

Mitsubishi Electric AC Servo System

MITSUBISHI ELECTRIC SERVO SYSTEM
MELSERVO-JET

MR-JET User's Manual (Hardware)

-MR-JET-_G
-MR-JET-_G-N1

SAFETY INSTRUCTIONS

Please read the instructions carefully before using the equipment.

To use the equipment correctly, do not attempt to install, operate, maintain, or inspect the equipment until you have read through this manual, installation guide, and appended documents carefully. Do not use the equipment until you have a full knowledge of the equipment, safety information and instructions.

In this manual, the safety instruction levels are classified into "WARNING" and "CAUTION".



WARNING

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 injury.

Note that the CAUTION level may lead to a serious consequence depending on conditions.

Please follow the instructions of both levels because they are important to personnel safety.

Forbidden actions and required actions are indicated by the following diagrammatic symbols.



Indicates a forbidden action. For example, "No Fire" is indicated by .



Indicates a required action. For example, grounding is indicated by .

In this manual, precautions for hazards that can lead to property damage, instructions for other functions, and other information are shown separately in the "POINT" area.

After reading this manual, keep it accessible to the operator.

[Installation/wiring]

WARNING

- To prevent an electric shock, turn off the power and wait for 15 minutes or more before starting wiring and/or inspection.
 - To prevent an electric shock, ground the servo amplifier.
 - To prevent an electric shock, any person who is involved in wiring should be fully competent to do the work.
 - To prevent an electric shock, mount the servo amplifier before wiring.
 - To prevent an electric shock, connect the protective earth (PE) terminal of the servo amplifier to the protective earth (PE) of the cabinet, then connect the grounding lead wire to the ground.
 - To prevent an electric shock, do not touch the conductive parts.
-

[Setting/adjustment]

WARNING

- To prevent an electric shock, do not operate the switches with wet hands.
-

[Operation]

WARNING

- To prevent an electric shock, do not operate the switches with wet hands.
-

[Maintenance]

WARNING

- To prevent an electric shock, any person who is involved in inspection should be fully competent to do the work.
 - To prevent an electric shock, do not operate the switches with wet hands.
-

ABOUT THE MANUAL

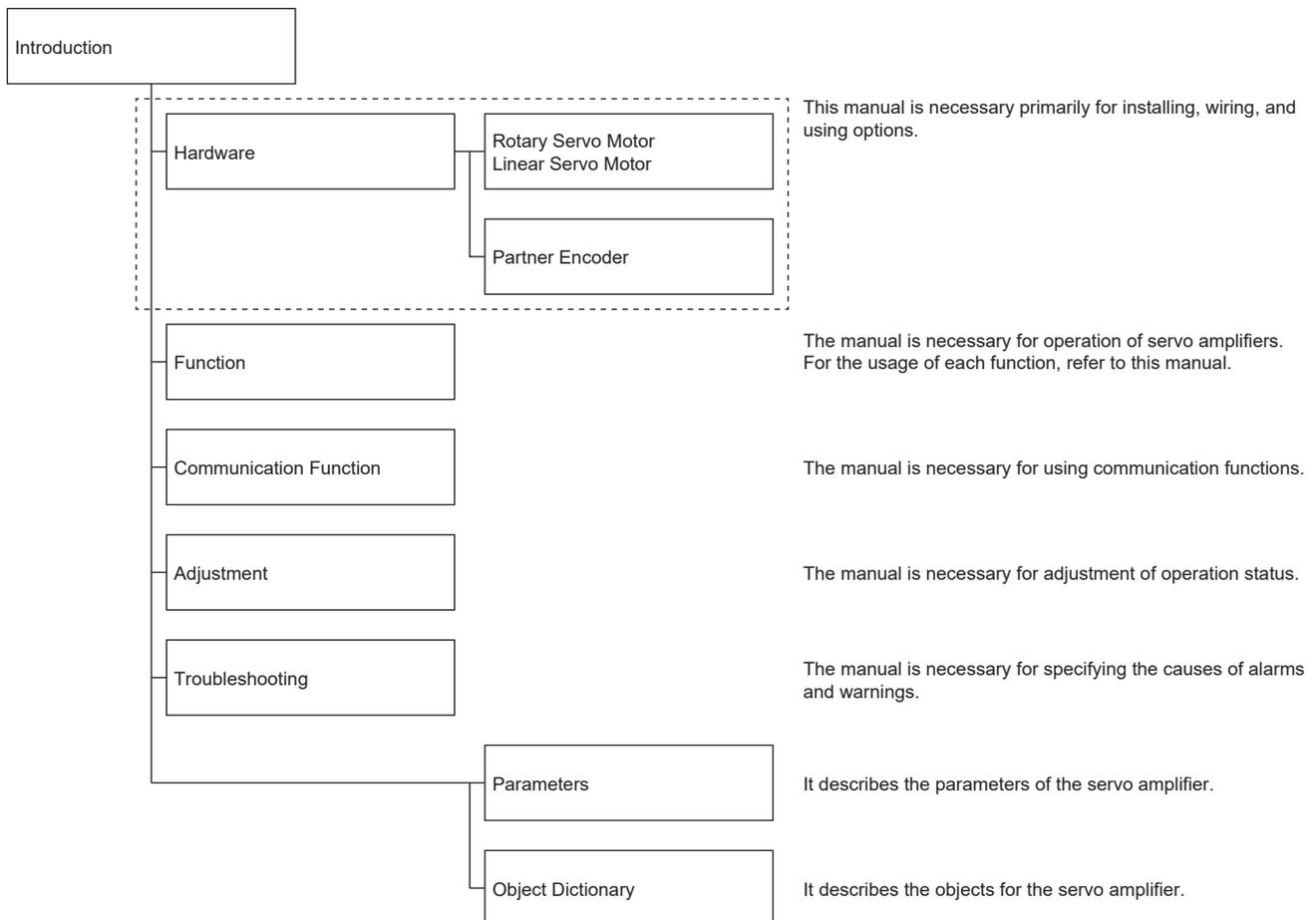
Point

e-Manuals are Mitsubishi Electric FA electronic book manuals that can be browsed with a dedicated tool.

e-Manuals enable the following:

- Searching for desired information in multiple manuals at the same time (manual cross searching)
- Jumping from a link in a manual to another manual for reference
- Browsing for hardware specifications by scrolling over the components shown in product illustrations
- Bookmarking frequently referenced information
- Copying sample programs to engineering tools

If using the servo for the first time, prepare and use the following related manuals to ensure that the servo is used safely. For the related manuals, refer to the User's Manual (Introduction).



U.S. CUSTOMARY UNITS

U.S. customary units are not shown in this manual. Convert the values if necessary according to the following table.

Quantity	SI (metric) unit	U.S. customary unit
Mass	1 [kg]	2.2046 [lb]
Length	1 [mm]	0.03937 [inch]
Torque	1 [N•m]	141.6 [oz•inch]
Moment of inertia	1 [($\times 10^{-4}$ kg•m ²)]	5.4675 [oz•inch ²]
Load (thrust load/axial load)	1 [N]	0.2248 [lbf]
Temperature	N [°C] $\times 9/5 + 32$	N [°F]

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1 INTRODUCTION

1.1 Wiring procedure

Procedure	Description	Reference
1. Installation	Install a servo amplifier.	☞ Page 12 INSTALLATION
2. Connecting the power circuit	Connect the power circuit.	☞ Page 20 Example power circuit connections
3. Connecting I/O signals	Connect I/O signals.	☞ Page 23 Example I/O signal connections
4. Connecting to the servo motor	Connect the servo amplifier to a servo motor.	☞ Rotary Servo Motor User's Manual (HG-KNS/HG-SNS)
5. Connecting options	Connect options.	☞ Page 56 OPTIONS AND PERIPHERAL EQUIPMENT
6. Other precautions	If using the absolute position detection system, perform wiring and settings as necessary.	☞ Page 101 ABSOLUTE POSITION DETECTION SYSTEM
7. Wiring check	Check that the servo amplifier and the servo motor are wired correctly by visually inspecting them or by using a method such as the DO forced output function.	☞ Page 9 Wiring check
8. Checking the surrounding environment	Check the environment surrounding the servo amplifier and servo motor.	☞ Page 11 Surrounding environment

1.2 Servo amplifier/motor combinations

Rotary servo motor

HG-KNS series

○: Standard torque

Rotary servo motor			Servo amplifier MR-JET-						
			10_	20_	40_	70_	100_	200_	300_
HG-KNS	□40	HG-KNS13	○	—	—	—	—	—	—
	□60	HG-KNS23	—	○	—	—	—	—	—
		HG-KNS43	—	—	○	—	—	—	—
	□80	HG-KNS73	—	—	—	○	—	—	—

HG-SNS series

○: Standard torque

Rotary servo motor			Servo amplifier MR-JET-						
			10_	20_	40_	70_	100_	200_	300_
HG-SNS	□130	HG-SNS52	—	—	—	○	—	—	—
		HG-SNS102	—	—	—	—	○	—	—
		HG-SNS152	—	—	—	—	—	○	—
	□176	HG-SNS202	—	—	—	—	—	○	—
		HG-SNS302	—	—	—	—	—	—	○

Linear servo motor

Set [Pr. PA17] and [Pr. PA18.0-3] according to the linear servo motor to be used.

LM-H3 series

Use servo amplifiers with firmware version B2 or later. Otherwise, [AL. 01A Servo motor combination error] occurs.

Linear servo motor		Servo amplifier MR-JET-		
Primary side (coil)	Secondary side (magnet)	40_	70_	200_
LM-H3P2A-07P-BSS0	LM-H3S20-288-BSS0 LM-H3S20-384-BSS0 LM-H3S20-480-BSS0 LM-H3S20-768-BSS0	○	—	—
LM-H3P3A-12P-CSS0	LM-H3S30-288-CSS0	○	—	—
LM-H3P3B-24P-CSS0	LM-H3S30-384-CSS0	—	○	—
LM-H3P3C-36P-CSS0	LM-H3S30-480-CSS0	—	○	—
LM-H3P3D-48P-CSS0	LM-H3S30-768-CSS0	—	—	○
LM-H3P7A-24P-ASS0	LM-H3S70-288-ASS0	—	○	—
LM-H3P7B-48P-ASS0	LM-H3S70-384-ASS0	—	—	○
LM-H3P7C-72P-ASS0	LM-H3S70-480-ASS0	—	—	○
	LM-H3S70-768-ASS0	—	—	○

LM-AJ series

Use servo amplifiers with firmware version B2 or later. Otherwise, [AL. 01A Servo motor combination error] occurs.

Linear servo motor		Servo amplifier MR-JET-	
Primary side (coil)	Secondary side (magnet)	40_	70_
LM-AJP1B-07K-JSS0	LM-AJS10-080-JSS0	○	—
LM-AJP1D-14K-JSS0	LM-AJS10-200-JSS0	—	○
	LM-AJS10-400-JSS0	—	○
LM-AJP2B-12S-JSS0	LM-AJS20-080-JSS0	○	—
LM-AJP2D-23T-JSS0	LM-AJS20-200-JSS0	—	○
	LM-AJS20-400-JSS0	—	○
LM-AJP3B-17N-JSS0	LM-AJS30-080-JSS0	○	—
LM-AJP3D-35R-JSS0	LM-AJS30-200-JSS0	—	○
	LM-AJS30-400-JSS0	—	○
LM-AJP4B-22M-JSS0	LM-AJS40-080-JSS0	○	—
LM-AJP4D-45N-JSS0	LM-AJS40-200-JSS0	—	○
	LM-AJS40-400-JSS0	—	○

1.3 Wiring check

Before switching on the power supply, check the following items.

Power supply system wiring

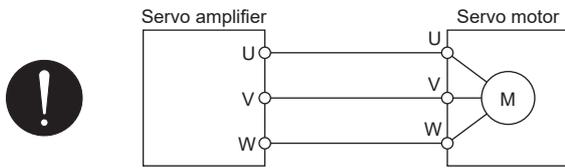
Power supply system wiring

- Check that the power supplied to the power input terminals (L1/L2/L3) of the servo amplifier satisfies the defined specifications.

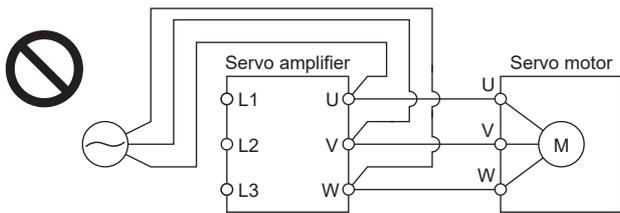
For the power supply specifications, refer to "Servo amplifier standard specifications" in the User's Manual (Introduction).

Connecting the servo amplifier to the servo motor

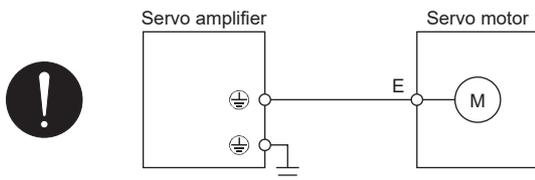
- Check that the phases (U/V/W) of the servo amplifier power outputs and the phases (U/V/W) of the servo motor power inputs match with each other.



- Check that the power to be supplied to the servo amplifier is not connected to the power outputs (U/V/W) as doing so will cause the servo amplifier and the servo motor to malfunction.



- Check that the grounding terminal of the servo motor is connected to the PE terminal of the servo amplifier.



- Check that the CN2 connector of the servo amplifier is securely connected to the encoder of the servo motor using the encoder cable.

Using options or peripheral equipment

■Regenerative option

- Check that the built-in regenerative resistor and wiring have been removed from the servo amplifier.
- Check that the lead wires of the built-in regenerative resistor connected to the P+ terminal and C terminal have been removed.
- Check that the wire of the regenerative option is connected to terminal P+ and terminal C.
- Check that twisted wires have been used for connecting the regenerative option to the servo amplifier.

☞ Page 65 Connection of regenerative option

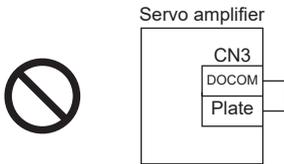
I/O signal wiring

- Check that I/O signals are connected correctly.

If the DO forced output mode is used, the pins of the CN3 connector can be forcibly switched on/off. This mode is used to check the wiring. Check the wiring in the servo-off state when using this mode.

☞ Page 23 Example I/O signal connections

- Check that a voltage exceeding 24 V DC has not been applied to the pins of the CN3 connector.
- Check that the plate and DOCOM of the CN3 connector have not been shorted.



1.4 Surrounding environment

Check the following items about the environment surrounding the servo amplifier and servo motor.

Handling cables

- Check that the wiring cables have not been stressed.
 - Check that the encoder cable has been used within its flex life.
- ☞ Page 54 Cable flex life
- Check that the connector of the servo motor has not been stressed.

Environment

Check that signal cables and power cables have not been shorted primarily by wire offcuts and metallic dust.

2 INSTALLATION

Precautions

- Remove the protective sticker on the front of the servo amplifier before use.
- Install the servo amplifier and regenerative resistor on incombustible material. Installing them either directly on or near combustibles may lead to smoke or a fire. In addition, the servo amplifier must be installed in a metal cabinet.
- Provide an adequate protection to prevent the following matter from entering the servo amplifier: conductive matter such as screws and metal fragments, and combustible matter such as oil.
- Devices such as the servo amplifier regenerative resistor and servo motor may become hot. Take safety measures such as providing covers.
- Do not stack in excess of the specified number of product packages.
- Do not carry the servo amplifier by the front cover, cables, connectors, or the lead wires of the built-in regenerative resistor. Doing so may cause the servo amplifier to drop.
- To prevent a malfunction, do not drop the servo amplifier or servo motor or subject them to impacts.
- Install the servo amplifier and servo motor in a place that can support their weight as stated in the user's manual.
- Do not get on the equipment or put a heavy load on it.
- Do not install or operate a servo amplifier that is missing parts or is damaged.
- To prevent a malfunction, do not block the intake and exhaust areas of the servo amplifier.
- Do not subject connectors to impacts. Doing so may cause a connection failure, malfunction, or other failures.
- Use the product within the specified environment. For the environment, refer to "Servo amplifier standard specifications" in the User's Manual (Introduction).
- To prevent a fire or injury from occurring in the event of an earthquake or other natural disaster, securely install, mount, and wire the servo amplifier as stated in the manual.
- If the product has been stored for an extended period of time, contact your local sales office.
- When handling the servo amplifier, be careful with the edges of the servo amplifier.
- Fumigants that are used to disinfect and protect wooden packaging from insects contain halogens (such as fluorine, chlorine, bromine, and iodine) cause damage if they enter our products. Please take necessary precautions to ensure that any residual materials from fumigants do not enter our products, or perform disinfection and pest control using a method other than fumigation, such as heat treatment. Perform disinfection and pest control on the wooden packaging materials before packing the products.
- Provide an external emergency stop circuit to stop the operation and shut-off the power immediately.
- For equipment in which the moving part of the machine may collide against the load side, install a limit switch or stopper to the end of the moving part.
- When installing the servo amplifier on the cabinet, do not damage the lead wires of the built-in regenerative resistor. The lead wires may be damaged if they are trapped between the servo amplifier and the cabinet or other devices.
- Do not use the servo amplifier in environments where it is exposed to strong magnetic fields, electric fields, or radiation. Doing so may cause operation failure or malfunction.

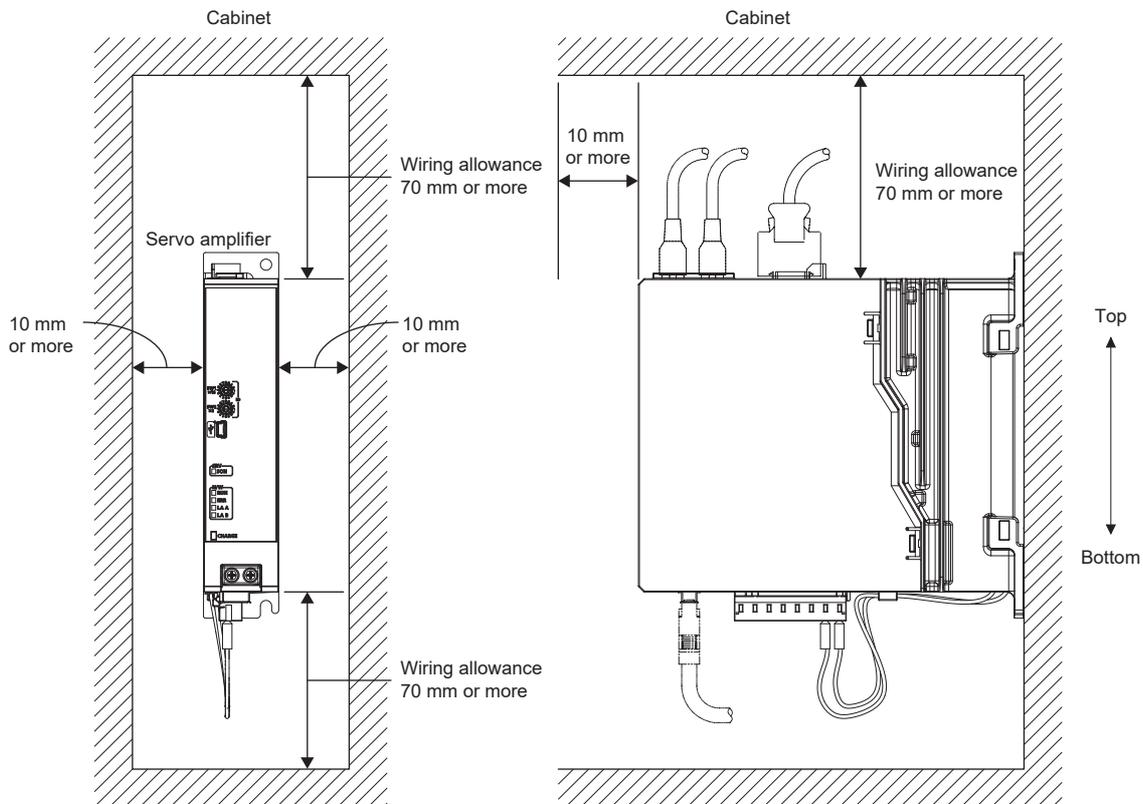
2.1 Mounting direction and clearances

Precautions

- The servo amplifier must be installed in the specified direction.
- To prevent a malfunction, maintain the specified clearances between the servo amplifier and cabinet walls or other equipment.
- MR-JET-40_ to MR-JET-300_ have a regenerative resistor on their back. The regenerative resistor generates heat of 100 °C higher than the ambient temperature. Install the servo amplifiers primarily taking into account heat dissipation and the installation position.

Installation clearances for the servo amplifier

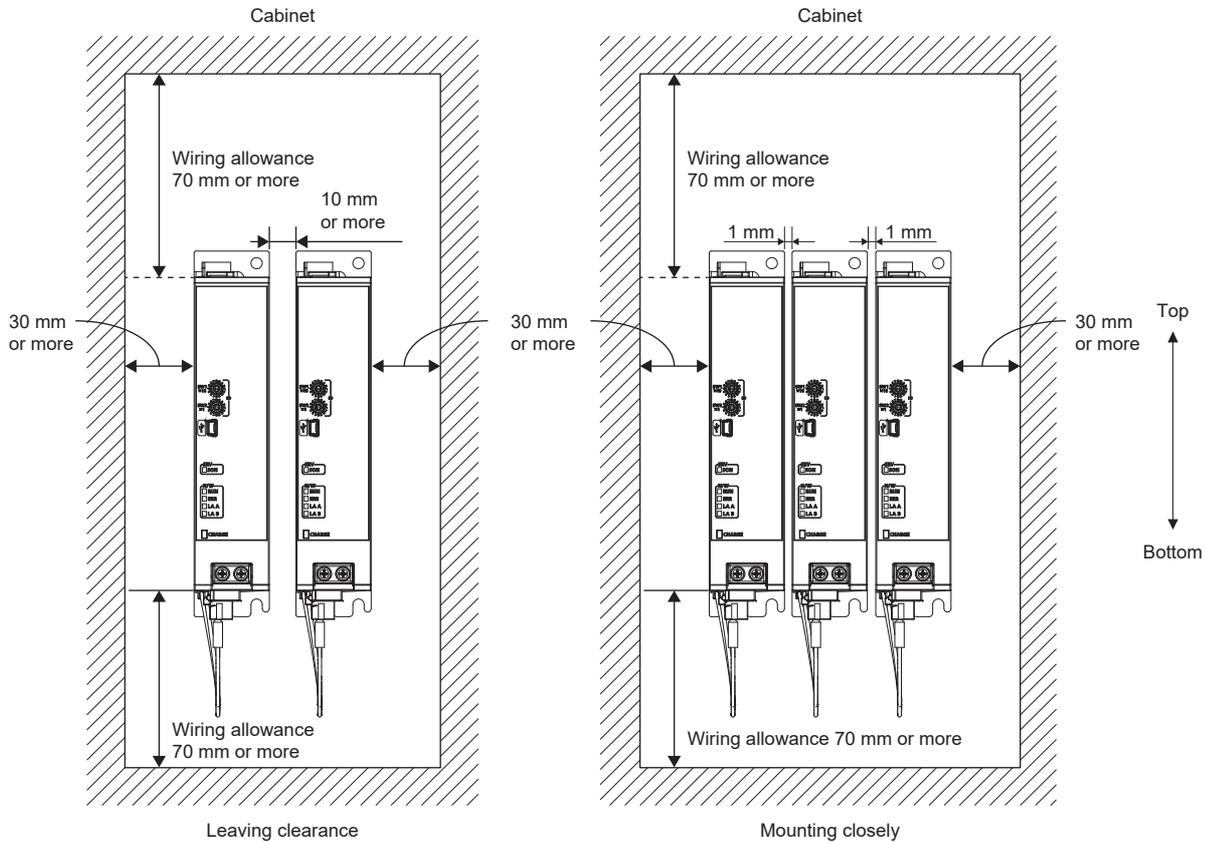
■ Installation of one servo amplifier



■ Installation of two or more servo amplifiers

Maintain a large clearance above the servo amplifiers and install a cooling fan to prevent the temperature inside the cabinet from exceeding the temperature specified in the environmental conditions.

When closely mounting the servo amplifiers, leave a clearance of 1 mm between the adjacent servo amplifiers in consideration of mounting tolerances. When mounting servo amplifiers in this manner, keep the ambient temperature within 0 °C to 45 °C, or use the servo amplifiers with 75 % or less of the effective load ratio.



Precautions

- Refer to the following table for availability of close mounting.

Servo amplifier	When 3-phase power supply is input	When 1-phase power supply is input
MR-JET-10_ to MR-JET-70_	Possible	Possible
MR-JET-100_ to MR-JET-200_		Impossible
MR-JET-300_		—

Other precautions

When using heat generating equipment such as the regenerative option, install it with full consideration of heat generation so that the servo amplifier is not affected.

Mount the servo amplifier on a perpendicular wall in the correct vertical direction.

2.2 Keeping out foreign materials

When drilling the cabinet for assembly, prevent drill chips and wire fragments from entering the servo amplifier.

Prevent foreign matter such as oil, water, and metallic dust from entering the servo amplifier through cooling fans installed in openings in the cabinet or on the ceiling.

When installing the cabinet in a place where toxic gas, dirt, and dust exist, conduct an air purge (force clean air into the cabinet from outside to make the internal pressure higher than the external pressure) to prevent such materials from entering the cabinet.

When not using the CN1A, CN1B, or CN3 connector, cover them with the supplied cap.

2.3 Cable stress

- The method used to clamp the cable must be fully examined so that bending stress and cable's own weight stress are not applied to the cable connection.
- When used for applications where the servo motor moves, fix the cable (encoder, power supply, brake) with gentle slack from the connecting part of the connector to prevent stress from being applied to the connecting part of the servo motor connector. Use the optional encoder cable within the flex life range.
- Prevent the cable insulator from being cut by sharp chips or from touching and rubbing against the machine corners.
- Prevent the cables from getting stepped on by workers or run over by vehicles.
- If installing the servo motor that moves on a machine, make the bend radius as large as possible. Refer to the following for the flex life.

 Page 54 Cable flex life

Precautions

- The cables should not be damaged, stressed, loaded, or pinched.

2.4 Fan unit replacement procedure

The fan unit is composed of a cooling fan and its cover. If replacing the cooling fan, replace the entire fan unit.

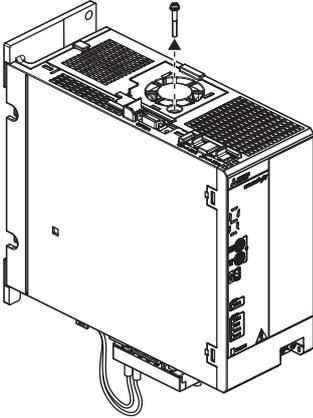
Shut off the power supply before replacing the fan unit.

List of applicable fan units

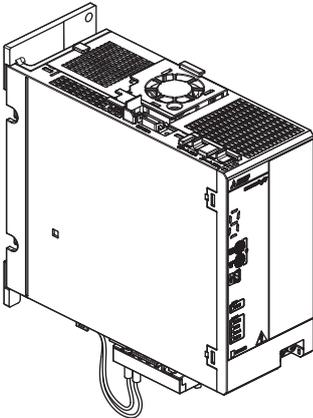
Servo amplifier	Model of fan unit to be replaced
MR-JET-200_ MR-JET-300_	MR-JET-FAN1

Fan unit removal procedure

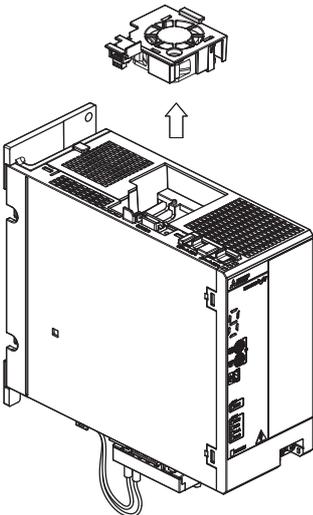
1. Remove the screws that fixed the fan unit. Keep the removed screws for installation of the new fan unit.



2. Pull up the cover of the fan unit.

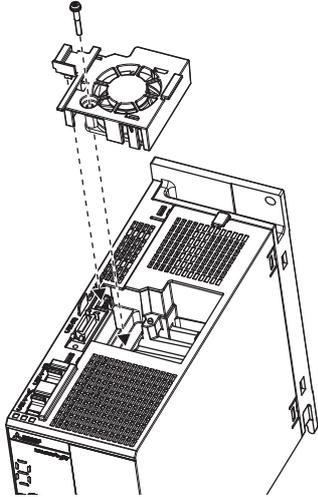


3. Pull out the fan unit vertically.



Fan unit installation procedure

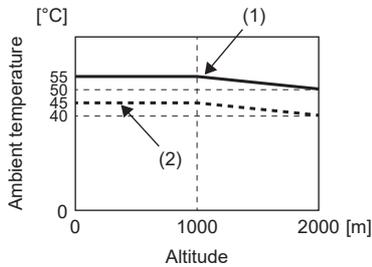
Insert the positioning part of the fan unit vertically, align it to the positioning part of the main unit case, and tighten with screws. Use the same screws as those used for the fan unit before replacement.



2.5 Restrictions when using this product at an altitude exceeding 1000 m and up to 2000 m

Altitude and ambient temperature

As heat dissipation effects decrease in proportion to the decrease in air density, use the product within the ambient temperature range shown in the following figure.



(1): Not closely mounted/closely mounted (75 % or less of the effective load ratio)

(2): Closely mounted (without limiting the effective load ratio)

Input voltage

Generally, withstand voltage decreases as altitude increases; however, there is no restriction on the withstand voltage.

Parts with a service life

■Smoothing capacitor

The capacitor will reach the end of its service life in 10 years of continuous operation in an air-conditioned environment (with an ambient temperature of 30 °C or less).

■Relays

There is no restriction.

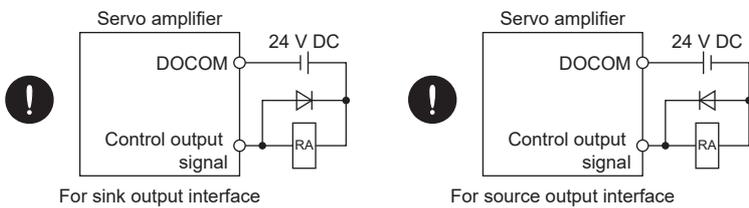
■Servo amplifier cooling fan

There is no restriction.

3 SIGNALS AND WIRING

Precautions

- Insulate the conductive parts of the terminals.
- If using a regenerative resistor, configure a circuit that shuts off the main circuit power supply with an alarm signal because abnormal overheating of the regenerative resistor may cause smoke and fire.
- To prevent failure and malfunction, only the power supply/signal specified in the manual should be connected to a corresponding terminal.
- To prevent unexpected operation of the servo motor, wire the equipment correctly and securely.
- Make sure to connect the cables and connectors by using the fixing screws and the locking mechanism. Failing to do so may cause the cables and connectors to disconnect during operation.
- Unless stated otherwise, all connection diagrams in this manual are sink interface diagrams.
- Install a surge absorbing diode in the correct direction. Failing to do so may cause the amplifier to malfunction and not to output signals, disabling protective circuits such as the emergency stop.



- If the wires are not properly secured to the terminal block, the poor contact may cause the wires and terminal block to generate heat. Be sure to secure the wires with the specified torque.
- Connecting the servo motor for an incorrect axis to the power outputs (U/V/W) or CN2 of the servo amplifier may cause a malfunction.
- Make sure that no operation signal is being input to the servo amplifier before resetting an alarm or releasing the emergency stop. Failing to do so may cause an unexpected operation.
- If the power supply is shut off by a molded-case circuit breaker or a fuse, remove the cause and secure safety before switching the power on.
- Install the servo amplifier according to the EMC guidelines because electromagnetic interference may affect the electronic equipment used near the servo amplifier.
- To prevent an electric shock or a fire, do not disassemble, repair, or modify the product. Disassembled, repaired, and/or modified products are not covered under warranty.
- Eliminate static electricity before performing actions such as wiring or operating a switch.
- When disconnecting the CNP1 connector from MR-JET-40_ to MR-JET-300_, do not forcibly pull the lead wires of the built-in regenerative resistor or the CNP1 connector. Doing so may snap the lead wires of the built-in regenerative resistor.
- Before wiring, turn off the power and wait for 15 minutes or more until the charge light turns off. In addition, when confirming whether the charge light is off or not, look at the light from the front of the servo amplifier.

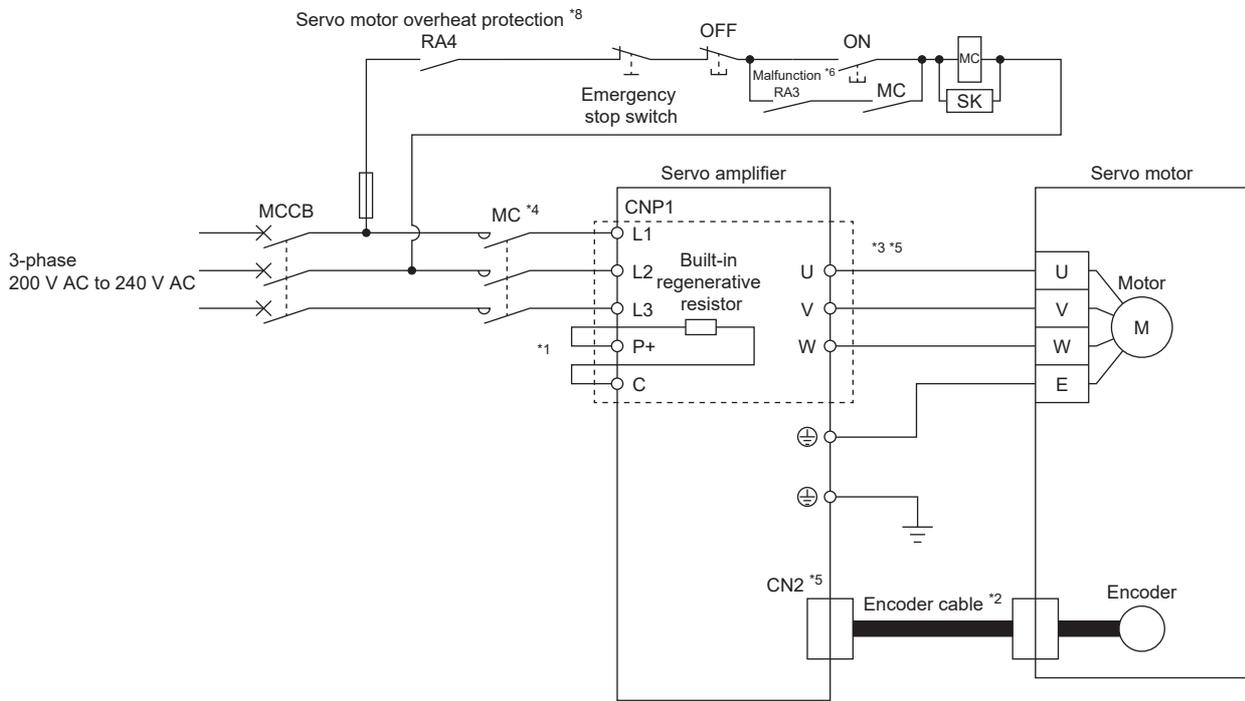
3.1 Example power circuit connections

Precautions

- Connect a magnetic contactor between a power supply and the power supply (L1/L2/L3) of a servo amplifier to configure a circuit that shuts off the power supply on the servo amplifier side because failure of the servo amplifier may cause smoke and fire if a magnetic contactor is not connected.
- Use a configuration that shuts off the power supply with ALM (Malfunction).
- Check the servo amplifier model and use the correct power supply voltage.
- Exogenous noise or lightning surges may degrade the characteristics of the surge absorber (varistor) built into the servo amplifier and damage it.
- In the torque mode, EM2 functions the same as EM1.
- To prevent malfunction, avoid bundling the servo amplifier's power lines (input/output) and signal cables together or running them parallel to each other. Separate the power lines from the signal cables.
- Provide adequate protection to prevent an unexpected restart after an instantaneous power failure.
- Configure wiring so that the power supply is shut off and the servo-on command is turned off after deceleration to a stop due to an alarm occurrence, an enabled servo forced stop, or a quick stop command from the controller. Use a molded-case circuit breaker (MCCB) with the input cables of the main circuit power supply.

