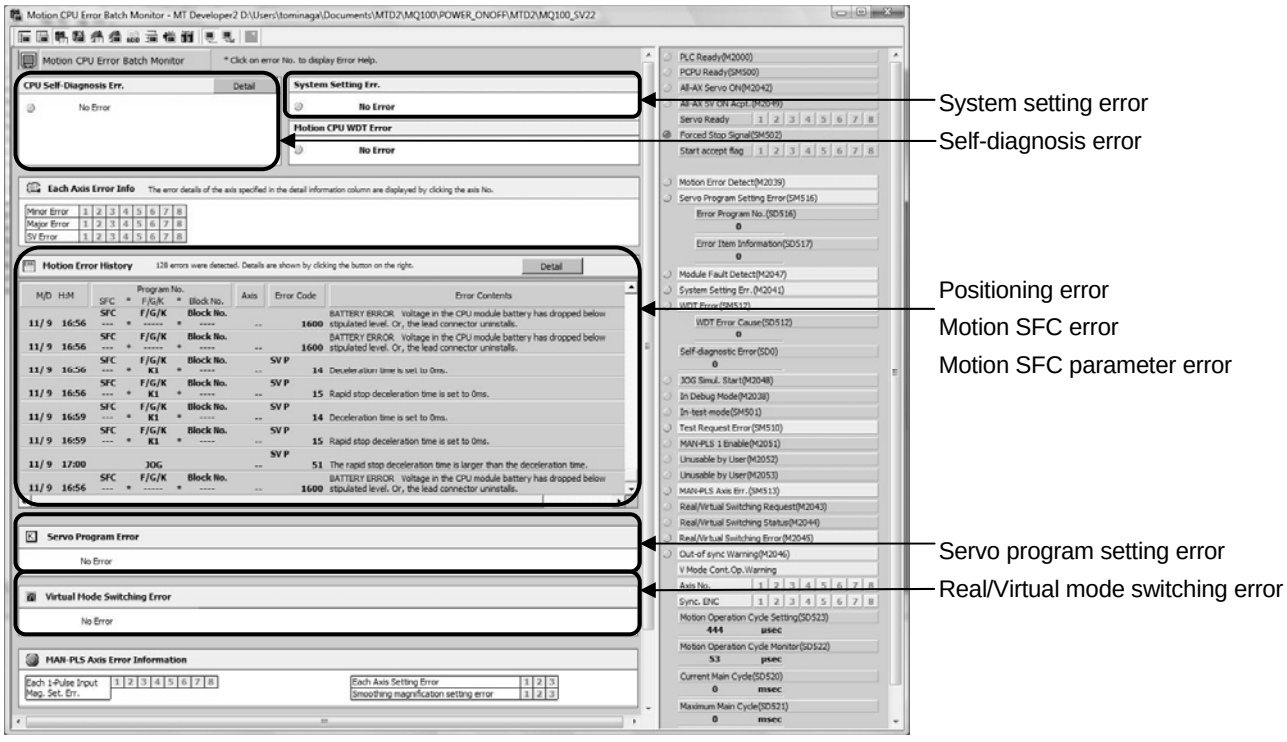
14. ERROR CODE

MR-MQ100 detects errors as below.
Refer to each programming manuals for details.

Error items		Manuals
Self-diagnosis errors		Q173DCPU/Q172DCPU Motion controller Programming Manual(COMMON) IB(NA)-0300134
System setting errors		
Servo program setting errors		Q173DCPU/Q172DCPU Motion controller SV13/SV22 Programming Manual (REAL MODE) IB(NA)-0300136
Positioning error	Minor errors	
	Major errors	
	Servo errors	
Motion SFC Errors		Q173DCPU/Q172DCPU Motion controller SV13/SV22 Programming Manual (Motion SFC) IB(NA)-0300135
Motion SFC parameter errors		
Real/Virtual mode switching errors		Q173DCPU/Q172DCPU Motion controller SV22 Programming Manual (VIRTUAL MODE) IB(NA)-0300137
Drive module errors		
Output module errors		

14.1 Self-diagnosis errors

When an error occurs, check the error code and details using the "Motion CPU Error. Batch Monitor" of MT Developer2, then troubleshoot the causes of the error.



Below table shows Self-diagnosis errors.

Table 14.1 Self-diagnosis errors

item	error code (SD0)	error message	Common Error data(SD5 to SD15)	Individual Error data (SD16 to SD26)	7 segments LED	Operating status of CPU
Power supply	1500	DC DOWN	—	—	No error	Continue
Battery	1600	BATTERY ERROR	Drive name	—	"BT1" is on "BT2" is on	Continue

error code	Diagnosis timing	Contents and causes	Corrective action
1500	Always	24VDC power supply has stopped supplying power.	Check the power supply.
1600	Always	(1) Voltage of the CPU has dropped below stipulated level . (2) The lead connector of CPU battery has not been installed.	(1) Replace the battery (2) Install a lead connector.

14.2 System setting errors

Below table shows System setting errors

Table 14.2 System setting error

Error name	7 segments LED(Note-1)	Error code (Note-2)	error cause	Check timing	Operation at error occurrence
AMP No. SETTING	"AL" 3 times flashes	10014 (Note-3)	• Servo axis is not set in system setting.	When the power is turned ON/ the key is reset.	Cannot be started. (Motion controller system setting error).
SYS.SET DATA ERR			• System setting data is not written. •System setting data is written before "Relative check" Or It is written with an error of "Relative check".		
AXIS No. ERROR			• System setting data is not written.		
ROM ERROR1			• Operating system software data type written to ROM is different.		
ROM ERROR2			• Data is not written to ROM.		
ROM ERROR3(**)			• ROM data size is wrong. (•Execute ROM write again. •Check for version adjustment of the motion controller, MT Developper2 and operating system software.)		
ROM ERROR4(**)			• ROM data is wrong. (•Execute ROM write again. •Check for version adjustment of the motion controller, MT Developper2 and operating system software.)		

Note-1 : ["AL" flashes 3 times → "L01" turns on] is continuously repeated. (No error code on 7-segments LED.

Note-2 : This error code is stored in Self-diagnosis error (SD0).

Note-3 : When error code 10014 occurs. System setting error flag (M2041) turns ON and the applicable error name shown above is displayed on the error list monitor of the MT Developer2.

14.3 Servo program setting error

MR-MQ100 has the same "Servo program setting errors" as Q173DCPU/Q172DCPU except for the below error. Refer to "Q173DCPU/Q172DCPU Motion controller SV13/SV22 Programming Manual (REAL MODE)" for all other errors.

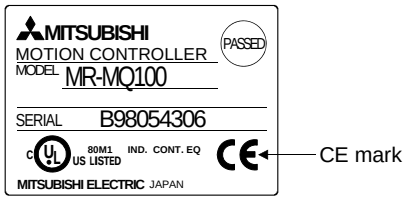
Table 14.3 Servo programming setting error

Error code	Error name	Error contents	Error processing	Corrective action
51	Rapid stop deceleration time setting error	The rapid stop deceleration time is bigger than the setting value of deceleration time.	Control with the setting value of deceleration time.	Set the rapid stop deceleration time within the range of 1 to deceleration time.

MEMO

15. EMC DIRECTIVES

Compliance to the EMC Directive, which is one of the EU Directives, has been a legal obligation for the products sold in European countries since 1996 as well as the Low Voltage Directive since 1997.
Manufacturers who recognize their products are compliant to the EMC and Low Voltage Directives are required to declare that print a "CE mark" on their products.



(1) Authorized representative in Europe

Authorized representative in Europe is shown below.
Name : Mitsubishi Electric Europe BV
Address: Gothaer strase 8, 40880 Ratingen, Germany

15.1 Requirements for Compliance with the EMC Directive

The EMC Directive specifies that products placed on the market must be so constructed that they do not cause excessive electromagnetic interference (emissions) and are not unduly affected by electromagnetic interference (immunity)".
Section 15.1.1 through Section 15.1.4 summarize the precautions on compliance with the EMC Directive of the machinery constructed with the Motion controllers.
These precautions are based on the requirements and the standards of the regulation, however, it does not guarantee that the entire machinery constructed according to the descriptions will comply with above-mentioned directive. The method and judgment for complying with the EMC Directive must be determined by the person who construct the entire machinery.

15.1.1 Standards relevant to the EMC Directive

The standards relevant to the EMC Directive are listed in table below.

