



## Mitsubishi Electric AC Servo System



# 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".

 <b>WARNING</b>	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
 <b>CAUTION</b>	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

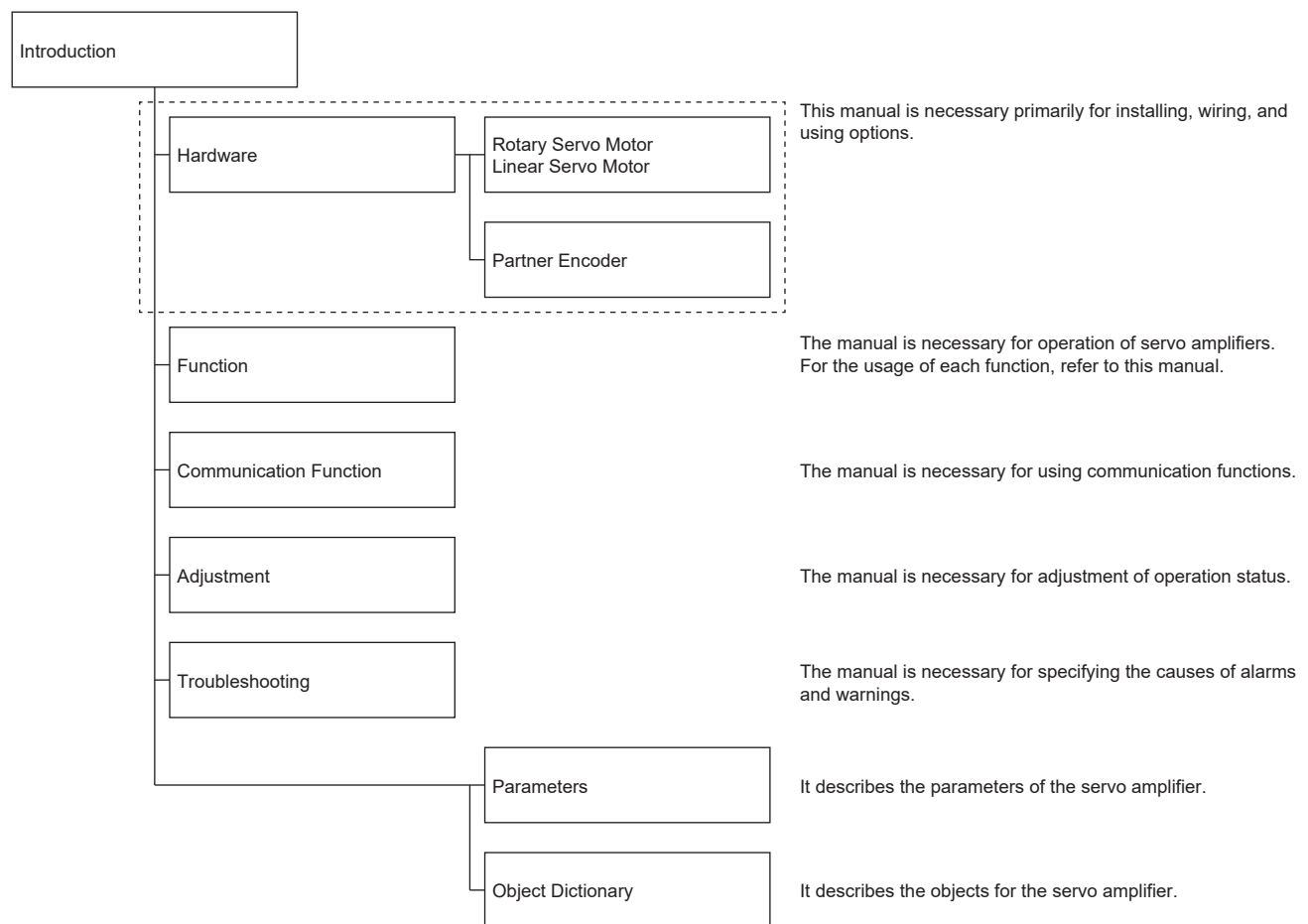


e-Manuals are Mitsubishi Electric FA electronic book manuals that can be browsed with a dedicated tool.

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 software

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).



## Global standards and regulations

Compliance with the indicated global standards and regulations is current as of the release date of this manual. Some standards and regulations may have been modified or withdrawn.

# CABLES USED FOR WIRING

Cables mentioned in this manual are selected based on an ambient temperature of 40 °C.

## 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 <sup>2</sup> ]	5.4675 [oz•inch <sup>2</sup> ]
Load (thrust load/axial load)	1 [N]	0.2248 [lbf]
Temperature	N [°C] $\times$ 9/5 + 32	N [°F]

# CONTENTS

SAFETY INSTRUCTIONS .....	1
ABOUT THE MANUAL .....	3
CABLES USED FOR WIRING .....	4
U.S. CUSTOMARY UNITS .....	4
<b>CHAPTER 1 INTRODUCTION</b> .....	<b>10</b>
1.1 <b>Wiring procedure</b> .....	<b>10</b>
1.2 <b>Servo amplifier/motor combinations</b> .....	<b>11</b>
Rotary servo motor .....	11
Linear servo motor .....	13
1.3 <b>Wiring check</b> .....	<b>14</b>
Power supply system wiring .....	14
I/O signal wiring .....	15
1.4 <b>Surrounding environment</b> .....	<b>16</b>
<b>CHAPTER 2 INSTALLATION</b> .....	<b>17</b>
2.1 <b>Mounting direction and clearances</b> .....	<b>18</b>
2.2 <b>Keeping out foreign materials</b> .....	<b>22</b>
2.3 <b>Cable stress</b> .....	<b>22</b>
2.4 <b>Fan unit replacement procedure</b> .....	<b>22</b>
List of applicable fan units .....	22
Fan unit removal procedure .....	23
Fan unit installation procedure .....	24
2.5 <b>Restrictions when using this product at an altitude exceeding 1000 m and up to 2000 m</b> .....	<b>25</b>
<b>CHAPTER 3 SIGNALS AND WIRING</b> .....	<b>26</b>
3.1 <b>Example power circuit connections</b> .....	<b>27</b>
200 V .....	27
400 V .....	30
3.2 <b>Example I/O signal connections</b> .....	<b>34</b>
MR-JET-_G(-N1) .....	34
MR-JET-_G_-HS(N1) .....	36
3.3 <b>Explanation of power supply system</b> .....	<b>39</b>
Explanation of signals (200 V) .....	39
Explanation of signals (400 V) .....	40
Power-on procedure (200 V) .....	41
Power-on procedure (400 V) .....	42
Wiring CNP1 (200 V) .....	43
Wiring CNP1, CNP2, and CNP3 (400 V) .....	46
3.4 <b>Connectors and pin assignments</b> .....	<b>50</b>
Precautions .....	50
Connectors and pin assignments .....	51
3.5 <b>Signal (device) explanation</b> .....	<b>56</b>
Input device .....	56
Output device .....	60
Power supply .....	63
3.6 <b>Interface</b> .....	<b>64</b>
Internal connection diagram .....	64