200 V class

For 3-phase 200 V AC to 240 V AC power supply



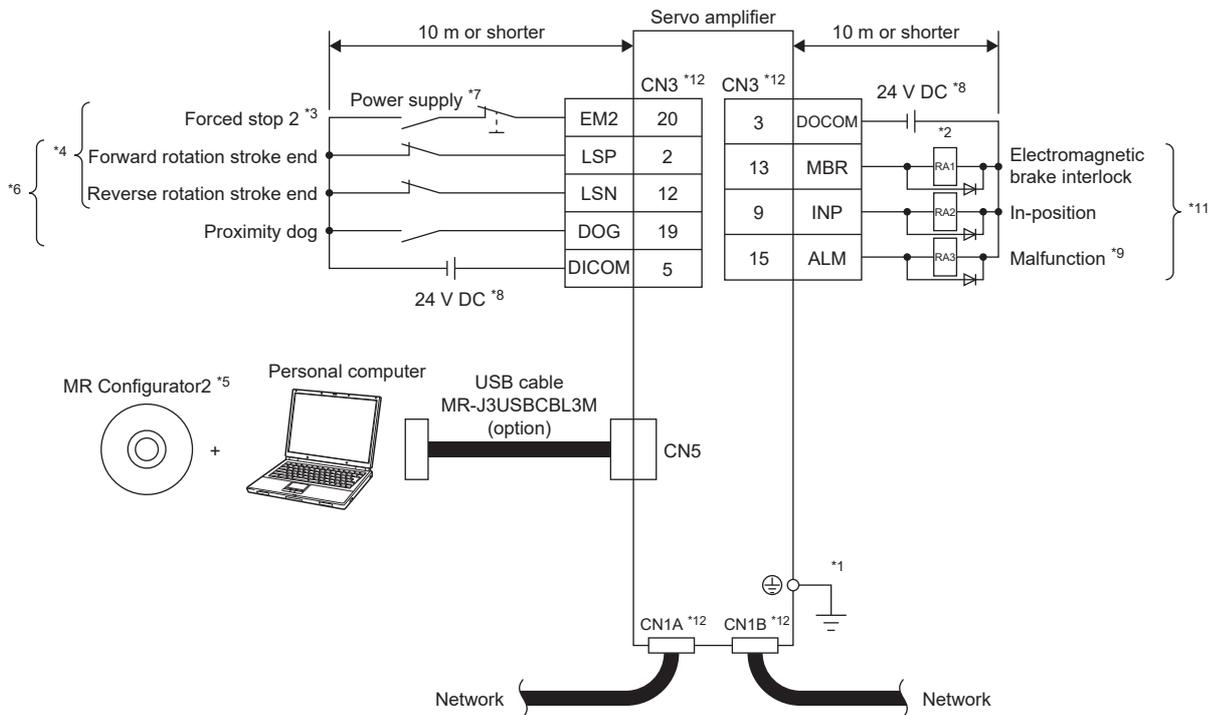
- *1 The built-in regenerative resistor is used for MR-JET-40_ to MR-JET-300_ (factory-wired). If using a regenerative option, refer to the following.
 ☞ Page 62 Regenerative option
- *2 Option cables are recommended for encoder cables. For selecting cables, refer to "Cables/connector sets" in the following manual.
 📖 Rotary Servo Motor User's Manual (HG-KNS/HG-SNS)
- *3 For connecting servo motor power wires, refer to "CONNECTION OF SERVO AMPLIFIER AND ROTARY SERVO MOTOR" in the following manual.
 📖 Rotary Servo Motor User's Manual (HG-KNS/HG-SNS)
- *4 Use the magnetic contactor with an operation delay time (interval between current being applied to the coil until closure of contacts) of 80 ms or less. The bus voltage may drop depending on the power supply voltage and operation pattern, causing a dynamic brake deceleration during a forced stop deceleration. If dynamic brake deceleration is not required, delay the time to turn off the magnetic contactor.
- *5 Connecting the servo motor for an incorrect axis to U, V, W, or CN2 of the servo amplifier may cause a malfunction.
- *6 If ALM (Malfunction) output is disabled with a servo parameter, configure a power circuit which switches off a magnetic contactor after detection of an alarm occurrence on the controller side.
- *7 For 1-phase 200 V AC to 240 V AC power supply, connect the power supply to L1 and L3. Leave L2 open.
- *8 When connecting a linear servo motor that has a thermal protector, add a contact that interlocks with the thermal protector output of the linear servo motor.

3.2 Example I/O signal connections

Precautions

- Do not connect CN1A and CN1B connectors to a network other than the network used by this servo amplifier. Doing so may cause a malfunction.
- In the torque mode, EM2 functions the same as EM1.

For sink I/O interface



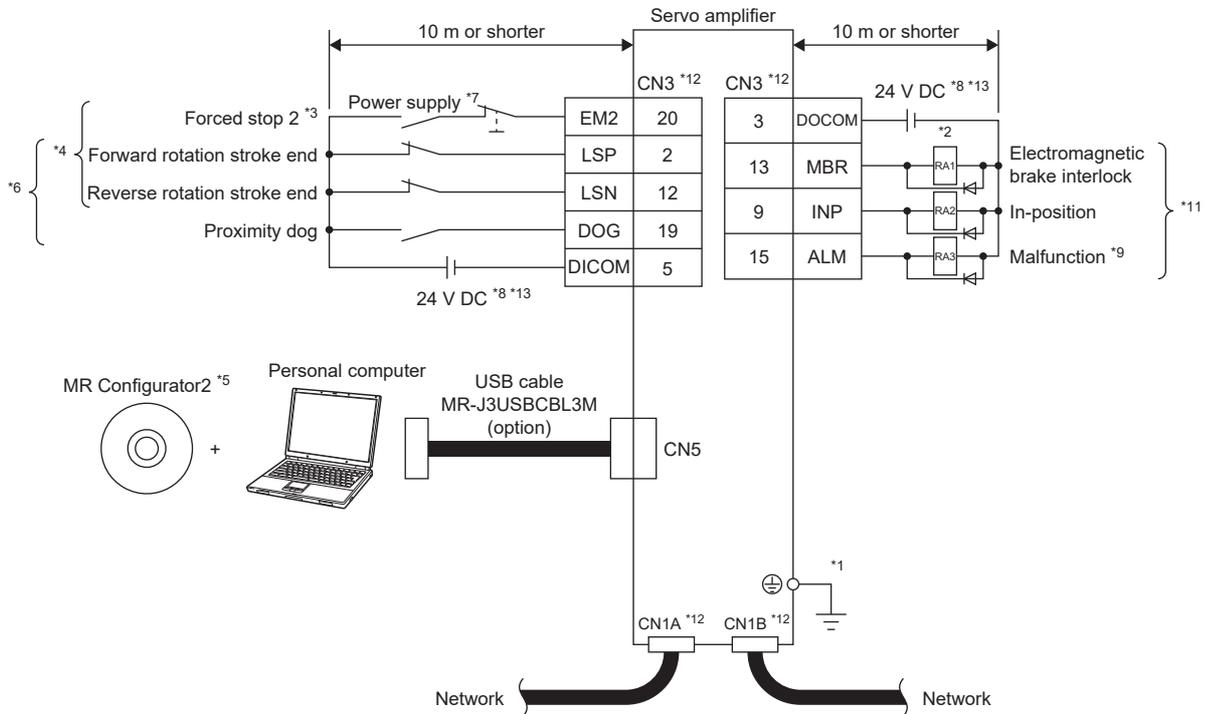
- *1 To prevent an electric shock, connect the protective earth (PE) terminal (the terminal marked with the ⊕ symbol) of the servo amplifier to the protective earth (PE) of the cabinet.
- *2 Connect the diode in the correct direction. If it is connected reversely, the servo amplifier may malfunction and not output signals, disabling protective circuits such as EM2 (Forced stop 2).
- *3 If the controller does not have the forced stop function, install a forced stop 2 switch (normally closed contact).
- *4 When starting operation, turn on EM2 (Forced stop 2), LSP (Forward rotation stroke end), and LSN (Reverse rotation stroke end) (normally closed contact). If FLS (Upper stroke limit) and RLS (Lower stroke limit) are used via a controller, wiring LSP and LSN is unnecessary. In that case, set [Pr. PD41].
- *5 Use SW1DNC-MRC2-.
- *6 The devices of these pins can be changed with servo parameters ([Pr. PD03] to [Pr. PD05]).
- *7 To prevent an unexpected restart of the servo amplifier, configure a circuit that turns off EM2 when the power supply is turned off.
- *8 Supply 24 V DC \pm 10 % to interfaces from an external source. The total current capacity of these power supplies is 300 mA maximum. The amperage will not exceed 300 mA when all I/O signals are used. Reducing the number of I/O points decreases the current capacity. For the amperage required for interfaces, refer to the following.
 Page 38 Digital input interface DI-1
 Although the diagram shows the input signal and the output signal each using a separate 24 V DC power supply for illustrative purposes, the system can be configured to use a single 24 V DC power supply.
- *9 If no alarm is occurring, ALM (Malfunction) is on (normally closed contact).
- *10 The pins with the same signal name are connected in the servo amplifier.
- *11 The devices of these pins can be changed with servo parameters ([Pr. PD07] to [Pr. PD09]).
- *12 When not using the CN1A, CN1B, or CN3 connector, cover them with the supplied cap.
- *13 For source interfaces, the positive and negative outputs of the power supply are reversed as compared with sink interfaces.

For source I/O interface

Precautions

- For notes, refer to the notes in the following section.

☞ Page 23 For sink I/O interface



3.3 Explanation of power supply system

Explanation of signals

Point

• For the layout of connectors and terminal blocks, refer to the following.

☞ Page 42 DIMENSIONS

L1/L2/L3 (Connection destination: Power supply)

Supply the following power to L1, L2, and L3. For 1-phase 200 V AC to 240 V AC power supply, connect the power supply to L1 and L3. Leave L2 open.

Power supply	Servo amplifier	
	MR-JET-10_ to MR-JET-200_	MR-JET-300_
3-phase 200 V AC to 240 V AC, 50 Hz/60 Hz	L1/L2/L3	
1-phase 200 V AC to 240 V AC, 50 Hz/60 Hz	L1/L3	—

P+/C (Connection destination: Regenerative option)

If using the regenerative resistor built into the servo amplifier, connect the regenerative resistor to P+ and C (factory-wired). MR-JET-10_ and MR-JET-20_ do not have a regenerative resistor.

If using a regenerative option, disconnect the lead wires of the built-in regenerative resistor from P+ and C. Then, connect the regenerative option to P+ and C.

U/V/W (Connection destination: Servo motor power supply)

Connect the servo motor power supply inputs (U/V/W) directly to the motor. Do not connect devices such as magnetic contactors between the motor and servo amplifier as this will lead to abnormal operation or malfunction.

⊕ (Connection destination: Protective earth (PE))

Connect a servo amplifier to the grounding terminal of a servo motor and to the protective earth (PE) of a cabinet.

Power-on procedure

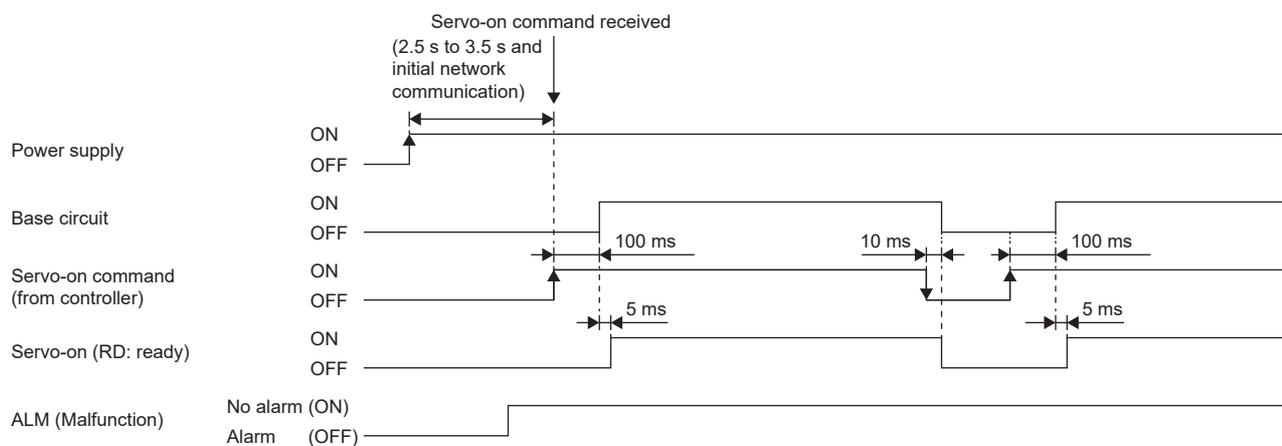


Signals such as output signals may be unstable at power-on.

Power-on procedure

1. Connect a magnetic contactor between the power supply and the power supply (L1/L2/L3) of a servo amplifier by referring to the following section. Switch off the magnetic contactor as soon as an alarm occurs.
☞ Page 20 Example power circuit connections
2. When the power supply is switched on, the servo amplifier will receive the servo-on command after 2.5 s to 3.5 s and initial network communication.

Timing chart



Wiring CNP1

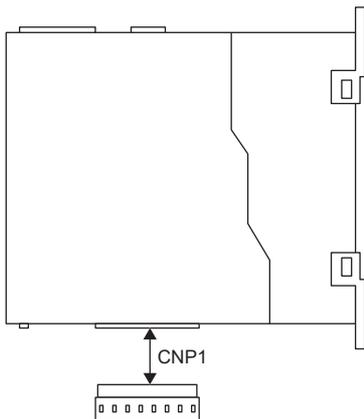
Point

- For the wire sizes, refer to the following.
 - ☞ Page 83 Selection example of wires
- When wiring, remove the power connectors from the servo amplifier.
- Insert only one wire or ferrule into each wire insertion hole on each power connector.

Use the supplied servo amplifier power connector for wiring CNP1.

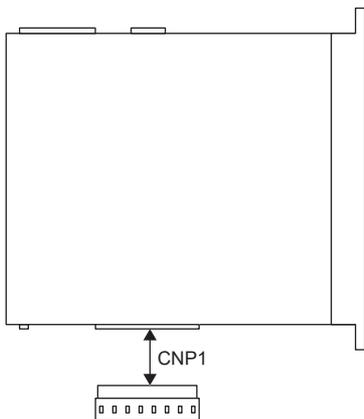
Connector

■MR-JET-10_ to MR-JET-100_



Connector	Receptacle assembly	Applicable wire		Stripped length [mm]	Open tool	Manufacturer
		Size	Insulator OD			
CNP1	1-2349815-2	AWG 18 to 14	3.9 mm or less	8.5 ± 0.5	1981045-1	TE Connectivity

■MR-JET-200_/MR-JET-300_



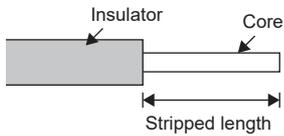
Connector	Receptacle assembly	Applicable wire		Stripped length [mm]	Open tool	Manufacturer
		Size	Insulator OD			
CNP1	1-2349825-8	AWG 16 to 10	4.7 mm or less	10.5 ± 0.5	2349891-1	TE Connectivity

Connecting wires

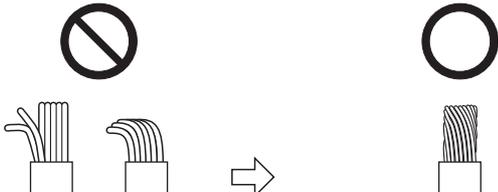
■ Fabricating the wire insulator

Refer to the following for the stripped length of the wire insulator. Set the appropriate length based on the wire type and fabrication condition.

☞ Page 27 Connector



Twist the core wires lightly and straighten them as follows.



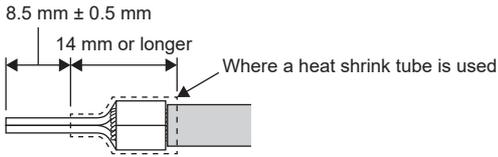
Loose and bent strands

Twist and straighten the strands.

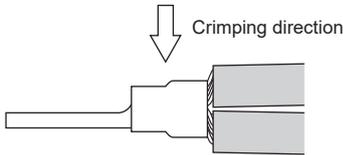
A ferrule can also be used when connecting to the connectors. If using a ferrule, choose from one of the ferrules and the crimping tools shown below.

Servo amplifier	Wire size	Ferrule model and its manufacturer *1		Crimping tool
		For one wire	For two wires	
MR-JET-10_ to MR-JET-100_	AWG 16	AI 1,5 -8 BU (Phoenix Contact)	A2 *2 (DAIDO SOLDERLESS TERMINAL MFG.)	CRIMPFOX-ZA3 (Phoenix Contact) DS-H12 (DAIDO SOLDERLESS TERMINAL MFG.) PZ 6/5 (Nihon Weidmueller)
		A2 (DAIDO SOLDERLESS TERMINAL MFG.)		
AWG 14	A2 (DAIDO SOLDERLESS TERMINAL MFG.)	—		
MR-JET-200_ / MR-JET-300_	AWG 16	AI 1,5 -10 BU (Phoenix Contact)	AI-TWIN 2X 1,5 -10 BK (Phoenix Contact)	
	AWG 14	AI 2,5 -10 BU (Phoenix Contact)	AI-TWIN 2X 2,5 -10 BU (Phoenix Contact)	
			H2.5/19D ZH (Nihon Weidmueller)	
AWG 12	AI 4 -10 GY (Phoenix Contact)	—		
	H4.0/18D (Nihon Weidmueller)			

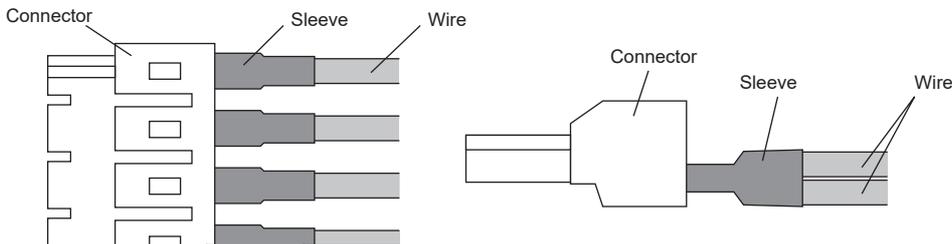
*1 If using the ferrule manufactured by DAIDO SOLDERLESS TERMINAL MFG., leave the stripped wire end $8.5\text{ mm} \pm 0.5\text{ mm}$ from the ferrule tip and insulate the wire using a heat shrink tube with a length of 14 mm or more.



*2 If crimping two wires into the ferrule, align the wires so that pressure can be applied in the crimping direction as shown below.



Insert the ferrule into the connector with the two crimped wires aligned vertically to the connector as shown below. Do not rotate the ferrule in the pitch direction.



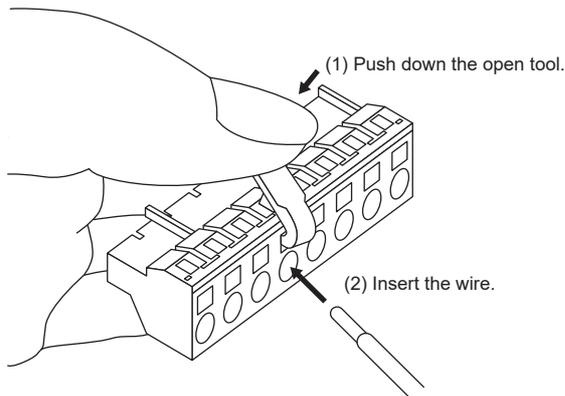
■Inserting wire

Insert only one wire or ferrule into each wire insertion hole on each power connector.

Insert the open tool as follows and push it down to open the spring.

While the open tool is pushed down, insert the stripped wire into the wire insertion hole. Check the wire insertion depth so that the wire insulator is not caught by the spring and that the conductive part of the stripped wire is not exposed.

Release the open tool to fix the wire. Pull the wire lightly to confirm that the wire is surely connected. In addition, confirm that the ends of the core wires do not stick out of the connector.

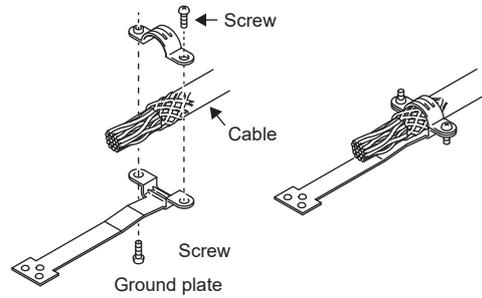


3.4 Connectors and pin assignments

Precautions

The pin assignments of the connectors are as viewed from the cable connector wiring section.

For wiring to the I/O signal connector (CN3), securely connect the external conductor of the shielded cable to the ground plate and fix it to the connector shell.



Connectors and pin assignments

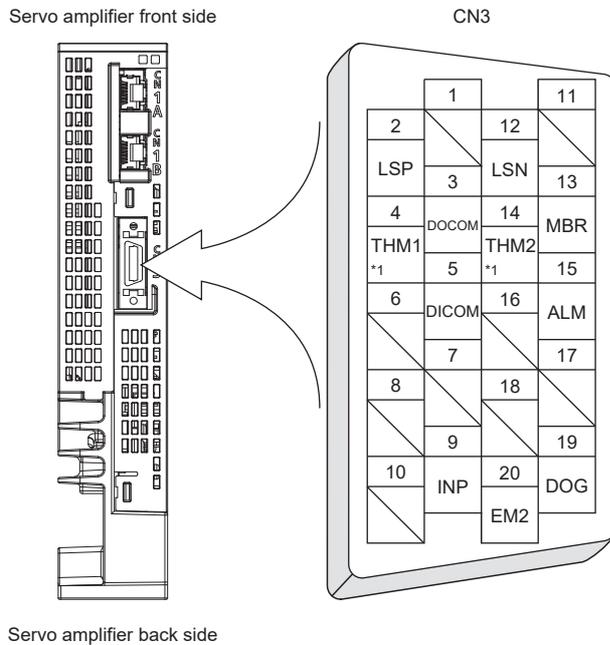
The front view of the servo amplifier shown below is of MR-JET-_G_ servo amplifier with a rated capacity symbol of 40 or less. Refer to the following for the appearance and connector layout of the other servo amplifiers.

☞ Page 42 DIMENSIONS

The frames of the CN2 and CN3 connectors are connected to the protective earth terminal in the servo amplifier.

- Assignment of CN3 connector pins

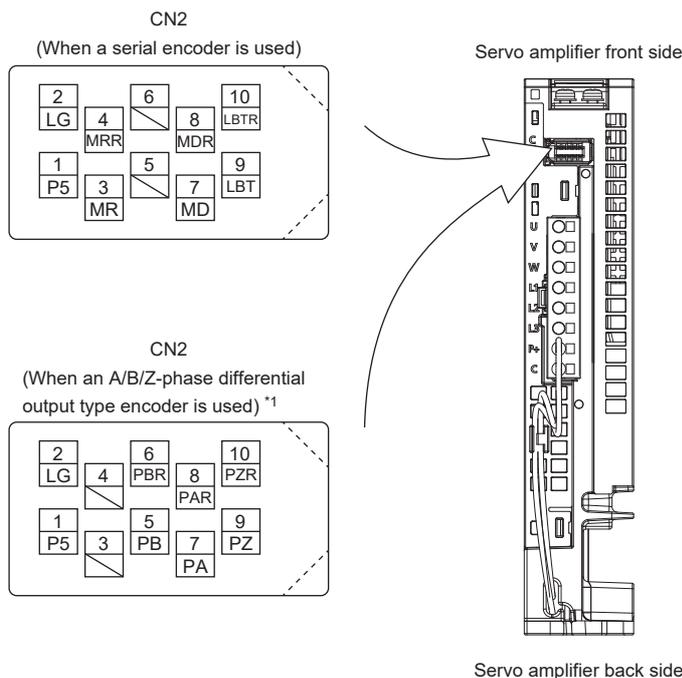
The following diagram is the servo amplifier as viewed from the top.



*1 THM1 and THM2 are for connecting a servo motor thermistor. These signals can be used on servo amplifiers with firmware version B2 or later.

- Assignment of CN2 connector pins

The following diagram is the servo amplifier as viewed from the bottom.



*1 When using an A/B/Z-phase differential output type encoder, set [Pr. PC26.0 A/B/Z-phase input encoder connection setting selection] to "2 (enabled)". [Pr. PC26.0] can be used on servo amplifiers with firmware version B2 or later.

3.5 Signal (device) explanation

For the I/O interfaces (symbols in the column "I/O signal interface type" in the table), refer to the following.

☞ Page 38 Detailed explanation of interfaces

The pin numbers in the connector pin No. column are default numbers.

📖 MR-JET-G User's Manual (Parameters)

Input device

Input device pins

The following shows input device pins and the servo parameters used for setting devices.

Connector pin No.	Servo parameter	Initially assigned device	I/O signal interface type
CN3-2	[Pr. PD03]	LSP	DI-1
CN3-12	[Pr. PD04]	LSN	
CN3-19	[Pr. PD05]	DOG	
CN3-20	—	EM2	

Input device explanation

■EM2 (Forced stop 2)

When EM2 is turned off (open between commons), the base circuit shuts off, and the dynamic brake operates to decelerate the servo motor to a stop.

The forced stop will be deactivated if EM2 is turned on (short between commons) while in the forced stop state.

EM2 and EM1 are mutually exclusive. In the torque mode, EM2 functions the same as EM1.

Setting value		EM2/EM1	Deceleration method	
[Pr. PA04.3]	[Pr. PA04.2]		EM2 or EM1 is off	Alarm occurrence
0	0	EM1	MBR (Electromagnetic brake interlock) turns off without the forced stop deceleration.	MBR (Electromagnetic brake interlock) turns off without the forced stop deceleration.
2	0	EM2	MBR (Electromagnetic brake interlock) turns off after the forced stop deceleration.	MBR (Electromagnetic brake interlock) turns off after the forced stop deceleration.
0	1	Neither EM2 nor EM1 is used.	—	MBR (Electromagnetic brake interlock) turns off without the forced stop deceleration.
2	1	Neither EM2 nor EM1 is used.	—	MBR (Electromagnetic brake interlock) turns off after the forced stop deceleration.

■EM1 (Forced stop 1)

When EM1 is turned off (open between commons), the base circuit shuts off, and the dynamic brake operates to decelerate the servo motor to a stop.

The forced stop will be deactivated if EM1 is turned on (short between commons) while in the forced stop state.

■LSP (Forward rotation stroke end)/LSN (Reverse rotation stroke end)

To operate a servo motor, turn on LSP/LSN. Turn LSP/LSN off to bring the servo motor to a stop and switch it to the servo-lock state.

For information about areas such as the supported control modes, automatic on, and restrictions, refer to "Stroke limit function" in the following manual.

MR-JET User's Manual (Function)

Input device		Operation	
LSP	LSN	CCW direction (positive direction)	CW direction (negative direction)
1 (on)	1 (on)	○	○
0 (off)	1 (on)	—	○
1 (on)	0 (off)	○	—
0 (off)	0 (off)	—	—

■PC (Proportional control)

Turn PC on to switch the speed amplifier from the proportional integral type to the proportional type.

If a servo motor is rotated even for a pulse due to any external factor while it is at a stop, it generates torque to compensate for a position mismatch. If locking the servo motor shaft mechanically after positioning completes, turn on PC (Proportional control) upon completion of positioning to suppress the unnecessary torque generated for compensation of a position mismatch.

If locking the shaft for a long period of time, set the torque value to be the rated torque or less.

Do not use PC in the torque mode. If PC is used in the torque mode, the servo motor may operate at a speed exceeding the speed limit value.

■CDP (Gain switching)

Turn on CDP to use the values of [Pr. PB29] to [Pr. PB36] and [Pr. PB56] to [Pr. PB60] as the load to motor inertia ratio and individual gain values.

When both CDP and CDP2 are on, the setting of CDP2 is prioritized.

■CDP2 (Gain switching 2)

Turn on CDP2 to use the values of [Pr. PB67] to [Pr. PB70] as the load to motor inertia ratio and individual gain values.

When both CDP and CDP2 are on, the setting of CDP2 is prioritized.

■DOG (Proximity dog)

Turning off DOG will detect a proximity dog. The polarity for the proximity dog can be changed with [Pr. PT29.0].

[Pr. PT29.0]	Polarity for proximity dog detection
1	Dog detection with off
0	Dog detection with on

Output device

Output device pins

The following shows the output device pins and the servo parameters used for assigning devices.

Connector pin No.	Servo parameter	Initially assigned device	I/O signal interface type
CN3-13	[Pr. PD07]	MBR	DO-1
CN3-9	[Pr. PD08]	INP	
CN3-15	[Pr. PD09]	ALM	

Output device explanation

■ALM (Malfunction)

If the protective circuit operates and shuts off the base circuit, ALM will turn off.

If an alarm is not occurring, ALM will turn on in 2.5 s to 3.5 s after power-on.

■INP (In-position)

If droop pulses are within the in-position range, INP will turn on. The in-position range can be changed with [Pr. PA10]. When the servo motor is operated at low speed by increasing the in-position range, INP may remain on.

The device cannot be used in the velocity mode or torque mode.

■RD (Ready)

When the servo amplifier is switched to the servo-on state, RD switches on.

■SA (Speed reached)

At servo-off, SA is off. When the servo motor speed reaches the following range, SA turns on.

Set speed $\pm ((\text{Set speed} \times 0.05) + 20)$ r/min

When the set speed is 20 r/min or less, SA is always on.

The device cannot be used in the position mode and torque mode.

■WNG (Warning)

WNG turns on when a warning occurs. If a warning is not occurring, WNG turns off in 2.5 s to 3.5 s after power-on.

■BWNG (Battery warning)

If [AL. 092 Battery cable disconnection warning] or [AL. 09F Battery warning] occurs, BWNG will turn on. If a battery warning is not occurring, BWNG will turn off in 2.5 s to 3.5 s after power-on.

■WNGSTOP (Motor stop warning)

WNGSTOP will turn on if a warning that the motor cannot be driven occurs. If a motor stop warning is not occurring, WNGSTOP will turn off in 2.5 s to 3.5 s after power-on.

■CDPS (Variable gain enabled)

When the gain of "Gain switching" is enabled, CDPS is on.

■CDPS2 (Variable gain enabled 2)

If the gain of "Gain switching 2" is enabled, CDPS2 will turn on.

■ABSV (Absolute position erased)

ABSV turns on when the absolute position is undetermined.

■MTTR (Tough drive in progress)

When a tough drive is set to "Enabled" in [Pr. PA20], activating the instantaneous power failure tough drive turns on MTTR.

■MBR (Electromagnetic brake interlock)

MBR is off in the servo-off state or at an alarm occurrence.

If using the device, set an operation delay time of the electromagnetic brake in [Pr. PC02].

For details, refer to "Electromagnetic brake interlock function" in the following manual.

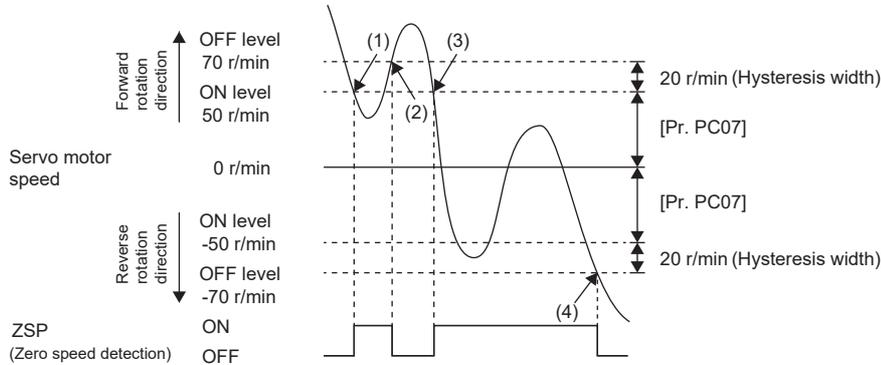
 MR-JET User's Manual (Function)

■VLC (Limiting speed)

If the speed reaches the speed limit value in the torque mode, VLC will turn on. VLC will turn off in the servo-off state. The device cannot be used in the position mode or the velocity mode.

■ZSP (Zero speed detection)

If the servo motor speed is the zero speed or less, ZSP will turn on. The zero speed can be changed with [Pr. PC07]. The following shows an example when the initial value (50) is set in [Pr. PC07].



ZSP will turn on when the servo motor speed is reduced to 50 r/min (at (1)), and will turn off when the servo motor is increased to 70 r/min again (at (2)).

ZSP will turn on when the servo motor is decelerated again to 50 r/min (at (3)), and will turn off when the servo motor speed reaches -70 r/min (at (4)).

The range from the point when the servo motor speed has reached the on-level and ZSP turns on, to the point when the speed has increased again and reached the off-level is called a hysteresis width.

The hysteresis width is 20 r/min for this servo amplifier.

■TLC (Limiting torque)

If the torque reaches the torque limit value when torque is generated, TLC will turn on. TLC will turn off in the servo-off state. In the torque mode, TLC is off.

■DOA (General-purpose output A)/DOB (General-purpose output B)/DOC (General-purpose output C)

The pins to which the device is assigned can be switched on/off with the object "Digital outputs". For details, refer to "[Digital outputs (Obj. 60FEh)]" in the User's Manual (Object Dictionary).

The output device is available on servo amplifiers with firmware version B6 or later.

Power supply

Power supply explanations

■DICOM (Digital input I/F power supply)

Input 24 V DC (24 V DC \pm 10 %, 300 mA) for I/O interfaces. The power supply capacity varies depending on the number of I/O interface points to be used.

For sink interfaces, connect the positive terminal of the 24 V DC external power supply.

For source interfaces, connect the negative terminal of the 24 V DC external power supply.

■DOCOM (Digital output I/F power supply)

Input 24 V DC (24 V DC \pm 10 %, 300 mA) for I/O interfaces. The power supply capacity varies depending on the number of I/O interface points to be used.

For sink interfaces, connect the negative terminal of the 24 V DC external power supply.

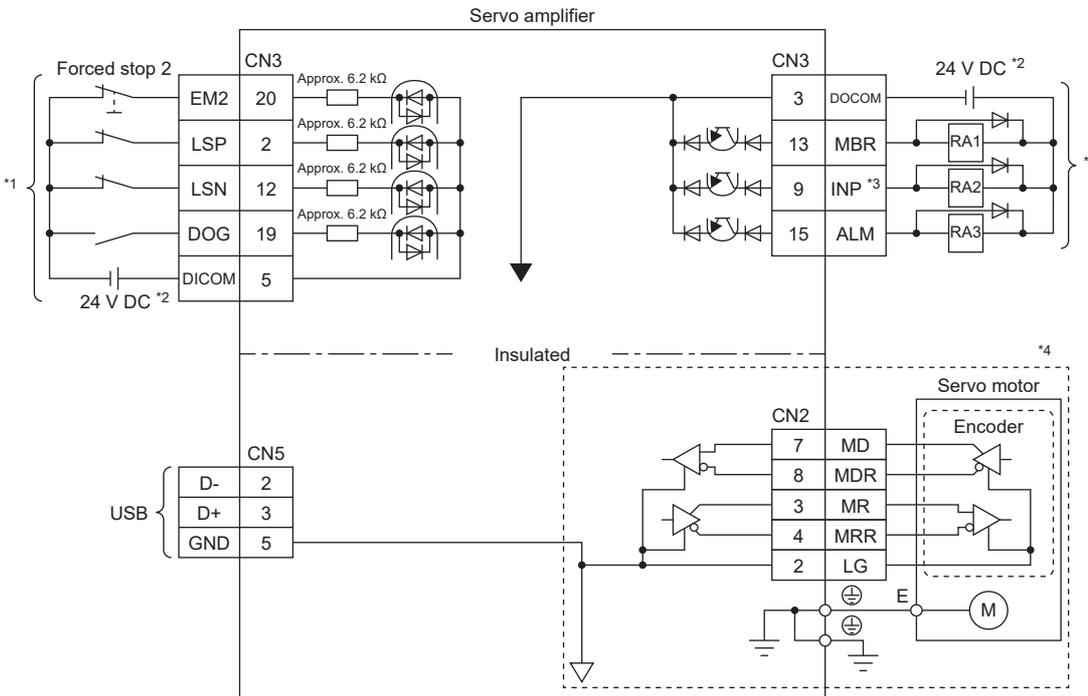
For source interfaces, connect the positive terminal of the 24 V DC external power supply.

■SD (Shield)

Connect the external conductor of a shielded wire to SD.

3.6 Interface

Internal connection diagram



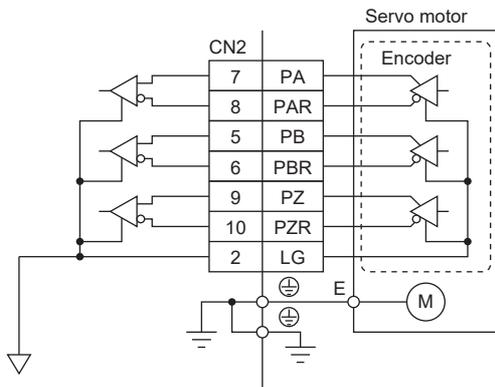
*1 This diagram shows a sink I/O interface. For the source I/O interface, refer to the following.

☞ Page 39 Source I/O interface

*2 Although the diagram shows the input signal and the output signal each using a separate 24 V DC power supply for illustrative purposes, the system can be configured to use a single 24 V DC power supply.

*3 The signal cannot be used in the velocity mode and torque mode.

*4 The internal wiring diagram shown below should be used when connecting an A/B/Z-phase differential output type encoder to CN2.



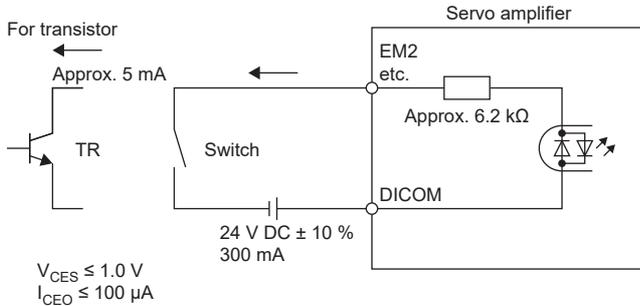
Detailed explanation of interfaces

The details of I/O signal interfaces stated in the following section (refer to the I/O signal interface type in the table) are as follows. Refer to the section and connect them with external devices.

☞ Page 32 Signal (device) explanation

Digital input interface DI-1

This is an input circuit in which the photocoupler cathode side is the input terminal. Transmit signals from a sink (open-collector) type transistor output, relay switch, etc. The following connection diagram is for sink input.



Refer to the following for source input.

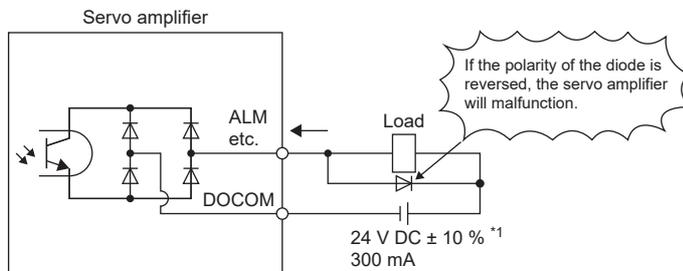
☞ Page 39 Source I/O interface

Digital output interface DO-1

This is a circuit in which the collector of the output transistor is the output terminal. When the output transistor is turned on, the current flows to the collector terminal.

A lamp, relay, or photocoupler can be driven. Install a diode (D) for an inductive load, or install an inrush current suppressing resistor (R) for a lamp load.

(Rated current: 40 mA or less, maximum current: 50 mA or less, inrush current: 100 mA or less) A maximum of 2.6 V voltage drop occurs in the servo amplifier. The following connection diagram is for the sink output.



*1 If the voltage drop (a maximum of 2.6 V) interferes with the relay operation, apply high voltage (a maximum of 26.4 V) from an external source.

Refer to the following for the source output.

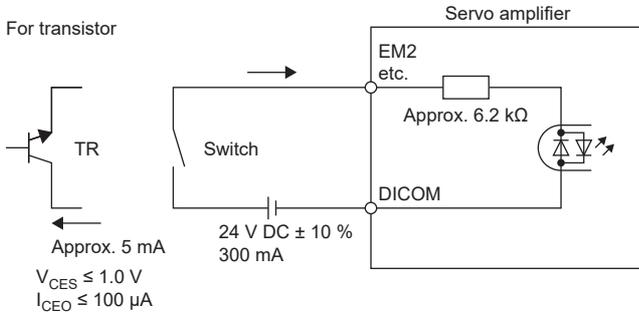
☞ Page 39 Source I/O interface

Source I/O interface

For the servo amplifiers in this manual, source type I/O interfaces can be used.