Certification	Test item	Test details	Standard value
EN61000-6-4:2007 EN61131-2:2007	EN55011:2007/A2:2007 Radiated emission(Note-1)	Radio waves from the product are measured.	30M-230MHz QP(Note-2): 40dBμV/m (10m (32.81ft.) in measurement range) 230M-1000MHz QP: 47dBμV/m (10m (32.81ft.) in measurement range)
	EN55011:2007/A2:2007(Note-3) (Power line) EN55022:2006/A1:2007(Note-4) (Electrical communication port) Conducted emission	Noise from the product to the power line and electrical communication port is measured.	AC power line 0.15M-0.5MHz QP : 79dBμV AV(Note-5) : 66dBμV 0.5M-30MHz QP: 73dBμV AV: 60dBμV Electrical communication port 0.15M-0.5MHz QP, AV: Logarithmic decrease 0.5M-30MHz QP: 87dBμV AV: 74dBμV
EN61000-6-2:2005 EN61131-2:2007	EN61000-4-2:1995 +A1:1998+A2:2001 Electrostatic discharge immunity	Immunity test in which electrostatic discharge is applied to the product.	8kV: 10 times at 1 second interval, Air discharge 4kV: 10 times at 1 second interval, Contact discharge
	EN61000-4-3:2006 Radiated immunity(Note-1)	Immunity test in which electric fields are radiated to the product.	80-1000MHz 10V/m, 1400M-2000MHz 3V/m, 2000M-2700MHz 1V/m, 80%AM modulation @1kHz
	EN61000-4-4:2004 Electrical fast transient/ burst (EFT/B) immunity	Immunity test in which burst noise is applied to the power cable and signal line.	AC power line: ±2kV/5kHz DC power line: ±2kV/5kHz I/O, communication line: ±1kV/5kHz
	EN61000-4-5:2006 Surge immunity	Immunity test in which surge is applied to the power line and signal line.	AC power line Common mode: ±2.5kV Differential mode: ±1.5kV DC power line Common mode: ±0.5kV Differential mode: ±0.5kV I/O, communication line Common mode: ±1kV
	EN61000-4-6:2007 +A:2001 Conducted immunity	Immunity test in which high frequency noise is applied to the power line and signal line.	0.15-80MHz, 80%AM modulation @1kHz, 10Vrms
	EN61000-4-11:2004(Note-3) Short interruptions immunity	Immunity test in which power supply has short interruptions.	0% of rated voltage, 250cycle
	EN61000-4-11:2004(Note-3) Voltage dip	Test in which voltage dip is applied to the power supply.	40% of rated voltage, 10cycle 70% of rated voltage, 25cycle
EN61131-2:2007	EN61131-2:2007(Note-3) Voltage dip immunity	Immunity test in which voltage dip is applied to the power supply.	0% of rated voltage, 0.5cycle 20 times

(Note-1): This product is an open type device (a device designed to be housed inside other equipment) and must be installed inside a conductive control panel.
The corresponding test has been done with the programmable controller installed inside a control panel.

(Note-2): QP : Quasi-peak value

(Note-3): For the AC power supply line.

(Note-4): For the electrical communication port.

(Note-5): AV: Average value

15.1.2 Installation instructions for EMC Directive

(1) Installation

Motion controller is an open type device and must be installed inside a control panel for use.
This not only ensures safety but also ensures effective shielding of Motion controller-generated electromagnetic noise.

(a) Control panel

1) Use a conductive control panel.
2) When attaching the control panel's top plate or base plate, expose bare metal surface and weld so that good surface contact can be made between the panel and plate.
3) To ensure good electrical contact with the control panel, mask the paint on the installation bolts of the inner plate in the control panel so that contact between surfaces can be ensured over the widest possible area.
4) Ground the control panel with a thick wire so that a low impedance connection to ground can be ensured even at high frequencies.
5) Holes made in the control panel must be 10cm (3.94inch) diameter or less. If the holes are 10cm (3.94 inch) or larger, radio frequency noise may be emitted.
   In addition, because radio waves leak through a clearance between the control panel door and the main unit, reduce the clearance as much as practicable.
   The leakage of radio waves can be suppressed by the direct application of an EMI gasket on the paint surface.

(2) Connection of power line and ground wire

It is necessary to use the Motion controller grounding terminal only when it is in the grounded condition. Be sure to ground the grounding for the safety reasons and EMC Directives.
Ground wire and power supply cable for the Motion controller system must be connected as described below.

(a) Provide an grounding point near the FG terminals. Ground the FG terminals (FG : Frame Ground) with the thickest and shortest wire possible. (The wire length must be 30cm (11.81inch) or shorter.) The FG terminals function is to pass the noise generated in the Motion controller system to the ground, so wire the ground wire as short as possible to ensure a low impedance.
The wire itself carries a large noise content and thus short wiring means that the wire is prevented from acting (noise emission) as an antenna.

(3) Cables

The cables extracted from the control panel contain a high frequency noise component. On the outside of the control panel, therefore, they serve as antennas to emit noise. To prevent noise emission, use shielded cables for the cables and may be extracted to the outside of the control panel.
The use of a shielded cable also increases noise resistance.
If a shielded cable is not used or not grounded correctly, the noise resistance will not meet the specified requirements.

(a) Grounding of shield section of shield cable

1) Ground the exposed shield section of the shielded cable close to the module. When the grounded cables and the not yet grounded cables are bundled, the cables might be induced to electromagnetic.
2) Ground the exposed shield section to spacious area on the control panel. A clamp can be used as shown in Figure 15.2.
In this case, mask the inner wall surface when coating the control panel, and contact the exposed shield section with the clamp at the exposed bare metal surface.

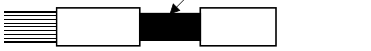


Figure 15.1 Part to be exposed

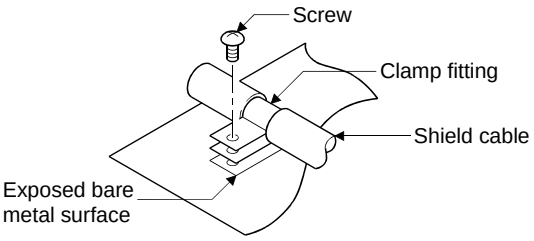


Figure 15.2 Shield grounding (Correct example)

Note) The method of grounding with a vinyl-coated wire soldered onto the shielded section of the shielded cable as in shown Figure 15.3 is not recommended. Doing so will raise the high-frequency impedance, resulting in loss of the shielding effect.

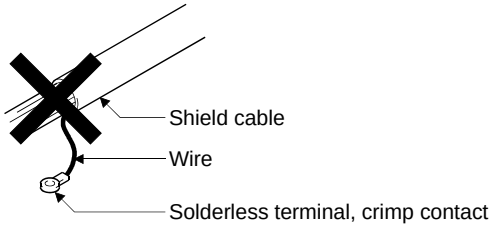


Figure 15.3 Shield grounding (Incorrect example)

(4) Precautions for static electricity

There are weak points to static electricity on a surface of modules. Before touching the modules, always touch grounded metal, etc. to discharge static electricity from human body. Failure to do so may cause the modules to fail or malfunction. And do not directly touch the module's conductive parts and electronic components. Touching them could cause an operation failure or give damage to the module.

15.1.3 Parts of measure against noise

(1) Ferrite core

A ferrite core has the effect of reducing noise in the 30MHz to 100MHz band.
It is not required to fit ferrite cores to cables, but it is recommended to fit ferrite cores if shield cables pulled out of the enclosure do not provide sufficient shielding effects.
Note that the ferrite cores must be fitted to the cables in the position immediately before they are pulled out of the enclosure. If the fitting position is improper, the ferrite will not produce any effect.

• Ferrite core (Recommended product)

Manufacturer	Model name
TDK	ZCAT3035-1330

(2) Noise filter (power supply line filter)

A noise filter is a component which has an effect on conducted noise.
The attachment of the noise filter to the power supply line of the servo amplifier or the controller is effective for the reducing noise.
(The noise filter has the effect of reducing conducted noise of 10 MHz or less.)

The precautions required when installing a noise filter are described below.

(a) Do not bundle the wires on the input side and output side of the noise filter. When bundled, the output side noise will be induced into the input side wires from which the noise was filtered.

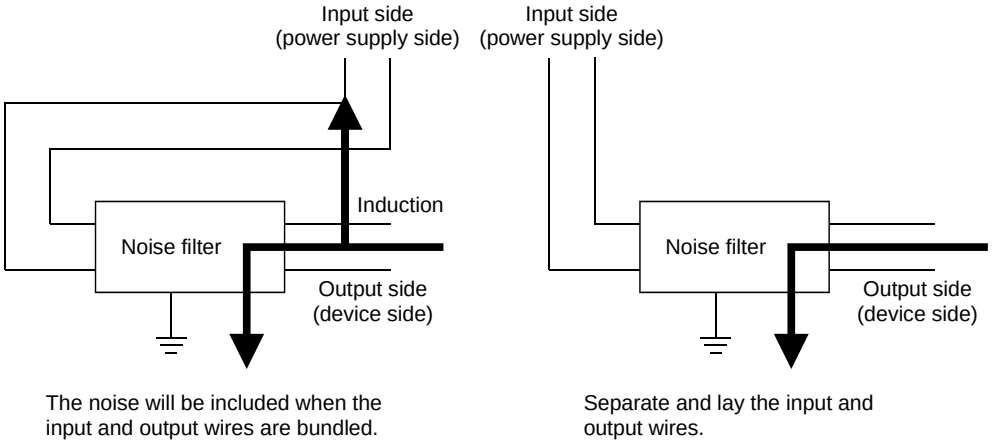


Figure 15.4 Precautions on noise filter

(b) Ground the noise filter grounding terminal to the control cabinet with the shortest wire possible (approx. 10cm (3.94 inch)).