	Detailed explanation of interfaces . . . . .	68
	Source I/O interface. . . . .	69
<b>3.7</b>	<b>Servo motor with an electromagnetic brake. . . . .</b>	<b>70</b>
	Connection diagram . . . . .	70
<b>3.8</b>	<b>Grounding . . . . .</b>	<b>71</b>
<b>CHAPTER 4 DIMENSIONS</b>		<b>72</b>
<b>4.1</b>	<b>Servo amplifier. . . . .</b>	<b>72</b>
	200 V . . . . .	72
	400 V . . . . .	75
<b>4.2</b>	<b>Connector. . . . .</b>	<b>77</b>
	CN3 connector. . . . .	77
	CN2 connector. . . . .	78
	CN2L connector. . . . .	78
<b>CHAPTER 5 CHARACTERISTICS</b>		<b>79</b>
<b>5.1</b>	<b>Overload protection characteristics . . . . .</b>	<b>79</b>
<b>5.2</b>	<b>Power supply capacity and generated loss . . . . .</b>	<b>82</b>
	Power supply capacity. . . . .	82
	Generated loss . . . . .	84
<b>5.3</b>	<b>Dynamic brake characteristics. . . . .</b>	<b>86</b>
	Dynamic brake operation. . . . .	87
<b>5.4</b>	<b>Cable flex life . . . . .</b>	<b>98</b>
<b>5.5</b>	<b>Inrush current at power-on. . . . .</b>	<b>99</b>
<b>CHAPTER 6 OPTIONS AND PERIPHERAL EQUIPMENT</b>		<b>100</b>
<b>6.1</b>	<b>Cables/connector sets . . . . .</b>	<b>100</b>
	Combinations of cables/connector sets. . . . .	101
	Battery branch cable . . . . .	105
	Ethernet cable . . . . .	107
<b>6.2</b>	<b>Regenerative option . . . . .</b>	<b>108</b>
	Combination and regenerative power . . . . .	108
	Selection of the regenerative option . . . . .	109
	Setting servo parameters . . . . .	112
	Connection of regenerative option. . . . .	112
	Mounting direction . . . . .	116
	Dimensions . . . . .	117
<b>6.3</b>	<b>PS7DW-20V14B-F junction terminal block (recommended) . . . . .</b>	<b>122</b>
<b>6.4</b>	<b>MR Configurator2 . . . . .</b>	<b>124</b>
	Engineering software. . . . .	124
	Precautions for using USB communication function and Ethernet communication function . . . . .	124
<b>6.5</b>	<b>Battery . . . . .</b>	<b>125</b>
	MR-BAT6V1SET-B battery . . . . .	125
	MR-BAT6V1 battery. . . . .	132
<b>6.6</b>	<b>Selection example of wires. . . . .</b>	<b>133</b>
<b>6.7</b>	<b>Molded-case circuit breakers, fuses, magnetic contactors . . . . .</b>	<b>135</b>
	Selection example . . . . .	135
	Example settings that comply with IEC/EN/UL 61800-5-1 and CSA C22.2 No.274 . . . . .	137
<b>6.8</b>	<b>Power factor improving AC reactor . . . . .</b>	<b>139</b>
<b>6.9</b>	<b>Relay (recommended). . . . .</b>	<b>143</b>

<b>6.10</b>	<b>Noise reduction techniques</b>	<b>143</b>
	Noise reduction techniques	143
	Noise reduction products	148
<b>6.11</b>	<b>Earth-leakage current breaker</b>	<b>152</b>
	Selection method	152
	Selection example	154
<b>6.12</b>	<b>EMC filter (recommended)</b>	<b>155</b>
<b>6.13</b>	<b>Shield clamp attachment</b>	<b>160</b>
	Compatible models	160
	Cable connection method	160
	MR-ASCHP06	161
<b>6.14</b>	<b>SCC 15-F Shield connection clamp</b>	<b>164</b>
	Compatible models	164
	Applicable wire diameter	164
	Cable connection method	164
	View when installed	165
<b>CHAPTER 7 ABSOLUTE POSITION DETECTION SYSTEM</b>		<b>166</b>
<b>7.1</b>	<b>Outline</b>	<b>166</b>
	Characteristics	166
	Restrictions	166
	Precautions	166
	System architecture	167
	Setting servo parameters	168
	Homing	168
	Checking the detected absolute position data	168
	Procedure of replacing a servo motor with battery-less absolute position encoder	169
<b>7.2</b>	<b>Configuration and specifications</b>	<b>170</b>
	Connecting the battery-less encoder	170
	Connecting the battery backup type absolute position encoder	171
<b>CHAPTER 8 USING FUNCTIONAL SAFETY</b>		<b>172</b>
<b>8.1</b>	<b>Introduction</b>	<b>172</b>
<b>8.2</b>	<b>Function Block Diagram</b>	<b>173</b>
	Safety sub-function control by input device	173
	Safety sub-function control by network	174
<b>8.3</b>	<b>System configuration</b>	<b>175</b>
	Safety sub-function control by input device	175
	Safety sub-function control by network	175
<b>8.4</b>	<b>Specifications</b>	<b>176</b>
<b>8.5</b>	<b>Connectors and pin assignments</b>	<b>176</b>
<b>8.6</b>	<b>Example I/O signal connections</b>	<b>177</b>
	Input signal	177
	Output signal	179
<b>8.7</b>	<b>Connecting safety I/O interfaces</b>	<b>181</b>
	Source input	181
	Sink input	182
	Source output	183
	Source/sink output	184
<b>8.8</b>	<b>Wiring the SBC output</b>	<b>185</b>

Using SDO1_ and SDO2_ for SBCS. . . . .	185
Using SDO3_ for SBCS. . . . .	185
<b>8.9 Noise reduction techniques . . . . .</b>	<b>186</b>
<b>8.10 Example of connection with other devices . . . . .</b>	<b>187</b>
Safety sub-function control by input device . . . . .	187
Safety sub-function control by network . . . . .	188

---

## **CHAPTER 9 USING A LINEAR SERVO MOTOR 189**

---

<b>9.1 Functions and configuration . . . . .</b>	<b>189</b>
Outline . . . . .	189
Configuration including peripheral equipment . . . . .	190
<b>9.2 Startup . . . . .</b>	<b>191</b>
Startup procedure . . . . .	191
Setting . . . . .	192
Magnetic pole detection. . . . .	195
How to replace servo amplifier without magnetic pole detection. . . . .	203
<b>9.3 Basic functions . . . . .</b>	<b>204</b>
Homing . . . . .	204
Linear servo control error detection function . . . . .	211
About MR Configurator2 . . . . .	214
<b>9.4 Adjustment. . . . .</b>	<b>216</b>
Auto tuning function. . . . .	216
Machine analyzer function. . . . .	216
<b>9.5 Characteristics. . . . .</b>	<b>217</b>
Overload protection characteristics . . . . .	217
Power supply capacity and generated loss . . . . .	219
Dynamic brake characteristics. . . . .	220
Permissible load to motor mass ratio when the dynamic brake is used . . . . .	221
<b>9.6 Absolute position detection system . . . . .</b>	<b>222</b>

---

## **CHAPTER 10 USING A FULLY CLOSED LOOP SYSTEM 223**

---

<b>10.1 Precautions . . . . .</b>	<b>223</b>
<b>10.2 Functions and configuration . . . . .</b>	<b>224</b>
Outline . . . . .	224
Function block diagram . . . . .	225
Operation mode and load-side encoder combinations . . . . .	226
System architecture. . . . .	226
<b>10.3 Signals and wiring. . . . .</b>	<b>229</b>
Encoder cable configuration diagram . . . . .	229
<b>10.4 Startup . . . . .</b>	<b>232</b>
Servo parameter setting . . . . .	232
Checking position data of the load-side encoder. . . . .	237
<b>10.5 Basic functions . . . . .</b>	<b>238</b>
Homing . . . . .	238
Operation from controller. . . . .	242
Fully closed loop control error detection function . . . . .	242
About MR Configurator2 . . . . .	244
<b>10.6 Options and peripheral equipment . . . . .</b>	<b>246</b>
MR-J4FCCBL03M branch cable . . . . .	246
<b>10.7 Absolute position detection system . . . . .</b>	<b>247</b>










Encoder cable configuration diagram (When using an HG-KNS servo motor) .....	248
------------------------------------------------------------------------------	-----

<b>CHAPTER 11 APPENDIX</b>	<b>249</b>
----------------------------	------------

<b>11.1 1-phase 200 V AC power supply input using a neutral point of 3-phase 400 V AC power supply .....</b>	<b>249</b>
REVISIONS .....	252
WARRANTY .....	253
TRADEMARKS .....	254