Digital input interface DI-1

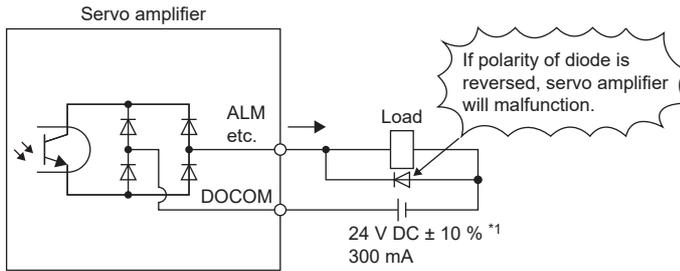
This is an input circuit in which the anode of the photocoupler is the input terminal. Transmit signals from a source (open-collector) type transistor output, relay switch, etc.



Digital output interface DO-1

This is a circuit in which the emitter of the output transistor is the output terminal. When the output transistor is turned on, the current flows from the output terminal to a load.

A maximum of 2.6 V voltage drop occurs in the servo amplifier.



*1 If the voltage drop (a maximum of 2.6 V) interferes with the relay operation, apply high voltage (a maximum of 26.4 V) from an external source.

3.7 Servo motor with an electromagnetic brake

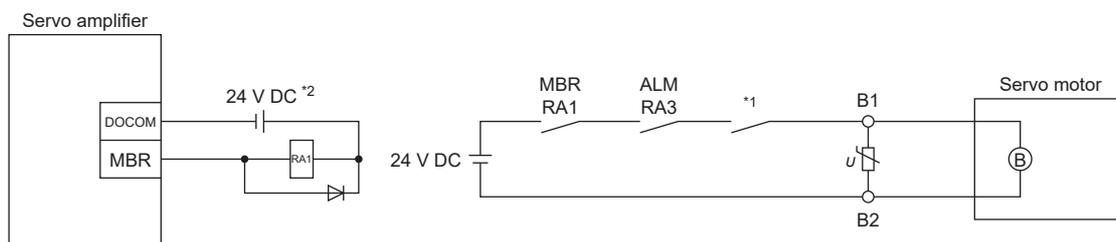
Precautions

- For specifications such as the power supply capacity and operation delay time of the electromagnetic brake, and for selecting the surge absorber for the electromagnetic brake, refer to "Characteristics of electromagnetic brake" in the following manual.

📖 Rotary Servo Motor User's Manual (HG-KNS/HG-SNS)

- The electromagnetic brake on the servo motor is designed to hold the motor shaft. Do not use it for normal braking.
- Incorrect wiring, service life, or the mechanical structure (e.g. when coupled via a timing belt) may cause the electromagnetic brake to be unable to hold the motor shaft. To ensure safety, install a stopper on the machine side.
- If it is assumed that a hazardous situation may arise when the equipment power is off or a product malfunction occurs, use a servo motor with an electromagnetic brake or provide an external brake system for holding purpose to prevent such hazard.
- Configure an electromagnetic brake circuit that interlocks with the external emergency stop switch.
- Before operating the servo motor, confirm that the electromagnetic brake operates properly.
- For the power supply of the electromagnetic brake, use the power supply designed exclusively for the electromagnetic brake.
- If using EM2 (Forced stop 2), use MBR (Electromagnetic brake interlock) for operating the electromagnetic brake.
- If using the servo motor with the electromagnetic brake, the electromagnetic brake will operate when the power (24 V DC) turns off.
- If using the servo motor with the electromagnetic brake, turn off the servo-on command after the servo motor stops.

Connection diagram



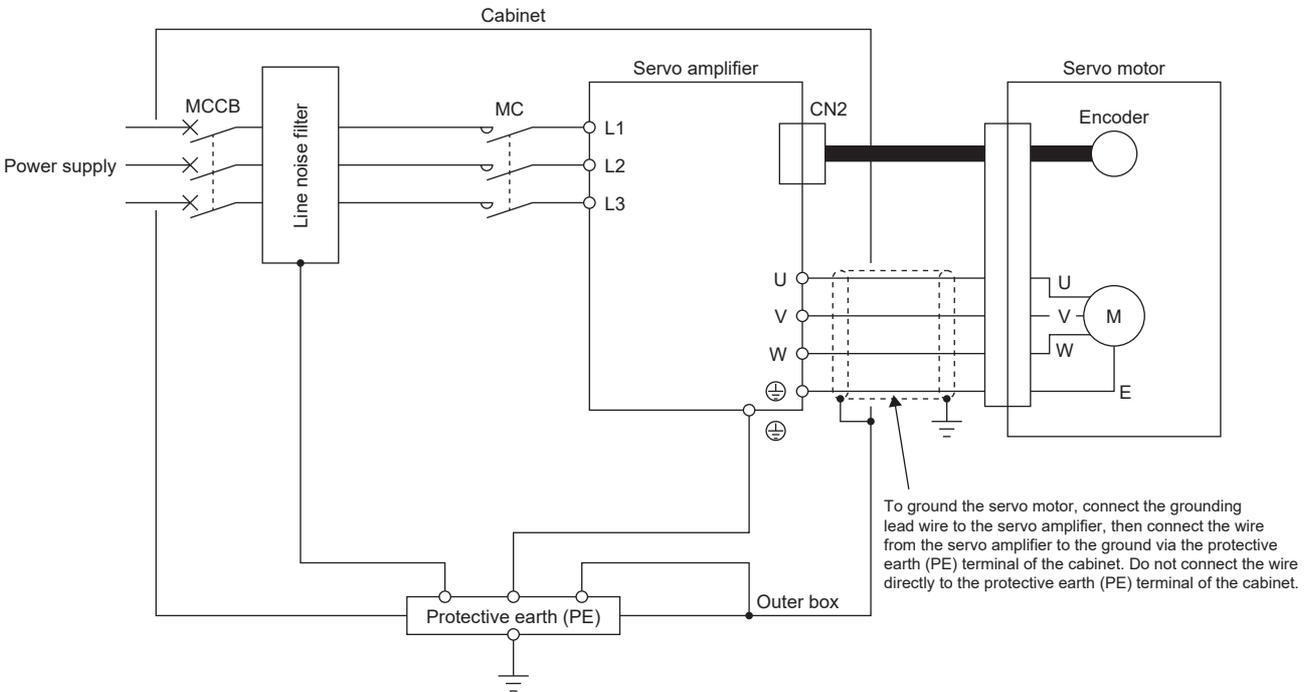
*1 Configure a circuit which interlocks with an emergency stop switch to shut off.

*2 Do not use the 24 V DC interface power supply for the electromagnetic brake.

3.8 Grounding

The servo amplifier supplies power to the servo motor by switching on and off a power transistor. Depending on the wiring and ground wire routing, the servo amplifier may be affected by the switching noise (due to di/dt and dv/dt) of the transistor. To prevent such a fault, refer to the following diagram and ground it.

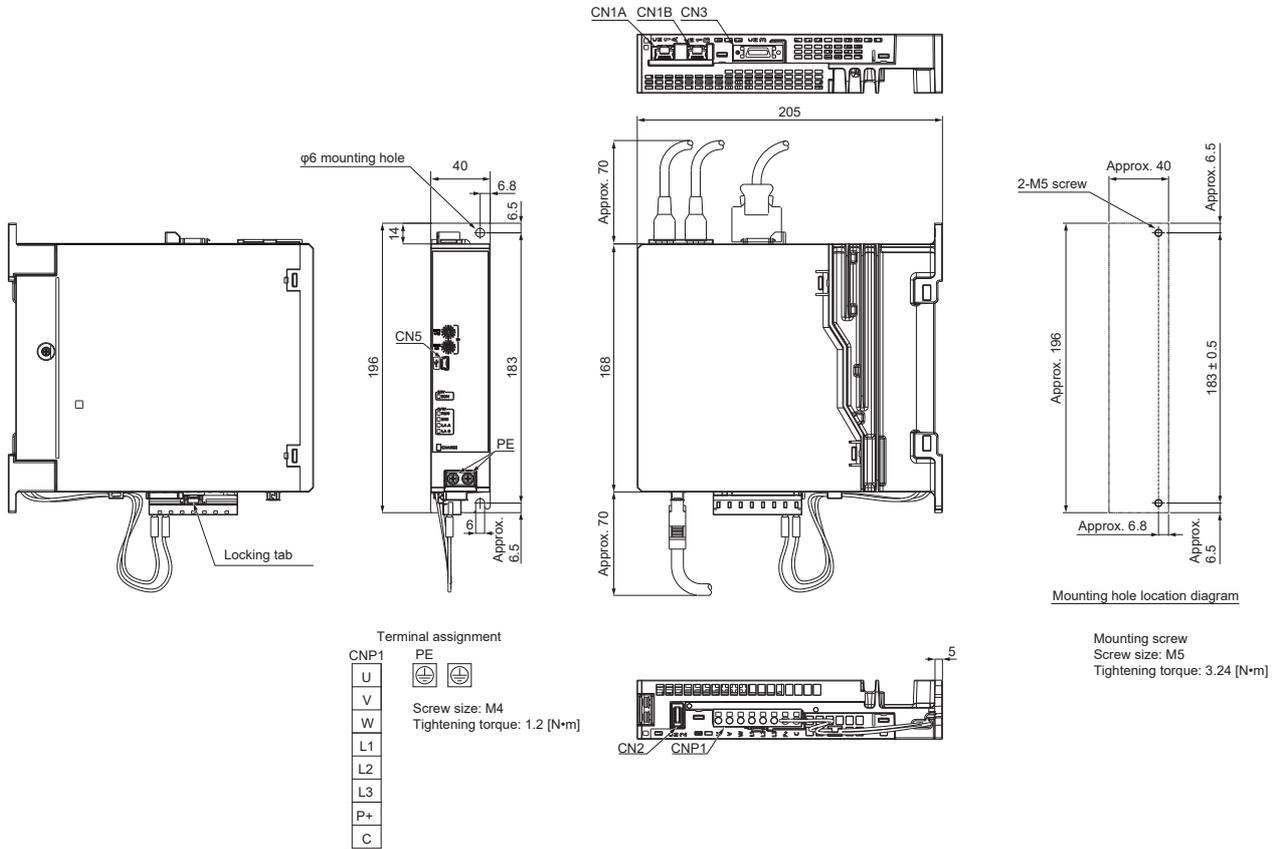
For information on how to comply with the EMC Directive, refer to "EMC Installation Guidelines".



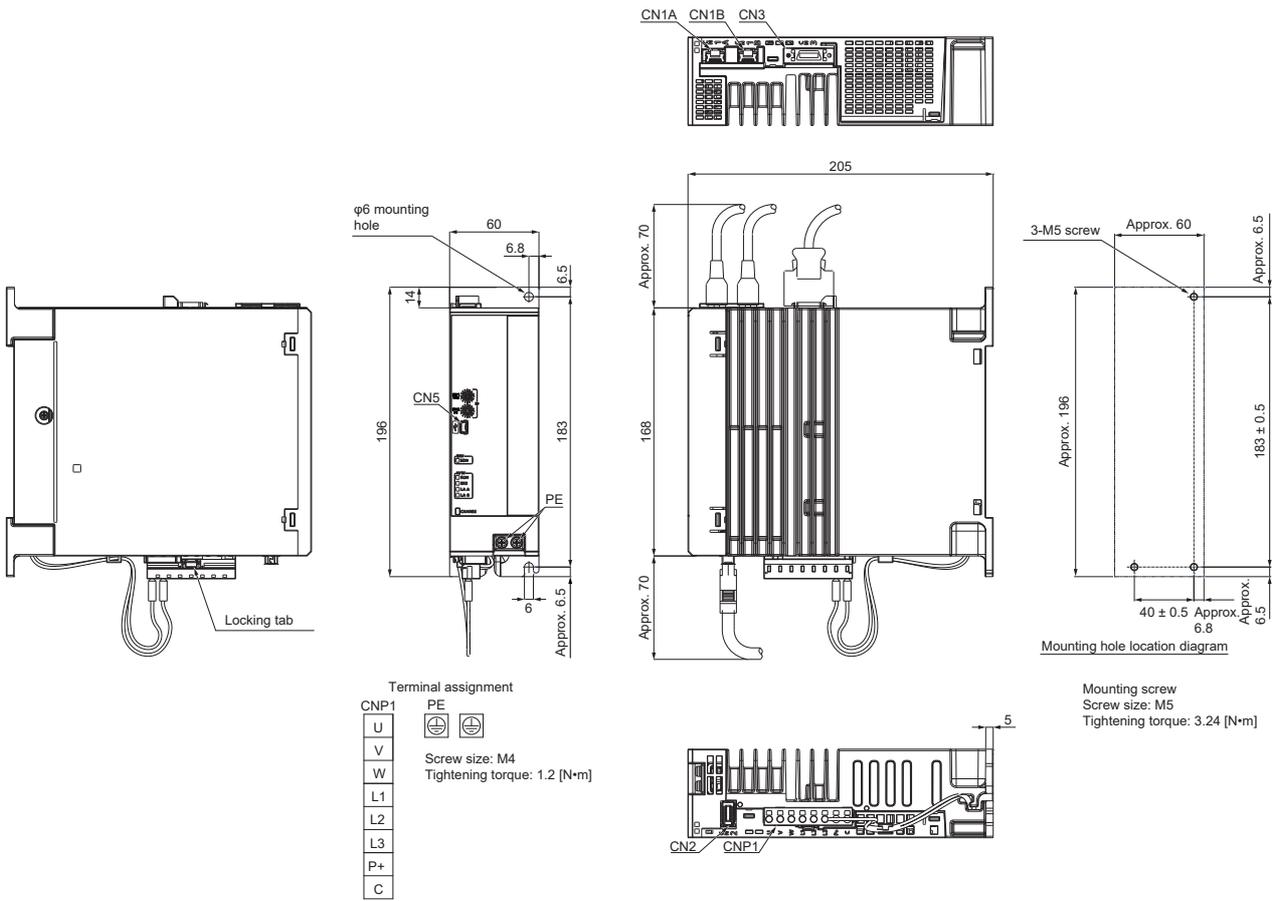
4 DIMENSIONS

4.1 Servo amplifier

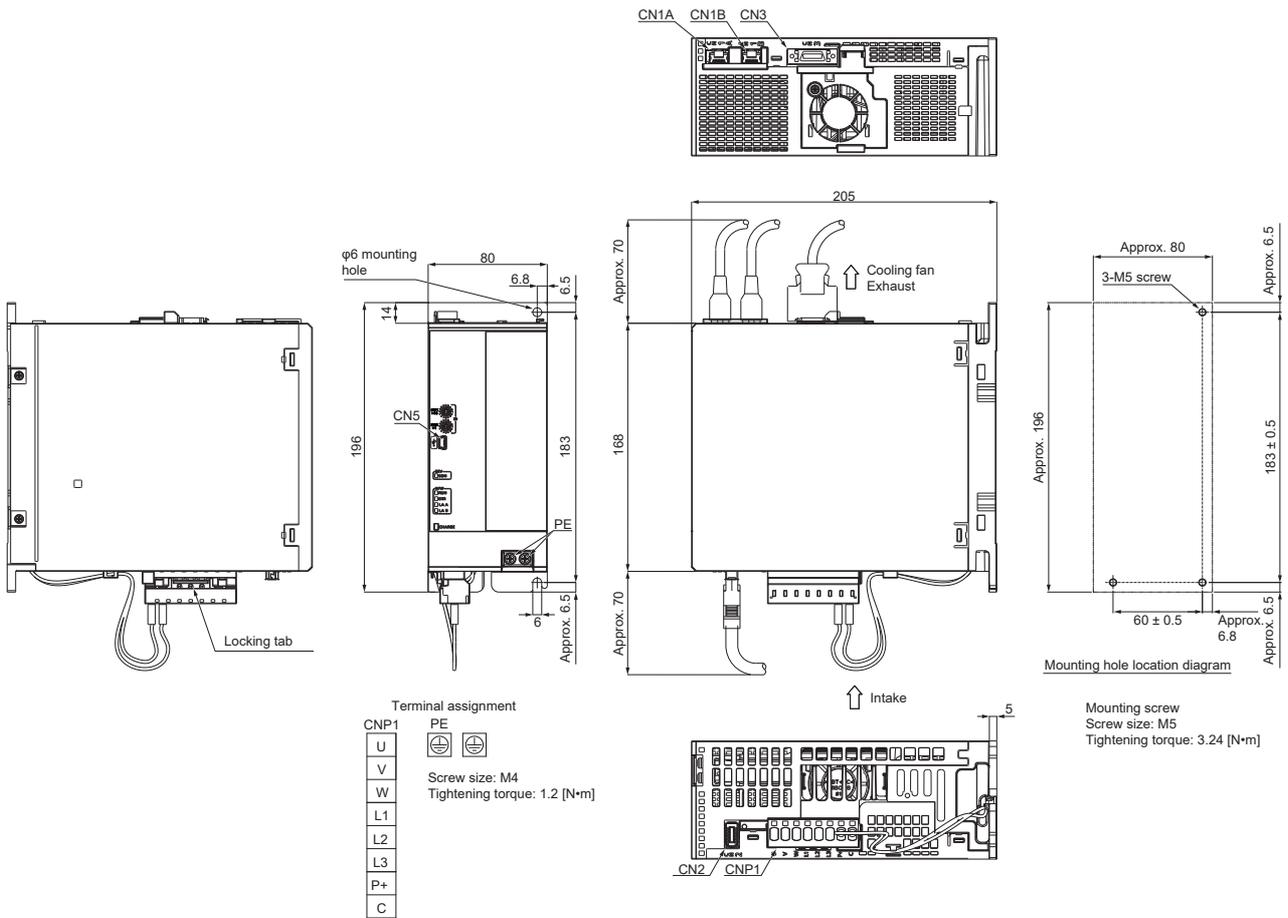
MR-JET-10G_/MR-JET-20G_/MR-JET-40G_



MR-JET-70G_/MR-JET-100G_



MR-JET-200G_/MR-JET-300G_



4.2 Connector

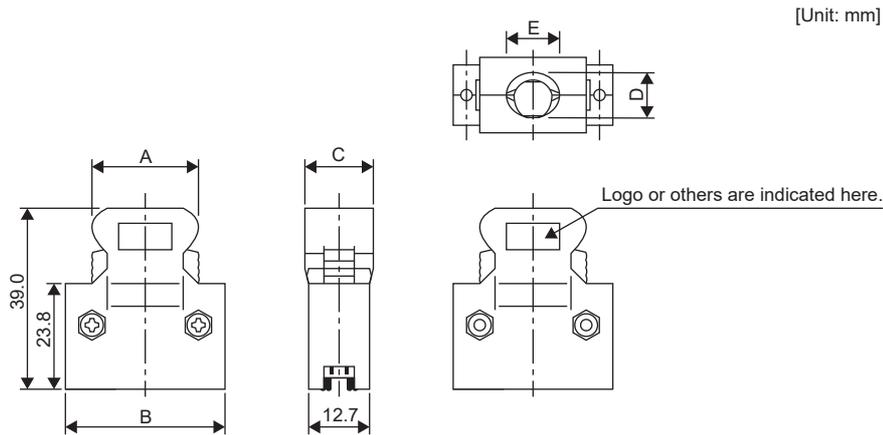
Precautions

- Obtain the wiring instructions from the manufacturer and wire connectors appropriately.

CN3 connector

Miniature delta ribbon (MDR) system (3M)

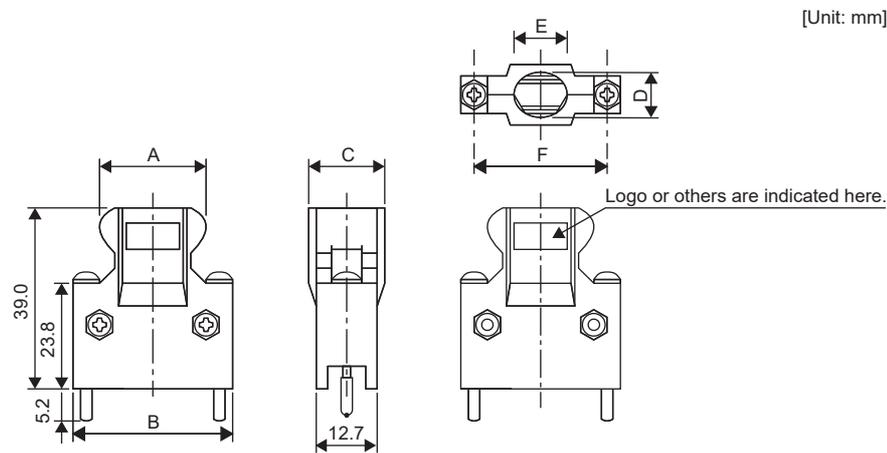
■One-touch lock type



Connector	Shell kit	Variable dimensions				
		A	B	C	D	E
10120-3000PE	10320-52F0-008	22.0	33.3	14.0	10.0	12.0

■Jack screw M2.6 type

This connector is not available as an option.



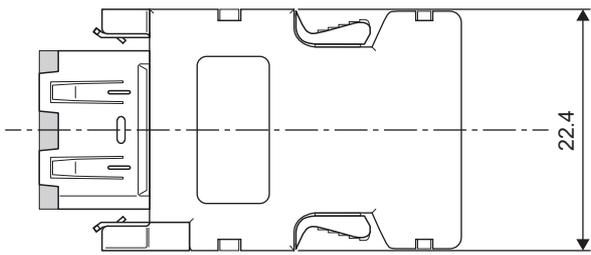
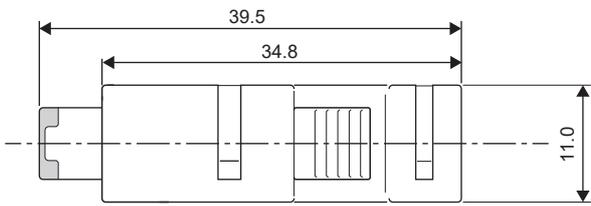
Connector	Shell kit	Variable dimensions					
		A	B	C	D	E	F
10120-3000PE	10320-52A0-008	22.0	33.3	14.0	10.0	12.0	27.4

SCR connector system (3M)

Receptacle: 36210-0100PL

Shell kit: 36310-3200-008

[Unit: mm]



5 CHARACTERISTICS

5.1 Overload protection characteristics

An electronic thermal is built in the servo amplifier to protect the servo motor, servo amplifier and servo motor power wires from overloads.

The actual overload protection level is lower than the electronic thermal protection curve of the servo amplifier and servo motor used.

[AL. 050 Overload 1] occurs if overload operation performed is above the electronic thermal protection curve shown below. [AL. 051 Overload 2] occurs if the maximum current is applied continuously for several seconds due to machine collision, etc. Use the equipment within the overload protection level indicated on the left side of the continuous or dotted lines in the following graphs.

For machines where unbalanced torque occurs, such as a vertical axis system, the unbalanced torque should be kept at 70 % or lower of the rated torque.

This servo amplifier has a servo motor overload protection function. (The servo motor overload current is set on the basis of 115 % rated current (full load current) of the servo amplifier.)

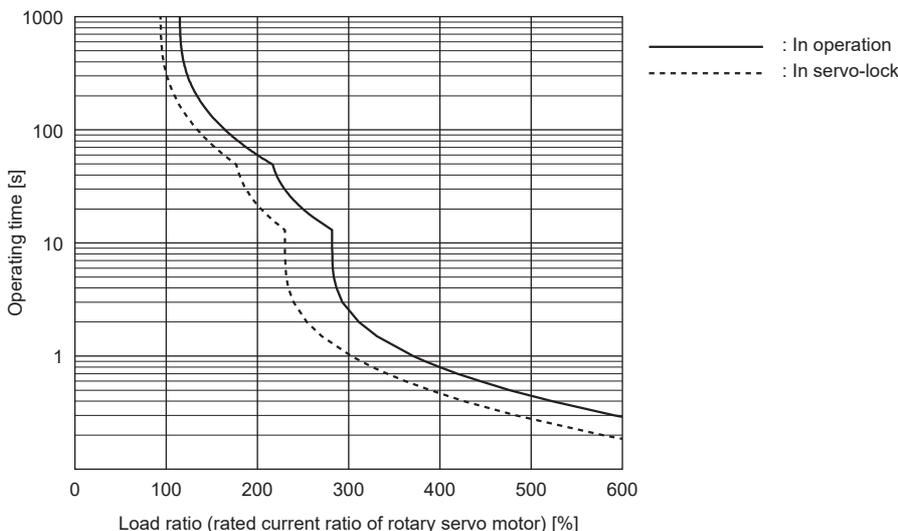
The servo amplifier may malfunction regardless of the electronic thermal protection if torque exceeding 100 % of the rated torque is generated too frequently while the servo motor is stopped (servo-lock status) or being operated at low speeds of 50 r/min or less.

Graph of overload protection characteristics

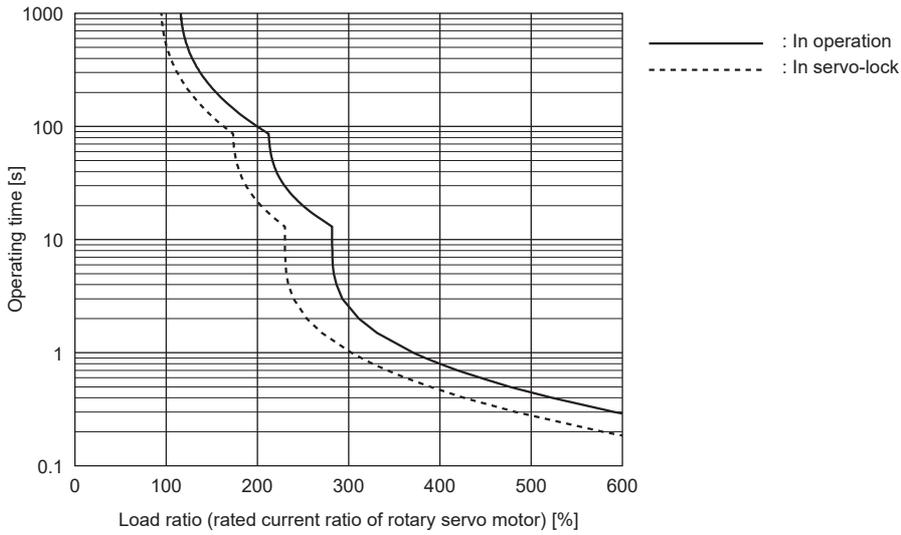
The following table lists servo motors and corresponding graphs of overload protection characteristics. The overload protection characteristics depend on the servo motor.

Rotary servo motor		Graph of overload protection characteristics
HG-KNS	HG-SNS	
13	—	☞ Page 47 Characteristic a
23 43 73	52 102	☞ Page 48 Characteristic b
—	152 202 302	☞ Page 48 Characteristic c

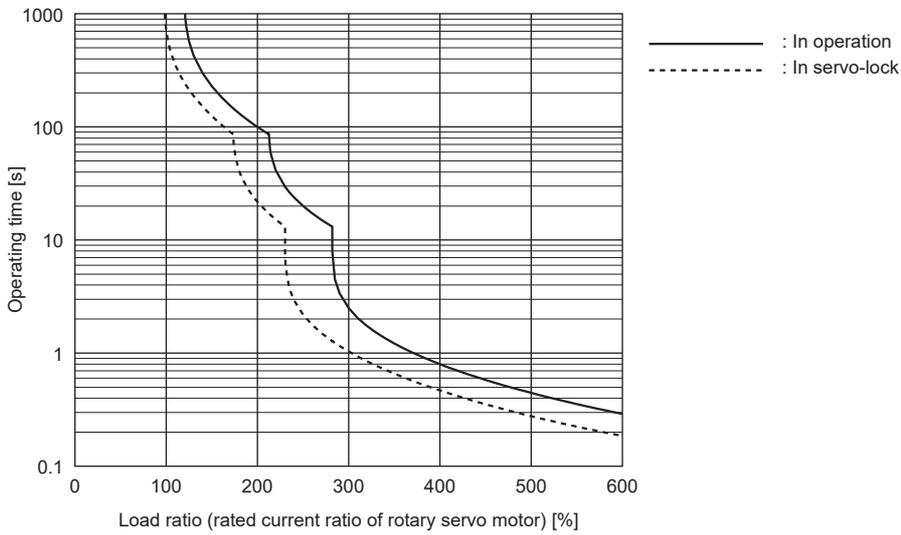
■Characteristic a



■Characteristic b



■Characteristic c



5.2 Power supply capacity and generated loss

Power supply capacity

The following table indicates power supply capacities of servo amplifiers.

When the servo motor runs at less than the rated speed, the power supply capacity is smaller than the value in the table.

Rotary servo motor		Servo amplifier	Power supply capacity [kVA] ^{*1}
HG-KNS series	HG-KNS13	MR-JET-10_	0.3
	HG-KNS23	MR-JET-20_	0.5
	HG-KNS43	MR-JET-40_	0.9
	HG-KNS73	MR-JET-70_	1.3
HG-SNS series	HG-SNS52	MR-JET-70_	1.0
	HG-SNS102	MR-JET-100_	1.7
	HG-SNS152	MR-JET-200_	2.5
	HG-SNS202		3.5
	HG-SNS302	MR-JET-300_	4.8

*1 The power supply capacity will vary according to the power impedance.

Generated loss

Servo amplifier generated heat

The following table indicates the losses generated by servo amplifiers under rated load. For thermal design of an enclosed type cabinet, use the values in the tables in consideration for the worst operating conditions including environments and operation patterns. The actual amount of generated heat depends on the frequency of operation and will be between the "At rated output" and "At servo-off" values.

Servo amplifier	Servo amplifier-generated heat [W] *1		Area required for heat dissipation [m ²]
	At rated output	At servo-off	
MR-JET-10_	25	15	0.5
MR-JET-20_	30	15	0.6
MR-JET-40_	35	15	0.7
MR-JET-70_	60	15	1.0
MR-JET-100_	60	15	1.0
MR-JET-200_	120	20	2.4
MR-JET-300_	120	20	2.4

*1 The values stated for heat generated by the servo amplifier do not take into account the heat generated during regeneration. To calculate heat generated by the regenerative option, refer to the following.

☞ Page 62 Regenerative option

Heat dissipation area for enclosed type cabinet

The enclosed type cabinet (hereafter called the cabinet) that stores the servo amplifier should be designed to ensure that its internal temperature rise is within +10 °C at an ambient temperature of 40 °C. Calculate the necessary heat dissipation area of the cabinet with the equation below (5.1) while allowing a margin of approximately 5 °C for a maximum ambient temperature of 55 °C.

$$A = \frac{P}{K \cdot \Delta T} \dots (5.1)$$

A: Heat dissipation area [m²]

P: Loss generated in the cabinet [W]

ΔT: Difference between internal and ambient temperatures [°C]

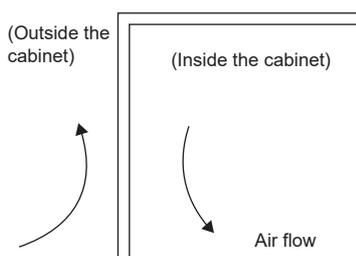
K: Heat dissipation coefficient [5 to 6]

When calculating the heat dissipation area with the equation (5.1), assume that P is the sum of all losses generated in the cabinet. Refer to the following for details about the heat generated by the servo amplifier.

☞ Page 50 Servo amplifier generated heat

"A" indicates the effective area for heat dissipation, but if the cabinet is directly installed on an insulated wall, that extra amount must be added to the cabinet's surface area. The required heat dissipation area will vary with the conditions in the cabinet. If convection in the cabinet is poor and heat builds up, effective heat dissipation will not be possible. Therefore, arrangement of the equipment in the cabinet and the use of a cooling fan should be considered. Refer to the following section for information on the required heat dissipation area (estimated) of servo amplifier cabinets when operating amplifiers at a rated load in ambient temperatures of 40 °C.

☞ Page 50 Servo amplifier generated heat



When air flows along the outer wall of the cabinet, effective heat exchange is possible, because the temperature slope inside and outside the cabinet is steeper.

5.3 Dynamic brake characteristics

Point

- The coasting distance is a theoretically calculated value that does not consider the running load such as friction. Since the coasting distance changes depending on the load moment of inertia, perform a test operation to check the actual braking distance. If the braking distance is too long, a moving part may crash into the stroke end. Install an anti-crash mechanism such as an air brake or an electric/mechanical stopper such as a shock absorber to reduce the shock of moving parts.
- The dynamic brake is a function used to stop in an emergency and should not be used to stop during normal operations.
- For a machine operating at the recommended load to motor inertia ratio or less, the dynamic brake can be used approximately 1000 times if the dynamic brake is used to stop the motor from the rated speed once every 10 minutes.
- If using EM1 (Forced stop 1) frequently in non-emergency situations, enable EM1 (Forced stop 1) after the servo motor has come to a complete stop.
- MR-JET compatible servo motors may have a different coasting distance than previous generation servo motor models.
- The time constant " τ " for the electronic dynamic brake will be shorter than that of the normal dynamic brake. Therefore, the coasting distance will be shorter than that of a normal dynamic brake. For how to set the electronic dynamic brake, refer to [Pr. PF06] and [Pr. PF12] in the following manual.

 MR-JET-G User's Manual (Parameters)

Precautions relating to the dynamic brake characteristics

The electronic dynamic brake is set to operate in the initial state for the following servo motors.

Series	Servo motor
HG-KNS	HG-KNS13/HG-KNS23/HG-KNS43
HG-SNS	HG-SNS52

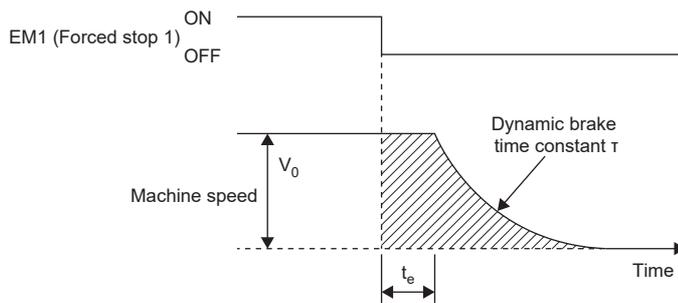
Dynamic brake operation

Calculation of coasting distance

The following figure shows the pattern in which the servo motor comes to a stop when the dynamic brake is operated. Use the equation (5.2) to calculate the approximate coasting distance to a stop. The dynamic brake time constant τ varies with the servo motor and machine operation speeds.

☞ Page 53 Dynamic brake time constant

A working part generally has a friction force. Therefore, the actual coasting distance will be shorter than the maximum coasting distance calculated with the following equation.



$$L_{\max} = \frac{V_0}{60} \cdot \left\{ t_e + \tau \left(1 + \frac{J_L}{J_M} \right) \right\} \dots (5.2)$$

L_{\max} : Maximum coasting distance [mm]

V_0 : Machine's fast feed speed [mm/min]

J_M : Moment of inertia of the servo motor [$\times 10^{-4}$ kg·m²]

J_L : Load moment of inertia converted into equivalent value on servo motor shaft [$\times 10^{-4}$ kg·m²]

τ : Dynamic brake time constant [s]

t_e : Delay time of control section [s]

There is an internal relay delay time of about 10 ms.

Dynamic brake time constant

The following shows dynamic brake time constant τ that is necessary to calculate the equation (5.2).

■HG-KNS/HG-SNS

Servo motor	Waveform
HG-KNS13_ HG-KNS23_ HG-KNS43_ HG-KNS73_	
HG-SNS52_ HG-SNS102_ HG-SNS152_ HG-SNS202_ HG-SNS302_	

5

Permissible load to motor inertia when the dynamic brake is used

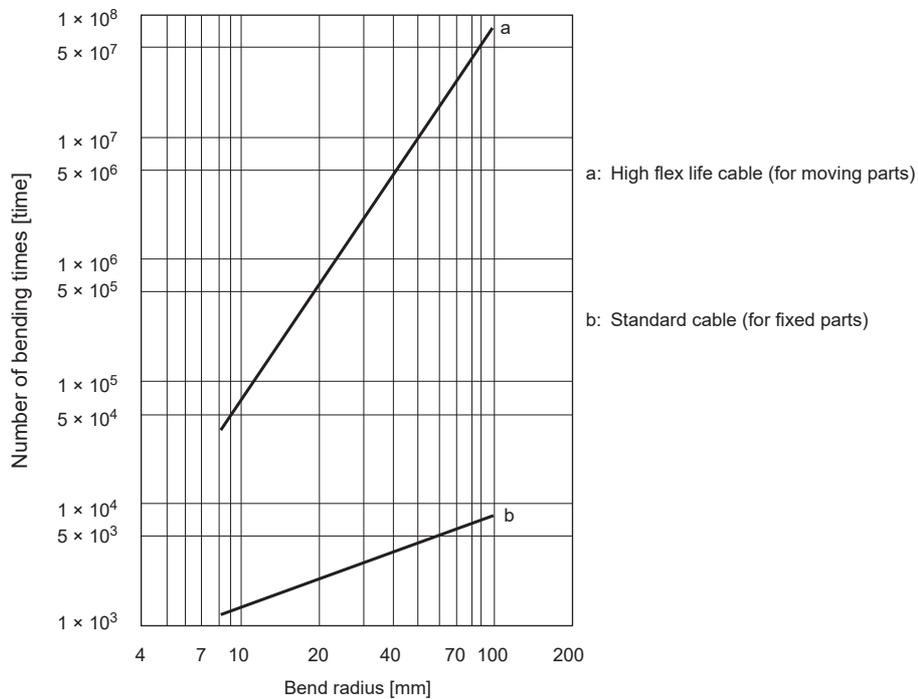
Use the dynamic brake under the load to motor inertia ratio indicated in the following table. If the ratio is higher than this value, the dynamic brake may burn. If the ratio exceeds the value, contact your local sales office.

The values of the permissible load to motor inertia ratio in the table are the values at the maximum speed of the servo motor.

Servo motor	Permissible load to motor inertia ratio [multiplier]
HG-KNS13_	30
HG-KNS23_	
HG-KNS43_	
HG-KNS73_	
HG-SNS52_	24
HG-SNS102_	
HG-SNS152_	
HG-SNS202_	16
HG-SNS302_	

5.4 Cable flex life

The flex life of the cables is shown below. This graph shows calculated values and not guaranteed values. The cable flex life factors in conductor and insulation breakage. The values are calculated from fully disconnected cables and do not take into account wear from electrical characteristics, sheath abrasion, or insulation deterioration. Allow for a deviation in these values.