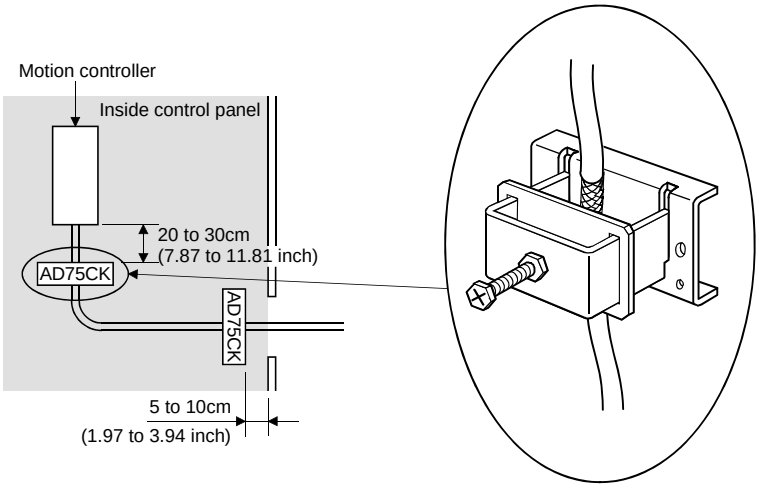
• Noise ferrite (Recommended product)

Manufacturer	Model name
Mitsubishi electric	FR-BLF
Soshin Electric	HF3010A-UN

(3) Cable clamp

It is also possible to ground the exposed shielded part of the cable to the panel with the cable clamp.

- Ground the shield at a position 20 to 30cm (7.87 to 11.81 inch) away from the module.
- When the cables pulled out from the control panel, ground the cables at a position 5 to 10cm (1.97 to 3.94inch) near the input/output hole of the control panel with the cable clamp.

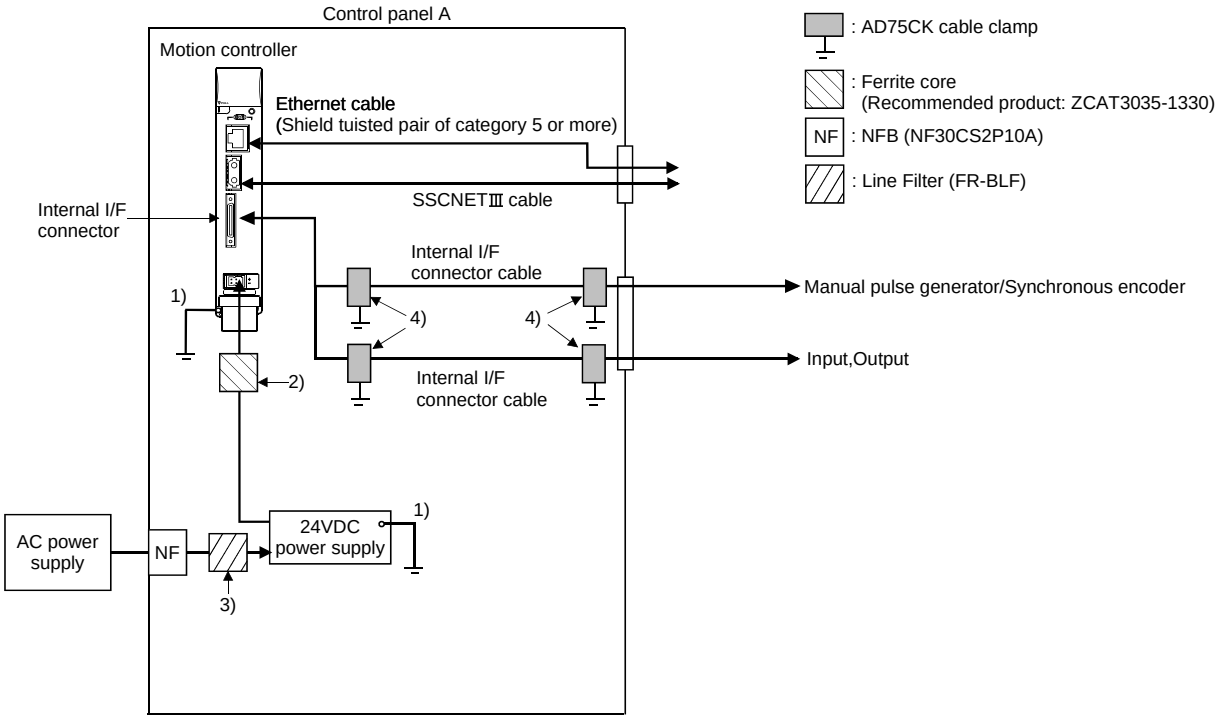


- Cable clamp (Recommended product)

Manufacturer	Model name
Mitsubishi electric	AERSBAN-DSET
	AERSBAN-ESET
	AD75CK

15.1.4 Example of measure against noise

The example of corrective action to use noise suppression modules is shown below.



1) Ground the FG terminal of the Motion controller and 24VDC power supply module to the control panel.

2) Measure against noise of the power supply cable (24VDC twisted cable)
- Wire the power supply cable as short as possible using the twisted cable.
- Install a ferrite core at a position 20 to 30cm (7.87 to 11.81inch) away from the product.

3) Install a line filter in the secondary side of NF. (Approx. 4 turn)

4) Measure against noise of the internal I/F connector cable
- Ground the cables at a position 30 to 40cm (11.81 to 15.75inch) away from the module with the cable clamp, etc.
- When the cables are extracted from the control panel, ground the cables at a position 5 to 10cm (1.97 to 3.94inch) away from the exit/entrance of the control panel with the cable clamp, etc.
- Refer to Section 2.5.2(b) for the internal I/F connector cable. Use the shielded twisted pair cable and correctly wire the internal I/F connector cable.

(1) Refer to Chapter 2 and appendix for the following cables.
- Ethernet cable
- SSCNETⅢ cable

(2) Refer to Section 2.5.2(b) and APPENDIX 1.3 for the internal I/F connector cable. Use the shielded twisted pair cable and correctly wire the internal I/F connector cable.

(3) In wiring inside the panel, the power line connected to the power or servo amplifier and the communication cable such as bus connection cable or network cable must not be mixed. If the cables are installed closely with each other for wiring reasons, using a separator (made of metal) can make the cables less influenced by noise.
Mixing the power line and communication cable may cause malfunction due to noise.

MEMO

APPENDICES

APPENDIX 1 Cables

In this cable connection diagram, maker names of connectors are omitted. Refer to "APPENDIX 2.3 Connector" for maker names of connectors.

APPENDIX 1.1 SSCNETⅢ cables

Generally use the SSCNETⅢ cables available as our products.

(1) Model explanation

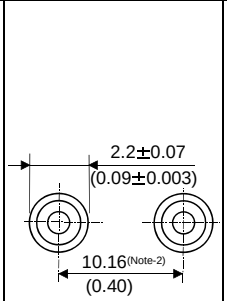
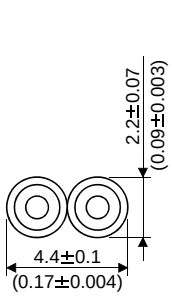
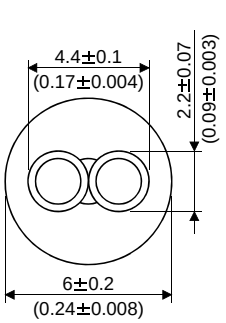
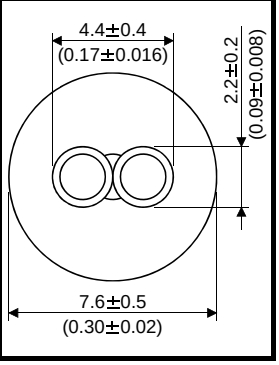
Numeral in the column of cable length on the table is a symbol put in the "□" part of cable model. Cables of which symbol exists are available.