# 1 INTRODUCTION

## 1.1 Wiring procedure

Procedure	Description	Reference
<b>1.</b> Installation	Install a servo amplifier.	 Page 17 INSTALLATION
<b>2.</b> Connecting the power circuit	Connect the power circuit.	 Page 27 Example power circuit connections
<b>3.</b> Connecting I/O signals	Connect I/O signals.	 Page 34 Example I/O signal connections
<b>4.</b> Connecting to the servo motor	Connect the servo amplifier to a servo motor.	 Rotary Servo Motor User's Manual (For MR-JET)
<b>5.</b> Connecting options	Connect options.	 Page 100 OPTIONS AND PERIPHERAL EQUIPMENT
<b>6.</b> Other precautions	If using the absolute position detection system and functional safety, perform wiring and settings as necessary.	 Page 166 ABSOLUTE POSITION DETECTION SYSTEM  Page 172 USING FUNCTIONAL SAFETY
<b>7.</b> 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 14 Wiring check
<b>8.</b> Checking the surrounding environment	Check the environment surrounding the servo amplifier and servo motor.	 Page 16 Surrounding environment



## 1.2 Servo amplifier/motor combinations

### Rotary servo motor

#### HK-KN series (200 V)

○: Standard torque

Rotary servo motor			Servo amplifier MR-JET-					
			10_	20_	40_	70_	100_	200_
HK-KN_ *1	□40	HK-KN053_	○	—	—	—	—	—
		HK-KN13_	○	—	—	—	—	—
		HK-KN1M3_	—	○	—	—	—	—
	□60	HK-KN23_	—	○	—	—	—	—
		HK-KN43_	—	—	○	—	—	—
		HK-KN63_	—	—	—	○	—	—
	□80	HK-KN7M3_	—	—	—	○	—	—
		HK-KN103_	—	—	—	—	○	—
	□90	HK-KN153_	—	—	—	—	—	○
		HK-KN203_	—	—	—	—	—	○
		HK-KN202_	—	—	—	—	—	○

\*1 Use servo amplifiers with firmware version E8 or later. Otherwise, [AL. 01A Servo motor combination error] occurs.

#### HK-FN series (200 V)

○: Standard torque

Rotary servo motor			Servo amplifier MR-JET-						
			10_	20_	40_	70_	100_	200_	300_
HK-FN_ *1	□40	HK-FN13_	○	—	—	—	—	—	—
	□60	HK-FN23_	—	○	—	—	—	—	—
		HK-FN43_	—	—	○	—	—	—	—
	□80	HK-FN7M3_	—	—	—	○	○	—	—
	□130	HK-FN102_	—	—	—	—	○	—	—
		HK-FN152_	—	—	—	—	—	○	—
	□176	HK-FN202_	—	—	—	—	—	○	—
		HK-FN301M_	—	—	—	—	—	—	○

\*1 Use servo amplifiers with firmware version E8 or later. Otherwise, [AL. 01A Servo motor combination error] occurs.

#### HK-KN series (400 V)

○: Standard torque

Rotary servo motor			Servo amplifier MR-JET-		
			60_4_	100_4_	200_4_
HK-KN_4	□40	HK-KN134_	○	—	—
	□60	HK-KN234_	○	—	—
		HK-KN434_	○	—	—
		HK-KN634_	○	—	—
	□80	HK-KN7M34_	—	○	—
		HK-KN1034_	—	○	—
	□90	HK-KN1534_	—	—	○
		HK-KN2034_	—	—	○

## HK-SN series (400 V)

○: Standard torque

Rotary servo motor			Servo amplifier MR-JET-		
			350_4_	500_4	700_4
HK-SN_4	□130	HK-SN3534_	○	—	—
		HK-SN5034_	—	○	—
	□176	HK-SN7034_	—	—	○

## HG-KNS series (200 V)

○: Standard torque

Rotary servo motor			Servo amplifier MR-JET-			
			10_	20_	40_	70_
HG-KNS_	□40	HG-KNS13_	○	—	—	—
	□60	HG-KNS23_	—	○	—	—
		HG-KNS43_	—	—	○	—
	□80	HG-KNS73_	—	—	—	○

## HG-SNS series (200 V)

○: Standard torque

Rotary servo motor			Servo amplifier MR-JET-			
			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.

1

## 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	—	○

## LM-AU series

Use servo amplifiers with firmware version D0 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-AUP3A-03V-JSS0	LM-AUS30-120-JSS0	○	—	—
LM-AUP3B-06V-JSS0	LM-AUS30-180-JSS0			
LM-AUP3C-09V-JSS0	LM-AUS30-240-JSS0			
LM-AUP3D-11R-JSS0	LM-AUS30-300-JSS0 LM-AUS30-600-JSS0			
LM-AUP4A-04R-JSS0	LM-AUS40-120-JSS0	—	○	—
LM-AUP4B-09R-JSS0	LM-AUS40-180-JSS0			
LM-AUP4C-13P-JSS0	LM-AUS40-240-JSS0			
LM-AUP4D-18M-JSS0	LM-AUS40-300-JSS0 LM-AUS40-600-JSS0			
LM-AUP4F-26P-JSS0		—	—	○
LM-AUP4H-35M-JSS0				

## 1.3 Wiring check

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

### Power supply system wiring

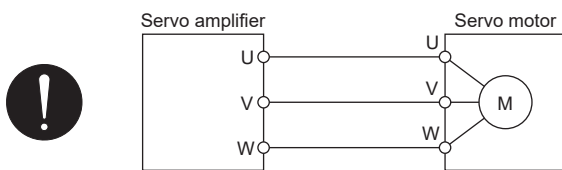
#### Power supply system wiring

- Check that the power supplied to the power input terminals (L1/L2/L3/L11/L21) of the servo amplifier satisfies the defined specifications.

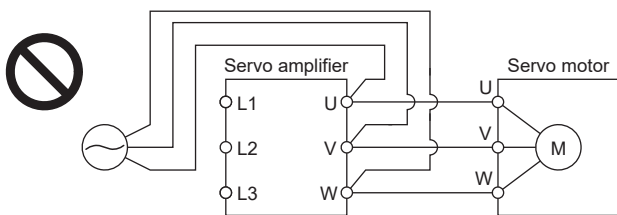
For the power supply specifications, refer to "Servo amplifier standard specifications" in the User's Manual (Introduction).

#### Connecting the servo amplifier to the servo motor

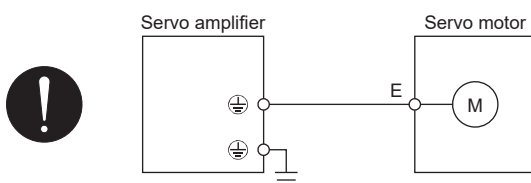
- Check that the phases (U/V/W) of the servo amplifier power outputs and the phases (U/V/W) of the servo motor power inputs match with each other.



- 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.

#### When using the regenerative option

##### ■MR-JET-\_G(-N1)

- 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 112 Connection of regenerative option

##### ■MR-JET-\_G\_-HS(N1)

- Check that the lead wire between terminal P+ and terminal D has 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 112 Connection of regenerative option

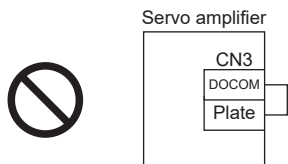
## I/O signal wiring

- 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. Refer to the following page for information on connecting I/O signals.

☞ Page 34 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 98 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. In addition, do not directly touch the servo amplifier, regenerative resistor, or servo motor during operation or immediately after stop.
- 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.
- The MR-JET-\_G(-N1) has a regenerative resistor on its 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.
- Circulate air so that the air at the top and bottom of the servo amplifier does not stagnate.