5.5 Inrush current at power-on

A molded-case circuit breaker and magnetic contactor may fail or malfunction due to an inrush current flowing through the servo amplifier's power lines (input lines) at power on. Therefore, use products with the specifications described on the following page.

☞ Page 84 Molded-case circuit breakers, fuses, magnetic contactors

When circuit protectors are used, it is recommended that the inertia delay type, which is not tripped by an inrush current, be used.

The following shows the inrush currents (reference data) that will flow when 240 V AC is applied. The inrush currents of the main circuit power supply will be the same even when a 1-phase 200 V AC power supply is used with MR-JET-10_ to MR-JET-200_.

Servo amplifier	Inrush currents ($A_{0,p}$)
MR-JET-10_ MR-JET-20_ MR-JET-40_	16 A (attenuated to approx. 2 A in 20 ms)
MR-JET-70_ MR-JET-100_	36 A (attenuated to approx. 7 A in 20 ms)
MR-JET-200_ MR-JET-300_	102 A (attenuated to approx. 12 A in 20 ms)

6 OPTIONS AND PERIPHERAL EQUIPMENT

Precautions

- HIV wires are recommended to wire the servo amplifiers, options, and peripheral equipment. Therefore, the recommended wire sizes may differ from those used for the previous generation servo amplifiers.
- To prevent an electric shock or a fire, correctly wire options and peripheral equipment, etc. in the correct combination.

6.1 Cables/connector sets

Point

The IP rating indicated for cables and connectors is their protection against ingress of dust and water drops when they are connected to a servo amplifier or servo motor. If the IP ratings of the cables, connectors, servo amplifier, and servo motor differ, the overall IP rating is determined by the lowest IP rating of all the components.

Purchase the cable and connector options indicated in this section for this servo amplifier.

Use a cable supplied by Mitsubishi Electric or Mitsubishi Electric System & Service Co., Ltd. When fabricating a cable, select wires in accordance with the uses. For selection example, NFPA 79 (2018 Edition) in North America demands the use of a listed, certified product that has a thermoset insulator and is compliant with the NEC standard RHH, RHW, RHW-2, XHH, XHHW, or XHHW-2.

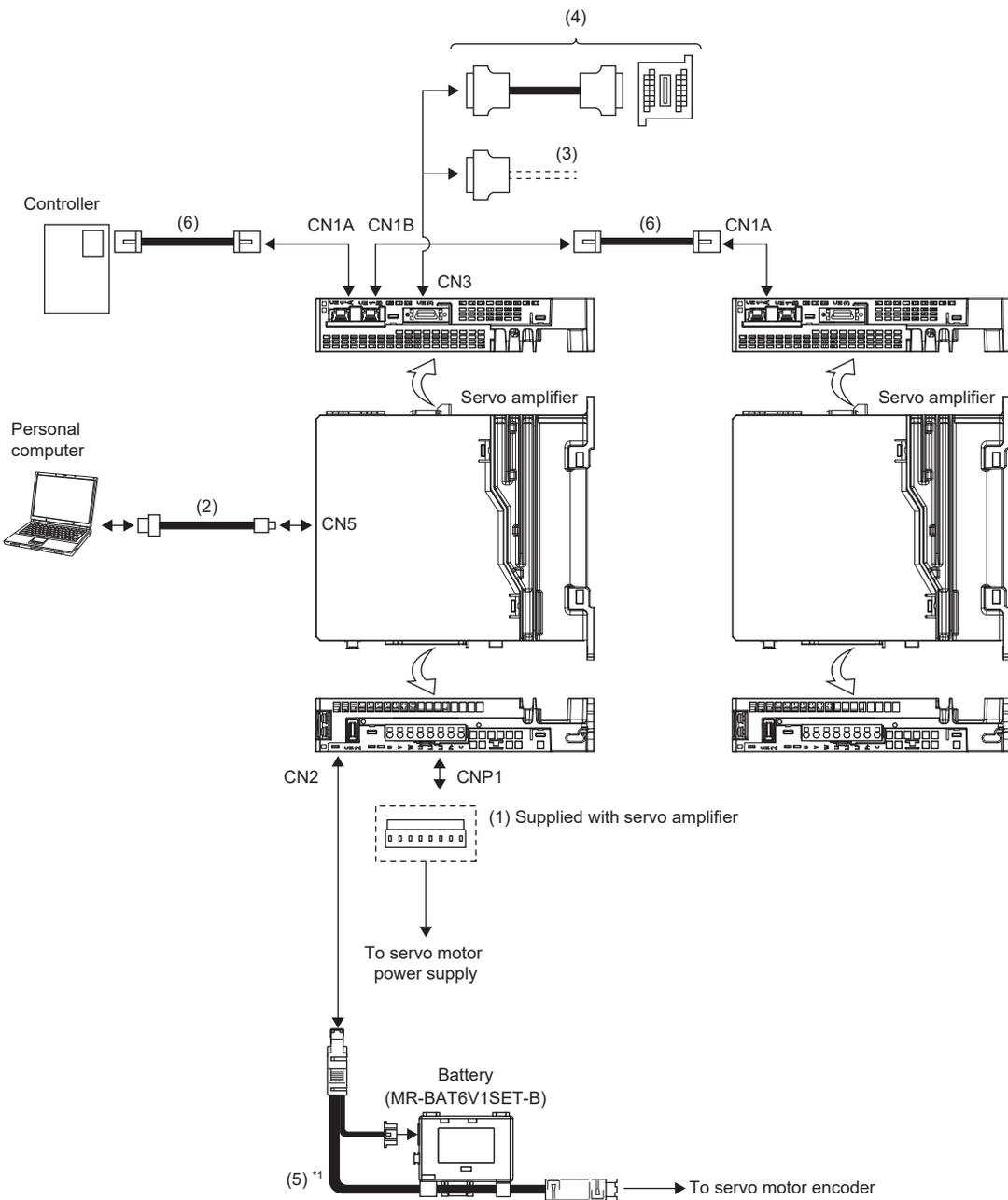
For information on options for servo motor power supplies, electromagnetic brakes, and servo motor encoders, refer to "WIRING OPTION" in the following manual.

 Rotary Servo Motor User's Manual (HG-KNS/HG-SNS)

For options for linear encoders, refer to "OPTION CABLES/CONNECTOR SETS" in the following manual.

 MR-JET Partner's Encoder User's Manual

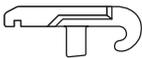
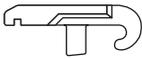
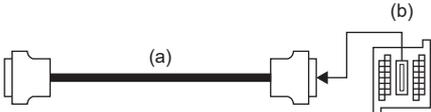
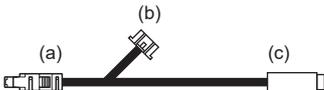
Combinations of cables/connector sets



*1 The cable is required to configure an absolute position detection system with an HG-KNS/HG-SNS series rotary servo motor. For configuration of an absolute position detection system, refer to the following.

☞ Page 101 ABSOLUTE POSITION DETECTION SYSTEM

List of cables/connector sets

No.	Product name	Model	Description	Remark
(1)	Servo amplifier power connector set	—	 <p>CNP1 connector 1-2349815-2 (TE Connectivity) Applicable wire size: 0.8 mm² to 2.1 mm² (AWG 18 to 14) Insulator OD: Up to 3.9 mm</p>  <p>Open tool: 1981045-1 (TE Connectivity)</p>	Supplied with servo amplifiers of 1 kW or less
		—	 <p>CNP1 connector 1-2349825-8 (TE Connectivity) Applicable wire size: 1.25 mm² to 5.5 mm² (AWG 16 to 10) Insulator OD: Up to 4.7 mm</p>  <p>Open tool: 2349891-1 (TE Connectivity)</p>	
(2)	USB cable	MR-J3USBCBL3M cable length: 3 m	 <p>(a) CN5 connector: mini-B connector (5 pins) (b) Personal computer connector: Connector A</p>	For connection with PC-AT compatible personal computer
(3)	Connector set	MR-CCN1	 <p>Connector: 10120-3000PE Shell kit: 10320-52F0-008 (3M or equivalent)</p>	For MR-JET-_G_
(4)	Junction terminal block cable	MR-J2HBUS__M Cable length: 0.5 m, 1 m, 5 m	 <p>(a) MR-J2HBUS__M (b) PS7DW-20V14B-F (Toho Technology Corp., Kyoto factory) Junction terminal block PS7DW-20V14B-F is not available as an option. To use the junction terminal block, option MR-J2HBUS__M is required.</p>	For MR-JET-_G_
(5)	Battery branch cable	MR-BT6V4CBL03M Page 59 Battery branch cable	 <p>(a) Receptacle: 36210-0100PL Shell kit: 36310-3200-008 (3M) (b) Housing: PAP-05V-S Contact: SPHD-002GW-P0.5 (JST) (c) Plug: 36110-3000FD Shell kit: 36310-F200-008 (3M)</p>	For batteries

No.	Product name	Model	Description	Remark
(6)	Ethernet cable	☞ Page 61 Ethernet cable	 Category 5e or higher, (double shielded/STP) straight cable The straight cable (double shielded/STP) is not available as an option.	Connection cable for CN1A/CN1B connectors

Battery branch cable

The cable is required to configure an absolute position detection system with an HG-KNS/HG-SNS series rotary servo motor. For configuration of an absolute position detection system, refer to the following.

☞ Page 101 ABSOLUTE POSITION DETECTION SYSTEM

Refer to the following page for information on the MR-BAT6V1SET-B.

☞ Page 75 Battery

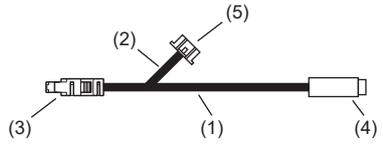
When fabricating cables, refer to "Fabrication of the encoder cable" in the following manual.

📖 Rotary Servo Motor User's Manual (HG-KNS/HG-SNS)

Model explanations

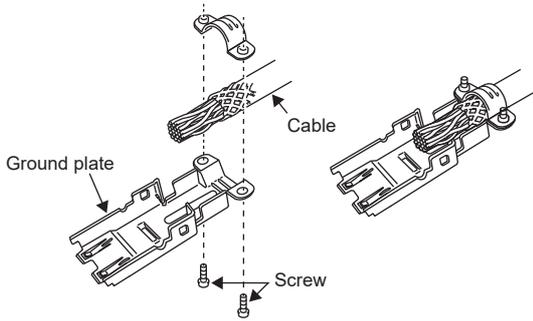
Cable model	Cable length	Flex life	Application/remark
MR-BT6V4CBL03M	(1) Encoder-side cable: 0.3 m (2) Battery-side cable: 0.1 m	Standard	For MR-BAT6V1SET-B connection

Appearance

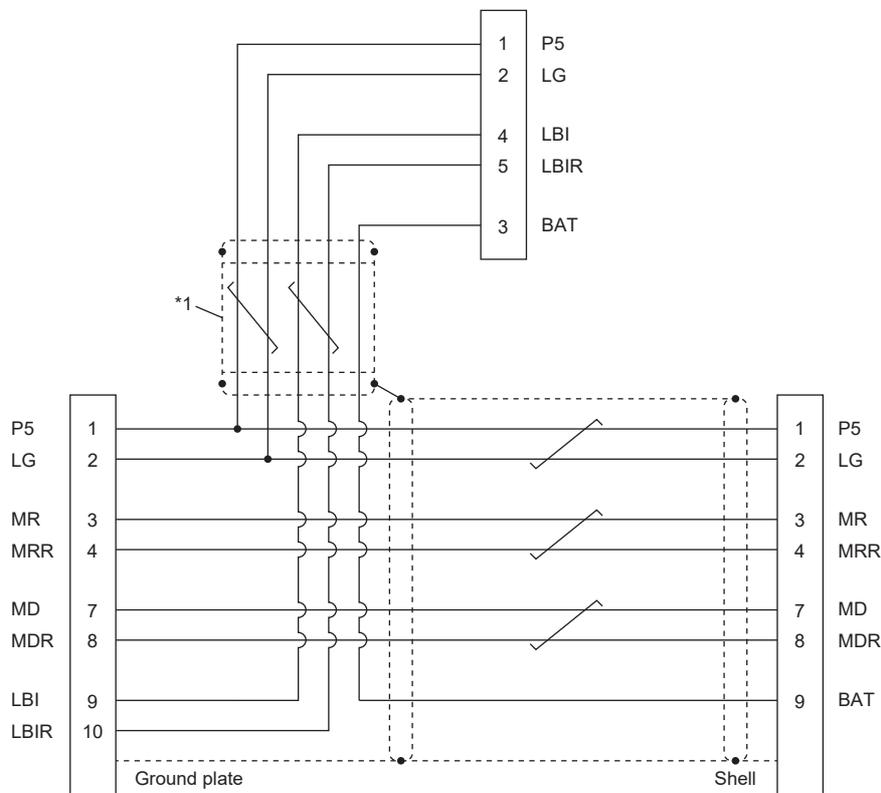
Figure	Components	Description
	(1) Encoder-side cable	20276 VSVP AWG#28 × 4P
	(2) Battery-side cable	
	(3) Amplifier-side connector	Receptacle: 36210-0100PL (3M) Shell kit: 36310-3200-008 (3M)
	(4) Encoder-side connector	Plug: 36110-3000FD (3M) Shell kit: 36310-F200-008 (3M)
	(5) Battery-side connector	Housing: PAP-05V-S (JST) Contact: SPHD-002GW-P0.5 (JST)

Precautions

- When wiring the connector, ensure that the conductor of the shielded cable is secure against the ground plate, then attach the connector shell.



Internal wiring diagram



*1 Ensure that no more than 5 mm of the conductor protrudes from the shielded cable.

Ethernet cable

For Ethernet cables used for network wiring, refer to "Communication specifications" in the User's Manual (Communication Function).

A commercially available product example is as follows. For the latest product information, contact the manufacturer.

Product name	Model	Specifications	
Ethernet cable	For indoor use	SC-E5EW-S_M "_" in the model represents the cable length (0.5 m, 1 to 100 m (in 1 m increments)).	Double shielded (Category 5e)
	For moving parts used indoors	SC-E5EW-S_M-MV "_" in the model represents the cable length (0.1, 0.2, 0.3, 0.5 m, 1 to 45 m (in 1 m increments)).	
	For indoor and outdoor use	SC-E5EW-S_M-L "_" in the model represents the cable length (1 to 100 m (in 1 m increments)).	

For commercial cables other than the above, refer to the CC-Link Partner Association website.

<https://www.cc-link.org/en/>

Precautions

- When branching the CC-Link IE TSN network using a switching hub, use a switching hub (Class B) that is recommended by the CC-Link Partner Association. Although a switching hub (Class A) can also be used, there are restrictions on the type of topology that can be used. For further information, refer to "MELSEC iQ-R Motion Module User's Manual (Startup)".
- When branching the CC-Link IE Field Network Basic network using a switching hub, use a switching hub with a transmission speed of 100 Mbps or more. When using a switching hub without the auto-negotiation function, set the transmission speed to 100 Mbps and half duplex.

6.2 Regenerative option

Combination and regenerative power

The power values in the table are resistor-generated powers and not rated powers.

200 V class

Servo amplifier	Regenerative power [W]						
	Built-in regenerative resistor	MR-RB032 [40 Ω]	MR-RB12 [40 Ω]	MR-RB14 [26 Ω]	MR-RB30 [13 Ω]	MR-RB34 [26 Ω]	MR-RB50 [13 Ω] *1
MR-JET-10_	—	30	—	—	—	—	—
MR-JET-20_	—	30	100	—	—	—	—
MR-JET-40_	10	30	100	—	—	—	—
MR-JET-70_	30	—	—	100	—	300	—
MR-JET-100_	30	—	—	100	—	300	—
MR-JET-200_	100	—	—	—	300	—	500
MR-JET-300_	100	—	—	—	300	—	500

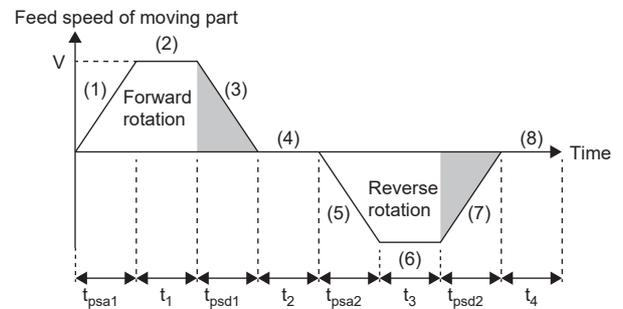
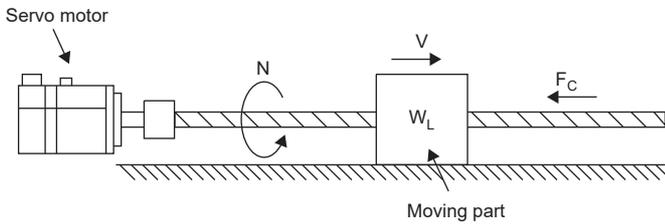
*1 Install a cooling fan when using this regenerative option.

Selection of the regenerative option

A regenerative option for a horizontal axis can be selected with the rough calculation shown in this section. To select a regenerative option precisely, use the capacity selection software.

Rotary servo motor

■ Regenerative energy calculation



V : Feed speed of moving part [mm/min]

N : Servo motor speed ($N = V/\Delta S$) [r/min]

ΔS : Travel distance per servo motor revolution ($\Delta S = P_B$) [mm/rev]

P_B : Ball screw lead [mm]

L_B : Ball screw length [mm]

D_B : Ball screw diameter [mm]

W_L : Moving part mass [kg]

F_C : Load antidrag setting [N]

T_L : Load torque converted into equivalent value on servo motor shaft [$N\cdot m$]

η : Drive system efficiency

μ : Friction coefficient

J_L : Load moment of inertia converted into equivalent value on servo motor shaft [$kg\cdot cm^2$]

J_M : Moment of inertia of the servo motor [$kg\cdot cm^2$]

π : Pi constant

g : Gravitational acceleration [m/s^2]

Regenerative power	Torque T applied to servo motor [N·m] *1*2	Energy E [J]
(1)	$T_1 = \frac{(J_L/\eta + J_M) \cdot N}{9.55 \cdot 10^4} \cdot \frac{1}{t_{psa1}} + T_L$	$E_1 = \frac{0.1047}{2} \cdot N \cdot T_1 \cdot t_{psa1}$
(2)	$T_2 = T_L$	$E_2 = 0.1047 \cdot N \cdot T_2 \cdot t_1$
(3)	$T_3 = \frac{-(J_L \cdot \eta + J_M) \cdot N}{9.55 \cdot 10^4} \cdot \frac{1}{t_{psd1}} + T_L$	$E_3 = \frac{0.1047}{2} \cdot N \cdot T_3 \cdot t_{psd1}$
(4), (8)	$T_4, T_8 = 0$	$E_4, E_8 = 0$ (No regeneration)
(5)	$T_5 = \frac{(J_L/\eta + J_M) \cdot N}{9.55 \cdot 10^4} \cdot \frac{1}{t_{psa2}} + T_L$	$E_5 = \frac{0.1047}{2} \cdot N \cdot T_5 \cdot t_{psa2}$
(6)	$T_6 = T_L$	$E_6 = 0.1047 \cdot N \cdot T_6 \cdot t_3$
(7)	$T_7 = \frac{-(J_L \cdot \eta + J_M) \cdot N}{9.55 \cdot 10^4} \cdot \frac{1}{t_{psd2}} + T_L$	$E_7 = \frac{0.1047}{2} \cdot N \cdot T_7 \cdot t_{psd2}$

*1 Load torque converted into equivalent value on servo motor shaft TL can be calculated with the following formula.

$$T_L = \{(F_C + (\mu \times W_L \times g)) \times \Delta S\} / (2000 \times \pi \times \eta)$$

*2 Load moment of inertia converted into equivalent value on servo motor shaft JL can be calculated with the following formula.

$$J_L = J_{L1} + J_{L2} + J_{L3}$$

J_{L1} is the load moment of inertia of the moving part, J_{L2} is the load moment of inertia of the ball screw, and J_{L3} is the load moment of inertia of the coupling. J_{L1} and J_{L2} can be calculated with the following formulas.

$$J_{L1} = W_L \times (\Delta S / (20 \times \pi))^2$$

$$J_{L2} = \{(\pi \times 0.0078 \times (L_B / 10)) / 32\} \times (D_B / 10)^4$$

From the calculation results in (1) to (8), find the absolute value (Es) of the sum total of negative energies.

■ Losses of servo motor and servo amplifier in regenerative mode

The following table lists the efficiencies and other data of the servo motor and servo amplifier in the regenerative mode.

Servo amplifier	Inverse efficiency [%]	Capacitor charging [J]
MR-JET-10_	55	11
MR-JET-20_	75	11
MR-JET-40_	85	11
MR-JET-70_	85	25
MR-JET-100_	85	25
MR-JET-200_	85	42
MR-JET-300_	85	42

Inverse efficiency (η_m): Efficiency including some efficiencies of the servo motor and servo amplifier when rated (regenerative) torque is generated at rated speed. Efficiency varies with the servo motor speed and generated torque. Because the characteristics of the electrolytic capacitor change with time, allow inverse efficiency of approximately 10 % higher than those shown above.

Capacitor charging (E_c): Energy charged into the electrolytic capacitor in the servo amplifier

Multiply the sum total of regenerative energies by the inverse efficiency, and subtract the capacitor charging from that result to calculate the energy consumed by the regenerative option.

$$E_R [J] = \eta_m \cdot E_s - E_c$$

Select a regenerative option that meets the requirements of the system by calculating the power consumption of the regenerative option based on a one-cycle operation period t_f [s].

$$P_R [W] = E_R / t_f$$

Servo parameter setting

Set [Pr. PA02] according to the regenerative option to be used.

MR-JET-G User's Manual (Parameters)

Connection of regenerative option

Point

If using a regenerative option with MR-JET-40_ to MR-JET-300_, remove the built-in regenerative resistor and its wiring from the servo amplifier.

If using the MR-RB50, cool it with a cooling fan. The cooling fan should be prepared by the customer.

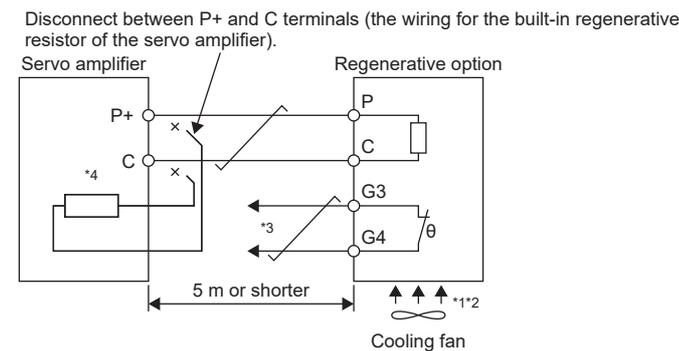
For the wire sizes, refer to the following. [Page 83 Selection example of wires](#)

The built-in regenerative resistor should not be mounted/removed frequently.

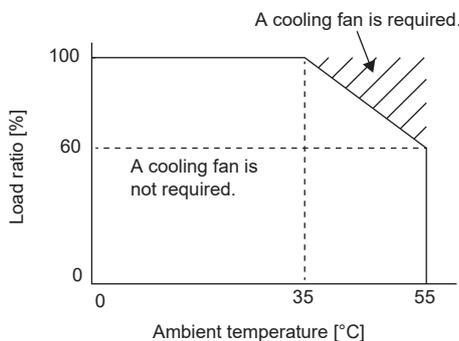
When remounting the built-in regenerative resistor, check the lead wires of the regenerative resistor for scratches or cracks.

The regenerative option generates heat that is 100 °C higher than the ambient temperature. Fully consider heat dissipation, the installation position, wires used, and other relevant areas before installing the option. For wiring, use flame-retardant wires or make the wires flame retardant, and do not let them touch the regenerative option. Use twisted wires with a maximum length of 5 m for a connection with the servo amplifier.

Disconnect the wiring between P+ and C and remove the built-in regenerative resistor from the servo amplifier. Then, wire the regenerative option between P+ and C. G3 and G4 are terminals for the thermal sensor. Between G3 and G4 opens if the regenerative option overheats abnormally.



- *1 If using the MR-RB50, forcibly cool it with a cooling fan (1.0 m³/min or more, 92 mm × 92 mm).
- *2 If using the MR-RB30 or MR-RB34 with a regenerative load ratio of higher than 60 % and at an ambient temperature of above 55 °C, forcibly cool the MR-RB30 or MR-RB34 with a cooling fan (1.0 m³/min or more, 92 mm × 92 mm). A cooling fan is not required if the ambient temperature is 35 °C or less. (A cooling fan is required for the shaded area in the following graph.)



- *3 Configure a sequence which will switch off the magnetic contactor when abnormal heating occurs.
G3-G4 contact specifications
Maximum voltage: 120 V AC/DC
Maximum current: 0.5 A/4.8 V DC
Maximum capacity: 2.4 VA
- *4 MR-JET-10_ and MR-JET-20_ do not have a regenerative resistor.

Refer to the following diagram and follow the steps (1) to (3) to remove the built-in regenerative resistor installed on the back of MR-JET-40_ to MR-JET-300_.

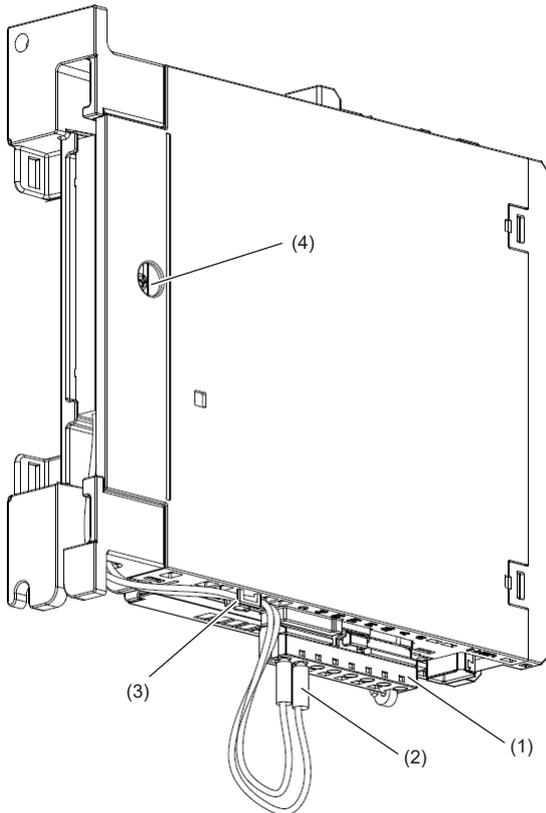
(1) Pull out the power connector (CNP1). Do not forcibly pull the lead wires of the built-in regenerative resistor or the CNP1 connector. Doing so may snap the lead wires.

(2) Pull out the wires of the built-in regenerative resistor from the power connector (CNP1).

☞ Page 27 Wiring CNP1

(3) Remove the wires of the built-in regenerative resistor from the servo amplifier. Carefully remove the wires to avoid snapping them.

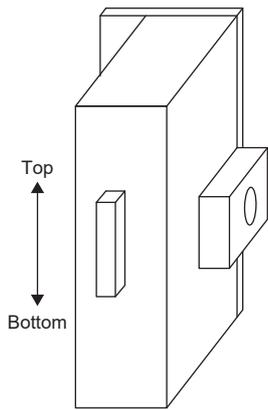
(4) Remove the screws (screw size: M3) used to fix the built-in regenerative resistor and take out the built-in regenerative resistor. Keep the removed built-in regenerative resistor and the removed screws as necessary. To install the regenerative resistor again, tighten the screws with a tightening torque of 0.72 N•m.



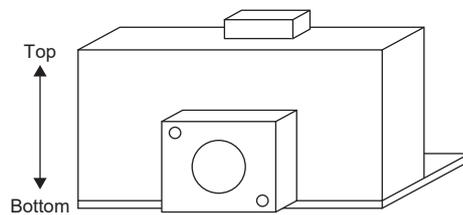
Mounting direction

The mounting direction of the regenerative option is shown below.

Regenerative option	Mounting direction
MR-RB032	Vertical mounting
MR-RB12	Vertical mounting
MR-RB14	Vertical mounting
MR-RB30	Vertical mounting
MR-RB50 (A cooling fan is required.)	Vertical mounting/horizontal mounting
MR-RB34	Vertical mounting



Vertical mounting

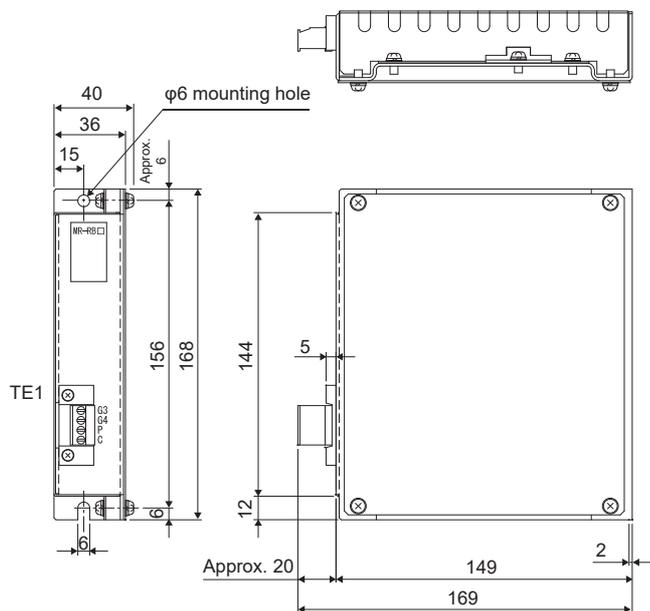


Horizontal mounting

Dimensions

MR-RB12/MR-RB14

[Unit: mm]



Mass: 1.1 [kg]

- Terminal TE1

G3
G4
P
C

Applicable wire size: 0.2 mm² to 2.5 mm² (AWG 24 to 12)

Tightening torque: 0.5 to 0.6 [N•m]

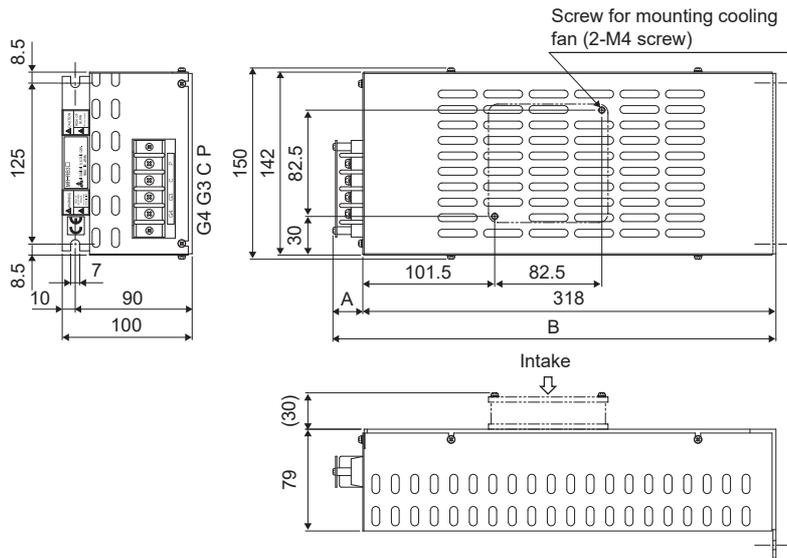
- Mounting screw

Screw size: M5

Tightening torque: 3.24 [N•m]

MR-RB30/MR-RB34

[Unit: mm]



- Terminal block

P
C
G3
G4

Screw size: M4

Tightening torque: 1.2 [N•m]

- Mounting screw

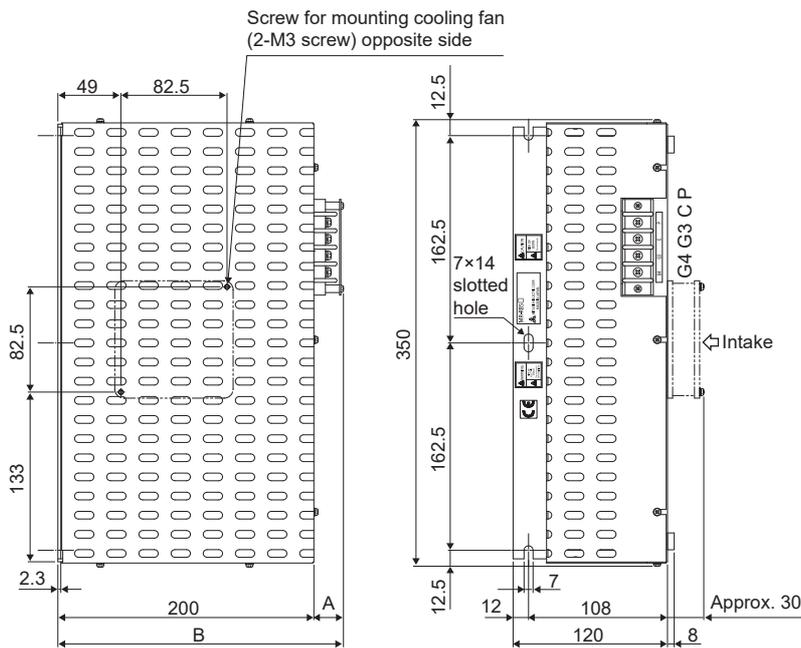
Screw size: M6

Tightening torque: 5.4 [N•m]

Regenerative option	Variable dimensions		Mass [kg]
	A	B	
MR-RB30	17	335	2.9
MR-RB34			

MR-RB50

[Unit: mm]



- Terminal block

P
C
G3
G4

Screw size: M4

Tightening torque: 1.2 [N•m]

- Mounting screw

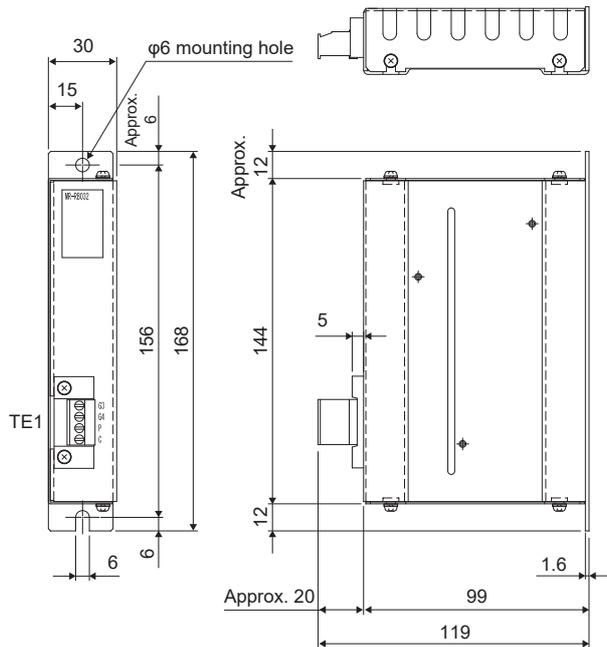
Screw size: M6

Tightening torque: 5.4 [N•m]

Regenerative option	Variable dimensions		Mass [kg]
	A	B	
MR-RB50	17	217	5.6

MR-RB032

[Unit: mm]



Mass: 0.5 [kg]

- Terminal TE1

G3
G4
P
C

Applicable wire size: 0.2 mm² to 2.5 mm² (AWG 24 to 12)

Tightening torque: 0.5 to 0.6 [N•m]

- Mounting screw

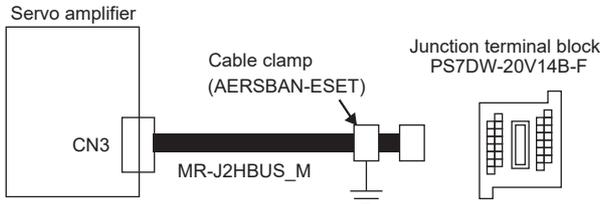
Screw size: M5

Tightening torque: 3.24 [N•m]

6.3 PS7DW-20V14B-F junction terminal block (recommended)

Usage

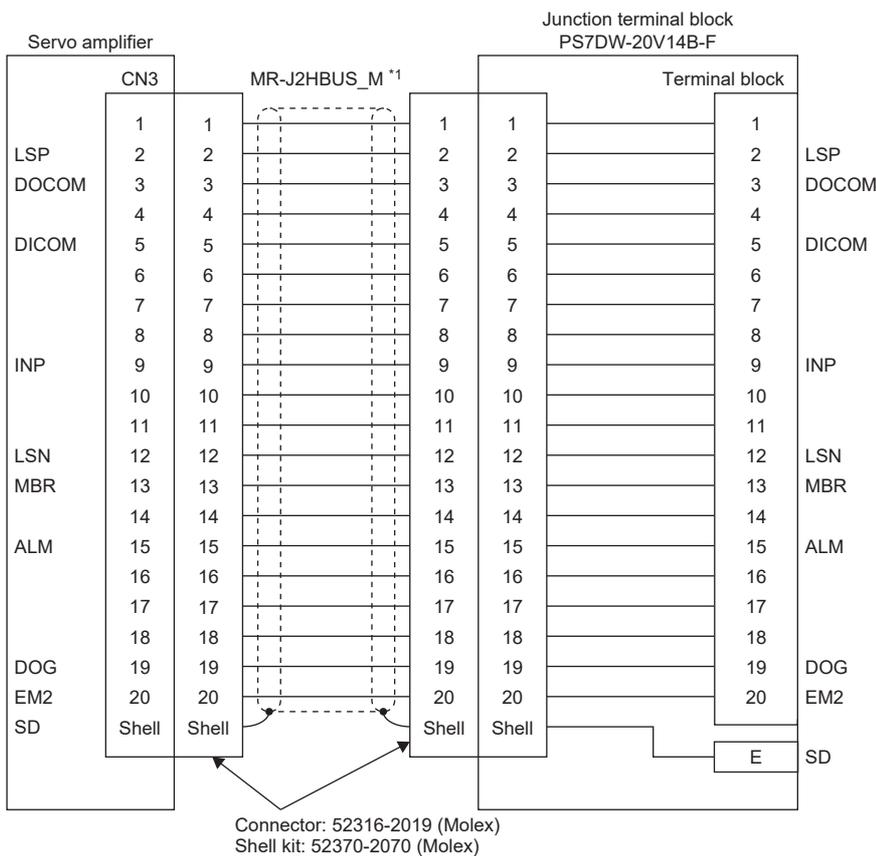
Use the junction terminal block (PS7DW-20V14B-F) with the option cable (MR-J2HBUS_M) as a set. A connection example is shown below.