Cable model	Cable length [m(ft.)]											Flex life	Application/ remark
	0.15 (0.49)	0.3 (0.98)	0.5 (1.64)	1 (3.28)	3 (9.84)	5 (16.40)	10 (32.81)	20 (65.62)	30 (98.43)	40 (131.23)	50 (164.04)		
MR-J3BUS□M	015	03	05	1	3							Standard	Standard code for inside panel
MR-J3BUS□M-A						5	10	20				Standard	Standard cable for outside panel
MR-J3BUS□M-B (Note-1)									30	40	50	Long flex	Long distance cable

(Note-1) : For the cable of less than 30[m](98.43[ft.]), contact your nearest Mitsubishi sales representative.

App.

(2) Specifications

		Description			
SSCNETⅢ cable model		MR-J3BUS□M		MR-J3BUS□M-A	MR-J3BUS□M-B
SSCNETⅢ cable length [m(ft.)]		0.15 (0.49)	0.3 to 3 (0.98 to 9.84)	5 to 20 (16.40 to 65.62)	30 to 50 (98.43 to 164.04)
Optical cable (Code)	Minimum bend radius [mm(inch)]	25(0.98)		Reinforcing coat cable: 50 (1.97) Code: 25 (0.98)	Reinforcing coat cable: 50 (1.97) Code : 30(1.18)
	Tension strength [N]	70	140	420 (Enforced covering cord)	980 (Enforced covering cord)
	Temperature range for use [°C(°F)] (Note-1)	-40 to 80 (-40 to 176)			-20 to 70 (-4 to 158)
	Ambient	Indoors (no direct sunlight), No solvent or oil			
	External appearance [mm(inch)]				

(Note-1): This temperature range for use is the value for optical cable (cord) only.
(Note-2): Dimension of connector fiber insert location. The distance of two cords is changed by how to bend it.

POINT

(1) If the end face of code tip for the SSCNETⅢ cable is dirty, optical transmission is interrupted and it may cause malfunctions. If it becomes dirty, wipe with a bonded textile, etc. Do not use solvent such as alcohol.

(2) If the end face of code tip for SSCNETⅢ cable is dirty, optical transmission is interrupted and it may cause malfunctions. If it becomes dirty, wipe with a bonded textile, etc. Do not use solvent such as alcohol.

(3) When incinerating the SSCNETⅢ cable (optical fiber), hydrogen fluoride gas or hydrogen chloride gas which is corrosive and harmful may be generated. For disposal of the SSCNETⅢ cable (optical fiber), request for specialized industrial waste disposal services who has incineration facility for disposing hydrogen fluoride gas or hydrogen chloride gas.

(a) MR-J3BUS□M

1) Model explanation

Type: MR-J3BUS□M-∗

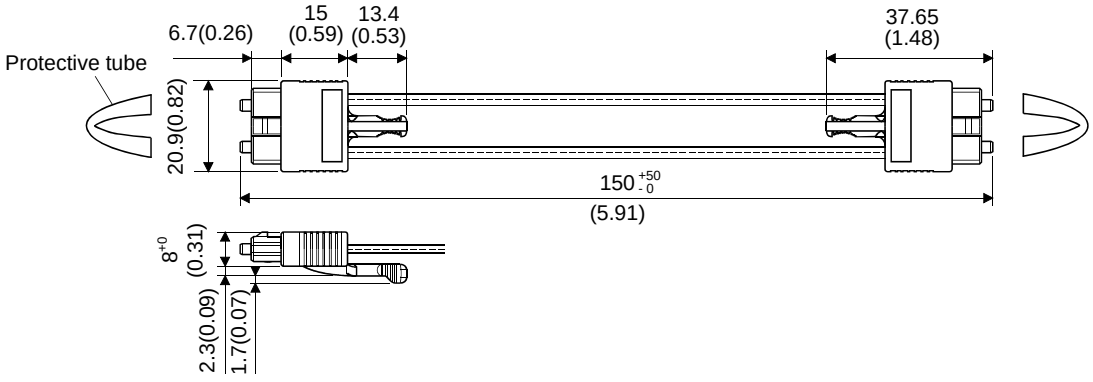
Symbol	Cable type
None	Standard code for inside panel
A	Standard cable for outside panel
B	Long distance cable

Symbol	Cable length [m(ft.)]
015	0.15(0.49)
03	0.3(0.98)
05	0.5(1.64)
1	1(3.28)
3	3(9.84)
5	5(16.40)
10	10(32.81)
20	20(65.62)
30	30(98.43)
40	40(131.23)
50	50(164.04)

2) Exterior dimensions

• MR-J3BUS015M

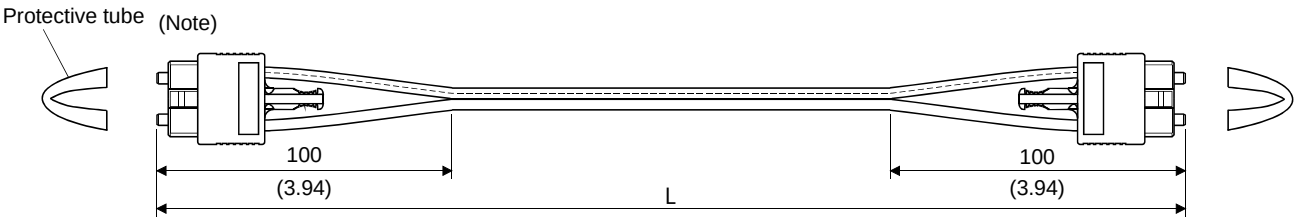
[Unit: mm(inch)]



• MR-J3BUS03M to MR-J3BUS3M

[Unit: mm(inch)]

Refer to the table of this section (1) for cable length (L).



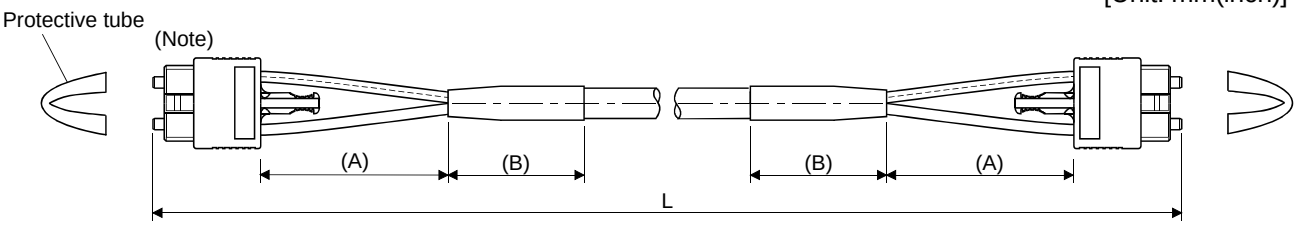
(Note) : Dimension of connector part is the same as that of MR-J3BUS015M.

• MR-J3BUS5M-A to MR-J3BUS20M-A,MR-J3BUS30M-B to MR-J3BUS50M-B

Refer to the table of this section (1) for cable length (L).

SSCNETⅢ cable	Variation [mm(inch)]	
	A	B
MR-J3BUS5M-A to MR-J3BUS20M-A	100(3.94)	30(1.18)
MR-J3BUS30M-B to MR-J3BUS50M-B	150(5.91)	50(1.97)

[Unit: mm(inch)]



(Note) : Dimension of connector part is the same as that of MR-J3BUS015M.

POINT

Keep the cap and the tube for protecting light code end of SSCNETⅢ cable in a plastic bag with a zipper of SSCNETⅢ cable to prevent them from becoming dirty.

APPENDIX 1.2 24VDC power supply cable

(1) Connection diagram

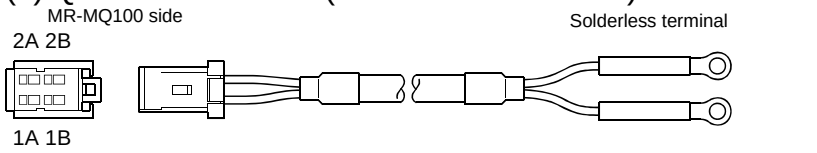
(a) Model explanation

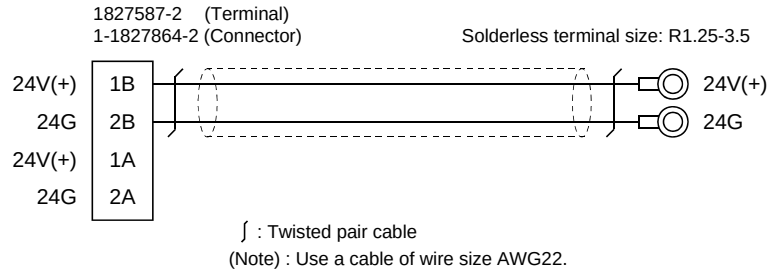
Type: Q170MPWCBL□M-∗

Symbol	Cable type
None	Without EMI terminal
E	With EMI terminal

Symbol	Cable length [m(ft.)]
2	2(6.56)