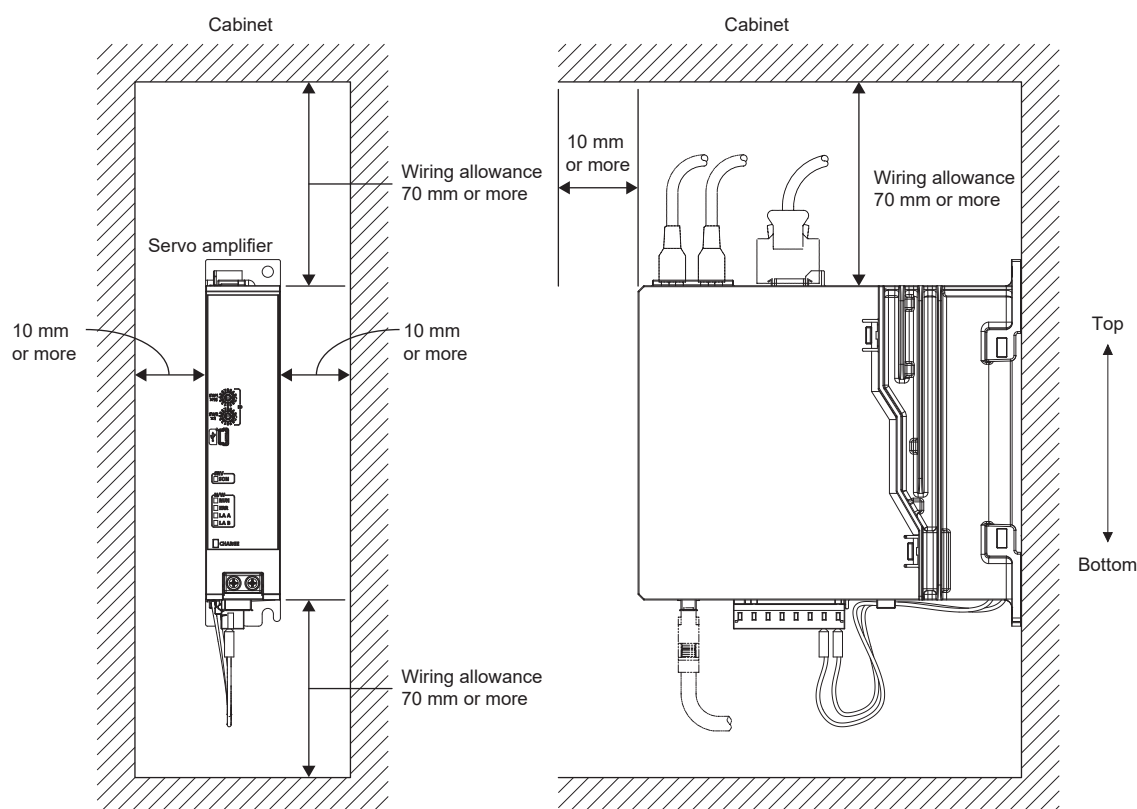
### Availability of close mounting

- 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_		—
MR-JET-60_4_ to MR-JET-700_4_	Impossible	—

### Installation clearances for the servo amplifier (200 V)

#### ■ Installation of one servo amplifier

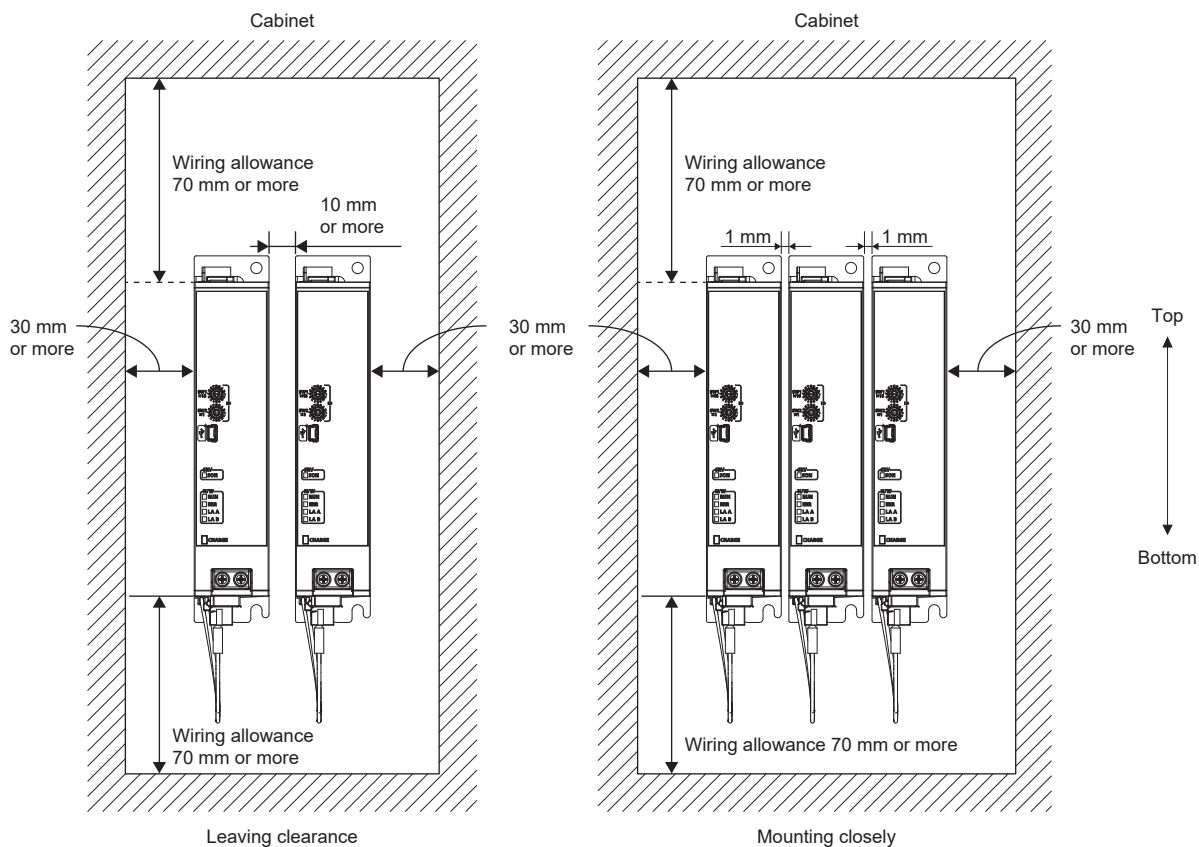




## ■ Installation of two or more servo amplifiers

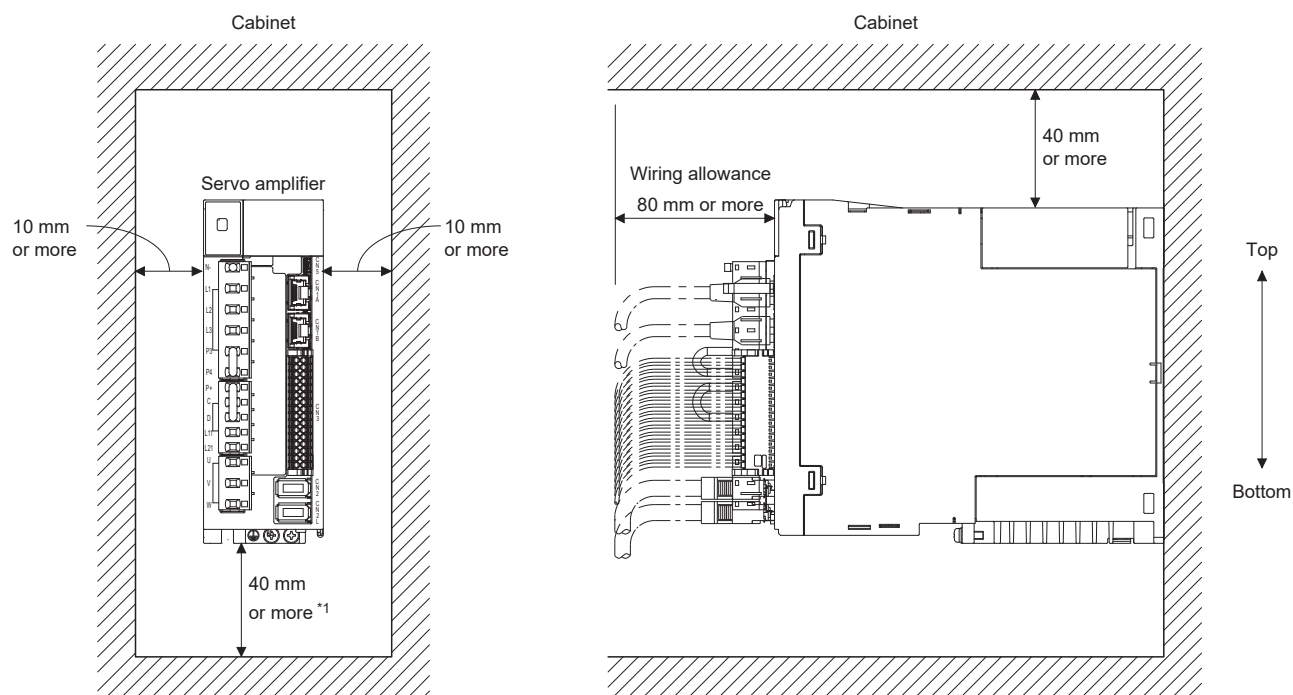
Maintain a large clearance above the servo amplifiers and install a cooling fan to prevent the temperature inside the cabinet from exceeding the temperature specified in the environmental conditions.