For MR-J2HBUS_M, ground the option cable on the junction terminal block side with the cable clamp fitting (AERSBAN-ESET). For the use of the cable clamp fitting, refer to the following.

☞ Page 92 Cable clamp fitting AERSBAN-_SET

Connection of MR-J2HBUS_M cable and junction terminal block



*1 Numbers in " _ " indicate the cable length.
05: 0.5 m
1: 1 m
5: 5 m

6.4 MR Configurator2

Engineering tool

MR Configurator2 (SW1DNC-MRC2-_) can be used with this servo amplifier.

For the engineering tool specifications and system configuration, refer to the installation guide of the engineering tool.

Precautions for using USB communication function and Ethernet communication function

Note the following to prevent an electric shock or malfunction of the servo amplifier.

Connecting the power of a personal computer

Connect the power of a personal computer with the following procedure.

■When using a personal computer with an AC power supply

- When using a personal computer with a three-core power plug or a power plug with a grounding wire, use a three-pin socket or ground the grounding wire.
- When your personal computer has a two-core power plug and has no grounding wire, connect the personal computer to the servo amplifier with the following procedure.

1. Disconnect the power plug of the personal computer from the AC power socket.
2. Check that the power plug has been disconnected and connect the computer to the servo amplifier.
3. Connect the power plug of the personal computer to the AC power socket.

- When using a personal computer with battery

The computer can be used as it is.

■Connection with other devices using servo amplifier communication function

When the servo amplifier is charged with electricity due to connection with a personal computer and the charged servo amplifier is connected with other devices, the servo amplifier or the connected devices may malfunction. Connect the servo amplifier and other devices with the following procedure.

1. Shut off the power of the device to be connected with the servo amplifier.
2. Shut off the power of the servo amplifier that was connected with the personal computer, and check that the charge light is off.
3. Connect the device with the servo amplifier.
4. Turn on the power of the servo amplifier and the connected device.

6.5 Battery

Point

- For battery transportation and the new EU Battery Directive, refer to "COMPLIANCE WITH GLOBAL STANDARDS" in User's Manual (Introduction).

Use a battery when connecting an HG-KNS/HG-SNS series rotary servo motor to configure an absolute position detection system. For configuration of an absolute position detection system, refer to the following.

 Page 101 ABSOLUTE POSITION DETECTION SYSTEM

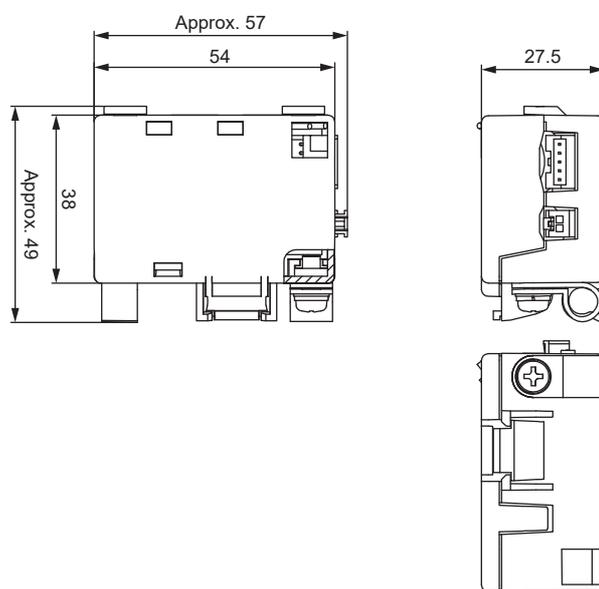
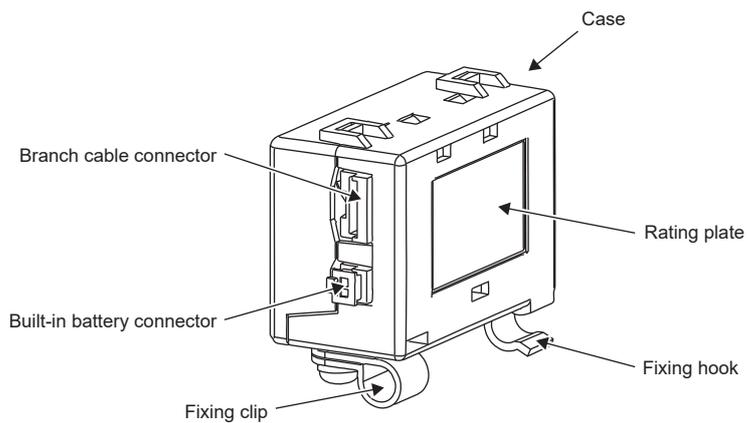
MR-BAT6V1SET-B battery

Point

- For the specifications and the date of manufacture of the built-in MR-BAT6V1 battery, refer to the following.
-  Page 82 MR-BAT6V1 battery

Parts identification and dimensions

[Unit: mm]



Mass: 62 [g] (including the MR-BAT6V1 battery)

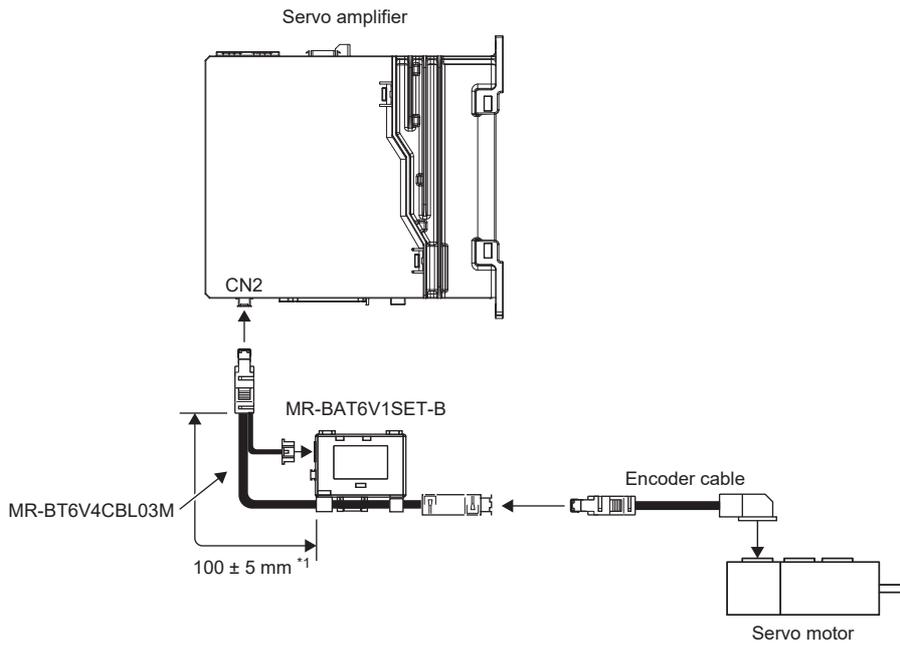
- Mounting screw

Screw size: M4

Tightening torque: 1.2 [N•m]

Battery connection

Connect as follows.



*1 To place the battery in a position within the wiring allowance indicated in section 2.1, allow for $100 \pm 5 \text{ mm}$ of wire between the encoder connector and the cable retainer clip.

Battery replacement procedure

Precautions

Before replacing batteries, turn off the power and wait for 15 minutes or more until the charge light turns off. In addition, when confirming whether the charge light is off or not, look at the light from the front of the servo amplifier.

The servo amplifier may be damaged by static electricity. Take the following precautions.

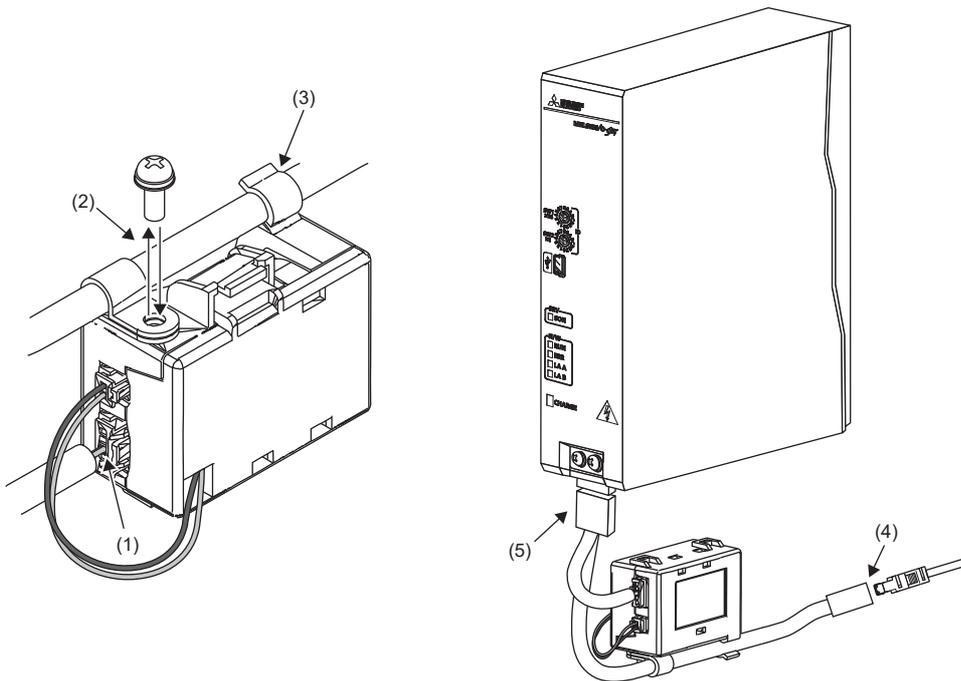
- Ensure that the work bench and your body are grounded.
- Do not directly touch conductive areas such as the connector pins and electrical parts.

Replacing batteries will erase the absolute position data.

Before replacing batteries, check that the new battery is within battery life.

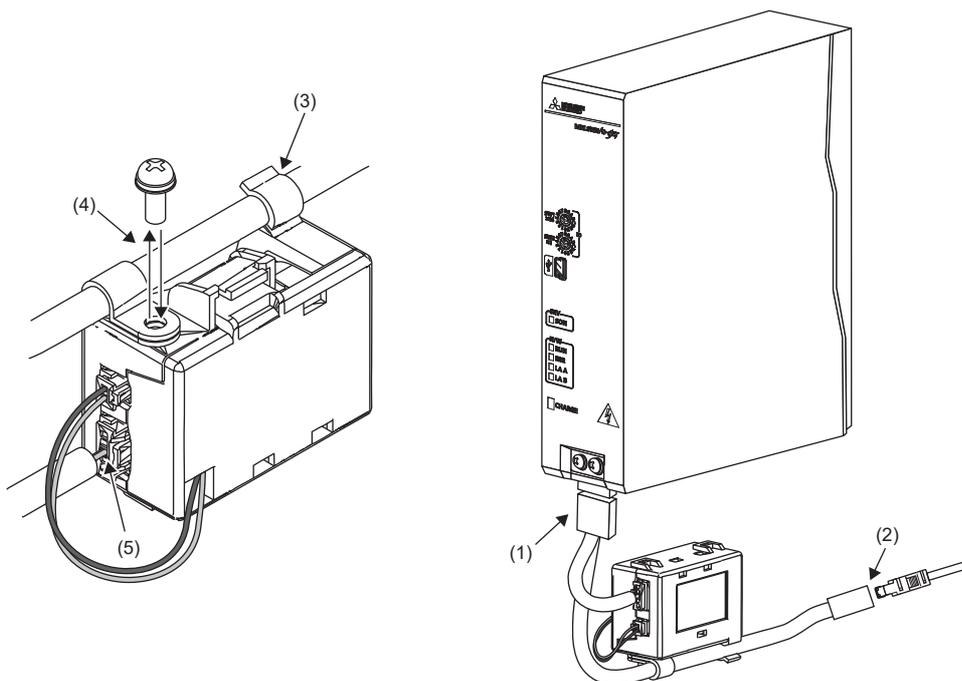
■Battery installation and removal procedure

- Fitting method



1. Connect the battery-side connector of the battery branch cable to the branch cable connector on the battery. (1)
2. Remove the screw for the retainer clip from the battery, clamp the encoder-side cable of the battery branch cable down, then reinstall the screw. (2)
3. Clip the encoder-side cable of the battery branch cable to the retainer clip. (3)
4. Connect the encoder cable to the encoder-side connector of the battery branch cable. (4)
5. Connect the servo amplifier-side connector of the battery branch cable to CN2 on the servo amplifier. (5)

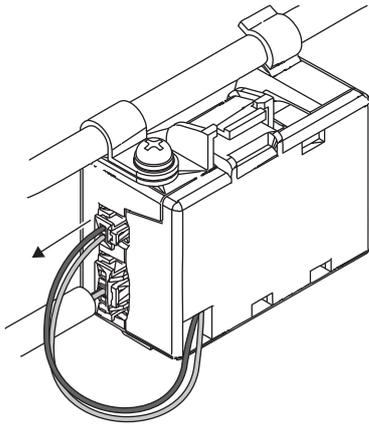
• Removal procedure



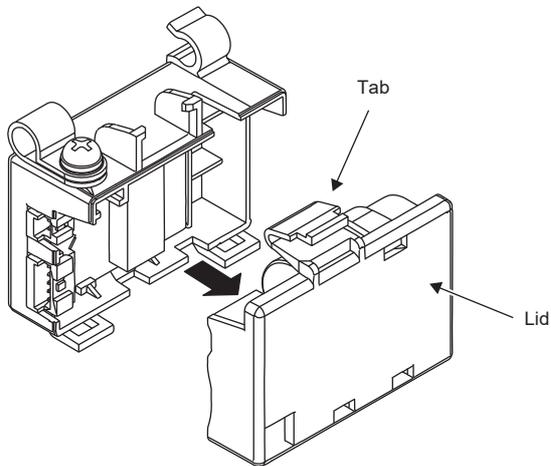
1. Remove the servo amplifier-side connector of the battery branch cable from CN2 on the servo amplifier. (1)
2. Remove the encoder cable from the encoder-side connector of the battery branch cable. (2)
3. Unclip the encoder-side cable of the battery branch cable from the retainer clip. (3)
4. Remove the screw for the retainer clip from the battery, unclip the encoder-side cable of the battery branch cable, then reinstall the screw. (4)
5. Remove the battery-side connector of the battery branch cable from the branch cable connector on the battery. (5)

■ Replacing the built-in battery

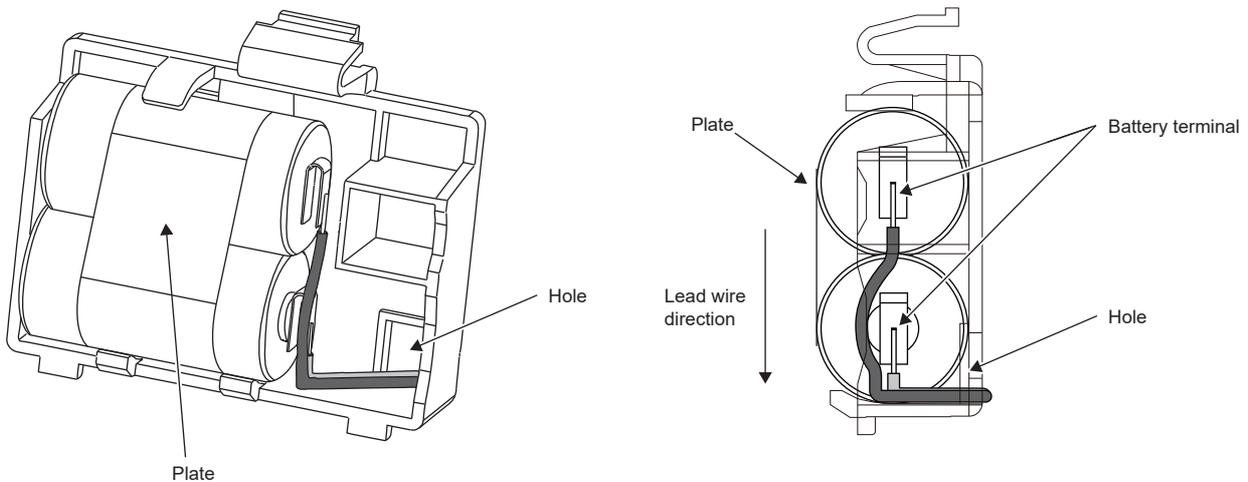
1. Remove the built-in battery connector from the built-in battery connector of the battery.



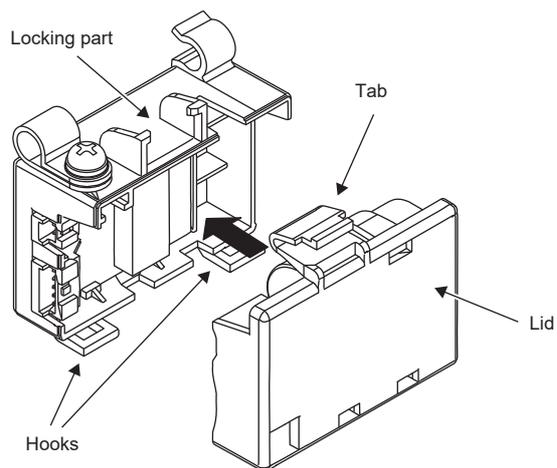
2. Push in the tab to unclip the case lid.



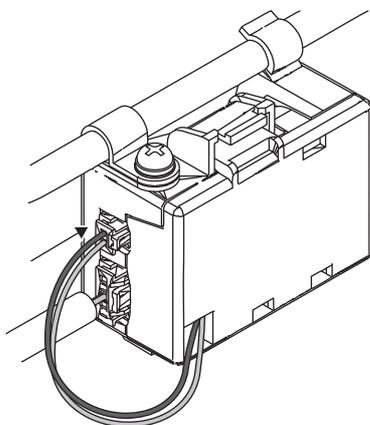
3. Pull the battery leads through the hole in the lid, then remove the battery and replace it with a new MR-BAT6V1 battery. Once the battery has been replaced, pull the battery leads through the hole in the lid. Insert the new MR-BAT6V1 battery into the case lid so that the label is visible.



4. Hook the lid to the tabs on the case, then push the two parts of the case together so that tab clips into lock.

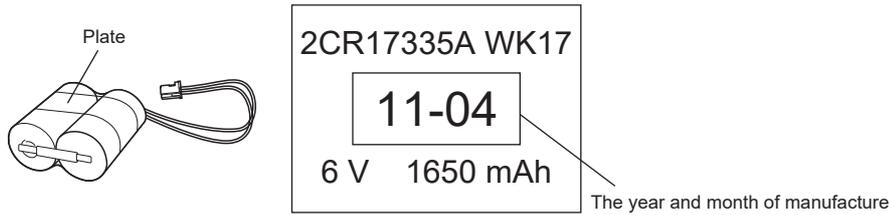


5. Connect the built-in battery connector to the built-in battery connector of the battery.



MR-BAT6V1 battery

The MR-BAT6V1 is a replacement lithium battery for the MR-BAT6V1SET-B. Store the MR-BAT6V1 in the case to use. The date of manufacture of the MR-BAT6V1 battery is indicated on the battery label.



Item	Description
Battery pack	2CR17335A (CR17335A × 2 pcs. connected in series)
Nominal voltage [V]	6
Nominal capacity [mAh]	1650
Storage temperature [°C]	0 to 55
Operating temperature [°C]	0 to 55
Lithium content [g]	1.2
Mercury content	Less than 1 ppm
Dangerous goods class	Not subject to the dangerous goods (Class 9) For details, refer to "Handling of AC servo amplifier batteries for the United Nations Recommendations on the Transport of Dangerous Goods" in User's Manual (Introduction).
Operating humidity and storage humidity	5 %RH to 90 %RH (non-condensing)
Battery life *1	Five years after the date of manufacture
Mass [g]	34

*1 Quality of the batteries degrades by the storage condition. The battery life is 5 years from the date of manufacture regardless of the connection status.

6.6 Selection example of wires

Point

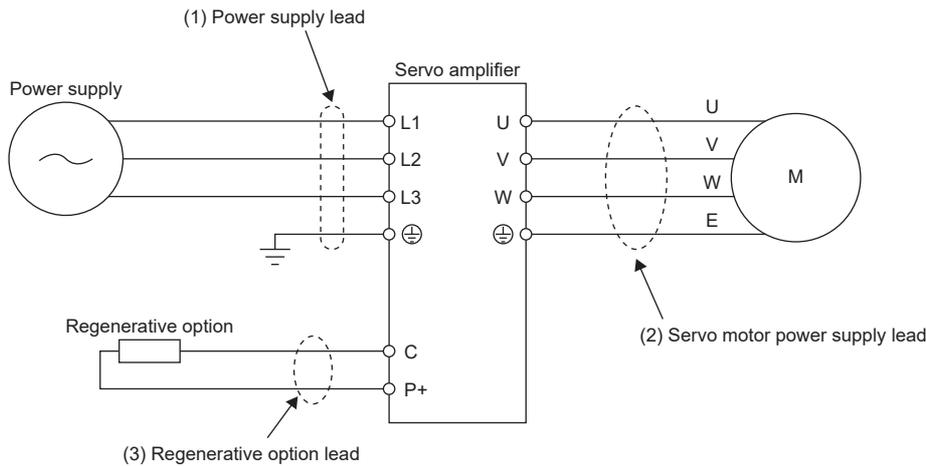
To comply with the IEC/EN/UL/CSA standard, select the wires by referring to the MR-JET Safety Instructions and Precautions for AC Servos (IB(NA)-0300492). To comply with other standards, use wires that comply with each standard.

Selection requirements for the wire size are as follows.

Construction requirements: Single wire set in midair

Wiring length: 30 m or less

The following shows the wires used for wiring. Use the wires given in this section or equivalent wires.



Wire size selection examples

Selection examples for the 600 V Grade heat-resistant polyvinyl chloride insulated wire (HIV wire) are indicated below.

Servo amplifier	Wire [mm ²]		
	(1) L1/L2/L3/⊕	(3) P+/C	(2) U/V/W/E *1
MR-JET-10_	2 (AWG 14)	2 (AWG 14)	0.75 to 2 (AWG 18 to 14) *2
MR-JET-20_			
MR-JET-40_			
MR-JET-70_			
MR-JET-100_			
MR-JET-200_ (3-phase power supply input)	3.5 (AWG 12)		1.25 to 5.5 (AWG 16 to 10)
MR-JET-200_ (1-phase power supply input)			
MR-JET-300_			

*1 The wire size shows applicable size of the servo amplifier connector. For wires connecting to servo motors, refer to "Selection example of wires" in the following manual.

Rotary Servo Motor User's Manual (HG-KNS/HG-SNS)

*2 Use the size of 2 mm² for compliance with the IEC/EN/UL/CSA standard.

6.7 Molded-case circuit breakers, fuses, magnetic contactors

When using a fuse instead of the molded-case circuit breaker, use the one having the specifications given in this section.

Precautions

- Select the molded-case circuit breakers specified in this section.
- Wire the molded-case circuit breaker and magnetic contactor as recommended.

Servo amplifier	Molded-case circuit breaker *1			Fuse			Magnetic contactor *2	
	Frame, rated current		Voltage AC [V]	Class	Current [A]	Voltage AC [V]		
	Power factor improving reactor is not used	Power factor improving reactor is used						
MR-JET-10_	30 A frame 5 A	30 A frame 5 A	240	Semiconductor	10	700	S-T10	
MR-JET-20_								
MR-JET-40_	30 A frame 10 A	30 A frame 5 A						15
MR-JET-70_	30 A frame 15 A	30 A frame 10 A						20
MR-JET-100_ (3-phase power supply input)								
MR-JET-100_ (1-phase power supply input)								30 A frame 15 A
MR-JET-200_	30 A frame 20 A	30 A frame 20 A			40		S-T21	
MR-JET-300_	30 A frame 30 A	30 A frame 30 A			70			

*1 Use a fuse to make the servo amplifier comply with UL/CSA standards. To make the servo amplifier comply with IEC/EN/UL/CSA standards, refer to "MR-JET Safety Instructions and Precautions for AC Servos (IB(NA)-0300492)" for selection of molded-case circuit breakers and fuses.

*2 Use the magnetic contactor with an operation delay time (interval between current being applied to the coil until closure of contacts) of 80 ms or less.

A Motor circuit breaker (Type E combination motor controller) can also be used instead of a molded-case circuit breaker. The Motor circuit breaker (Type E combination motor controller) is the product combined with the motor circuit breaker, the short-circuit indicator unit UT-TU, and the line side terminal adapter UT-CV3.

Servo amplifier	Rated input voltage AC [V]	Input phase	Motor circuit breaker (Type E combination motor controller)			SCCR [kA]
			Model	Rated voltage AC [V]	Rated current [A] (heater design)	
MR-JET-10_	200 to 240	3-phase	MMP-T32	240	1.6	50
MR-JET-20_					2.5	
MR-JET-40_					4	
MR-JET-70_					6.3	
MR-JET-100_					8	
MR-JET-200_					18	
MR-JET-300_					25	

Example settings that comply with IEC/EN/UL 61800-5-1 and CSA C22.2 No.274

The molded-case circuit breakers, semiconductor fuses, and recommended wire gauges in the tables are selections based on the rated I/O of the servo amplifier.

Molded-case circuit breaker/Semiconductor fuse

Servo amplifier	Molded-case circuit breaker (240 V AC) SCCR 50 kA	Semiconductor fuse (700 V) SCCR 100 kA (Manufactured by Eaton Bussman)
MR-JET-10_	NF125-SVU-15A (125 A frame 15 A)	170M1408 (10 A)
MR-JET-20_		
MR-JET-40_		
MR-JET-70_ (3-phase power supply input)		
MR-JET-70_ (1-phase power supply input)		
MR-JET-100_ (3-phase power supply input)	NF125-SVU-15A (125 A frame 15 A)	170M1409 (16 A)
MR-JET-100_ (1-phase power supply input)	NF125-SVU-15A (125 A frame 15 A)	170M1412 (32 A)
MR-JET-200_ (3-phase power supply input)	NF125-SVU-20A (125 A frame 20 A)	170M1413 (40 A)
MR-JET-200_ (1-phase power supply input)		
MR-JET-300_		

Recommended wire

Servo amplifier	75 °C Stranded wire [AWG]		
	L1/L2/L3 ⊕	P+/C	U/V/W/E
MR-JET-10_	14	14	14
MR-JET-20_			
MR-JET-40_			
MR-JET-70_			
MR-JET-100_			
MR-JET-200_ (3-phase power supply input)			
MR-JET-200_ (1-phase power supply input)	12		
MR-JET-300_			

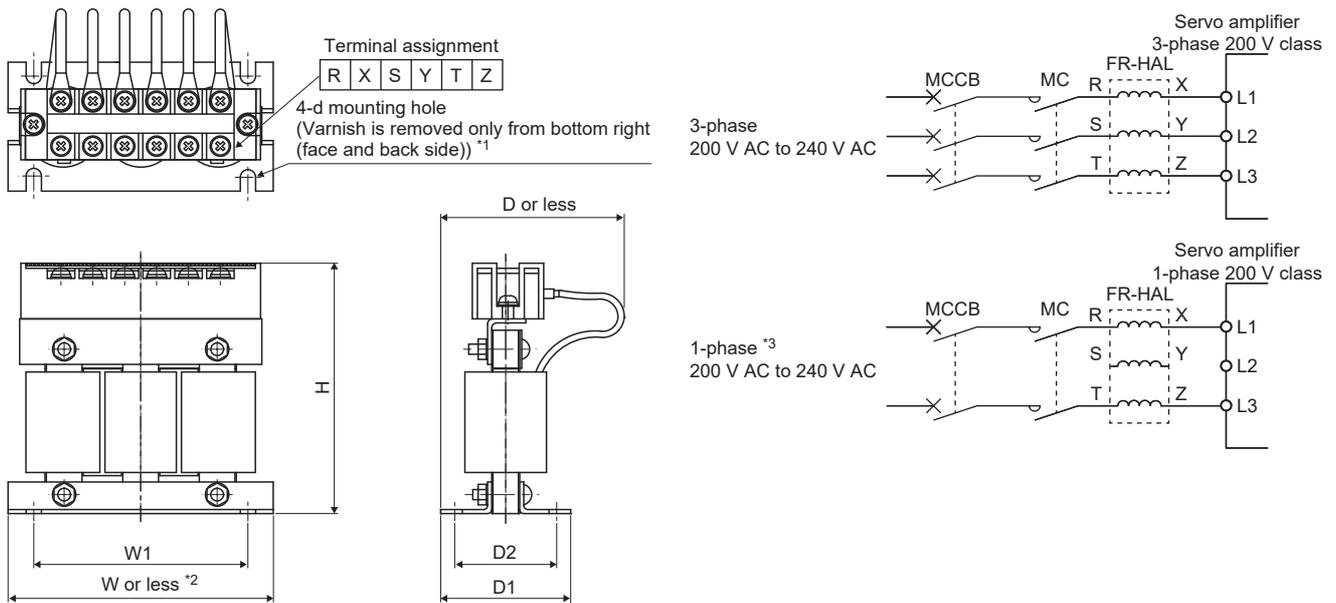
6.8 Power factor improving AC reactor

Advantages

- It improves the power factor by increasing the form factor of the servo amplifier's input current.
- It decreases the power supply capacity.
- The input power factor is improved to about 80 %.

Restrictions

When using power factor improving AC reactors for two servo amplifiers or more, connect a power factor improving AC reactor to each servo amplifier. If one unit of power factor improving reactor is used for multiple servo amplifiers, the power factor cannot be improved sufficiently unless all servo amplifiers are operated.



Servo amplifier	Power factor improving AC reactor	Dimensions [mm]							Terminal size	Mass [kg]
		W	W1	H	D ^{*4}	D1	D2	d		
MR-JET-10_ MR-JET-20_	FR-HAL-0.4K	104	84	99	72	51	40	M5	M4	0.6
MR-JET-40_	FR-HAL-0.75K	104	84	99	74	56	44	M5	M4	0.8
MR-JET-70_	FR-HAL-1.5K	104	84	99	77	61	50	M5	M4	1.1
MR-JET-100_ (3-phase power supply input)	FR-HAL-2.2K	115 ^{*4}	40	115	77	71	57	M6	M4	1.5
MR-JET-100_ (1-phase power supply input) MR-JET-200_ (3-phase power supply input)	FR-HAL-3.7K	115 ^{*4}	40	115	83	81	67	M6	M4	2.2
MR-JET-200_ (1-phase power supply input) MR-JET-300_	FR-HAL-5.5K	115 ^{*4}	40	115	83	81	67	M6	M4	2.3

*1 Use this for grounding.

*2 For FR-HAL-0.4K to FR-HAL-1.5K, the W dimension is "W ± 2".

*3 For 1-phase 200 V AC to 240 V AC power supply, connect the power supply to L1 and L3. Leave L2 open.

*4 Maximum dimensions. The dimensions vary depending on the curvature of the input/output lines.

6.9 Relay (recommended)

The following relays should be used with each interface.

Interface	Selection example
Digital input signal (interface DI-1) Relay used for digital input command signals	To prevent loose connections, use a relay for small signal (twin contacts). (Ex.) Omron: type G2A, type MY
Digital output signal (interface DO-1) Relay used for digital output signals	Small relay with 12 V DC or 24 V DC of rated current 40 mA or less (Ex.) Omron: type MY

6.10 Noise reduction techniques

Noises are classified into external noises, which enter the servo amplifier to cause it to malfunction, and those radiated by the servo amplifier to cause peripheral equipment to malfunction. Because the servo amplifier is an electronic device that handles small signals, the following general noise reduction techniques are required.

The servo amplifier can also be a source of noise as its outputs are chopped by high carrier frequencies. If peripheral equipment malfunctions due to noise produced by the servo amplifier, take measures to reduce the noise. The reduction techniques will vary slightly with the routes of noise transmission.

Noise reduction techniques

■General reduction techniques

- Avoid bundling power lines (input/output lines) and signal cables together or running them in parallel to each other. Separate the power lines from the signal cables.
- Use a shielded twisted pair cable for connection with the encoder and for control signal transmission, and connect the external conductor of the cable to the SD terminal.
- For grounding, refer to the following.

 Page 41 Grounding

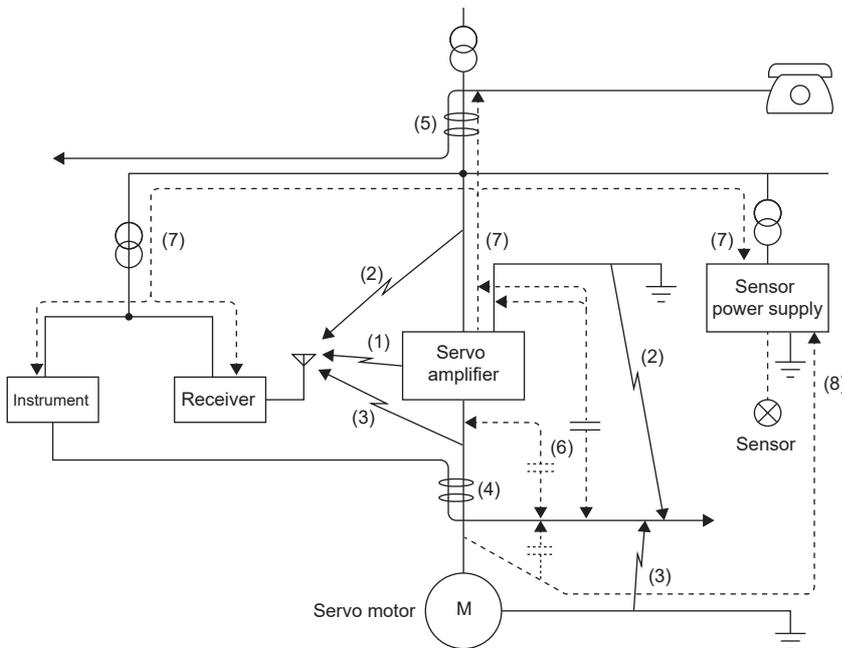
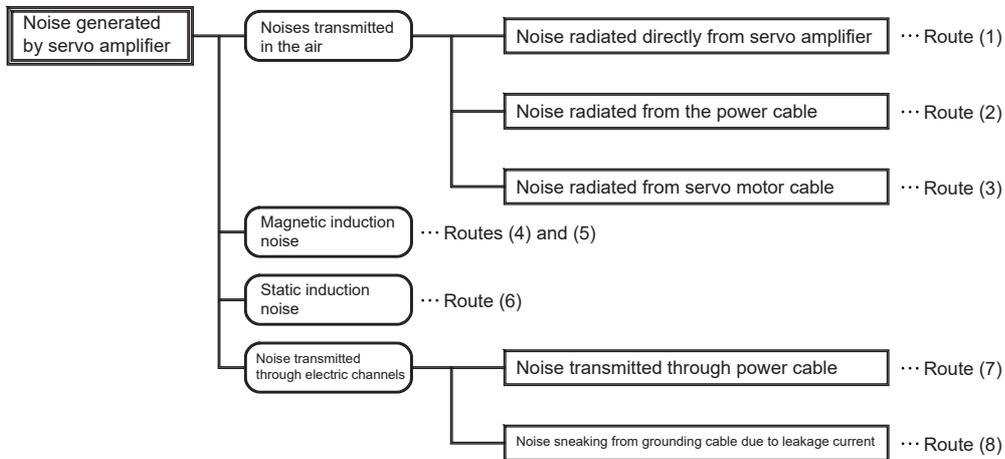
■Reduction techniques for external noises that cause the servo amplifier to malfunction

If there are noise sources (such as a magnetic contactor, an electromagnetic brake, and many relays) that make a large amount of noise near the servo amplifier and the servo amplifier may malfunction, the following countermeasures are required.

- Provide surge killers on the noise sources to suppress noise.
- Attach data line filters to the signal cables.
- Ground the shields of the encoder connecting cable and the control signal cables with cable clamp fittings.
- Although a surge absorber is built into the servo amplifier, to protect the servo amplifier and other equipment against large exogenous noise and lightning surge, attaching a varistor to the power input section of the equipment is recommended.

■ Techniques for noises radiated by the servo amplifier that cause peripheral equipment to malfunction

Noises produced by the servo amplifier are classified into those radiated from the cables connected to the servo amplifier and its main circuits (input/output), those induced electromagnetically or statically by the signal cables of the peripheral equipment located near the main circuit cables, and those transmitted through the power supply cables.



Noise transmission route	Suppression techniques
(1), (2), (3)	<p>A malfunction due to noise transmitted through the air may occur in devices which handle weak signals and are susceptible to noise, such as measuring instruments, receivers and sensors. In addition, a malfunction may also occur when their signal cables are stored in a cabinet together with the servo amplifier or when the signal cables run near the servo amplifier. Take the following measures to prevent a malfunction:</p> <ul style="list-style-type: none"> • Provide maximum clearance between easily affected devices and the servo amplifier. • Provide maximum clearance between easily affected signal cables and the I/O cables of the servo amplifier. • Avoid bundling power lines (input/output lines of the servo amplifier) and signal cables together or running them in parallel to each other. • Insert a line noise filter to the I/O cables or a radio noise filter on the input line to reduce radiated noise from the cables. • Use shielded wires for the signal and power lines, or put the lines in separate metal conduits.
(4), (5), (6)	<p>When power cables and signal cables are laid side by side or bundled together, electromagnetic and static induction noise is transmitted to the signal cables, causing malfunctions. Take the following precautions to protect the signal cables against noise.</p> <ul style="list-style-type: none"> • Provide maximum clearance between easily affected devices and the servo amplifier. • Provide maximum clearance between easily affected signal cables and the I/O cables of the servo amplifier. • Avoid bundling power lines (input/output lines of the servo amplifier) and signal cables together or running them in parallel to each other. • Use shielded wires for the signal and power lines, or put the lines in separate metal conduits.
(7)	<p>When the power supply of peripheral equipment is connected to the power supply of the servo amplifier system, noise produced by the servo amplifier may be transmitted back through the power supply cable, and the equipment may malfunction. The following techniques are required.</p> <ul style="list-style-type: none"> • Install the radio noise filter (FR-BIF) on the power lines (input lines) of the servo amplifier. • Install the line noise filter (FR-BSF01) on the power lines of the servo amplifier.
(8)	<p>If the grounding wires of the peripheral equipment and the servo amplifier make a closed loop circuit, leakage current may flow through, causing the equipment to malfunction. In this case, the malfunction may be prevented by disconnecting the grounding wires from the equipment.</p>

■ Noise reduction techniques for the network cable

Point

Take measures against noise for both ends of the network cable.