(b) Q170MPWCBL2M (Without EMI terminal)

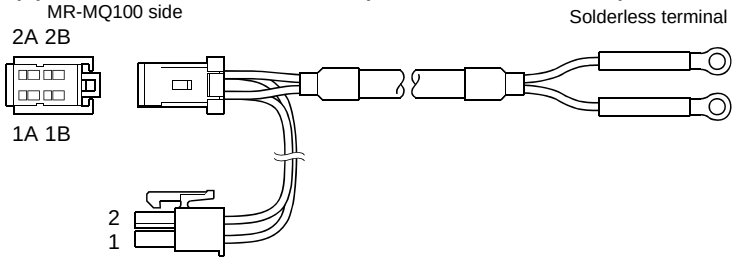


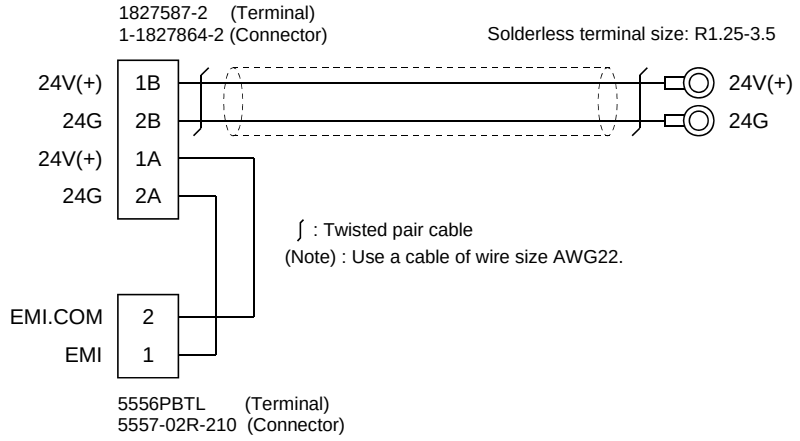


∫ : Twisted pair cable

(Note) : Use a cable of wire size AWG22.

(c) Q170MPWCBL2M-E (With EMI terminal)





∫ : Twisted pair cable

(Note) : Use a cable of wire size AWG22.

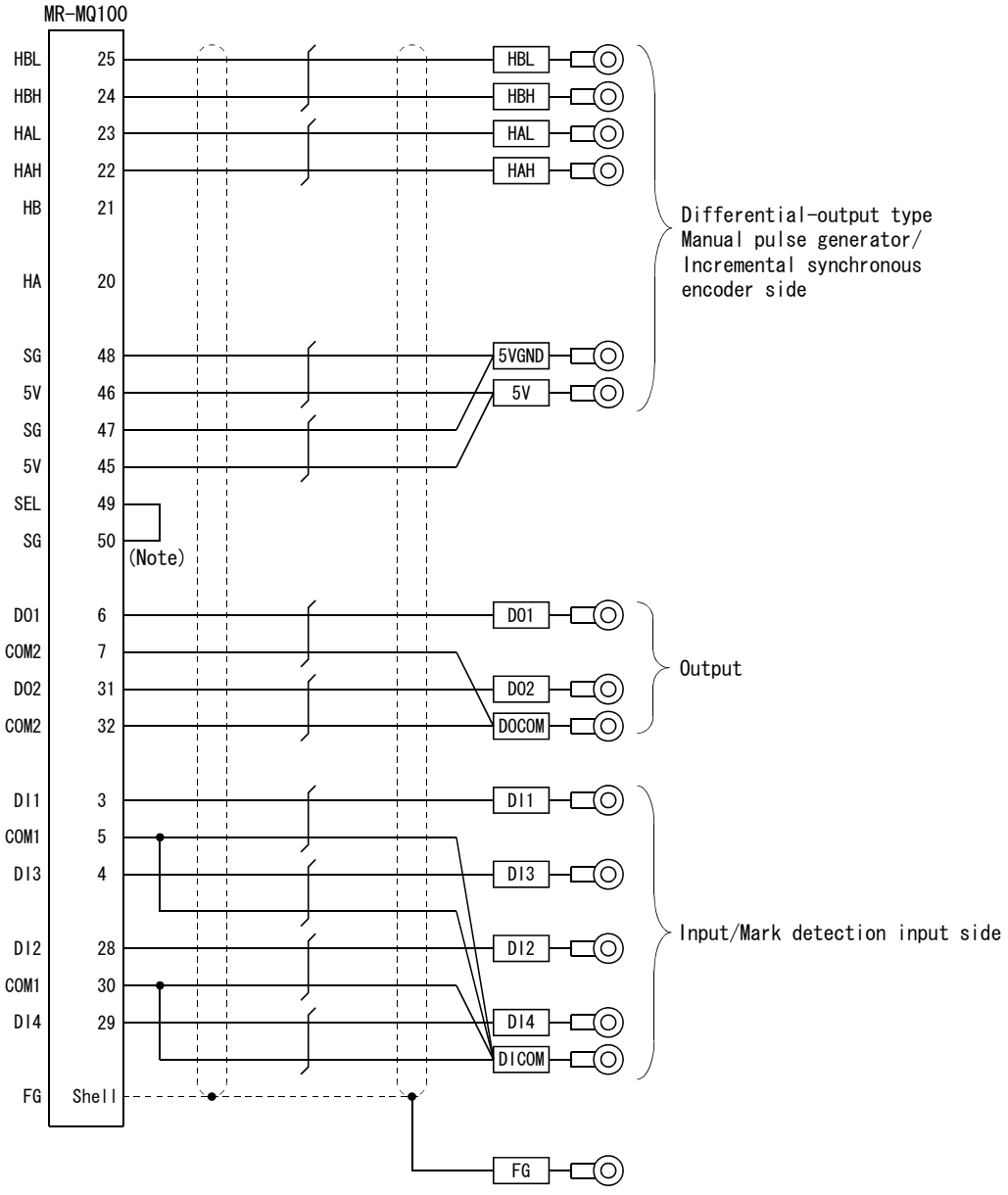
5556PBTL (Terminal)
5557-02R-210 (Connector)

APPENDIX 1.3 Internal I/F connector cable

Fabricate the MR-MQ100's internal I/F connector cable on the customer side.

(1) Connection diagram with differential-output type

Make the cable within 30m (98.43ft.).