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.



## Installation clearances for the servo amplifier (400 V)

### ■ Installation of one servo amplifier

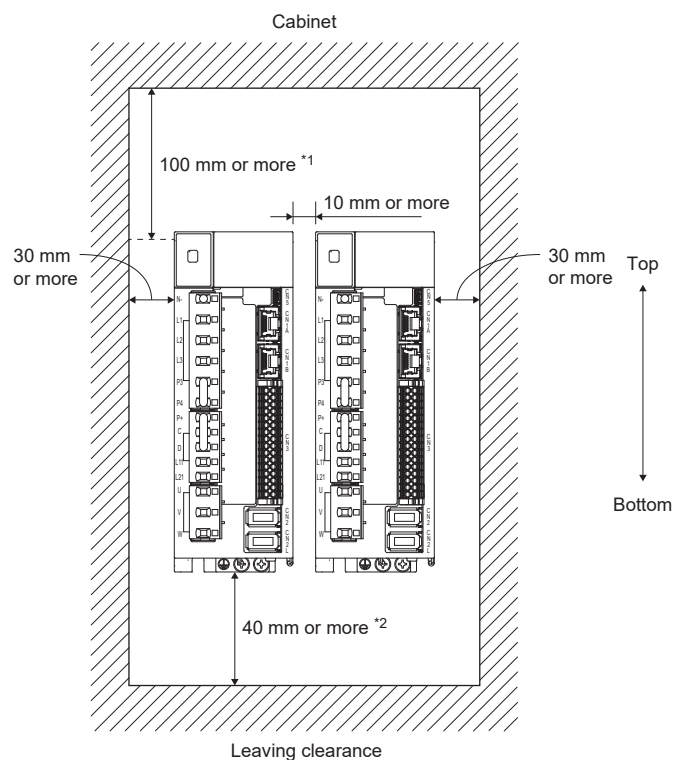


\*1 For the MR-JET-500\_4\_ and MR-JET-700\_4\_, leave a clearance of at least 70 mm between the bottom of the servo amplifier and the cabinet. When using a shield clamp attachment, refer to the following.

☞ Page 160 Shield clamp attachment

## ■ 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.



\*1 Leave a clearance of 100 mm or more above the fan units.

\*2 For the MR-JET-500\_4\_ and MR-JET-700\_4\_, leave a clearance of at least 70 mm between the bottom of the servo amplifier and the cabinet. When using a shield clamp attachment, refer to the following.

☞ Page 160 Shield clamp attachment

## 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 98 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.

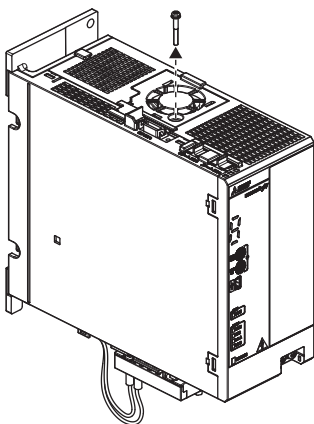
### List of applicable fan units

Servo amplifier	Model of fan unit to be replaced
MR-JET-200_ MR-JET-300_	MR-JET-FAN1
MR-JET-200_4_ MR-JET-350_4_	MR-J5-FAN6
MR-JET-500_4_ MR-JET-700_4_	MR-J5-FAN7

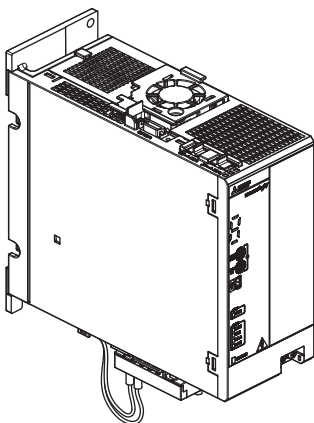
## Fan unit removal procedure

The following illustrates an example where the MR-JET-FAN1 is removed from the MR-JET-200G. The number of screws for mounting differs depending on the fan unit.

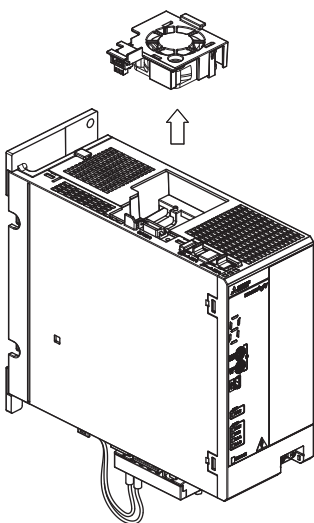
1. Remove the screws that fixed the fan unit. Keep the removed screws for installation of the new fan unit.



2. Pull up the cover of the fan unit.



3. Pull out the fan unit vertically.

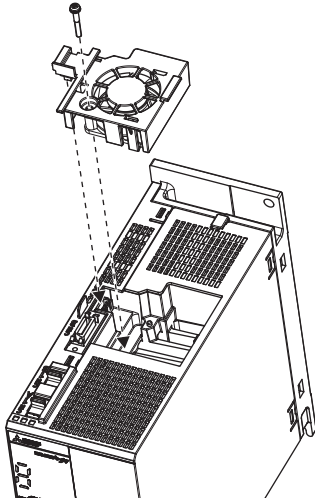


## Fan unit installation procedure

---

The following illustrates an example where the MR-JET-FAN1 is installed to the MR-JET-200G. The number of screws for mounting differs depending on the fan unit.

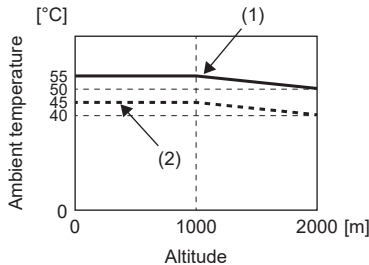
Insert the positioning part of the fan unit vertically, align it to the positioning part of the main unit case, and tighten with screws. Use the same screws as those used for the fan unit before replacement.



## 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)

Refer to "Restrictions on using this product at an altitude exceeding 1000 m and up to 2000 m above sea level" in the user's manual of each servo motor for servo motor restrictions.

### 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

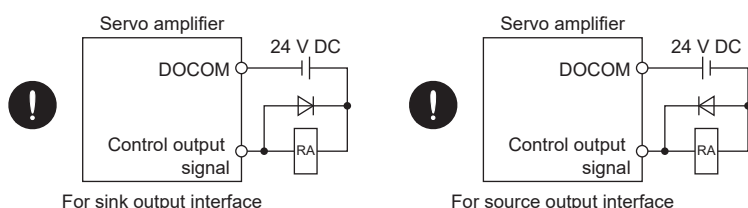
## Precautions

- When using a linear servo motor, the terms below have the following meanings.