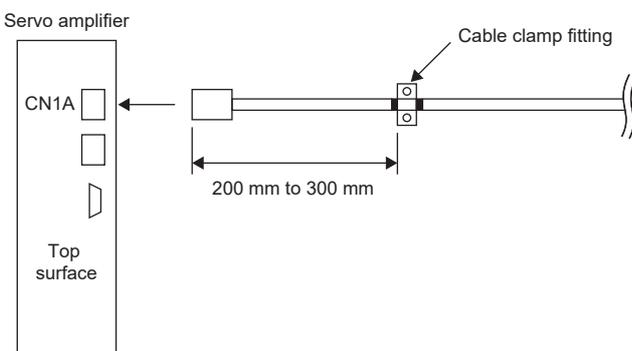
If using the network cable in an environment with excessive noise, directly connect the shield of the cable to the ground plate with cable clamp fittings at a place 200 mm to 300 mm from the servo amplifier.

When connecting the network cable from outside the cabinet, connect it to the ground plate 5 mm to 10 mm away from the cabinet entrance.

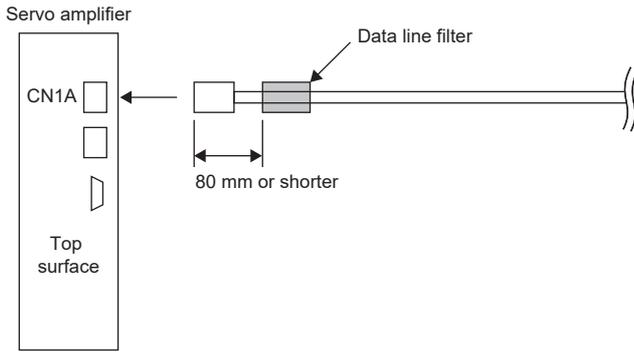
To reinforce noise reduction techniques, installing a data line filter (TDK ZCAT1730-0730) to the network cable is recommended. Install the data line filter to a place 80 mm or less from the servo amplifier.

- Inside the cabinet

When using cable clamp fittings

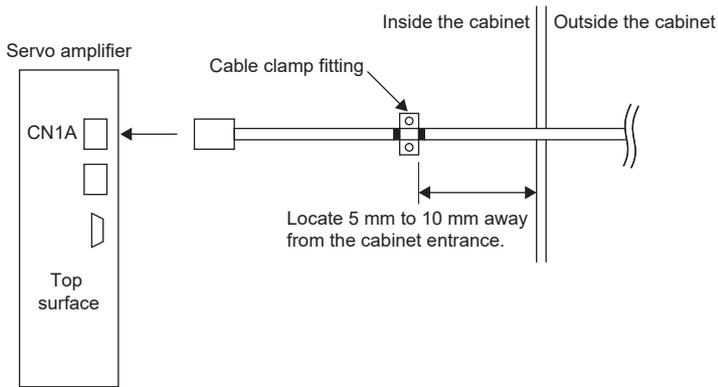


When using a data line filter

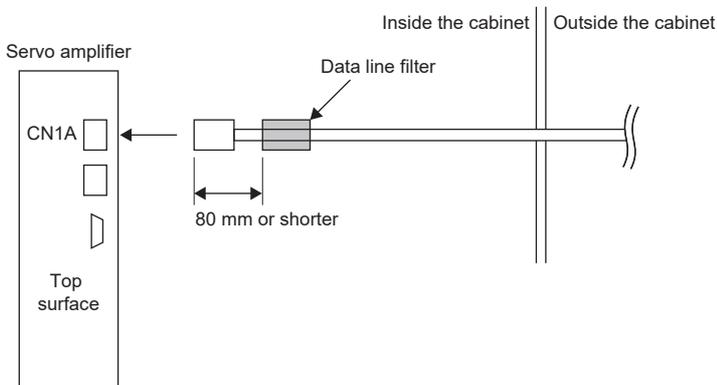


- Outside the cabinet

When using cable clamp fittings



When using a data line filter



Noise reduction products

■Data line filter (recommended)

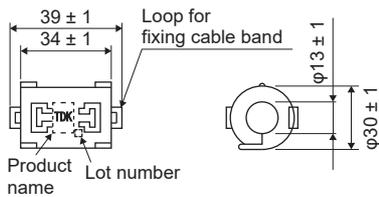
Noise can be prevented by installing a data line filter onto cables such as the encoder cable.

For example, ZCAT3035-1330 by TDK, ESD-SR-250 by TOKIN, GRFC-13 by Kitagawa Industries, and E04SRM563218 by SEIWA ELECTRIC are available as data line filters.

As a reference example, the impedance specifications of the ZCAT3035-1330 (TDK) are indicated below. These impedances are reference values and not guaranteed values.

Impedance [Ω]	
10 MHz to 100 MHz	100 MHz to 500 MHz
80	150

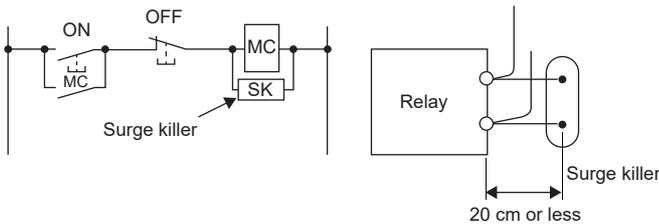
[Unit: mm]



Dimensions (ZCAT3035-1330)

■Surge killer (recommended)

Use of a surge killer is recommended for AC relay, magnetic contactor or the like near the servo amplifier. Use the following surge killer or equivalent.



Ex.

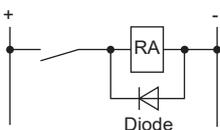
CR-50500 (Okaya Electric Industries)

Rated voltage AC [V]	C [μ F $\pm 20\%$]	R [$\Omega \pm 30\%$]	Test voltage	Dimensions [Unit: mm]
250	0.5	50 (1/2W)	Between terminals: 625 V AC, 50 Hz/60 Hz 60 s Between terminal and case: 2000 V AC 50/60 Hz 60 s	

Note that a diode should be installed to a DC relay or the like.

Maximum voltage: Not less than four times the drive voltage of the relay or the like

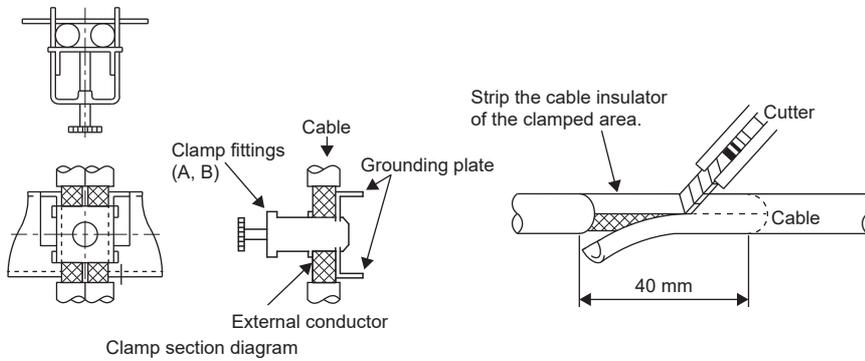
Maximum current: Not less than two times the drive current of the relay or the like



■ Cable clamp fitting AERSBAN-_SET

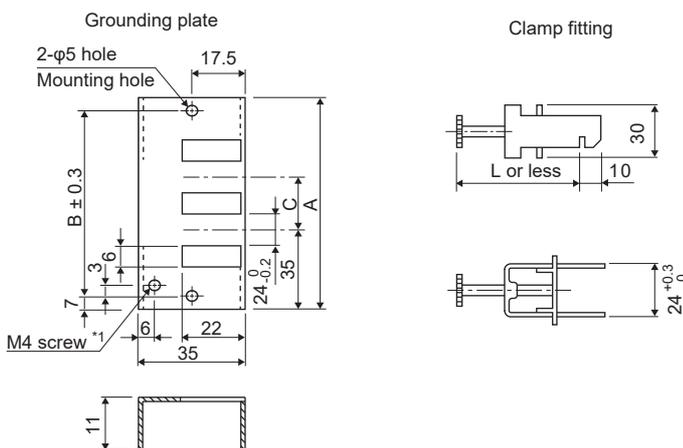
Generally, connecting the grounding wire of the shielded wire to the SD terminal of the connector provides a sufficient effect. However, the effect can be increased when the shielded wire is connected directly to the ground plate as shown below. Install the ground plate near the servo amplifier for the encoder cable. Peel part of the cable insulator to expose the external conductor, and press that part against the ground plate with the cable clamp. If the cable are thin, bunch several cables together and clamp them in place.

The cable clamp comes as a set with the grounding plate.



• Dimensions

[Unit: mm]



*1 Screw hole for grounding. Connect it to the ground plate of the cabinet.

Model	A	B	C	Accessory fittings
AERSBAN-DSET	100	86	30	Clamp A: 2 pcs.
AERSBAN-ESET	70	56	—	Clamp B: 1 pc.
Clamp fitting		L		
A				70
B				45

Line noise filter (FR-BSF01)

This filter is effective in suppressing noise radiated from the power supply side and output side of the servo amplifier and also in suppressing high-frequency leakage current (0-phase current). It is especially effective for noise between 0.5 MHz and 5 MHz band.

Connection diagram	Dimensions [Unit: mm]
<p>The line noise filters can be mounted on lines of the power supply (L1/L2/L3) and of the servo motor power (U/V/W). Pass each of the wires through the line noise filter the same number of times in the same direction. For wires of the power supply, the effect of the filter rises as the number of passes increases, but generally four passes would be appropriate. For the servo motor power supply lines, passes must be four times or less. Do not pass the grounding wire through the filter. Otherwise, the effect of the filter will drop.</p> <p>Wind the wires through the line noise filter to satisfy the required number of passes, as shown in Example 1. If the wires are too thick to wind, use two or more line noise filters to have the required number of passes, as shown in Example 2.</p> <p>Place the line noise filters as close to the servo amplifier as possible for their best performance. Noise-reducing effect will be enhanced.</p> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; align-items: center; margin-bottom: 20px;"> <div style="text-align: center;"> <p>Example 1</p> </div> <div style="margin-left: 20px;"> <p>Line noise Filter</p> <p>(Number of passes: 4)</p> </div> </div> <div style="display: flex; align-items: center;"> <div style="text-align: center;"> <p>Example 2</p> </div> <div style="margin-left: 20px;"> <p>Line noise Filter</p> <p>For two filters (Total number of passes: 4)</p> </div> </div> </div>	<p>FR-BSF01 (for wire size 3.5 mm² (AWG 12) or less)</p>

Radio noise filter (FR-BIF)

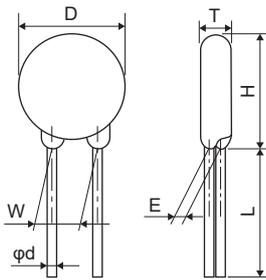
This filter is effective in suppressing noise radiated from the power supply side of the servo amplifier, especially in 10 MHz and lower radio frequency bands. The FR-BIF(-H) is designed for the input only.

Connection diagram	Dimensions [Unit: mm]
<p>Make the connection cables as short as possible. Grounding is required.</p> <p>When using the FR-BIF with a single-phase power supply, insulate the lead wires that are not used for wiring.</p>	<p>Leakage current: 4 mA</p>

■Varistor for input power supply (recommended)

Varistors are effective to prevent exogenous noise and lightning surges from entering the servo amplifier. When using a varistor, connect it between each phase of the input power supply of the equipment. For varistors, the TND20V-431K and TND20V-471K manufactured by Nippon Chemi-Con are recommended. For detailed specification and usage of the varistors, refer to the manufacturer catalog.

Power supply voltage	Varistor	Maximum rating					Maximum limit voltage		Static capacity (reference value)	Varistor voltage rating (range) V1 mA
		Permissible circuit voltage		Surge current immunity	Energy immunity	Rated pulse power	[A]	[V]		
		AC [Vrms]	DC [V]	8/20 μ s [A]	2 ms [J]	[W]			[pF]	[V]
200 V class	TND20V-431K	275	350	10000/1 time	195	1.0	100	710	1300	430 (387 to 473)
	TND20V-471K	300	385	7000/2 times	215			775	1200	470 (423 to 517)



[Unit: mm]

Model	D Max.	H Max.	T Max.	E \pm 1.0	L Min.*1	ϕ d \pm 0.05	W \pm 1.0
TND20V-431K	21.5	24.5	6.4	3.3	20	0.8	10.0
TND20V-471K			6.6	3.5			

*1 For special purpose items for lead length (L), contact the manufacturer.

6.11 Earth-leakage current breaker

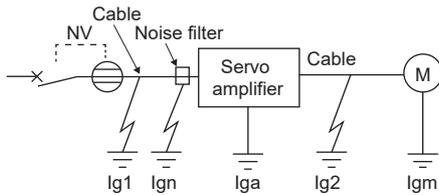
Selection method

High-frequency chopper currents controlled by pulse width modulation flow in the AC servo circuits. Leakage currents containing harmonic contents are larger than those of the motor, which runs on AC power.

Select an earth-leakage current breaker according to the following formula, and ground the servo amplifier, servo motor, etc. securely.

To minimize leakage currents, make the input and output wires as short as possible, and keep a distance of 30 cm or longer between the wires and ground.

$$\text{Rated sensitivity current} \geq 10 \cdot \{I_{g1} + I_{gn} + I_{ga} + K \cdot (I_{g2} + I_{gm})\} \text{ [mA]} \dots (6.1)$$



Earth-leakage current breaker		K
Type	Mitsubishi Electric products	
Models provided with harmonic and surge reduction techniques	NV-SP NV-SW NV-CP NV-CW NV-HW	1
General models	BV-C1 NFB NV-L	3

Ig1: Leakage current on the electric channel from the earth-leakage current breaker to the input terminals of the servo amplifier

☞ Page 95 Example of leakage current (Ig1, Ig2) per km of CV cable run in metal conduit

Ig2: Leakage current on the electric channel from the output terminals of the servo amplifier to the servo motor

☞ Page 95 Example of leakage current (Ig1, Ig2) per km of CV cable run in metal conduit

Ign: Leakage current when a filter is connected to the input side (4.4 mA per FR-BIF(-H))

Iga: Servo amplifier leakage current

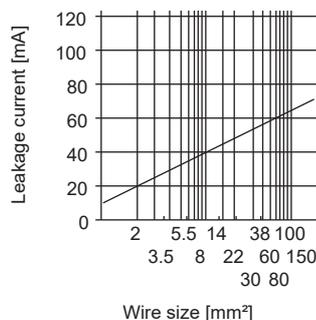
☞ Page 96 Servo amplifier leakage current example (Iga)

Igm: Servo motor leakage current

☞ Page 96 Servo motor leakage current example (Igm)

Example of leakage current (Ig1, Ig2) per km of CV cable run in metal conduit

• 200 V class



Servo motor leakage current example (Igm)

Servo motor output [kW]	Leakage current [mA]
0.1 to 1	0.1
1.5 to 2	0.2
3	0.3

Servo amplifier leakage current example (Iga)

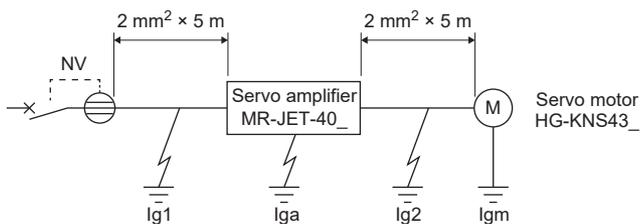
Servo amplifier	Leakage current [mA]
MR-JET-10_ MR-JET-20_ MR-JET-40_	0.1
MR-JET-70_ MR-JET-100_ MR-JET-200_ MR-JET-300_	0.15

Earth-leakage current breaker selection example

Servo amplifier	Rated sensitivity current of earth-leakage current breaker [mA]
MR-JET-10_ to MR-JET-300_	15

Selection example

This section shows examples of selecting an earth-leakage current breaker under the following conditions.



Use an earth-leakage current breaker designed for suppressing harmonics/surges.

Find each term of formula (6.1) from the diagram.

$$I_{g1} = 20 \cdot \frac{5}{1000} = 0.1 \text{ [mA]}$$

$$I_{g2} = 20 \cdot \frac{5}{1000} = 0.1 \text{ [mA]}$$

$I_{gn} = 0$ (not used)

$I_{ga} = 0.1 \text{ [mA]}$

$I_{gm} = 0.1 \text{ [mA]}$

Insert these values in formula (6.1).

$$I_g \geq 10 \cdot \{0.1 + 0 + 0.1 + 1 \cdot (0.1 + 0.1)\}$$

$$I_g \geq 4 \text{ [mA]}$$

According to the result of calculation, use an earth-leakage current breaker having the rated sensitivity current (I_g) of 4.0 mA or more.

Use an earth-leakage current breaker having I_g of 15 mA for the NV-SP/SW/CP/CW/HW.

6.12 EMC filter (recommended)



When connecting multiple servo amplifiers to one EMC filter, refer to "EMC Installation Guidelines".

It is recommended that one of the following filters be used to comply with EN EMC directive. Some EMC filters have a large leakage current.

Application environment	Total length of servo motor power cable	EMC filter					
		Model	Rated current [A]	Rated voltage [VAC]	Operating temperature [°C]	Mass [kg]	Manufacturer
IEC/EN 61800-3 Category C2, C3 *1	50 m or less	FSB-10-254-HU	10	250	-40 to 85	1.8	COSEL Co., Ltd.
		FSB-20-254-HU	20				
		FSB-30-254-HU	30				
IEC/EN 61800-3 Category C3 *1	50 m or less *2	HF3010C-SZB	10	500	-20 to 50	0.9	Soshin Electric Co., Ltd.
		HF3020C-SZB	20			1.3	
		HF3030C-SZB	30				

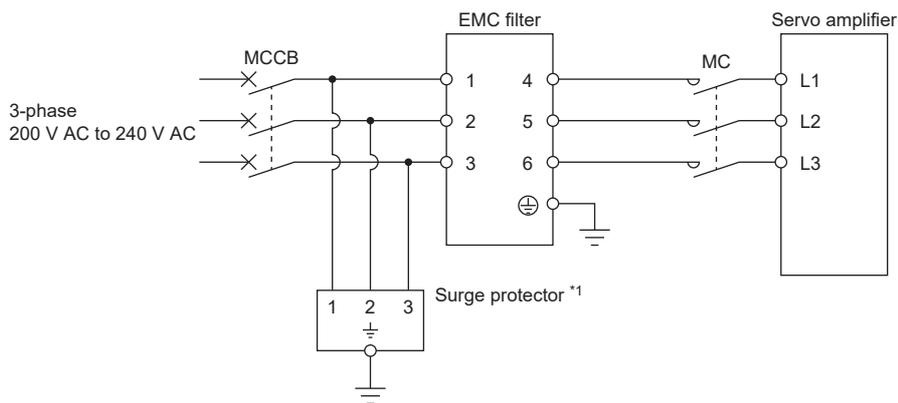
*1 Category C2: intended for use in the first environment (residential environment) only when installed by professional personnel or for use in the second environment (commercial, light industry and industrial environments)

Category C3: intended for use in the second environment (commercial, light industry and industrial environments)

*2 Install the radio noise filter (FR-BIF) on the input power lines of the servo amplifier if the power cable length is over 20 m.

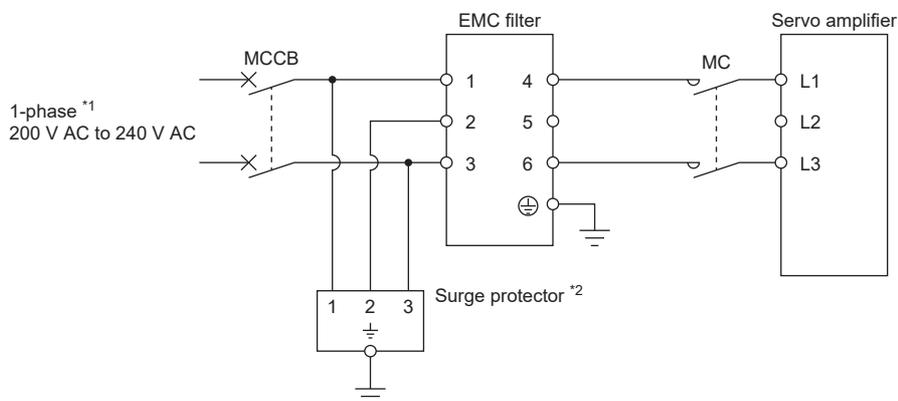
Connection example

■ For 3-phase 200 V AC to 240 V AC power supply



*1 When a surge protector is used.

■ For 1-phase 200 V AC to 240 V AC power supply



*1 Connect the power supply to L1 and L3. Leave L2 open.

*2 When a surge protector is used.

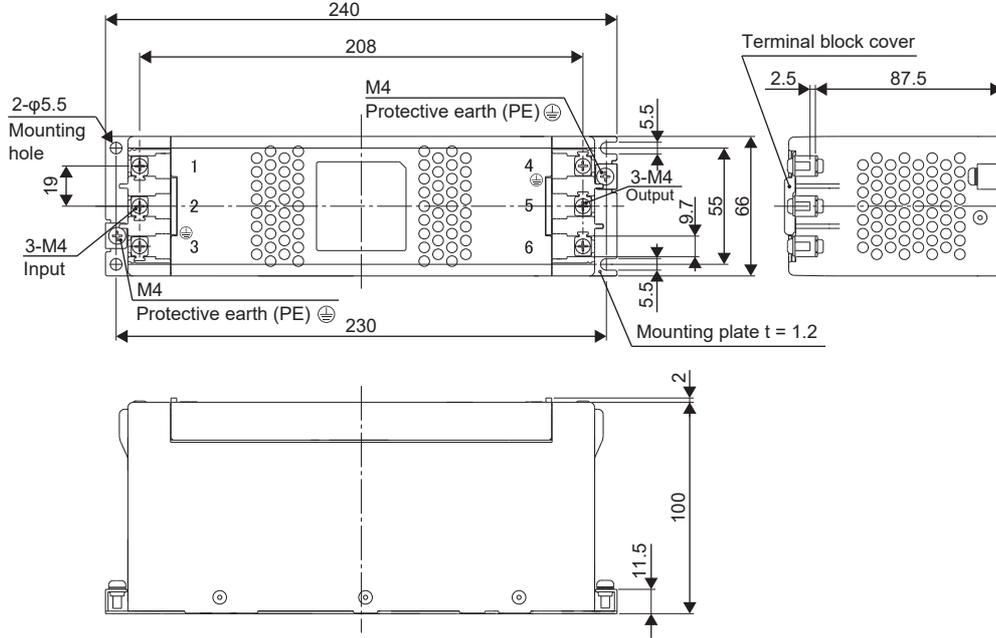
Dimensions

■ EMC filter

For dimensions including tolerances, contact the manufacturer.

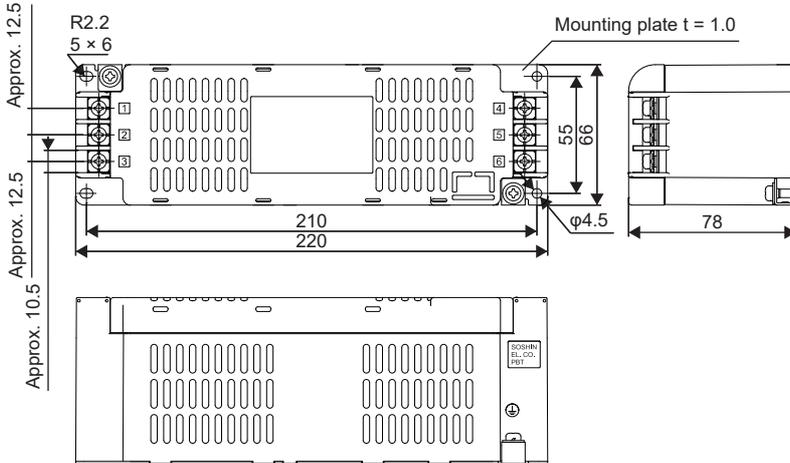
- FSB-10-254-HU/FSB-20-254-HU/FSB-30-254-HU

[Unit: mm]



- HF3010C-SZB/HF3020C-SZB/HF3030C-SZB

[Unit: mm]



■ Surge protector (recommended)

Point

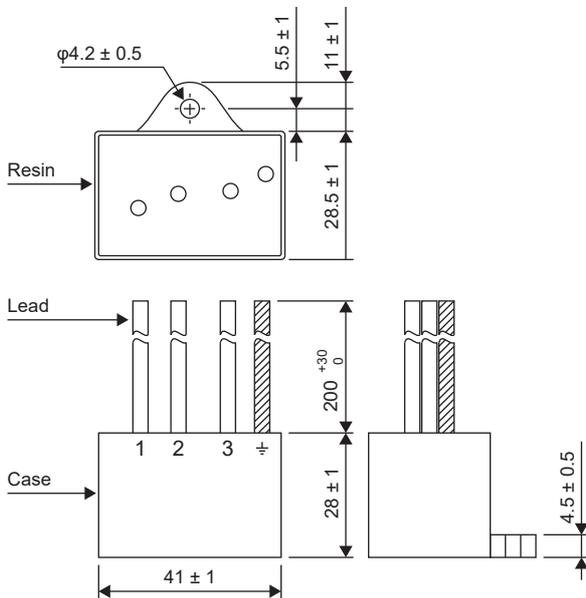
To use an EMC filter, a surge protector is required.

To prevent damage due to surges (such as lightning and sparks) applied to the AC power supply lines, connect the following surge protectors to the power supply (L1/L2/L3).

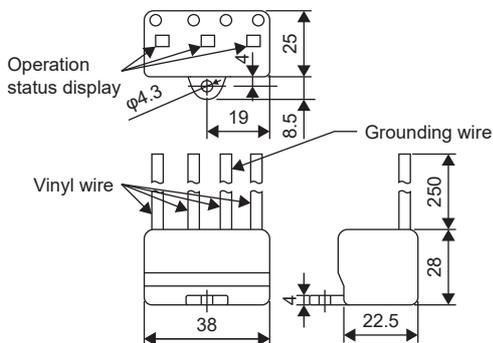
Surge protector model	Maximum continuous operating voltage 50/60 Hz	DC operating start voltage	Voltage protection level	Nominal discharge current 8/20 μ s	Maximum discharge current 8/20 μ s	Impulse current life 8/20 μ s - 1000 A	Manufacturer
RSPD-250-U4	3-phase 250 V AC	700 V \pm 25 %	1300 V	2500 A	5000 A	About 300 times	Okaya Electric Industries Co., Ltd.
LT-CS32G801WS	3-phase 275 V AC	660 V \pm 10 %	1400 V	5000 A	8000 A	About 1000 times	Soshin Electric Co., Ltd.

- RSPD series (Okaya Electric Industries)

[Unit: mm]



- LT-CS-WS series (Soshin Electric)



7 ABSOLUTE POSITION DETECTION SYSTEM

Precautions

- If [AL. 025 Absolute position erased] or [AL. 0E3 Absolute position counter warning] occurs, execute homing again.
- For the replacement procedure of the battery, refer to the following.

☞ Page 75 Battery

- Once the absolute position detection system has been setup, absolute position data will not be lost even if the connector connected to CN2 is removed.
- Replacing batteries will erase the absolute position data.
- If the absolute position data is erased, execute home position setting before operation.
- When the battery is used out of specification, the absolute position data may be erased.

7.1 Outline

Characteristics

The encoder consists of a circuit designed to detect a position within one revolution and the number of revolutions.

The absolute position detection system always detects and memorize the absolute position of the machine, regardless of whether the controller power is on/off. Therefore, once homing is performed at the time of machine installation, homing is not needed when power is switched on thereafter.

Even if a power failure or a malfunction occurs, the system can be easily restored.

Restrictions

The absolute position detection system cannot be configured in the following conditions.

- When an incremental type encoder is being used
- Stroke-less coordinate system for infinite positioning and the like in combination with a controller other than a Mitsubishi Electric motion module

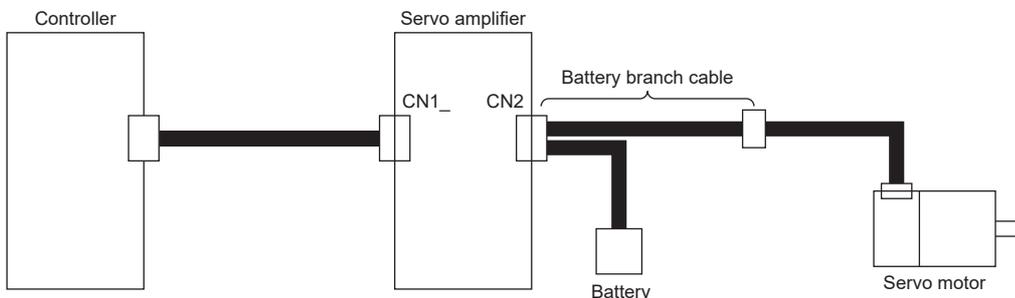
System architecture

The following shows the architecture of the absolute position detection system.

When connecting the battery backup type absolute position encoder

For battery connection, refer to the following.

☞ Page 75 Battery



Servo parameter setting

Set [Pr. PA03 Absolute position detection system] to "1" (enabled (absolute position detection system)).

Homing

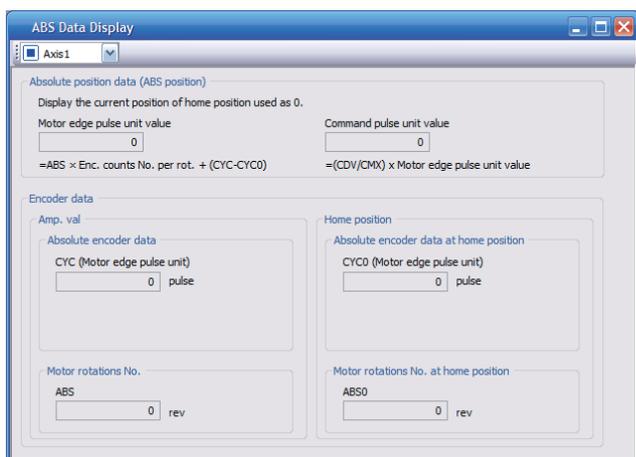
After the absolute position detection system is enabled, [AL. 025 Absolute position erased] occurs at the initial startup. Then, ABSV (Absolute position erased) turns on. Refer to "CONTROL MODE" in the following manual and perform homing.

MR-JET User's Manual (Function)

Checking the detected absolute position data

Absolute position data can be checked with MR Configurator2.

Choose "Monitor" and "ABS Data Display" to open the absolute position data display screen.



No.	Item		Screen operation
	MR Configurator2	System architecture *1	
(1)	Motor side pulse unit value	—	Acquires and displays values in the unit of the servo motor side pulses from the servo amplifier of the specified axis.
(2)	Command pulse unit value	Current position	Acquires and displays the command pulse unit value from the servo amplifier for the specified axis.
(3)	CYC	1X	Acquires and displays the position within one revolution in the unit of the servo motor side pulses from the servo amplifier of the specified axis.
(4)	ABS	LS	Acquires and displays the multi-revolution counter travel distance from the absolute home position from the servo amplifier of the specified axis.
(5)	CYC0	1XO	Acquires and displays the home position within one revolution in the unit of the servo motor side pulses from the servo amplifier of the specified axis.
(6)	ABS0	LSO	Acquires and displays the multi-revolution counter value of the absolute home position from the servo amplifier of the specified axis.

*1 Refer to the following for the system architecture.

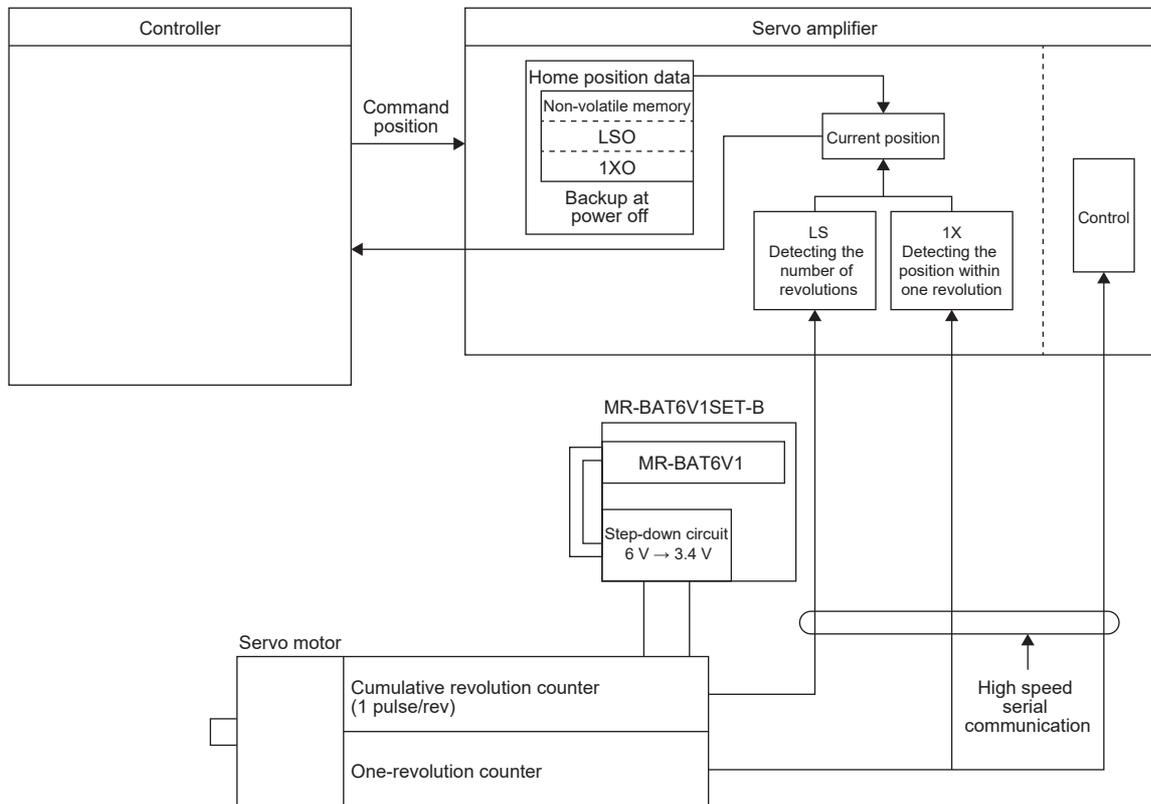
Page 103 Connecting the battery backup type absolute position encoder

7.2 Configuration and specifications

Connecting the battery backup type absolute position encoder

Refer to the following diagram when connecting the absolute position encoder.

System architecture



7

Specification list

Item	Description
System	Electronic, battery backup type
Maximum revolution range	Home position ± 32767 rev
Maximum speed at power failure [r/min] ^{*1}	6000 (only when the acceleration/deceleration time until 6000 r/min is 0.2 or longer)
Battery backup time ^{*2}	Approximately 20000 hours (when the equipment power is off, and the ambient temperature is 20 °C) Approximately 29000 hours (when the power-on ratio is 25 %, and the ambient temperature is 20 °C) ^{*3}

*1 Maximum speed available when the shaft is rotated by external force at the time of power failure. Note that if the power is turned on while the servo motor is being rotated by an external force at a speed of 3000 r/min or higher, a position mismatch may occur.

*2 The data-retention time with the MR-BAT6V1SET-B. Replace the batteries within three years since the operation start regardless of the power supply of the servo amplifier on/off. If the battery is used outside of specification range, [AL. 025 Absolute position erased] may occur.

*3 Power-on ratio of 25 % is the equivalent to power-on for 8 hours on weekdays and power-off on weekends.

8 USING A LINEAR SERVO MOTOR

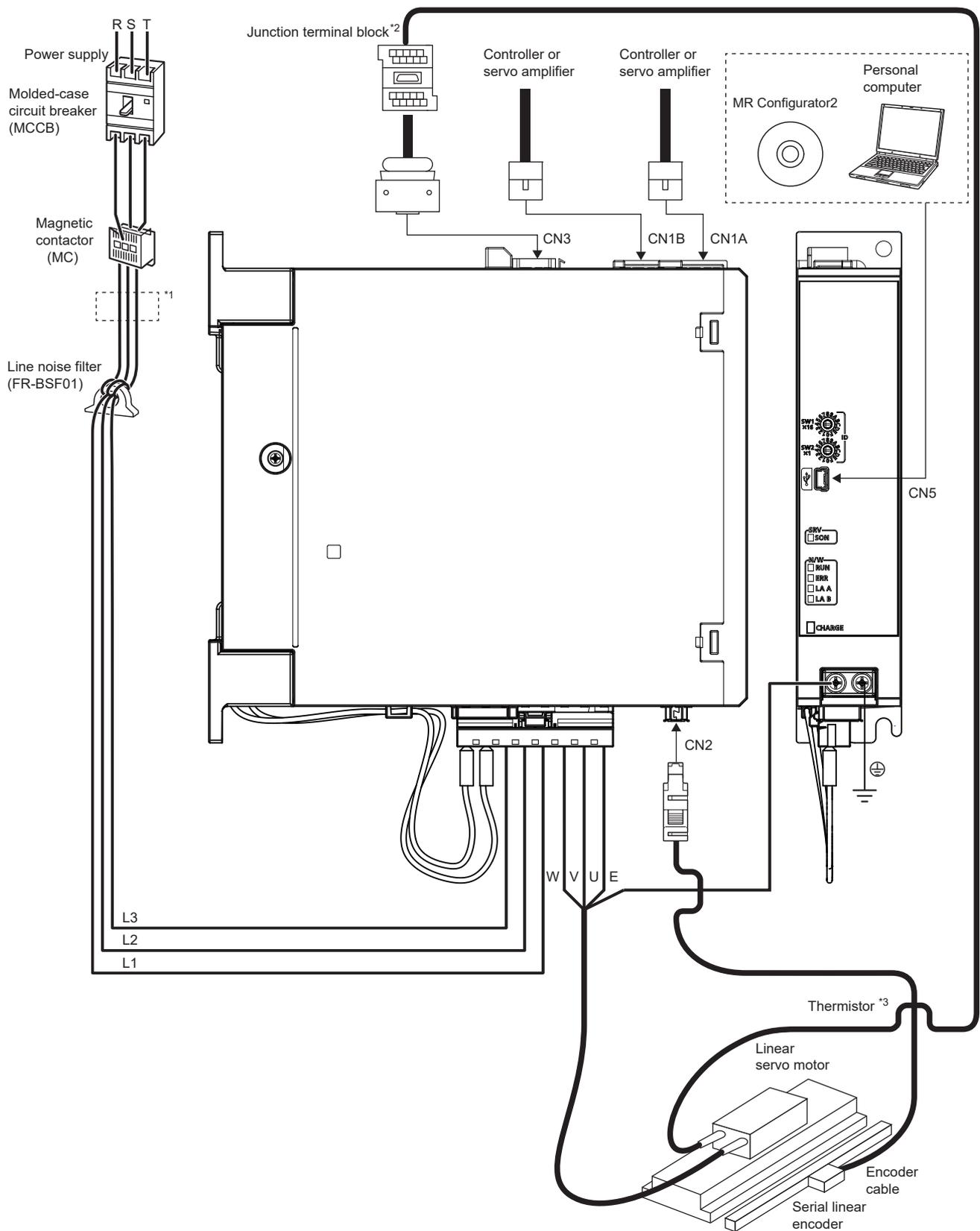
8.1 Functions and configuration

Outline

The following shows the differences between the linear servo motor and the rotary servo motor.