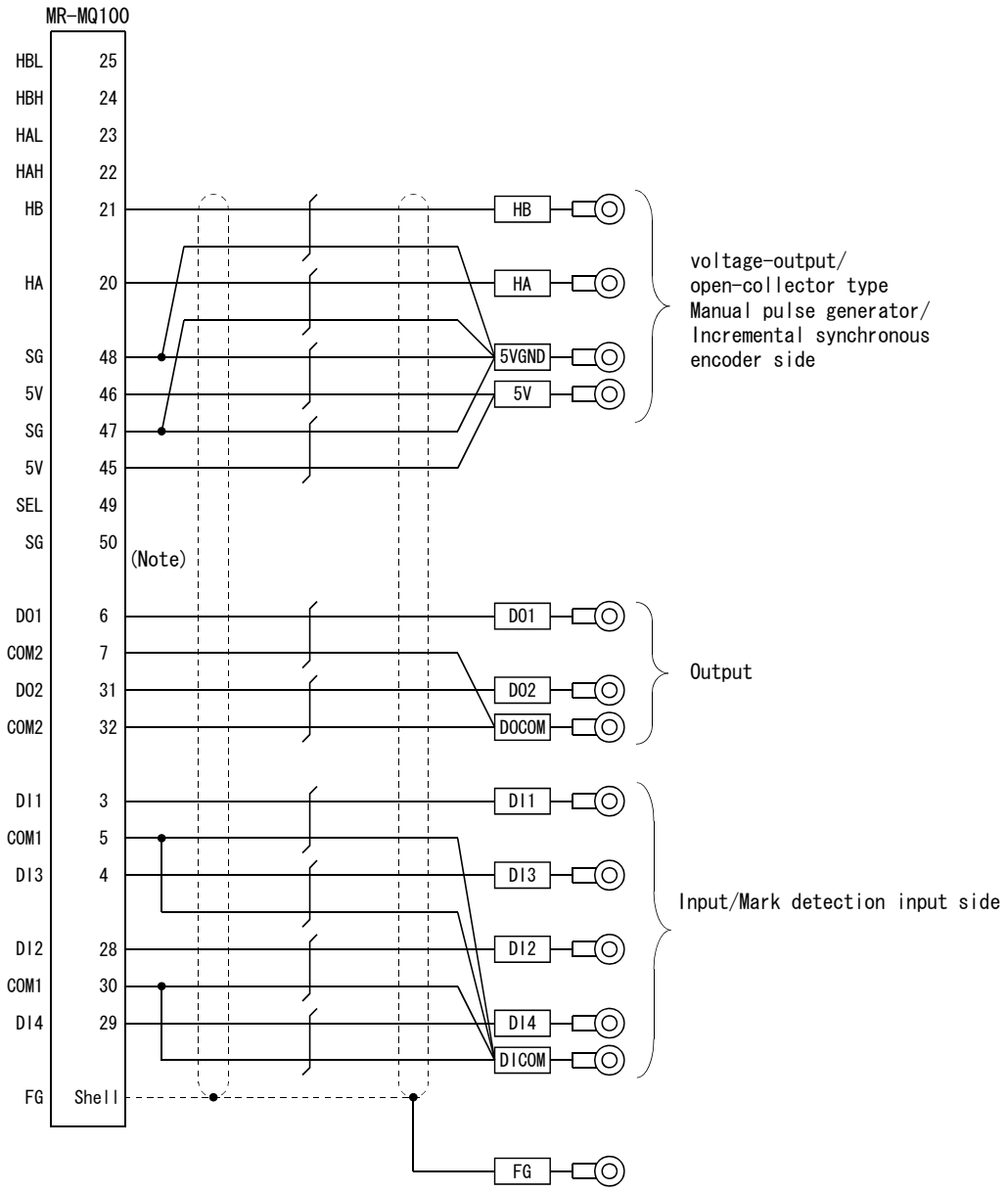


: Twisted pair cable

(Note) : Connect SEL to the SG terminal if differential-output type is used.

(2) Connection diagram with voltage-output/ open-collector type

Make the cable within 30m (98.43ft.).



: Twisted pair cable

(Note) : When "Voltage-output/Open-collector type" is used, open between SEL and SG.

(3) Internal I/F connector cable

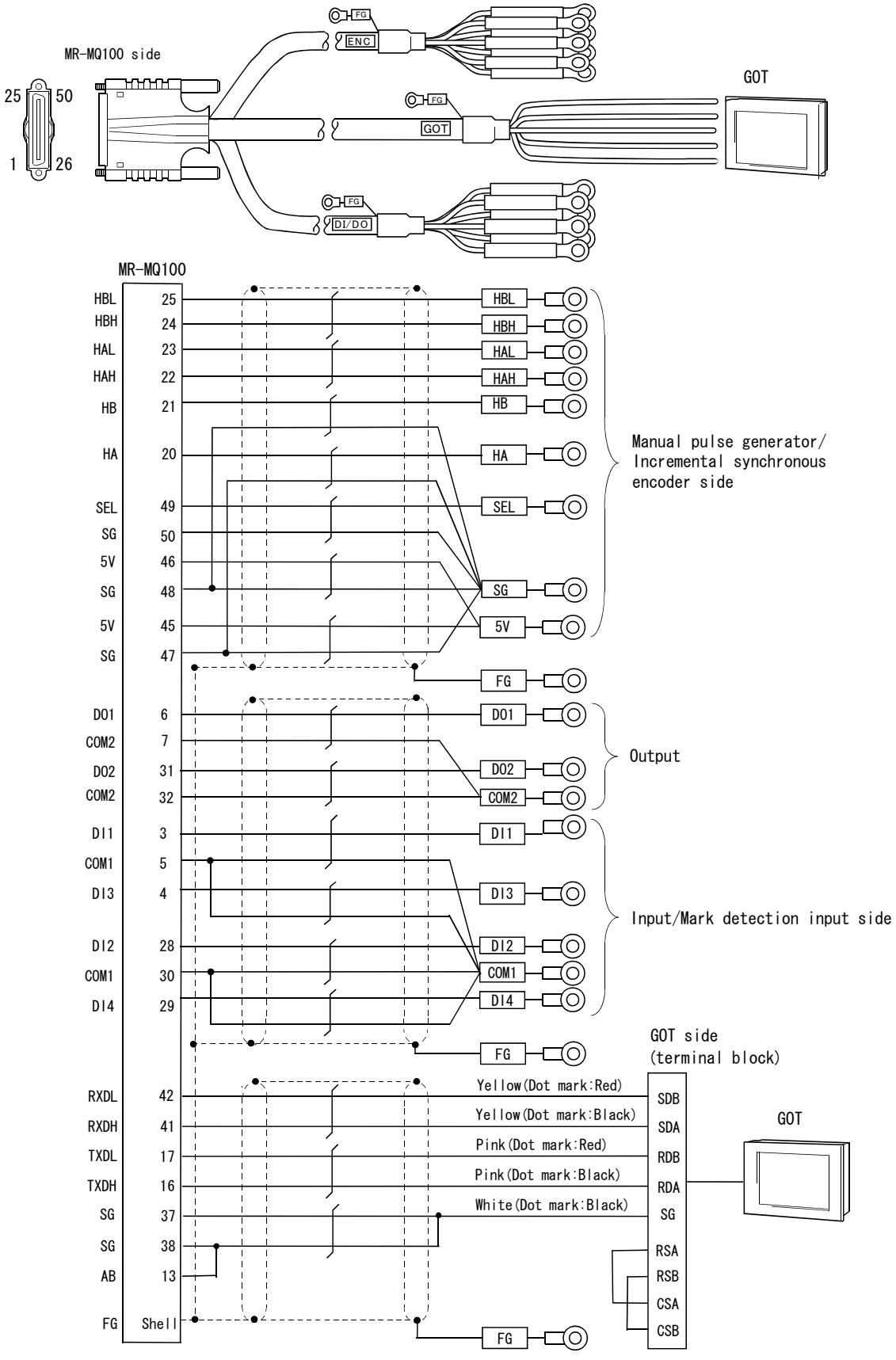
(a) Q170MIOCBL1M-A

Type: Q170MIOCBL□M-＊

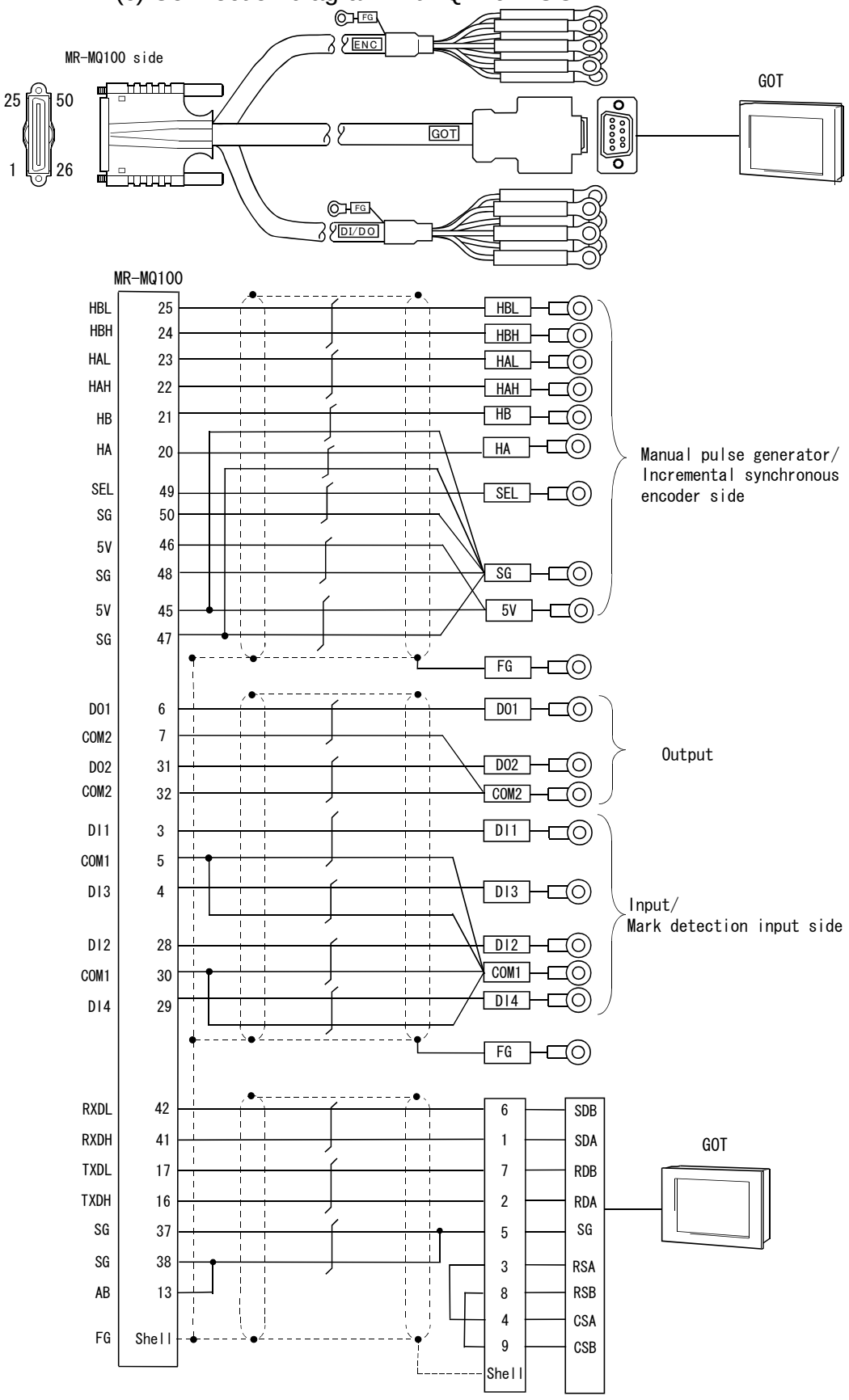
Symbol	Cable type
A	The GOT side is cable covering
B	The GOT side is D-SUB (9pin)