Load to motor inertia ratio → Load to motor mass ratio

Torque → Thrust

- 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

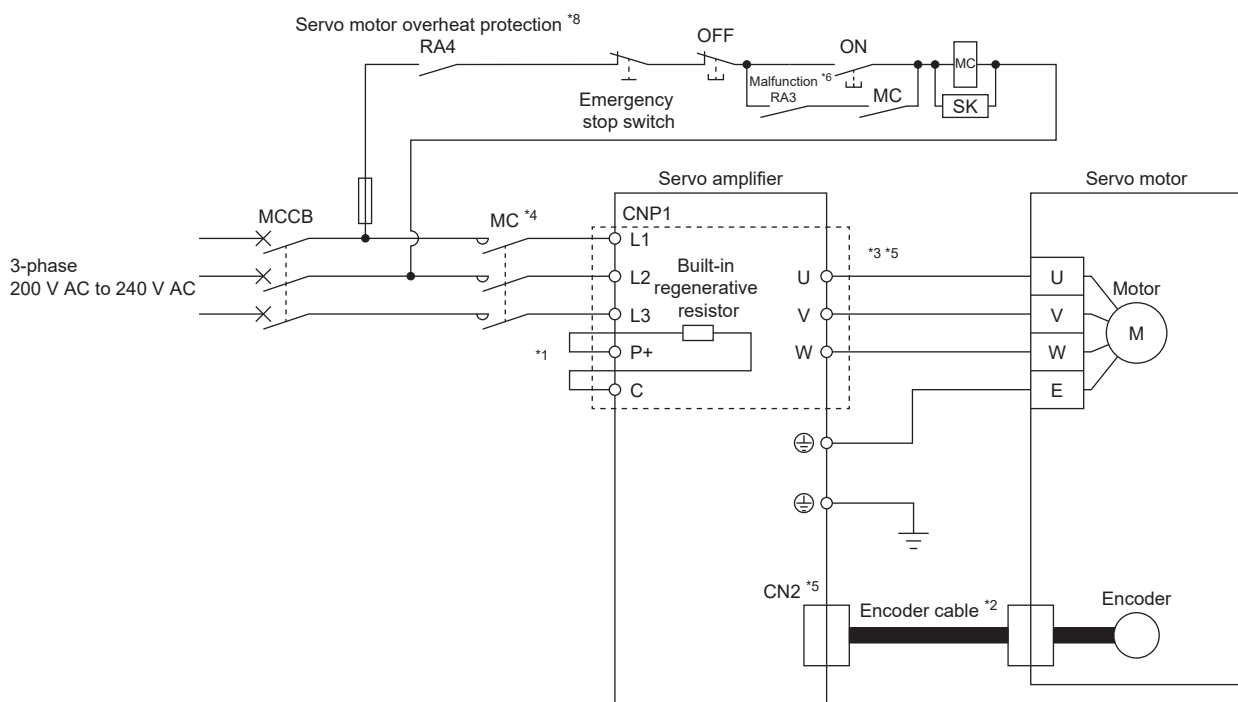
## 200 V

3

### 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.

### 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 108 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 (For MR-JET)

\*3 For connecting servo motor power wires, refer to "CONNECTION OF SERVO AMPLIFIER AND ROTARY SERVO MOTOR" in the following manual.

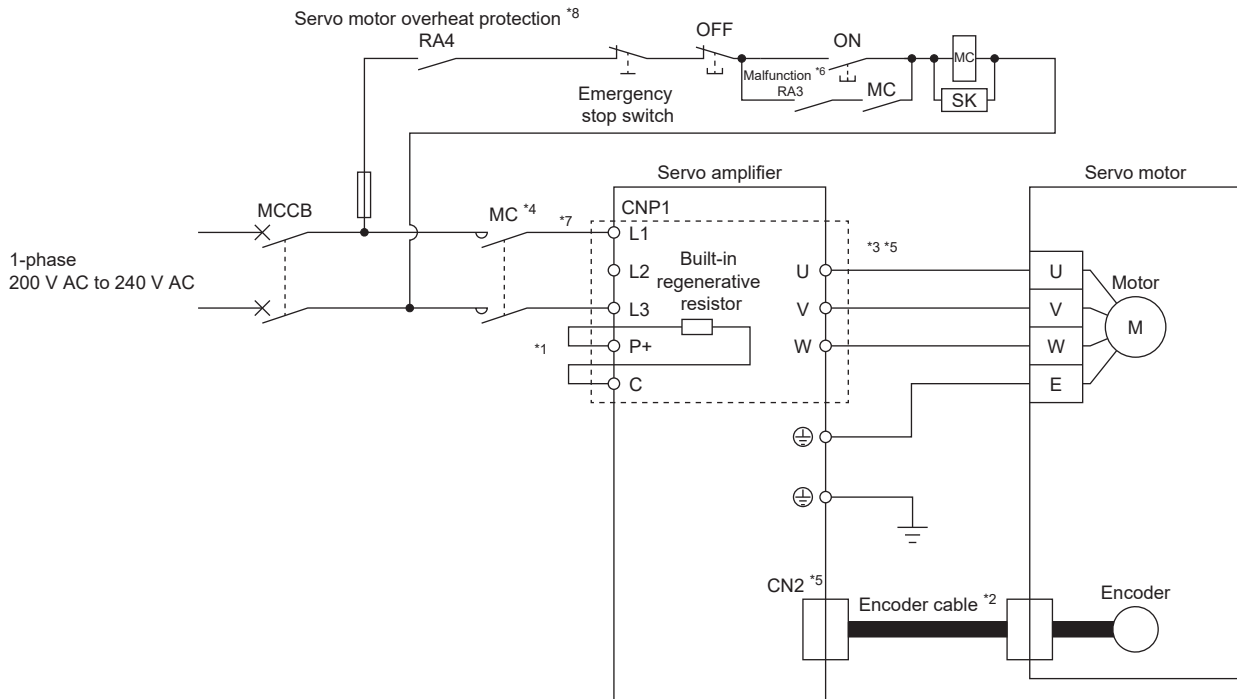
📖 Rotary Servo Motor User's Manual (For MR-JET)

- \*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.

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

### Precautions

- For notes, refer to the notes in the following section.
- ☞ Page 27 For 3-phase 200 V AC to 240 V AC power supply