Category	Item	Differences		Remark	
		Linear servo motor	Rotary servo motor		
Servo motor magnetic pole alignment	Magnetic pole detection	Required	Not required (adjusted before shipping)	Automatically executed at the first servo-on after the power is turned on. For the absolute position linear encoder, [Pr. PL01] can disable the magnetic pole detection. The timing of magnetic pole detection can be changed with [Pr. PL01]. ☞ Page 113 Magnetic pole detection method setting	
Homing	Reference home position	1048576 pulses unit (initial value)	One servo motor revolution unit	Homing pitch can be changed with servo parameter setting. ☞ Page 113 Magnetic pole detection method setting	
Absolute position detection system	Absolute position encoder battery	Not required	Differs depending on the servo motor.	The following alarms and warnings are not detected. <ul style="list-style-type: none"> • [AL. 025 Absolute position erased] • [AL. 092 Battery cable disconnection warning] • [AL. 09F Battery warning] • [AL. 0E3 Absolute position counter warning] 	
Auto tuning	Load to motor inertia ratio (J)	Load to motor mass ratio	Load to motor inertia ratio	—	
MR Configurator2 (SW1DNC-MRC2- _)	Servo motor speed (Data display and setting)	mm/s unit	r/min unit	—	
	Test operation function	Positioning operation	○	○	—
		Motor-less operation	×	○	—
		JOG operation	×	○	—
Program operation		○	○	—	

Configuration including peripheral equipment



*1 The power factor improving AC reactor can also be used.

*2 Used when connecting a linear servo motor with built-in thermistor.

*3 The LM-AJ series do not have a thermistor. For wiring thermal protectors of the LM-AJ series, refer to "Servo motor power supply cable wiring diagrams" in the following manual.

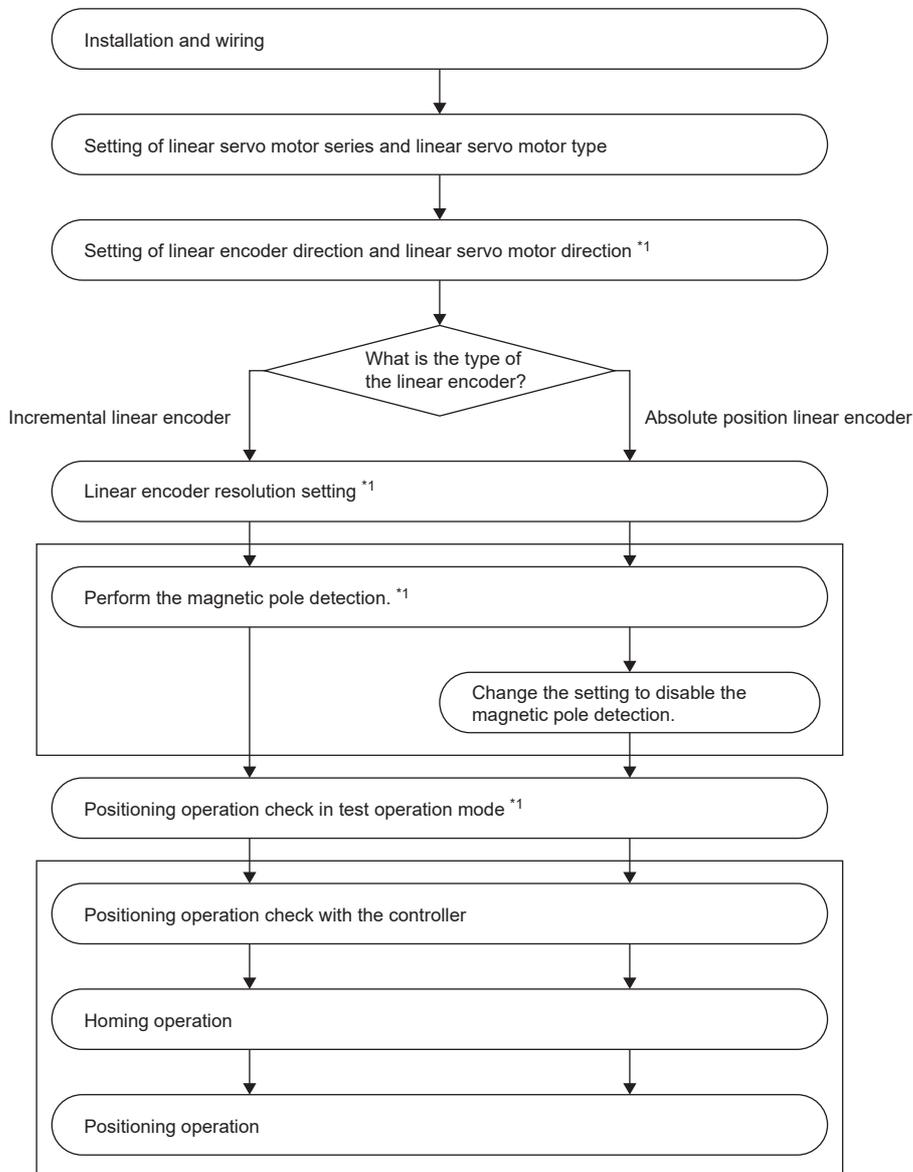
Linear Servo Motor User's Manual (LM-AJ series)

8.2 Startup

When using a linear servo motor, set [Pr. PA01.1 Operation mode selection] to "4" (Linear servo motor control mode).

Startup procedure

Start up the linear servo system with the following procedure.



*1 Use MR Configurator2.

Setting

Setting of linear servo motor series and linear servo motor type

Set the linear servo motor series and linear servo motor type with [Pr. PA17 Servo motor series setting] and [Pr. PA18 Servo motor type setting].

Setting of linear encoder direction and linear servo motor direction

Set [Pr. PC27.0 Encoder pulse count polarity selection] so that the positive direction of the linear servo motor matches the increasing direction of the linear encoder feedback.

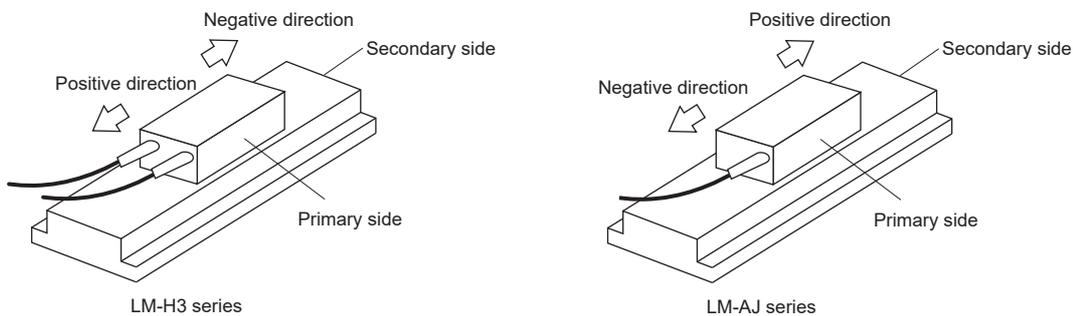
Servo parameter	Description
PC27.0	Encoder pulse count polarity selection 0: Encoder pulse increasing direction in the servo motor CCW or positive direction 1: Encoder pulse decreasing direction in the servo motor CCW or positive direction Initial value: 0 (encoder pulse increasing direction in the servo motor CCW or positive direction)

■ Servo parameter setting method

1. Confirm the positive direction of the linear servo motor. [Pr. PA14] determines the relation of the travel direction of the linear servo motor under commands. Refer to the following table.

Setting value of [Pr. PA14]	Travel direction of linear servo motor	
	Address increasing command	Address decreasing command
0	Positive direction	Negative direction
1	Negative direction	Positive direction

The positive and negative directions of the linear servo motor are as follows.



2. Check the increasing direction of the linear encoder.
3. If the positive direction of the linear servo motor matches the increasing direction of the linear encoder, set [Pr. PC27.0 Encoder pulse count polarity selection] to "0" (encoder pulse increasing direction in the servo motor CCW or positive direction). If the positive direction of the linear servo motor does not match the increasing direction of the linear encoder, set [Pr. PC27.0] to "1" (encoder pulse decreasing direction in the servo motor CCW or positive direction).

■Confirmation method

Confirm the positive direction of the linear servo motor and the increasing direction of the linear encoder in the following procedure.

1. In servo-off status, move the linear servo motor in the positive direction manually.
2. Confirm the servo motor speed (in the positive and negative directions) at that time with MR Configurator2.
3. The servo motor speed is a positive value when [Pr. PC27.0 Encoder pulse count polarity selection] is set to "0" (encoder pulse increasing direction in the servo motor CCW or positive direction), the positive direction of the linear servo motor matches the increasing direction of the linear encoder, and the linear servo motor is operated in the positive direction. If the positive direction of the linear servo motor does not match the increasing direction of the linear encoder, the servo motor speed will be a negative value. The servo motor speed is a negative value when [Pr. PC27.0 Encoder pulse count polarity selection] is set to "1" (encoder pulse decreasing direction in the servo motor CCW or positive direction), the positive direction of the linear servo motor matches the increasing direction of the linear encoder, and the linear servo motor is operated in the positive direction.

Linear encoder resolution setting

Set the ratio to the linear encoder resolution with [Pr. PL02 Linear encoder resolution setting - Numerator] and [Pr. PL03 Linear encoder resolution setting - Denominator].

Precautions

- The setting values of these servo parameters are enabled after the power is cycled or the software is reset.
- If incorrect values are set for [Pr. PL02] and [Pr. PL03], the linear servo motor may not operate properly, or [AL. 027] or [AL. 042] may occur in the positioning operation and the magnetic pole detection.

■ Servo parameter setting

Set the values that apply to the following equation.

$$\frac{[\text{Pr. PL02 Linear encoder resolution setting - Numerator}]}{[\text{Pr. PL03 Linear encoder resolution setting - Denominator}]} = \text{Linear encoder resolution } [\mu\text{m}]$$

■ Servo parameter setting example

- When the linear encoder resolution is 0.5 μm

$$\frac{[\text{Pr. PL02}]}{[\text{Pr. PL03}]} = \text{Linear encoder resolution} = 0.5 \mu\text{m} = \frac{1}{2}$$

The following shows the simplified chart for the setting values of [Pr. PL02] and [Pr. PL03].

—		Linear encoder resolution [μm]							
		0.01	0.02	0.05	0.1	0.2	0.5	1.0	2.0
Setting value	[Pr. PL02]	1	1	1	1	1	1	1	2
	[Pr. PL03]	100	50	20	10	5	2	1	1

Settings when connecting an A/B/Z-phase differential output linear encoder

When connecting an A/B/Z-phase differential output encoder, set [Pr. PC26.0 A/B/Z-phase input encoder connection setting selection] to "2". If an A/B/Z-phase input encoder is connected to the servo amplifier while [Pr. PC26.0] is set to "0", [AL. 016.3] will occur.

Settings when connecting the LM-AJ series

The LM-AJ series is not equipped with a thermistor that can be connected to a servo amplifier. It is equipped only with a thermal protector that can be connected to an external relay. For that reason, when driving the LM-AJ series, set [Pr. PD12.3 Servo motor thermistor - Enabled/disabled selection] to "1" to disable the thermistor. If this setting is not configured, [AL. 046.3 Thermistor disconnected error] will occur.

Magnetic pole detection

Outline of magnetic pole detection

Before the positioning operation of the linear servo motor, perform the magnetic pole detection. When [Pr. PL01.0] is set to the initial value, perform the magnetic pole detection only at the first servo-on after the power is turned on.

The magnetic pole detection includes the following two methods. Each method has advantages and disadvantages. Select a magnetic pole detection method suitable for the usage.

In the initial value, the position detection method is selected.

Magnetic pole detection	Advantage	Disadvantage
Position detection method	<ol style="list-style-type: none">1. The magnetic pole detection has a high degree of accuracy.2. The adjustment procedure at the magnetic pole detection is simple.	<ol style="list-style-type: none">1. The travel distance at the magnetic pole detection is long.2. For equipment with small friction, the initial magnetic pole detection error may occur.
Minute position detection method	<ol style="list-style-type: none">1. The travel distance at the magnetic pole detection is short.2. Even for equipment with small friction, the magnetic pole detection is available.	<ol style="list-style-type: none">1. The adjustment procedure at the magnetic pole detection is complex.2. If a disturbance occurs during the magnetic pole detection, [AL. 027 Initial magnetic pole detection error] may occur.

Precautions on magnetic pole detection

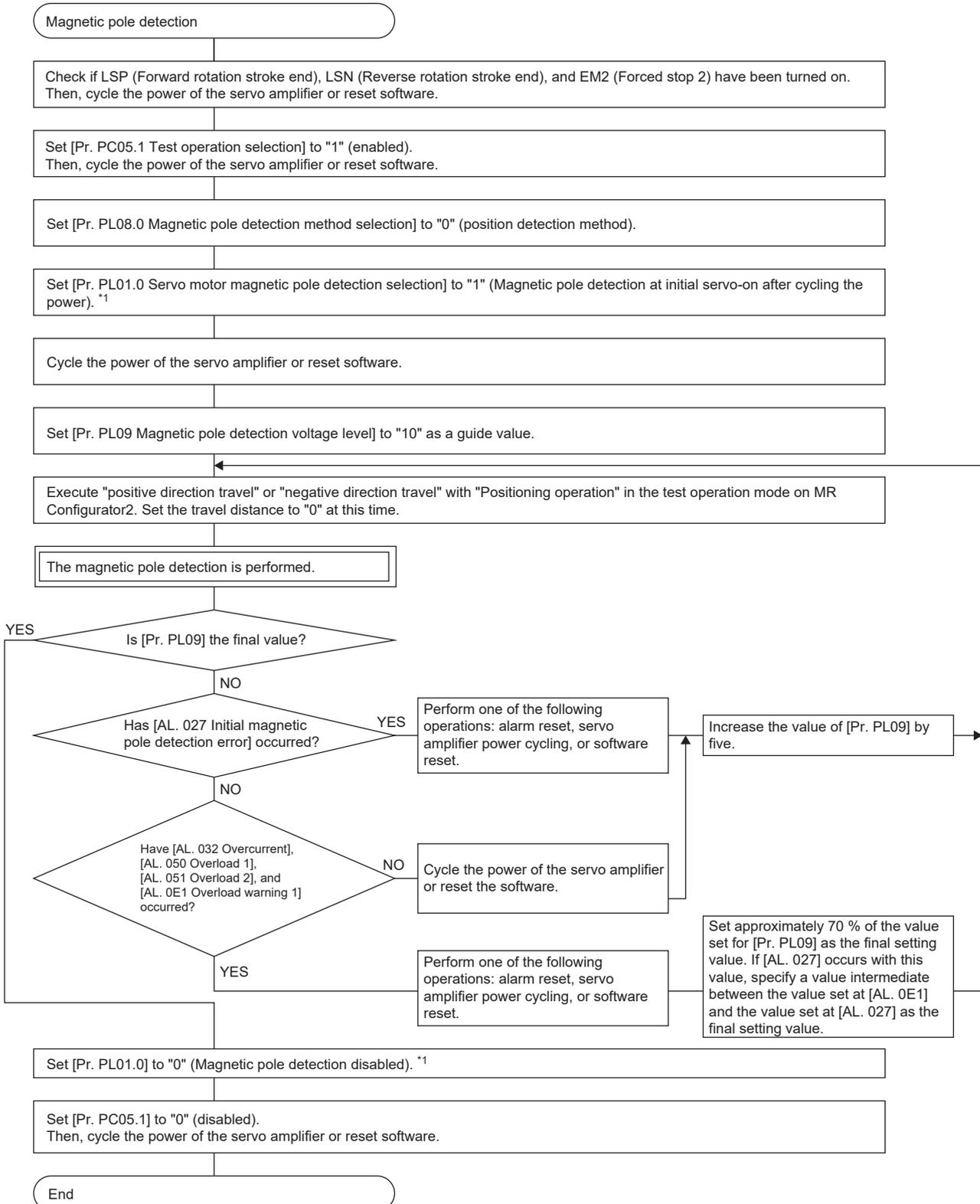
- For the magnetic pole detection, the linear servo motor automatically starts to move simultaneously with turning-on of the servo-on command.
- If the magnetic pole detection is not executed properly, the linear servo motor may operate unexpectedly.
- Establish the machine configuration to use LSP (Forward rotation stroke end) and LSN (Reverse rotation stroke end). The machine may be damaged due to a collision without LSP and LSN.
- Assign LSP and LSN, and perform the magnetic pole detection also in the torque mode.
- At the magnetic pole detection, whether the direct drive motor moves in the positive or negative direction is unpredictable.
- Depending on the setting value of [Pr. PL09 Magnetic pole detection voltage level], an overload, overcurrent, magnetic pole detection alarm, or others may occur.
- When performing the positioning operation from a controller, use the sequence which confirms the normal completion of the magnetic pole detection and the servo-on status, then outputs the positioning command. If the controller outputs the positioning command before RD (Ready) turns on, the command may not be accepted or an alarm may occur.
- If the linear encoder is installed incorrectly, an alarm may occur.
- If the linear encoder resolution setting ([Pr. PL02 Linear encoder resolution setting - Numerator] and [Pr. PL03 Linear encoder resolution setting - Denominator]) or the setting value of [Pr. PL09] is incorrect, an alarm may occur.
- For the machine whose friction becomes 30 % or more of the continuous thrust, the direct drive motor may not operate properly after the magnetic pole detection.
- For the horizontal shaft of the machine whose unbalanced thrust becomes 20 % or more of the continuous thrust, the direct drive motor may not operate properly after the magnetic pole detection.
- The magnetic pole detection may fail if performed simultaneously with multiple axes connected to each other (e.g. a tandem configuration). Perform the magnetic pole detection for each axis. At this time, set the axes for which the magnetic pole detection is not performed to servo-off.
- During the magnetic pole detection, the value of [Pr. PE47 Unbalanced torque offset] is regarded as "0".
- When detecting magnetic poles on the vertical axis, use a counterweight or the like to prevent the linear servo motor from moving with the force of gravity.

Magnetic pole detection procedure



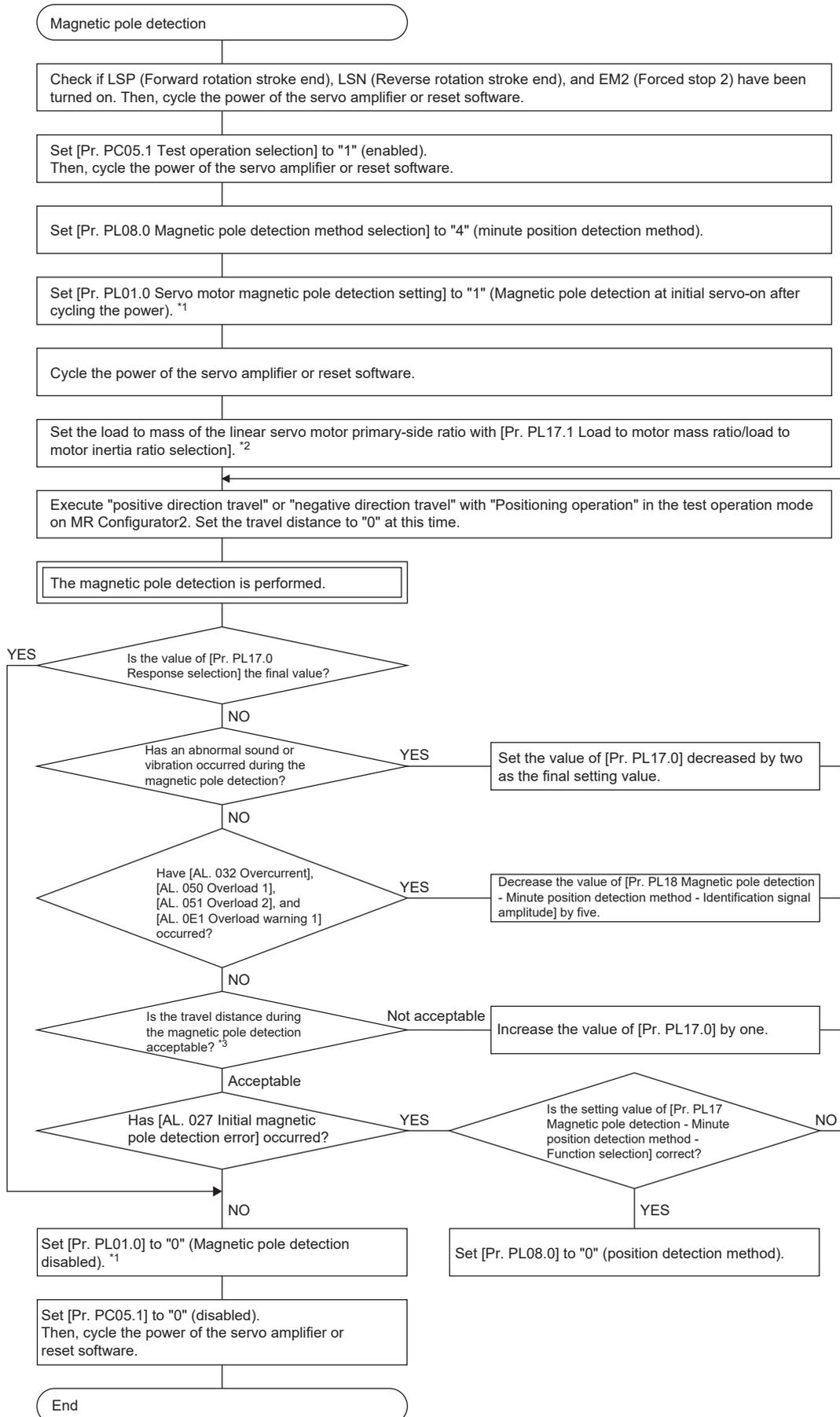
When using a controller manufactured by Mitsubishi Electric, the servo parameter setting values are overwritten from the controller. Once magnetic pole detection is complete, note down the changed servo parameter setting values, and set the same values in the controller.

■Magnetic pole detection by position detection method



*1 For the incremental system, the setting of [Pr. PL01] is not required.

■Magnetic pole detection by minute position detection method



- *1 For the incremental system, the setting of [Pr. PL01] is not required.
- *2 If the load to mass of the linear servo motor primary-side ratio is unknown, perform the magnetic pole detection by the position detection method, and then perform the auto tuning to set an estimated value.
- *3 For the magnetic pole detection by the minute position detection method, the maximum travel distance at the magnetic pole detection must be 0.5 mm or less. To shorten the travel distance, increase the value of [Pr. PL17.0].

Stroke limit disabled setting at magnetic pole detection

When performing a magnetic pole detection without LSP (Forward rotation stroke end) and LSN (Reverse rotation stroke end), set [Pr. PL08.2 Magnetic pole detection - Stroke limit enabled/disabled selection].

Servo parameter	Description
PL08.2	Magnetic pole detection - Stroke limit enabled/disabled selection 0: Enabled 1: Disabled Initial value: 0 (enabled)

Preparation for magnetic pole detection

For the magnetic pole detection, use the test operation mode (positioning operation) of MR Configurator2. Set [Pr. PC05.1 Test operation selection] to "1" to enable the test operation mode. Once the parameter has been set, cycle the power to enable the test operation mode.

Magnetic pole detection method setting

Set the magnetic pole detection method by using [Pr. PL08.0 Magnetic pole detection method selection]. In the following cases, set the magnetic pole detection method to the minute position detection method.

- When a shortened travel distance at the magnetic pole detection is required
- When the magnetic pole detection by the position detection method is not completed properly

Servo parameter	Description
PL08.0	Magnetic pole detection method selection 0: Position detection method 4: Minute position detection method Initial value: 0 (position detection method)

For an absolute position linear encoder, set [Pr. PL01.0 Servo motor magnetic pole detection selection] to "1" (magnetic pole detection at initial servo-on after cycling the power). After the completion of the magnetic pole detection, change [Pr. PL01.0] to "0" (magnetic pole detection disabled).

Servo parameter	Description
PL01.0	Servo motor magnetic pole detection selection 0: Magnetic pole detection disabled 1: Magnetic pole detection at initial servo-on after cycling the power 5: Magnetic pole detection at every servo-on Initial value: 1 (magnetic pole detection at initial servo-on after cycling the power)

Setting of magnetic pole detection voltage level by position detection method

For magnetic pole detection using the position detection method, set the voltage level with [Pr. PL09 Magnetic pole detection voltage level]. For the magnetic pole detection by the minute position detection method, the voltage level setting is not required.

■Guideline of servo parameter setting

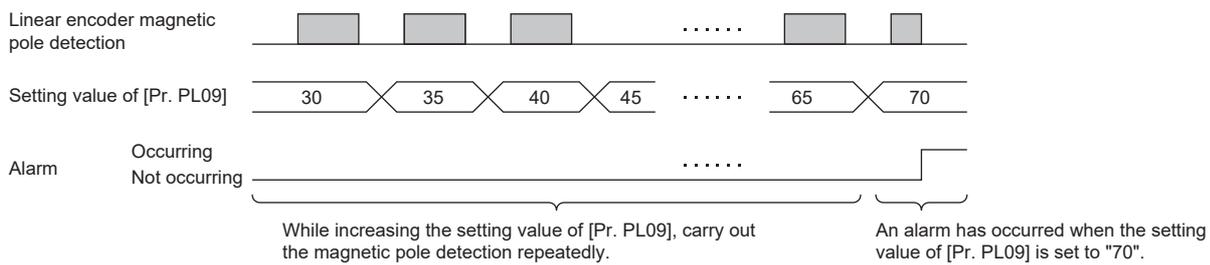
Set the parameters by referring to the following table.

Servo status	Small ← Medium → Large (10 or less (initial value) 50 or more)	
	Small	Large
Thrust at operation	Small	Large
Overload, overcurrent alarm	Hardly occurs	Easily occurs
Magnetic pole detection alarm	Easily occurs	Hardly occurs
Magnetic pole detection accuracy	Low	High

■Setting procedure

1. Detect the magnetic poles, then increase the setting value of [Pr. PL09 Magnetic pole detection voltage level] until [AL. 050 Overload 1], [AL. 051 Overload 2], [AL. 033 Overvoltage], [AL. 0E1 Overload warning 1], and [AL. 0EC Overload warning 2] occur. Increase the setting value by five as a guide value. When these alarms and warnings occur during the magnetic pole detection with MR Configurator2, the test operation of MR Configurator2 automatically completes and the servo-off state is established.
2. Set the value to approximately 70 % of the value which triggers [AL. 050], [AL. 051], [AL. 033], [AL. 0E1], and [AL. 0EC]. If [AL. 027 Initial magnetic pole detection error] occurs with this value, specify a value intermediate between the value set at occurrence of [AL. 050], [AL. 051], [AL. 033], [AL. 0E1], and [AL. 0EC] and the value set at the magnetic pole detection alarm occurrence as the final setting value.
3. Perform the magnetic pole detection again with the final setting value, and make sure that the accuracy of the magnetic pole detection is as required.

■Setting example



In this example, set the final setting value of [Pr. PL09 Magnetic pole detection voltage level] to 49 (setting value at the alarm occurrence = 70×0.7).

Setting of response performance and load to motor mass ratio by minute position detection method

When using the minute position detection method, set the response performance with [Pr. PL17.0 Response selection] and set the load to motor mass ratio with [Pr. PL17.1 Load to motor mass ratio/load to motor inertia ratio selection]. If the load to mass of the linear servo motor primary-side ratio is unknown, perform the magnetic pole detection by the position detection method, and then perform the auto tuning to set an estimated value.

- [Pr. PL17.0 Response selection]

Setting value	Responsiveness
0	<div style="text-align: center;"> <p>Low response</p> <p>↑</p> <p>↓</p> <p>Middle response</p> <p>↑</p> <p>↓</p> <p>High response</p> </div>
1	
2	
3	
4	
5	
6	
7	
8	
9	
A	
B	
C	
D	
E	
F	

Initial value: 0

- [Pr. PL17.1 Load to motor mass ratio/load to motor inertia ratio selection]

Setting value	Load to motor mass ratio/load to motor inertia ratio
0	10 times or less
1	10 multiplier
2	20 multiplier
3	30 multiplier
4	40 multiplier
5	50 multiplier
6	60 multiplier
7	70 multiplier
8	80 multiplier
9	90 multiplier
A	100 multiplier
B	110 multiplier
C	120 multiplier
D	130 multiplier
E	140 multiplier
F	150 times or more

Initial value: 0

Setting of identification signal amplitude by minute position detection method

If [AL. 032 Overcurrent], [AL. 050 Overload 1], [AL. 051 Overload 2], or [AL. 0E1 Overload warning 1] occurs at the magnetic pole detection by the minute position detection method, set a smaller value for [Pr. PL18 Magnetic pole detection - Minute position detection method - Identification signal amplitude]. Basically, [Pr. PL18] does not need to be changed from the initial value.

Operation at magnetic pole detection

Precautions

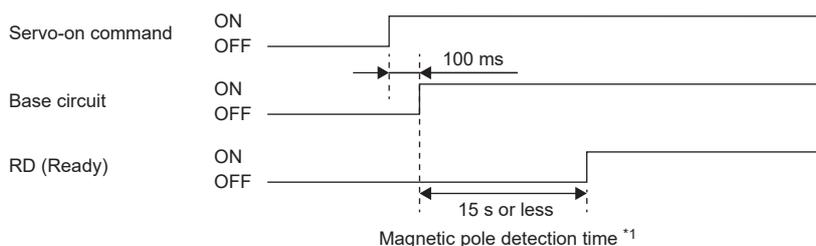
- After the magnetic pole detection, check the positioning accuracy with the test operation (positioning operation function) of MR Configurator2.
- When the absolute position linear encoder is used, if a gap is generated to the positional relation between the linear encoder and the linear servo motor, perform the magnetic pole detection again.
- The magnetic pole detection improves in accuracy when performed with no load.

■For incremental encoder

For the incremental linear encoder, the magnetic pole detection is required every time the power is turned on or the software is reset.

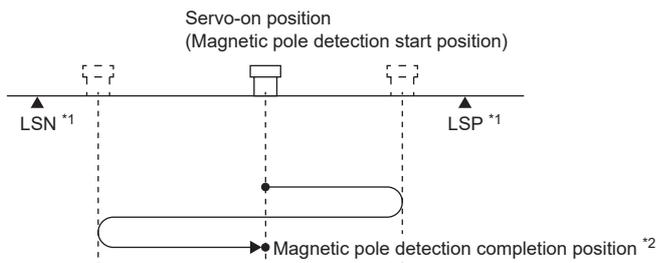
By turning on the servo-on command from the controller after the power-on, the magnetic pole detection is automatically carried out. Therefore, there is no need to set [Pr. PL01.0 Servo motor magnetic pole detection selection] for executing magnetic pole detection.

- Timing chart



*1 The magnetic pole detection time indicates the operation time when LSP (Forward rotation stroke end) and LSN (Reverse rotation stroke end) are on.

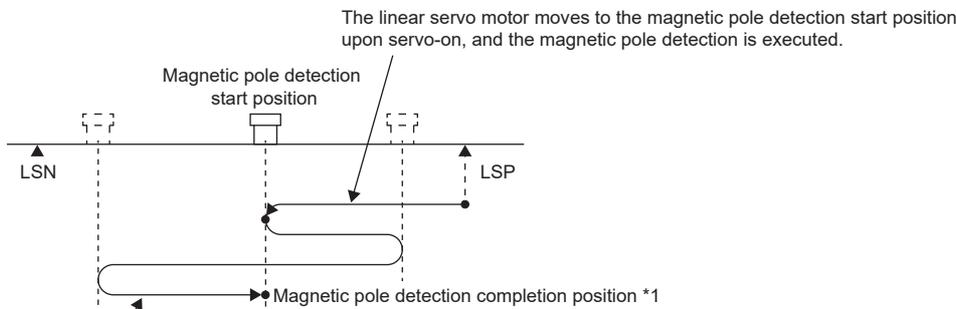
- Linear servo motor movement (when LSP (Forward rotation stroke end) and LSN (Reverse rotation stroke end) are on)



- *1 When LSP (Forward rotation stroke end) or LSN (Reverse rotation stroke end) is turned off during the magnetic pole detection, the operation of the magnetic pole detection is carried on to the opposite direction. When both LSP and LSN are off, [AL. 027 Initial magnetic pole detection error] occurs.
- *2 The following shows the pitch against the magnetic pole.

Linear servo motor series	LM-H3	LM-AJ
Pitch against magnetic pole [mm]	48	20

- Linear servo motor movement (when LSP (Forward rotation stroke end) or LSN (Reverse rotation stroke end) is off)
- When LSP or LSN is off at servo-on, the magnetic pole detection is performed as follows.



The linear servo motor reciprocates several times and returns to the magnetic pole detection start position to complete the magnetic pole detection, and then changes into the servo-lock status. At this time, there may be a gap, approximately a quarter of the pitch against magnetic pole, from the start position.

- *1 The following shows the pitch against the magnetic pole.

Linear servo motor series	LM-H3	LM-AJ
Pitch against magnetic pole [mm]	48	20

■ For absolute position linear encoder

The magnetic pole detection is required in the following cases.

- When the system is set up (at initial startup of equipment)
- After a servo amplifier is replaced
- After a linear servo motor (primary-side or secondary-side) is replaced
- After a linear encoder (scale or head) is replaced or remounted

If a gap is generated to the positional relation between the linear encoder and the linear servo motor, perform the magnetic pole detection again.

1. Execute the magnetic pole detection.

☞ Page 115 For incremental encoder

2. After the completion of the magnetic pole detection, change [Pr. PL01.0 Servo motor magnetic pole detection selection] to "0" (magnetic pole detection disabled).

Servo parameter	Description
PL01.0	Servo motor magnetic pole detection selection 0: Magnetic pole detection disabled 1: Magnetic pole detection at initial servo-on after cycling the power 5: Magnetic pole detection at every servo-on Initial value: 1 (magnetic pole detection at initial servo-on after cycling the power)

When [Pr. PL01.0 Servo motor magnetic pole detection selection] is set to "0" (magnetic pole detection disabled) after the magnetic pole detection, the magnetic pole detection after each power-on is not required.

How to replace servo amplifier without magnetic pole detection

When replacing the servo amplifier, carry out the magnetic pole detection again. If the magnetic pole detection cannot be performed, write the magnetic pole information from the servo amplifier before replacement to the one after replacement by using MR Configurator2.

Procedure

1. Read the magnetic pole information of the servo amplifier before replacement.
2. Write the read magnetic pole information to the servo amplifier after replacement.
3. To ensure safety, perform the test operation with the torque limited and confirm that the servo motor can be operated safely.

Migration method of the magnetic pole information

■How to read magnetic pole information from servo amplifier before replacement

1. Open the project in MR Configurator2 and select the model.
2. Check that the personal computer is connected with the servo amplifier, and select "Diagnosis" and then "Linear diagnosis".
3. Click "Magnetic Pole Information" to open the magnetic pole information window.
4. Click "Read" in the magnetic pole information window.
5. Note down the values shown in data 1 of the magnetic pole information window.

■How to write magnetic pole information to servo amplifier after replacement

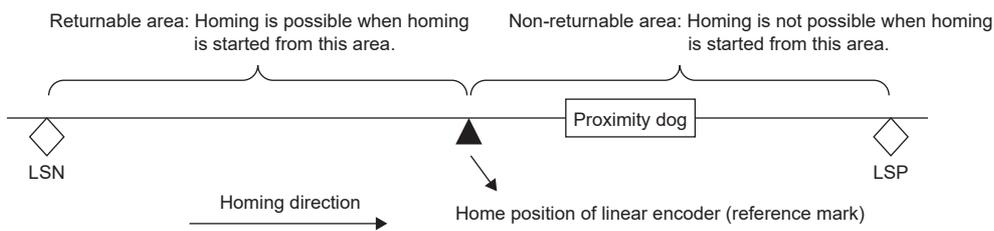
1. Open the project in MR Configurator2 and select the model.
2. Check that the personal computer is connected with the servo amplifier, and select "Diagnosis" and then "Linear diagnosis".
3. Click "Magnetic Pole Information" to open the magnetic pole information window.
4. To data 1 of the magnetic pole information window, input the values of the magnetic pole information which were noted down.
5. Click "Write" in the magnetic pole information window.
6. Cycle the power of the servo amplifier.

8.3 Basic functions

Homing

Precautions

- The incremental linear encoder and the absolute position linear encoder have different reference home positions at homing.
- For the incremental linear encoder, a home position (reference mark) of the linear encoder is necessary in the homing direction.
- To execute homing securely in the following example, move the linear servo motor to LSN with an operation such as the JOG operation, then start homing.



Homing setting method

■ Incremental linear encoder

- Interval setting of homing

When an incremental linear encoder is used, the home position is the position per 1048576 pulses (changeable with [Pr. PL01.2 Homing stop interval setting]) with reference to the linear encoder home position (reference mark) that passed through first after a homing start. Change the setting value of [Pr. PL01] according to the linear encoder resolution.