Symbol	Cable length [m(ft.)]
1	1(3.28)

(b) Connection diagram with Q170MIOCBL1M-A



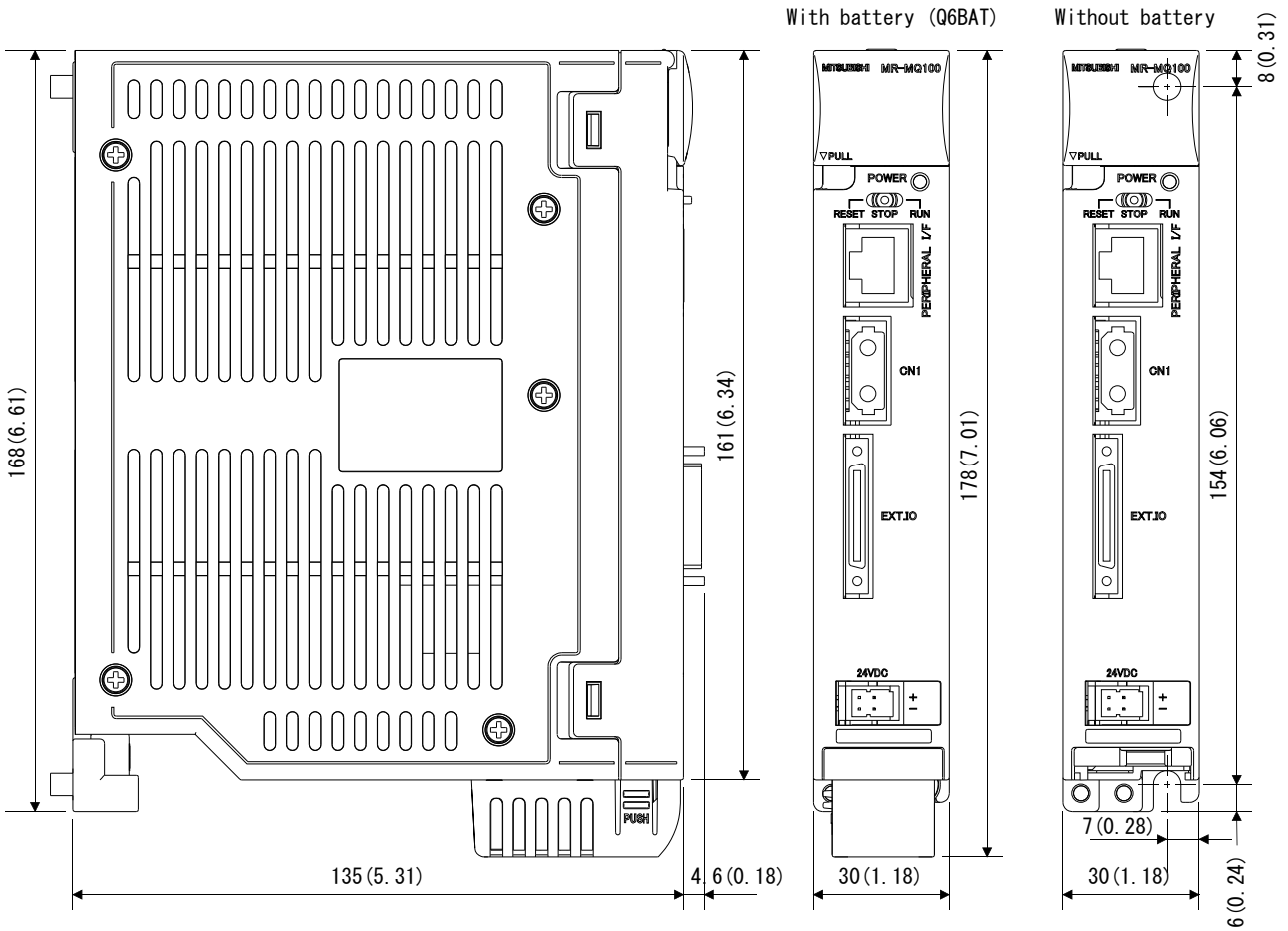
(c) Connection diagram with Q170MIOCBL1M-B



APPENDIX 2 Exterior Dimensions

APPENDIX 2.1 MR-MQ100

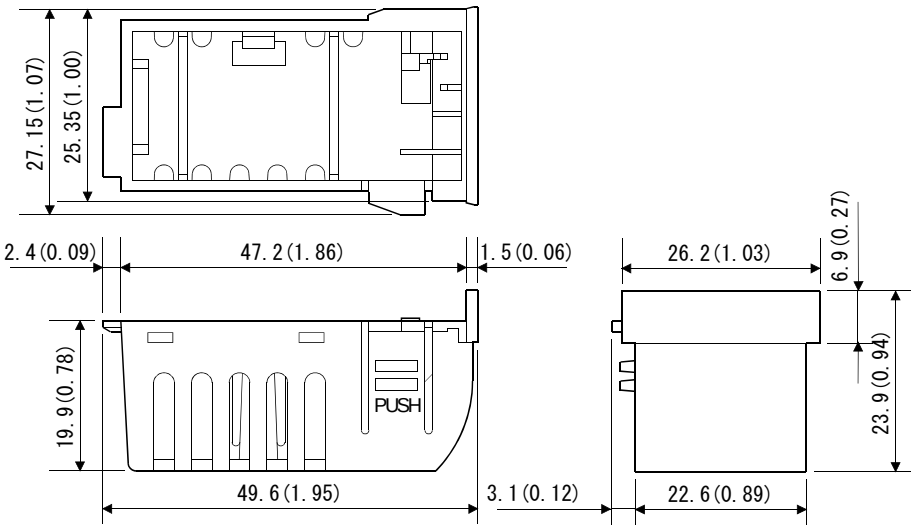
[unit : mm(inch)]



APPENDIX 2.2 Battery holder

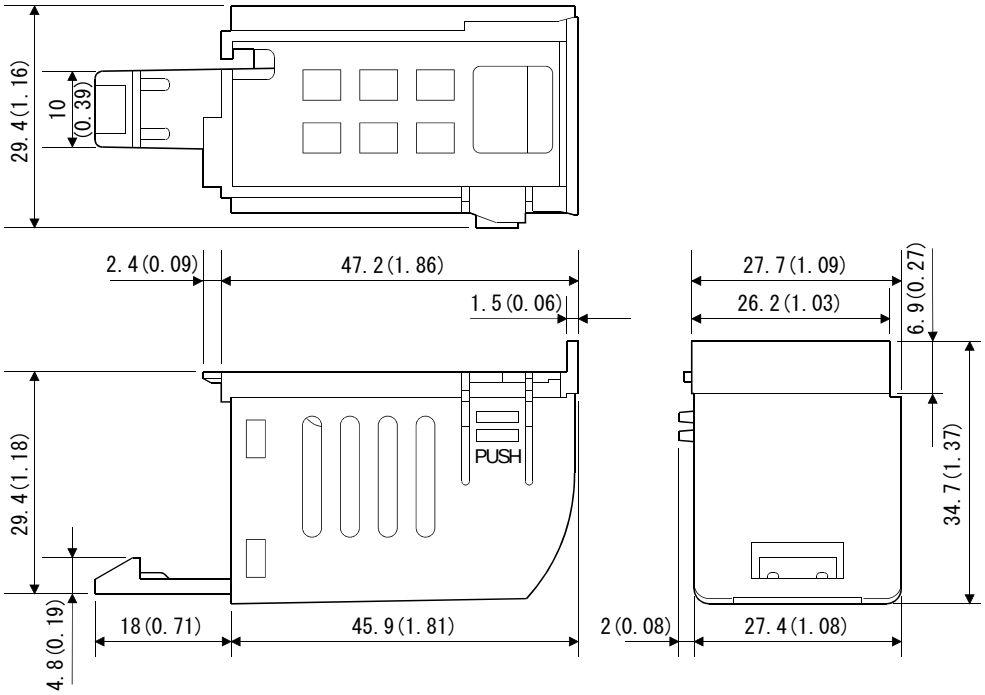
(1) Battery holder (For Q6BAT)