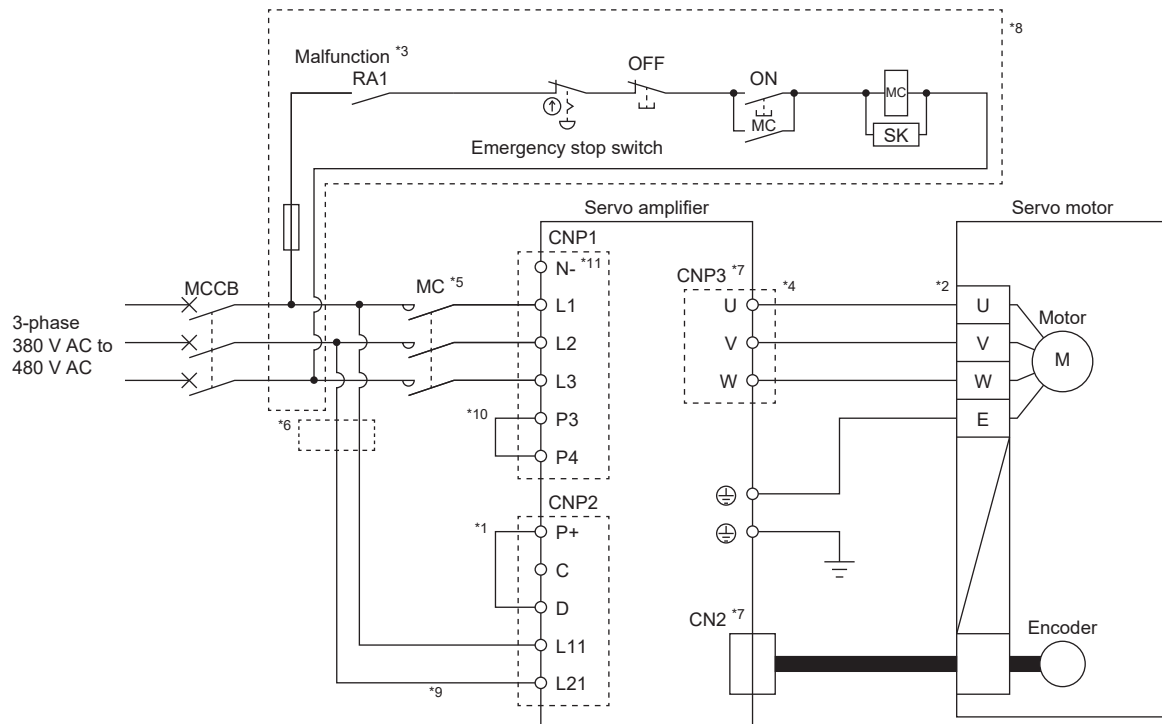







## Precautions

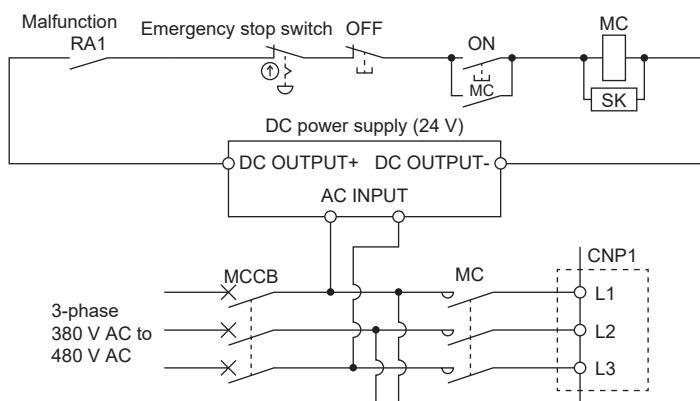
- To prevent a fire, install a molded-case circuit breaker or fuse to the main circuit power supply (L1/L2/L3) of a servo amplifier.
- Connect a magnetic contactor between a power supply and the main circuit power supply (L1/L2/L3) of a servo amplifier to configure a circuit that shuts off the main circuit power supply of the servo amplifier when a malfunction or alarm of the servo amplifier occurs.
- Use a configuration that shuts off the main circuit 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.
- Do not shut off the control circuit power supply even if an alarm occurs. If the control circuit power supply is shut off, network communication will be interrupted.
- 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 main circuit 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.
- When insulating the main circuit power supply (L1/L2/L3) and the control circuit power supply (L11/L21) of the servo amplifier using an isolation transformer, etc., connect between L1 and L11 and between L2 and L21 at equipotential.

## For 3-phase 380 V AC to 480 V AC power supply

### ■MR-JET-60\_4\_ to MR-JET-350\_4\_

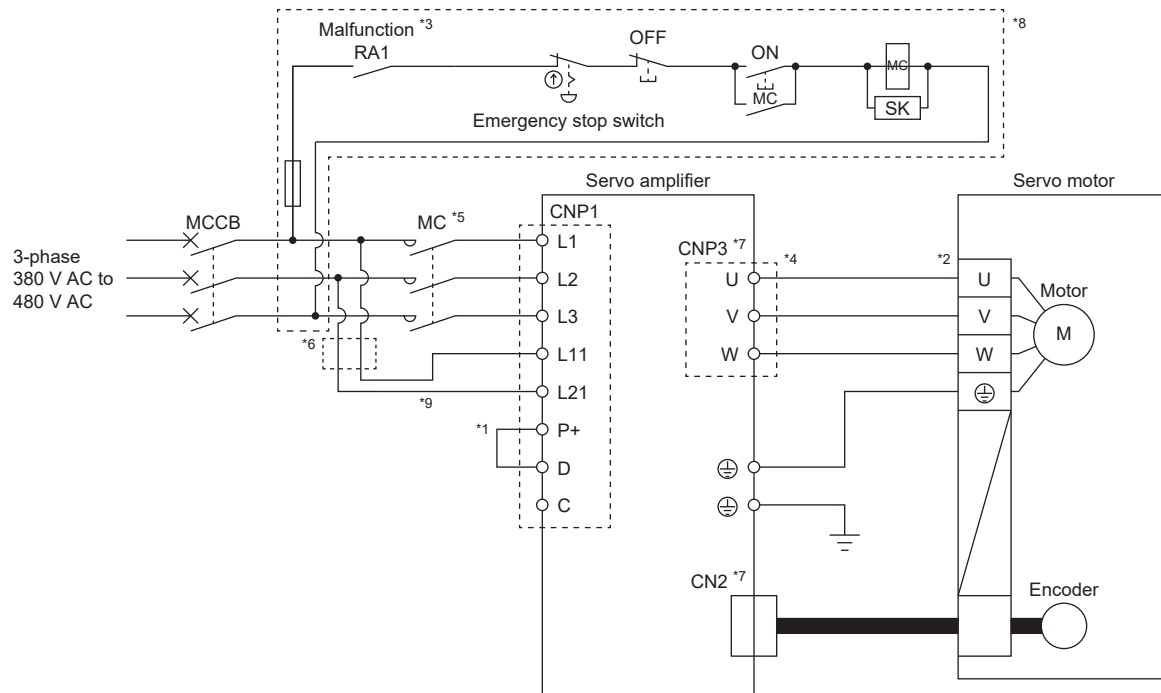







- \*1 Connect P+ and D terminals. P+ and D are connected from the factory. If using a regenerative option, refer to the following.  
 Page 108 Regenerative option
- \*2 Option cables are recommended for servo motor power cables and encoder cables. For selecting cables, refer to "Cables/connector sets" in the following manual.  
 Rotary Servo Motor User's Manual (For MR-JET)
- \*3 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.
- \*4 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 (For MR-JET)
- \*5 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 (90 ms or less if operating the on switch and off switch of the main circuit power supply with a DC power supply). The bus voltage may drop depending on the main circuit 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.
- \*6 If wires used for L11 and L21 are thinner than wires used for L1, L2, and L3, use a molded-case circuit breaker.  
 Page 135 Molded-case circuit breakers, fuses, magnetic contactors
- \*7 Connecting the servo motor for an incorrect axis to U, V, W, or CN2 of the servo amplifier may cause a malfunction.
- \*8 If operating the on switch and off switch of the main circuit power supply with a DC power supply, do not share the 24 V DC power supply for interface with the magnetic contactor. Use the power supply designed exclusively for the magnetic contactor. Refer to the following for the magnetic contactors that can be used.  
 Page 136 Driving on/off of main circuit power supply with DC power supply  
 Operating the on switch and off switch with the DC power supply meets IEC/EN 60204-1 requirements. Also, change the configuration of the part inside the dotted line as follows.

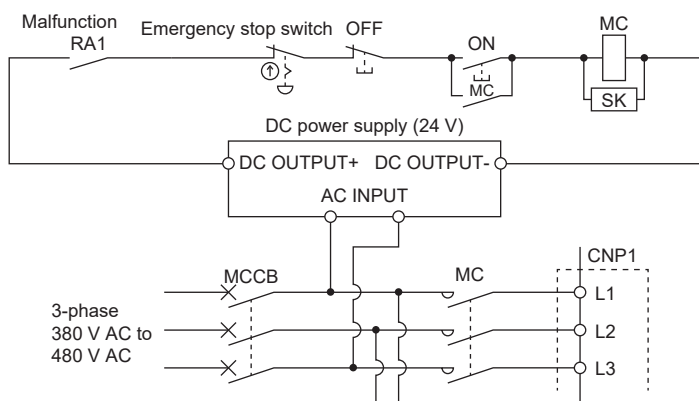


- \*9 Even if the control circuit power supply is separated from the main circuit power supply using an uninterruptible power supply (UPS) or insulation transformer, do not ground L11 and L21.
- \*10 P3 and P4 are connected from the factory. Use P3 and P4 in the default state.
- \*11 Do not use it.

## ■MR-JET-500\_4\_ to MR-JET-700\_4\_



- \*1 Connect P+ and D terminals. P+ and D are connected from the factory. If using a regenerative option, refer to the following.  
 Page 108 Regenerative option
- \*2 Option cables are recommended for servo motor power cables and encoder cables. For selecting cables, refer to "Cables/connector sets" in the following manual.  
 Rotary Servo Motor User's Manual (For MR-JET)
- \*3 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.
- \*4 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 (For MR-JET)
- \*5 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 (90 ms or less if operating the on switch and off switch of the main circuit power supply with a DC power supply). The bus voltage may drop depending on the main circuit 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.
- \*6 If wires used for L11 and L21 are thinner than wires used for L1, L2, and L3, use a molded-case circuit breaker.  
 Page 135 Molded-case circuit breakers, fuses, magnetic contactors
- \*7 Connecting the servo motor for an incorrect axis to U, V, W, or CN2 of the servo amplifier may cause a malfunction.
- \*8 If operating the on switch and off switch of the main circuit power supply with a DC power supply, do not share the 24 V DC power supply for interface with the magnetic contactor. Use the power supply designed exclusively for the magnetic contactor. Refer to the following for the magnetic contactors that can be used.  
 Page 136 Driving on/off of main circuit power supply with DC power supply  
 Operating the on switch and off switch with the DC power supply meets IEC/EN 60204-1 requirements. Also, change the configuration of the part inside the dotted line as follows.