Servo parameter	Description
PL01.2	Homing stop interval setting 0: 2^{13} (= 8192) pulses 1: 2^{17} (= 131072) pulses 2: 2^{18} (= 262144) pulses 3: 2^{20} (= 1048576) pulses 4: 2^{22} (= 4194304) pulses 5: 2^{24} (= 16777216) pulses 6: 2^{26} (= 67108864) pulses 7: 2^{30} (= 1073741824) pulses Initial value: 3 (2^{20} (= 1048576) pulses)

The following shows the relation between the stop interval at the homing and the linear encoder resolution. For example, when the linear encoder resolution is 0.001 μm and [Pr. PL01.2 Homing stop interval setting] = "5" (16777216 pulses), the linear encoder resolution is 16.777 mm.

[Unit: mm]

Pr. PL01.2	Stop interval [pulse]	Linear encoder resolution				
		0.001 μm	0.005 μm	0.01 μm	0.02 μm	0.05 μm
0	8192	0.008	0.041	0.082	0.164	0.410
1	131072	0.131	0.655	1.311	2.621	6.554
2	262144	0.262	1.311	2.621	5.243	13.107 (Recommended value)
3	1048576	1.049	5.243	10.486 (Recommended value)	20.972 (Recommended value)	52.429
4	4194304	4.194	20.972 (Recommended value)	41.943	83.886	209.715
5	16777216	16.777 (Recommended value)	83.886	167.772	335.544	838.861
6	67108864	67.109	335.544	671.089	1342.177	3355.443
7	1073741824	1073.742	5368.700	10737.418	21474.836	53687.091

Pr. PL01.2	Stop interval [pulse]	Linear encoder resolution				
		0.1 μm	0.2 μm	0.5 μm	1 μm	2 μm
0	8192	0.819	1.638	4.096 (Recommended value)	8.192 (Recommended value)	16.384 (Recommended value)
1	131072	13.107 (Recommended value)	26.214 (Recommended value)	65.536	131.072	262.144
2	262144	26.214	52.429	131.072	262.144	524.288
3	1048576	104.858	209.715	524.288	1048.576	2097.152
4	4194304	419.430	838.861	2097.152	4194.304	8388.608
5	16777216	1677.722	3355.443	8388.608	16777.216	33554.432
6	67108864	6710.886	13421.773	33554.432	67108.864	134217.728
7	1073741824	107374.182	214748.364	536870.912	1073741.824	2147483.648

- Multipoint Z-phase input - Function selection

When two or more reference marks exist during the full stroke of the linear encoder, set "1" (enabled) in [Pr. PC17.1 Linear encoder multipoint Z-phase input function selection].

■Absolute position linear encoder

The reference home position using an absolute position linear encoder is per 1048576 pulses based on the linear encoder home position (absolute position data = 0). The stop intervals at homing can be changed with [Pr. PL01.2 Homing stop interval setting]. For the specifications of the stop intervals at homing, refer to the following.

☞ Page 119 Incremental linear encoder

The specifications are the same as the ones when an incremental encoder is used.

Homing operation

Precautions

- To execute homing securely, move the linear servo motor to the opposite stroke end with the JOG operation from the controller or by other means, then start homing.
- Change the setting value of [Pr. PL01.2 Homing stop interval setting] in accordance with the linear encoder resolution.

■Incremental linear encoder

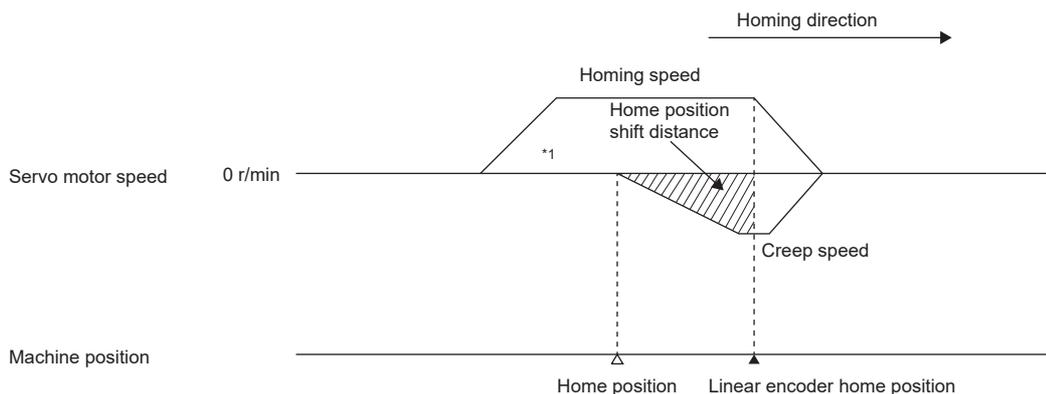
- When the linear encoder home position (reference mark) exists in the homing direction

The position obtained by moving the home position shift distance from the linear encoder home position (reference mark) is set as the home position.

Ex.

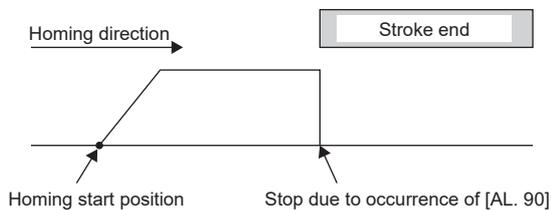
Homing methods 33 and 34

The following figure shows the operation of Homing method 34. The operation of Homing method 33 is opposite to that of Homing method 34.



*1 Home position shift distance can be changed with [Pr. PT07 Home position shift distance].

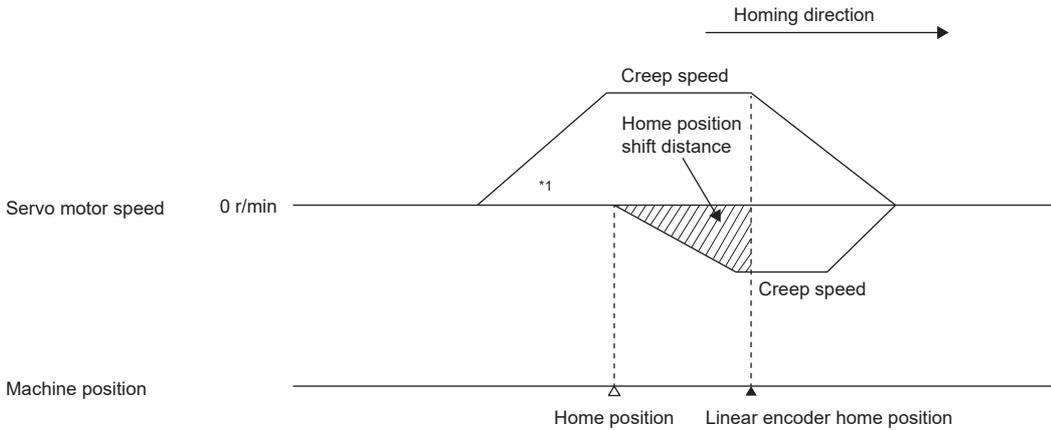
When the stroke end is detected



Ex.

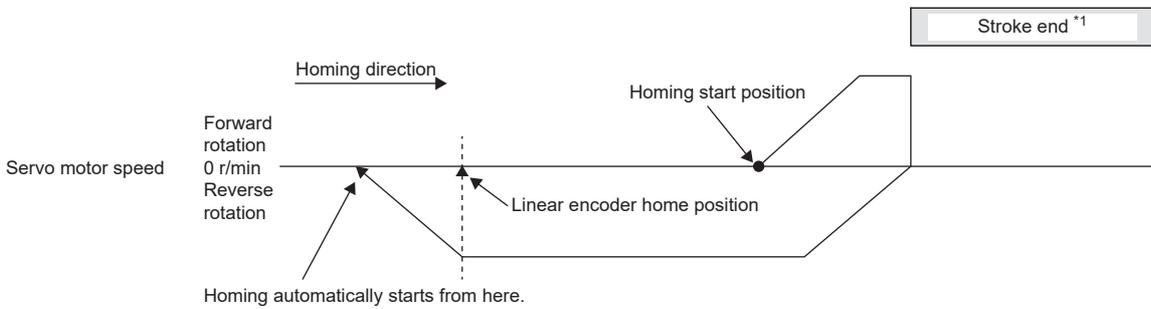
Homing methods -11 and -43

The following figure shows the operation of Homing method -11. The operation of Homing method -43 is opposite to that of Homing method -11.



*1 Home position shift distance can be changed with [Pr. PT07 Home position shift distance].

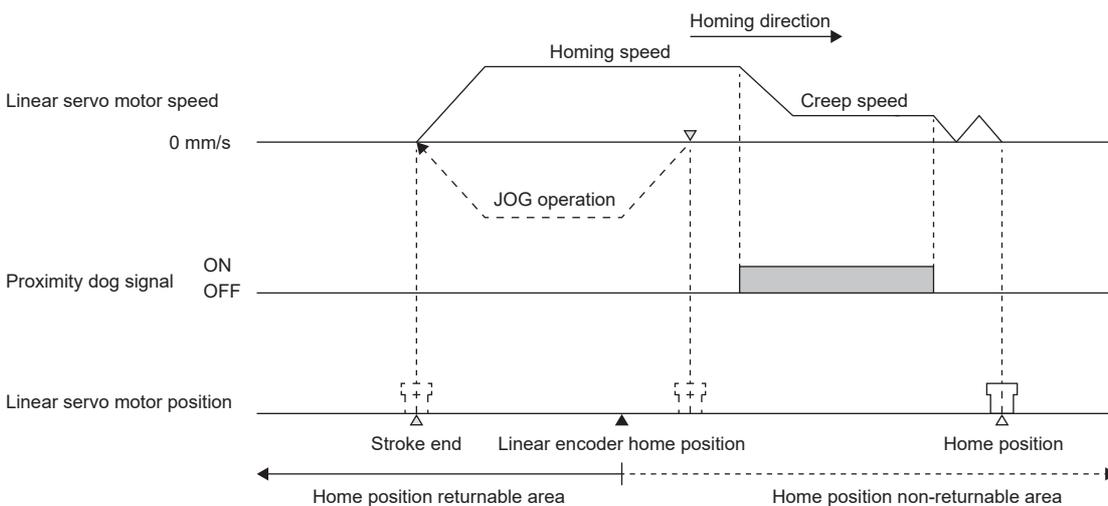
When the servo motor returns at the stroke end



*1 This cannot be used with the software limit.

- When the linear encoder home position does not exist in the homing direction

If the homing is performed from the position where the linear encoder home position does not exist in the homing direction, an error may occur. If an error occurs, change the homing method or move the linear servo motor to the stroke end on the opposite side of the homing direction with operations such as the JOG operation from the controller, then start homing.

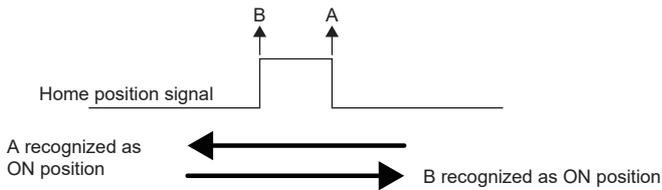


- Caution for passing the home position (reference mark)

An interval for turning on home position (reference mark) signal of the linear encoder has a certain width. (Specifications differ depending on the linear encoder.)

MR-JET Partner's Encoder User's Manual

Example: When the Z-phase is recognized at startup



The position where LZ (Encoder Z-phase pulse) is turned on depends on the direction of home position passing. In cases where each homing is required to be completed at the same position, such as dog type homing, start homing with the same direction.

- Point to note for linear encoder without home position (reference mark)

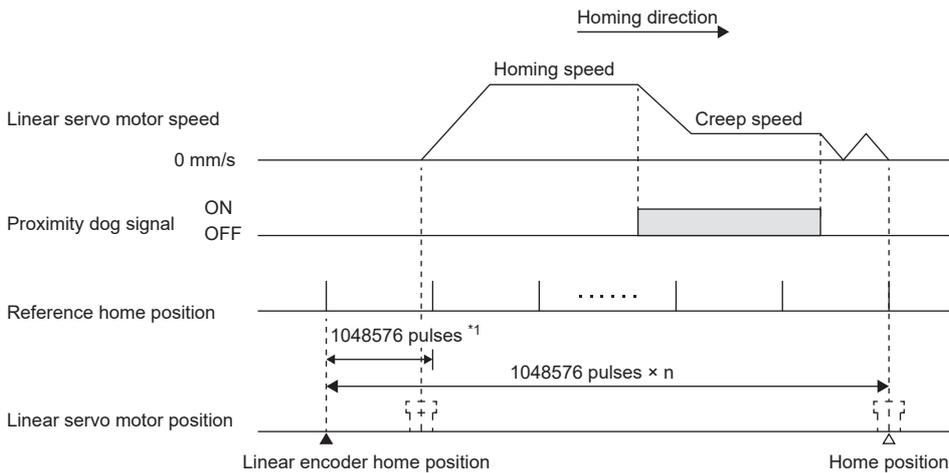
For the linear encoder without home position (reference mark), LZ (Encoder Z-phase pulse) of the servo amplifier is not outputted. Check the specifications of the controller for whether LZ (Encoder Z-phase pulse) is necessary or not for homing.

■ Absolute position linear encoder

When using an absolute position linear encoder, the data set type homing can also be carried out.

- For proximity dog type homing

For a proximity dog type homing, the nearest reference home position after proximity dog off is the home position. The linear encoder home position can be set in any position. LZ (Encoder Z-phase pulse) is outputted based on the set value of [Pr. PL01.2 Homing stop interval setting].



*1 This can be changed with [Pr. PL01].

Linear servo control error detection function

If the linear servo control becomes unstable for some reason, the linear servo motor may not operate properly. To detect this state and to stop operation, the linear servo control error detection function is used as a protective function.

The linear servo control error detection function has three types of detection methods: the position deviation, speed deviation, and thrust deviation. An error is detected when each method is enabled with [Pr. PL04.0 [AL. 042 Servo control error] detection function selection]. The detection level can be changed with [Pr. PL05 Position deviation error detection level], [Pr. PL06 Speed deviation error detection level], and [Pr. PL07 Torque deviation error detection level].

Precautions

- For the linear servo control error detection function, the position and speed deviation error detections are enabled before shipping. ([Pr. PL04.0]: 3)

Linear servo control error detection selection function

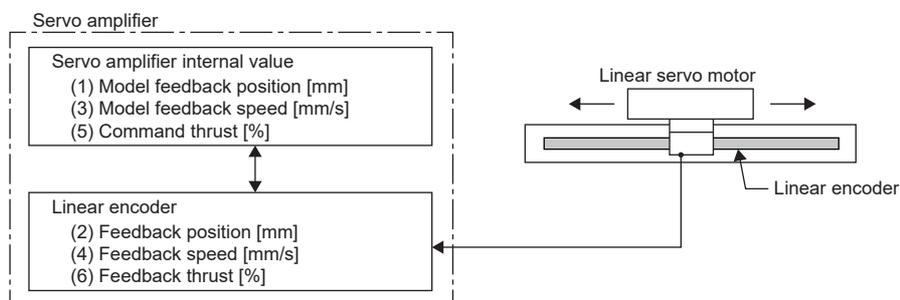
Select the linear servo control error detection function.

- [Pr. PL04.0 [AL. 042 Servo control error] detection function selection]

Refer to the following table.

Setting value	Position deviation error detection	Speed deviation error detection	Thrust deviation error detection
1	Enabled	Disabled	Disabled
2	Disabled	Enabled	Disabled
3	Enabled	Enabled	Disabled
4	Disabled	Disabled	Enabled
5	Enabled	Disabled	Enabled
6	Disabled	Enabled	Enabled
7	Enabled	Enabled	Enabled

Initial value: 3



Position deviation error detection

Set [Pr. PL04.0 [AL. 042 Servo control error] detection function selection] to "1" to enable the position deviation error detection.

Servo parameter	Description
PL04.0	[AL. 042 Servo control error] detection function selection 1: Position deviation error detection enabled

If the difference between the model feedback position (1) and the feedback position (2) in the figure is equal to or more than the value of [Pr. PL05 Position deviation error detection level] (1 mm to 1000 mm), [AL. 042.1 Servo control error based on position deviation] will occur and the linear servo motor will stop. The initial value of this detection level is 50 mm. Change the setting value as necessary.

■Speed deviation error detection

Set [Pr. PL04.0] to "2" to enable the speed deviation error detection.

Servo parameter	Description
PL04.0	[AL. 042 Servo control error] detection function selection 2: Speed deviation error detection enabled

If the difference between the model feedback speed (3) and the feedback speed (4) in the figure is equal to or more than the value of [Pr. PL06 Speed deviation error detection level] (1 mm/s to 5000 mm/s), [AL. 042.2 Servo control error based on speed deviation] will occur and the linear servo motor will stop. The initial value of this detection level is 1000 mm/s. Change the setting value as necessary.

■Thrust deviation error detection

Set [Pr. PL04.0] to "4" to enable the thrust deviation error detection.

Servo parameter	Description
PL04.0	[AL. 042 Servo control error] detection function selection 4: Thrust deviation error detection enabled

If the difference between the command thrust (5) and the feedback thrust (6) in the figure is equal to or more than the value of [Pr. PL07 Torque/thrust deviation error detection level] (1 % to 1000 %), [AL. 042.3 Servo control error based on torque/thrust deviation] will occur and the linear servo motor will stop. The initial value of this detection level is 100 %. Change the setting value as necessary.

■Detecting multiple deviation errors

When [Pr. PL04.0 [AL. 042 Servo control error] detection function selection] is set as follows, multiple deviation errors can be detected. Refer to the following for the error detection method.

☞ Page 123 Position deviation error detection

☞ Page 124 Speed deviation error detection

☞ Page 124 Thrust deviation error detection

- [Pr. PL04.0 [AL. 042 Servo control error] detection function selection]

Setting value	Position deviation error detection	Speed deviation error detection	Thrust deviation error detection
1	○	—	—
2	—	○	—
3	○	○	—
4	—	—	○
5	○	—	○
6	—	○	○
7	○	○	○

Initial value: 3

Linear servo control error controller reset condition selection

Select the reset condition of the linear servo control error.

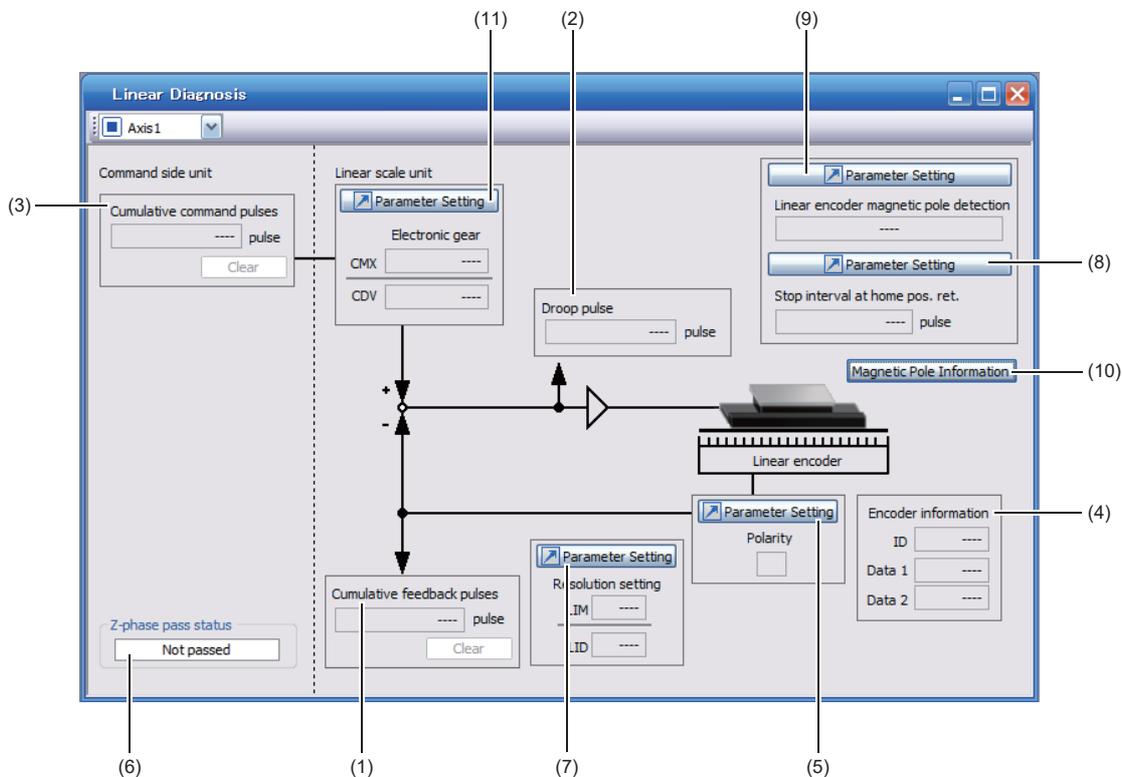
Servo parameter	Description
PL04.3	[AL. 042 Servo control error] detection controller reset condition selection 0: Reset disabled (reset by powering off/on or software reset enabled) 1: Reset enabled Initial value: 0 (reset disabled)

When [Pr. PL04.3 [AL. 042 Servo control error] detection controller reset condition selection] is set to "1" (reset enabled), [AL. 042.1 Servo control error based on position deviation], [AL. 042.2 Servo control error based on speed deviation], and [AL. 042.3 Servo control error based on torque/thrust deviation] can be canceled by resetting the controller. When [Pr. PL04.3] is "0" (reset disabled (reset by powering off/on or software reset enabled)), [AL. 042.1], [AL. 042.2], and [AL. 042.3] can be canceled only by cycling the servo amplifier power or resetting the software.

About MR Configurator2

With MR Configurator2, the servo parameters can be checked if set correctly, and the servo motor and the load-side encoder can be checked if operated properly.

This section explains the Linear Diagnosis screen.



Symbol	Name	Explanation	Unit
(1)	Cumulative feedback pulses	Feedback pulses from the linear encoder are counted and displayed. The displayed value returns to "0" when "99999999" is exceeded. Click "Clear" to reset the value to "0". In reverse rotation, the value is negative.	pulse
(2)	Droop pulse	Droop pulses of the deviation counter between a linear servo motor-side position and a command are displayed. In reverse rotation, the value is negative.	pulse
(3)	Cumulative command pulses	Position command input pulses are counted and displayed. Click "Clear" to reset the value to "0". Under reverse command, the value is negative.	pulse
(4)	Encoder information	The linear encoder information is displayed. The display contents differ depending on the linear encoder type. <ul style="list-style-type: none"> ID: The ID No. of the linear encoder is displayed. Data 1: For an incremental type linear encoder, the counter from powering on is displayed. For an absolute position type linear encoder, absolute position data is displayed. Data 2: For the incremental type linear encoder, the distance (number of pulses) from the reference mark (Z-phase) is displayed. For the absolute position type linear encoder, "00000000" is displayed. 	—
(5)	Polarity	For the address increasing direction in the linear servo motor positive direction, "+" is displayed, and for the address decreasing direction in the linear servo motor negative direction, "-" is displayed.	—
(6)	Z-phase pass status	The Z-phase pass status of the linear encoder is displayed.	—
(7)	Parameter Setting (Resolution setting)	The servo parameters for the resolution of the linear encoder ([Pr. PL02] and [Pr. PL03]) can be displayed and set. Page 109 Servo parameter setting	—
(8)	Parameter Setting (Homing stop interval)	The servo parameter for the homing can be displayed and set.	—
(9)	Parameter Setting (Linear encoder magnetic pole detection)	The servo parameter for the magnetic pole detection can be displayed and set.	—

Symbol	Name	Explanation	Unit
(10)	Magnetic Pole Information	The magnetic pole information can be displayed and set.	—
(11)	Parameter Setting (Electronic gear)	The servo parameters for the electronic gear ([Pr. PA06] and [Pr. PA07]) can be displayed and set.	—

8.4 Adjustment

Auto tuning function

Although the auto tuning function during the linear servo motor operation is the same as that of the rotary servo motor, the calculation method of the load to motor mass ratio (J ratio) is different. The load to motor mass ratio (J ratio) on the linear servo motor is calculated by dividing the load mass by the mass of the linear servo motor primary side.

Ex.

Mass of linear servo motor primary side = 2 kg

Load mass (excluding the mass of the linear servo motor primary side) = 4 kg

Mass ratio = $4/2 = 2$ times

For other servo parameters set with the auto tuning function, refer to "Auto tuning mode 1" and "Auto tuning mode 2" in the following manual.

 MR-JET User's Manual (Adjustment)

Precautions for the auto tuning function

If the following conditions are not satisfied, the auto tuning mode 1 may not operate properly.

- Time to reach 2000 mm/s is the acceleration/deceleration time constant of 5 s or less.
- The linear servo motor speed is 50 mm/s or higher.
- The load to mass of the linear servo motor primary-side ratio is 100 times or less.
- The acceleration/deceleration thrust is 10 % or higher of the continuous thrust.

Machine analyzer function

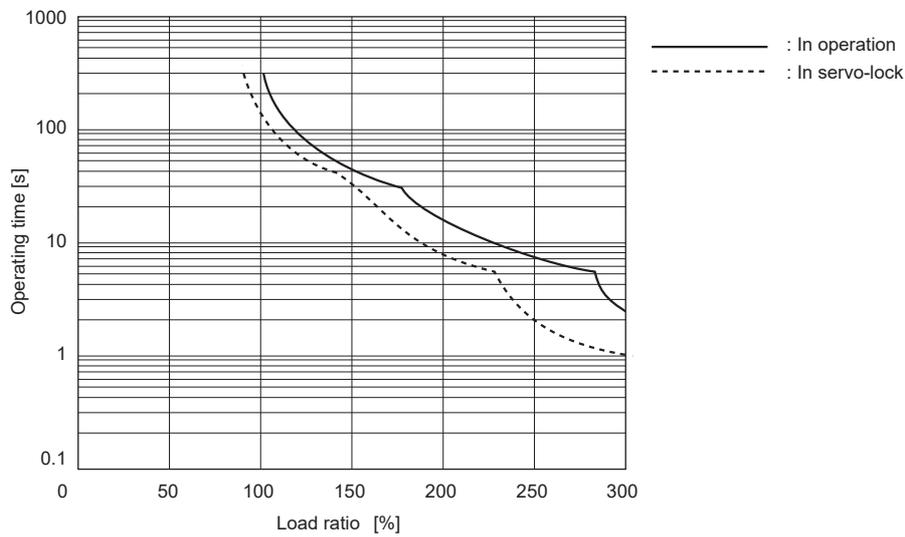
Perform the machine analyzer function after the magnetic pole detection. If the magnetic pole detection is not performed, the machine analyzer function may not operate properly.

The stop position at the completion of the machine analyzer function is arbitrary.

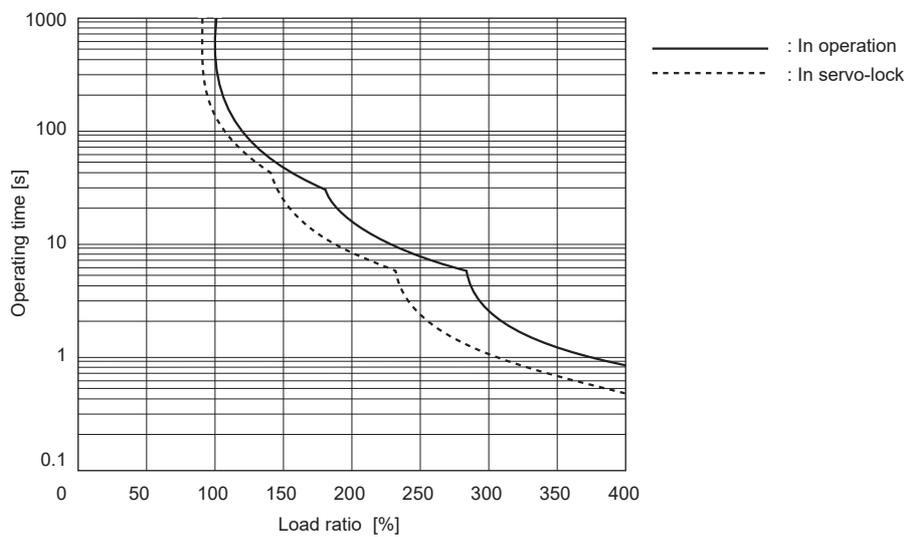
8.5 Characteristics

Overload protection characteristics

LM-H3 series



LM-AJ series



Power supply capacity and generated loss

Linear servo motor (primary side)	Servo amplifier	Power supply capacity [kVA]	Servo amplifier-generated heat [W]		Area required for heat dissipation [m ²]
			At rated output	At servo-off	
LM-H3P2A-07P-BSS0	MR-JET-40_	0.9	35	15	0.7
LM-H3P3A-12P-CSS0		0.9	35	15	0.7
LM-H3P3B-24P-CSS0	MR-JET-70_	1.3	50	15	1.0
LM-H3P3C-36P-CSS0		1.9	50	15	1.0
LM-H3P3D-48P-CSS0	MR-JET-200_	3.5	90	20	1.8
LM-H3P7A-24P-ASS0	MR-JET-70_	1.3	50	15	1.0
LM-H3P7B-48P-ASS0	MR-JET-200_	3.5	90	20	1.8
LM-H3P7C-72P-ASS0		3.8	90	20	1.8
LM-AJP1B-07K-JSS0	MR-JET-40_	0.9	35	15	0.7
LM-AJP1D-14K-JSS0	MR-JET-70_	1.3	50	15	1.0
LM-AJP2B-12S-JSS0	MR-JET-40_	0.9	35	15	0.7
LM-AJP2D-23T-JSS0	MR-JET-70_	1.3	50	15	1.0
LM-AJP3B-17N-JSS0	MR-JET-40_	0.9	35	15	0.7
LM-AJP3D-35R-JSS0	MR-JET-70_	1.3	50	15	1.0
LM-AJP4B-22M-JSS0	MR-JET-40_	0.9	35	15	0.7
LM-AJP4D-45N-JSS0	MR-JET-70_	1.3	50	15	1.0

Dynamic brake characteristics

The approximate coasting distance from when the dynamic brake is activated until when the linear servo motor stops can be calculated with the equation below.

$$L_{\max} = V_0 \cdot (0.03 + M \cdot (A + B \cdot V_0^2))$$

L_{\max} : Coasting distance of the machine [m]

V_0 : Speed when the brake is activated [m/s]

M: Full mass of the moving part [kg]

A: Coefficient (Refer to the following table.)

B: Coefficient (Refer to the following table.)

Linear servo motor (primary side)	Coefficient A	Coefficient B
LM-H3P2A-07P-BSS0	7.15×10^{-3}	2.94×10^{-3}
LM-H3P3A-12P-CSS0	2.81×10^{-3}	1.47×10^{-3}
LM-H3P3B-24P-CSS0	7.69×10^{-3}	2.27×10^{-4}
LM-H3P3C-36P-CSS0	7.22×10^{-3}	1.13×10^{-4}
LM-H3P3D-48P-CSS0	1.02×10^{-3}	2.54×10^{-4}
LM-H3P7A-24P-ASS0	7.69×10^{-3}	2.14×10^{-4}
LM-H3P7B-48P-ASS0	9.14×10^{-4}	2.59×10^{-4}
LM-H3P7C-72P-ASS0	7.19×10^{-4}	1.47×10^{-4}
LM-AJP1B-07K-JSS0	6.85×10^{-3}	3.70×10^{-3}
LM-AJP1D-14K-JSS0	4.08×10^{-2}	3.42×10^{-4}
LM-AJP2B-12S-JSS0	3.42×10^{-3}	2.06×10^{-3}
LM-AJP2D-23T-JSS0	1.35×10^{-2}	2.48×10^{-4}
LM-AJP3B-17N-JSS0	2.24×10^{-3}	1.47×10^{-3}
LM-AJP3D-35R-JSS0	6.61×10^{-3}	2.23×10^{-4}
LM-AJP4B-22M-JSS0	1.65×10^{-3}	1.12×10^{-3}
LM-AJP4D-45N-JSS0	4.03×10^{-3}	1.94×10^{-4}

Permissible load to motor mass ratio when the dynamic brake is used

Linear servo motor (primary side)	Permissible load to motor mass ratio [Multiplier]
LM-H3 series	40
LM-AJP1B-07K-JSS0	15
LM-AJP1D-14K-JSS0	30
LM-AJP2B-12S-JSS0	25
LM-AJP2D-23T-JSS0	30
LM-AJP3B-17N-JSS0	35
LM-AJP3D-35R-JSS0	35
LM-AJP4B-22M-JSS0	35
LM-AJP4D-45N-JSS0	35

8.6 Absolute position detection system

When the linear servo motor is used with the absolute position detection system, an absolute position linear encoder is required.

Operating conditions of absolute position detection system

- Use an absolute position type linear encoder.
- Perform magnetic pole detection in the incremental system, and disable magnetic pole detection after detection.
- Enable the absolute position detection system with [Pr. PA03 Absolute position detection system].

Alarm detection

[AL. 025 Absolute position erased], [AL. 092 Battery cable disconnection warning], [AL. 09F Battery warning], and [AL. 0E3 Absolute position counter warning] are not detected.

Backup

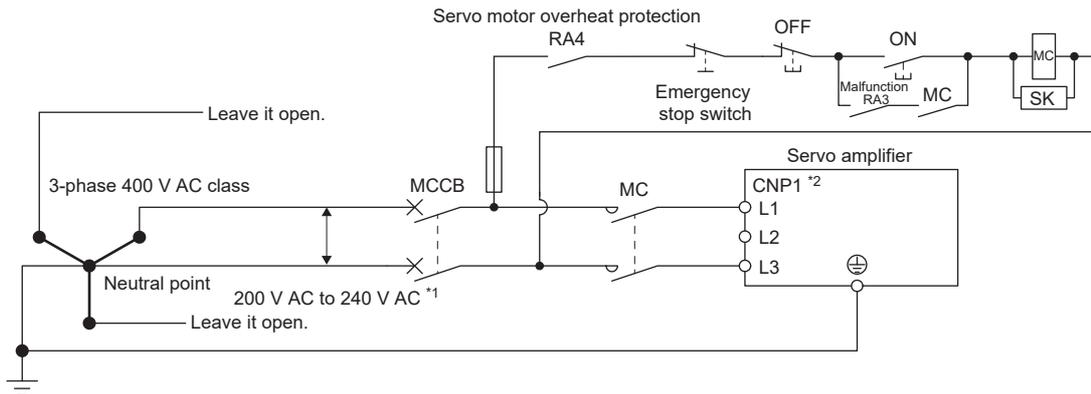
The linear encoder backs up the absolute position data. Therefore, the encoder battery need not be installed to the servo amplifier.

9 APPENDIX

9.1 1-phase 200 V AC class power supply input using a neutral point of 3-phase 400 V AC class power supply

A 1-phase 200 V AC class power can be supplied to the servo amplifier with a use of a neutral point of a 3-phase 400 V AC class power supply.

Use a step-down transformer as necessary to keep the power supply voltage between 200 V AC and 240 V AC.

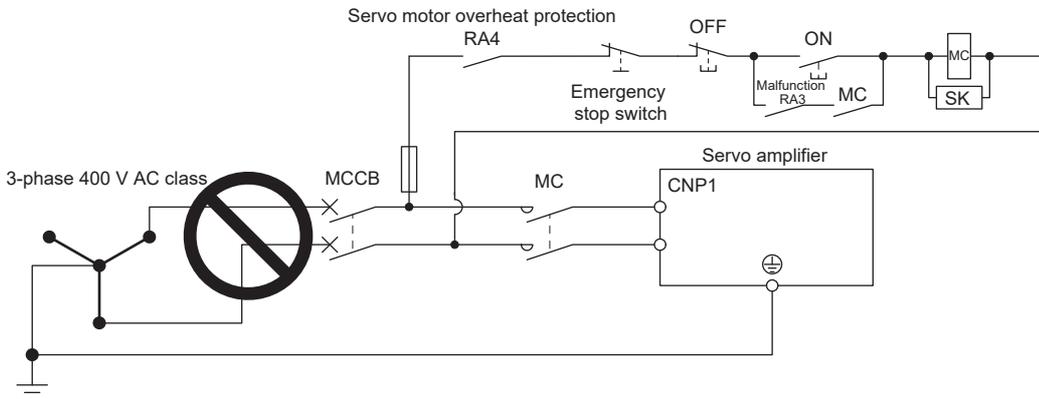


*1 Use a step-down transformer as necessary to keep the power supply voltage between 200 V AC and 240 V AC.

*2 For 1-phase 200 V AC to 240 V AC, connect the power supply to L1 and L3.

Precautions

Do not directly input the 3-phase 400 V AC class power supply to a 200 V class servo amplifier. Doing so may cause a malfunction.



REVISIONS

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

Revision date	*Manual number	Description
November 2019	IB(NA)-0300453ENG-A	First edition
July 2020	IB(NA)-0300453ENG-B	■Information on the following functions is added: Linear servo motor control mode ■Added/edited: Section 1.2, Section 1.3, Section 3.1, Section 3.4, Section 3.6, Section 4.1, Section 5.4, Section 6.1, Section 6.5, Section 6.7, Chapter 7, Chapter 8.
November 2020	IB(NA)-0300453ENG-C	■Information on the following functions is added: Output devices, EMC filter ■Added/edited: Section 3.5, Section 6.12
July 2021	IB(NA)-0300453ENG-D	■Information on the following function is added: CC-Link IE Field Network Basic ■Added/edited: Section 1.2, Section 1.3, Section 2.1, Section 3.1, Section 3.5, Section 3.6, Chapter 5, Section 6.1, Section 6.2, Section 6.5, Section 6.6, Section 6.7, Section 6.10, Section 6.12, Section 7.1, Section 7.2

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WARRANTY

Warranty

1. Warranty period and coverage

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 are repaired or replaced.

[Term]

For terms of warranty, please contact your original place of purchase.

[Limitations]

(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, smoothing capacitor, 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. Term of warranty after the stop 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

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation to:

- (1) Damages caused by any cause found not to be the responsibility of Mitsubishi.
- (2) Loss in opportunity, lost profits incurred to the user by Failures of Mitsubishi products.
- (3) Special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi products.
- (4) Replacement by the user, maintenance of on-site equipment, start-up test run and other tasks.

5. Change of Product specifications

Specifications listed in our catalogs, manuals or technical documents may be changed without notice.

6. Application and use of the Product

- (1) For the use of our AC Servo, its applications should be those that may not result in a serious damage even if any failure or malfunction occurs in AC Servo, and a backup or fail-safe function should operate on an external system to AC Servo when any failure or malfunction occurs.
- (2) Our AC Servo 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.

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IB(NA)-0300453ENG-D(2107)MEE

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