[unit : mm(inch)]



(2) Large capacity battery holder (For Q7BAT)

[unit : mm(inch)]

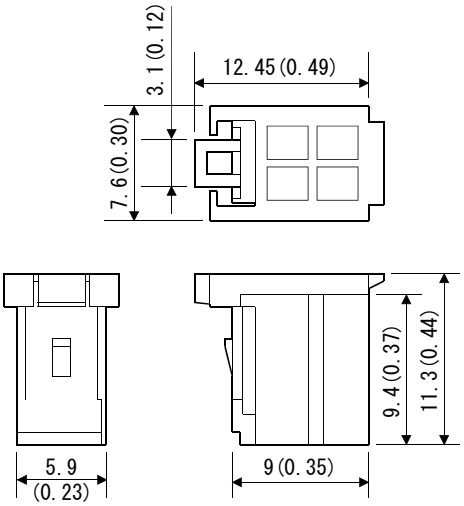


APPENDIX 2.3 Connector

(1) 24VDC power supply connector (Tyco Electronics AMP K.K. make)

Type connector : 1-1827864-2
Terminal : 1827587-2

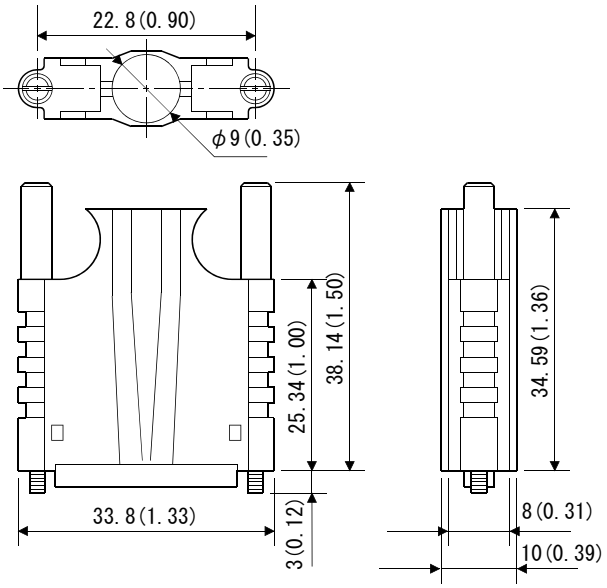
[unit : mm(inch)]



(2) Internal I/F connector (HONDA TSUSHIN KOGYO CO. make)

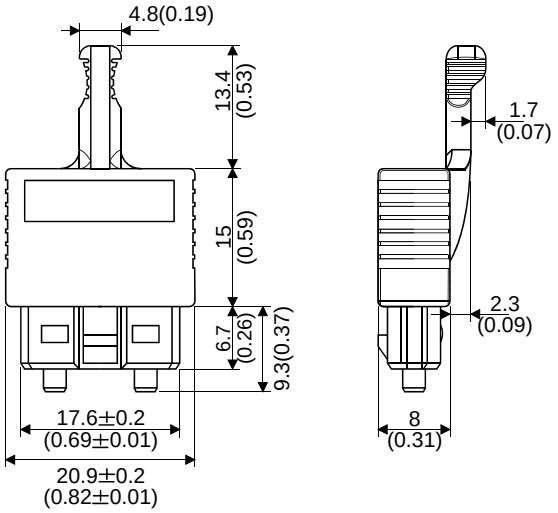
Item	Type	Core size (AWG)	Remark
soldering type connector	HDR-E50MSG1+	AWG19 to AWG22	Attachment
Pressure-displacement type connector	HDR-E50MAG1+	AWG28	-
	HDR-E50MG1+	AWG30	-
connector case	HDR-E50LPH	-	Attachment

[unit : mm(inch)]



(3) SSCNETⅢ cable connector

[unit : mm(inch)]



MEMO

WARRANTY

Please confirm the following product warranty details before using this product.

1. Gratis Warranty Term and Gratis Warranty Range

We will repair any failure or defect hereinafter referred to as "failure" in our FA equipment hereinafter referred to as the "Product" arisen during warranty period at no charge due to causes for which we are responsible through the distributor from which you purchased the Product or our service provider. However, we will charge the actual cost of dispatching our engineer for an on-site repair work on request by customer in Japan or overseas countries. We are not responsible for any on-site readjustment and/or trial run that may be required after a defective unit is repaired or replaced.

[Gratis Warranty Term]

The term of warranty for Product is thirty six (36) months after your purchase or delivery of the Product to a place designated by you or forty two (42) months from the date of manufacture whichever comes first "Warranty Period". Warranty period for repaired Product cannot exceed beyond the original warranty period before any repair work.

[Gratis Warranty Range]

(1) You are requested to conduct an initial failure diagnosis by yourself, as a general rule.
It can also be carried out by us or our service company upon your request and the actual cost will be charged. However, it will not be charged if we are responsible for the cause of the failure.

(2) This limited warranty applies only when the condition, method, environment, etc. of use are in compliance with the terms and conditions and instructions that are set forth in the instruction manual and user manual for the Product and the caution label affixed to the Product.

(3) Even during the term of warranty, the repair cost will be charged on you in the following cases;

1) A failure caused by your improper storing or handling, carelessness or negligence, etc., and a failure caused by your hardware or software problem
2) A failure caused by any alteration, etc. to the Product made on your side without our approval
3) A failure which may be regarded as avoidable, if your equipment in which the Product is incorporated is equipped with a safety device required by applicable laws and has any function or structure considered to be indispensable according to a common sense in the industry
4) A failure which may be regarded as avoidable if consumable parts designated in the instruction manual, etc. are duly maintained and replaced
5) Any replacement of consumable parts (battery, fan, etc.)
6) A failure caused by external factors such as inevitable accidents, including without limitation fire and abnormal fluctuation of voltage, and acts of God, including without limitation earthquake, lightning and natural disasters
7) A failure generated by an unforeseeable cause with a scientific technology that was not available at the time of the shipment of the Product from our company
8) Any other failures which we are not responsible for or which you acknowledge we are not responsible for

2. Onerous Repair Term after Discontinuation of Production

(1) We may accept the repair at charge for another seven (7) years after the production of the product is discontinued.
The announcement of the stop of production for each model can be seen in our Sales and Service, etc.

(2) Please note that the Product (including its spare parts) cannot be ordered after its stop of production.

3. Service in overseas countries

Our regional FA Center in overseas countries will accept the repair work of the Product; However, the terms and conditions of the repair work may differ depending on each FA Center. Please ask your local FA center for details.

4. Exclusion of Loss in Opportunity and Secondary Loss from Warranty Liability

Whether under or after the term of warranty, we assume no responsibility for any damages arisen from causes for which we are not responsible, any losses of opportunity and/or profit incurred by you due to a failure of the Product, any damages, secondary damages or compensation for accidents arisen under a specific circumstance that are foreseen or unforeseen by our company, any damages to products other than the Product, and also compensation for any replacement work, readjustment, start-up test run of local machines and the Product and any other operations conducted by you.

5. Change of Product specifications

Specifications listed in our catalogs, manuals or technical documents may be changed without notice.

6. Precautions for Choosing the Products

(1) For the use of our Motion controller, its applications should be those that may not result in a serious damage even if any failure or malfunction occurs in Motion controller, and a backup or fail-safe function should operate on an external system to Motion controller when any failure or malfunction occurs.

(2) Our Motion controller is designed and manufactured as a general purpose product for use at general industries. Therefore, applications substantially influential on the public interest for such as atomic power plants and other power plants of electric power companies, and also which require a special quality assurance system, including applications for railway companies and government or public offices are not recommended, and we assume no responsibility for any failure caused by these applications when used.
In addition, applications which may be substantially influential to human lives or properties for such as airlines, medical treatments, railway service, incineration and fuel systems, man-operated material handling equipment, entertainment machines, safety machines, etc. are not recommended, and we assume no responsibility for any failure caused by these applications when used.
We will review the acceptability of the abovementioned applications, if you agree not to require a specific quality for a specific application. Please contact us for consultation.

MOTION CONTROLLER User's Manual (Details)
(MR-MQ100)

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE : TOKYO BUILDING, 2-7-3 MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN
NAGOYA WORKS : 1-14 , YADA-MINAMI 5-CHOME , HIGASHI-KU, NAGOYA , JAPAN

MODEL	MRMQ1-U-E
MODEL CODE	1XB818
IB(NA)-0300150-E(1112)MEE	