- \*9 Even if the control circuit power supply is separated from the main circuit power supply using an uninterruptible power supply (UPS) or insulation transformer, do not ground L11 and L21.

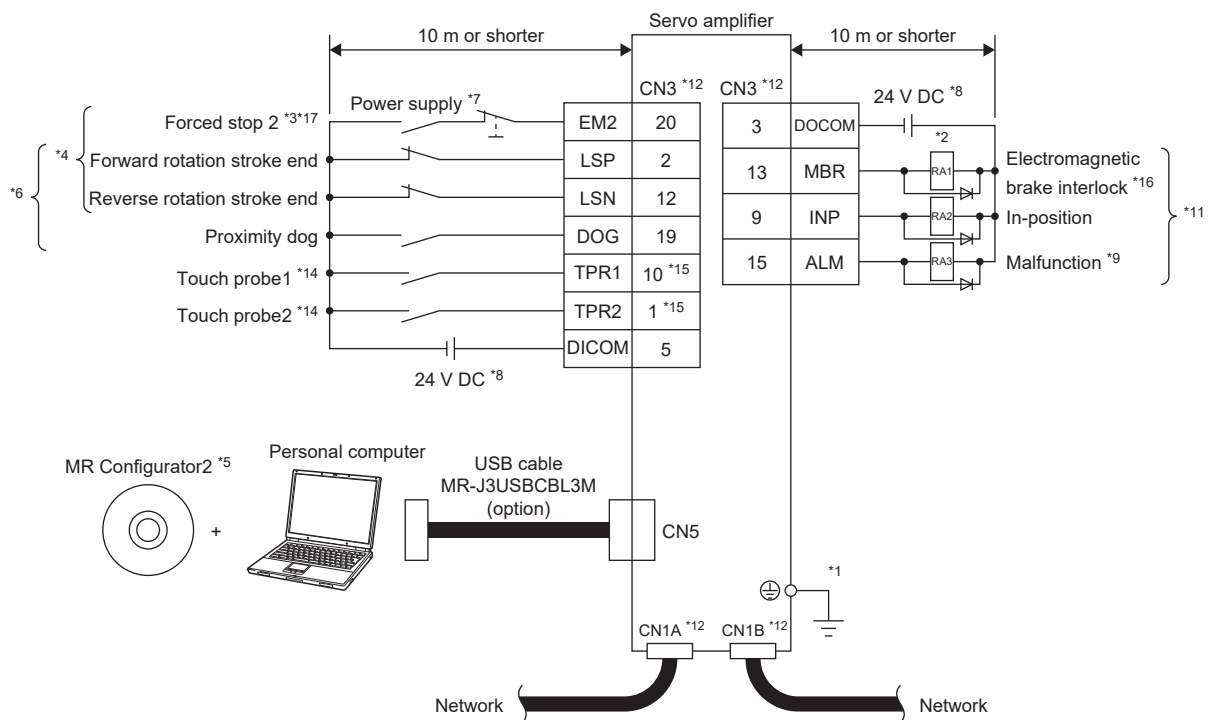
## 3.2 Example I/O signal connections

### 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.

### MR-JET-\_G(-N1)

#### For sink I/O interface





- 👉 Page 68 Digital input interface DI-1

\*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.

\*14 Some device functions are limited by the firmware version and the date of manufacture of the servo amplifier being used.

Refer to the following for details.

👉 Page 56 Input device explanation

\*15 Some pin functions are limited by the date of manufacture of the servo amplifier being used.

Refer to the following for details.

👉 Page 56 Input device pins

\*16 If installing an external brake mechanism for a linear servo motor, use MBR (Electromagnetic brake interlock).

\*17 This device is used for forced stop of the servo amplifier. Perform an emergency stop of the whole system on the controller side.

### For source I/O interface

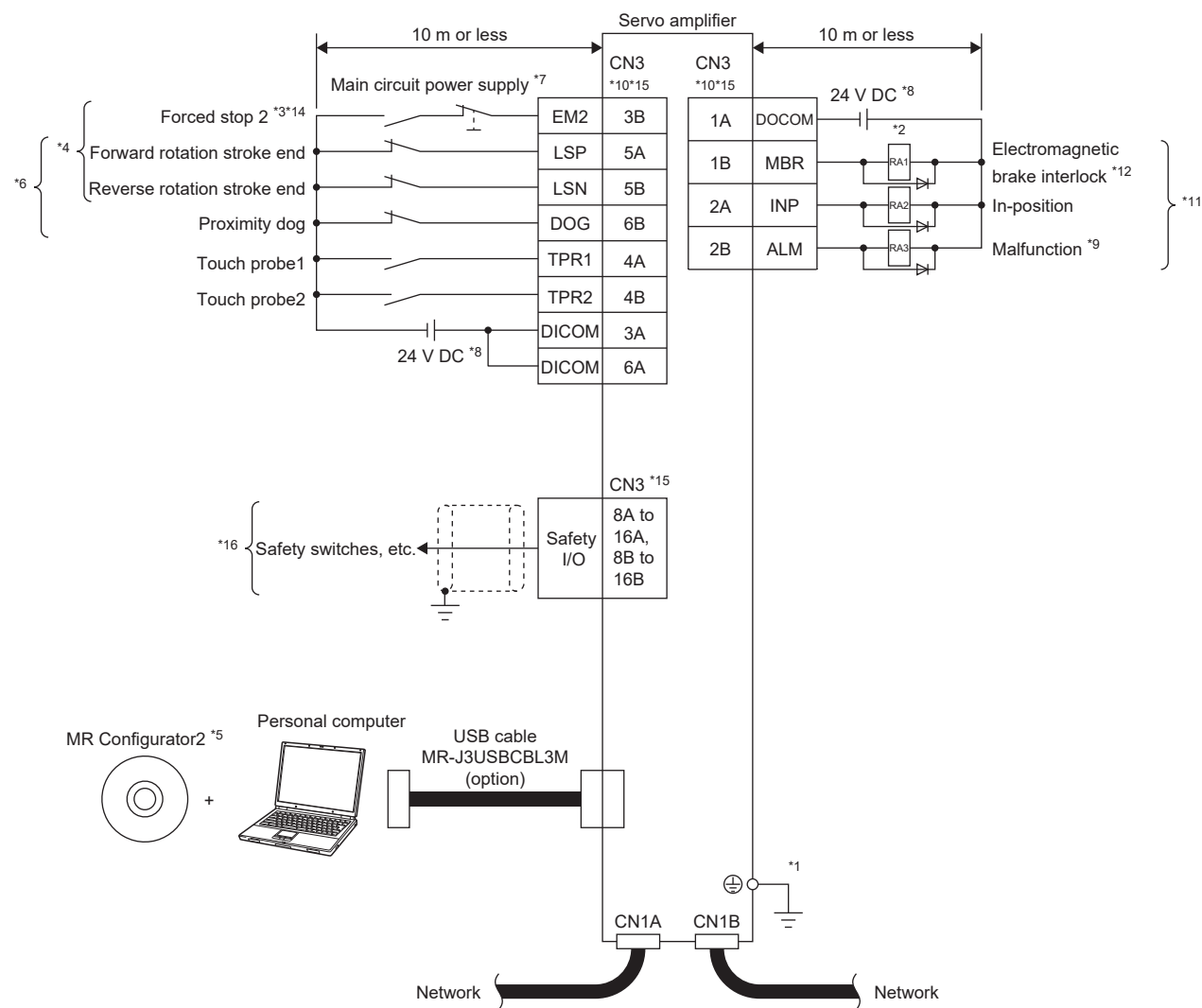
## Precautions





- 👉 Page 34 For sink I/O interface



# MR-JET-\_G\_-HS(N1)

## Sink I/O interface



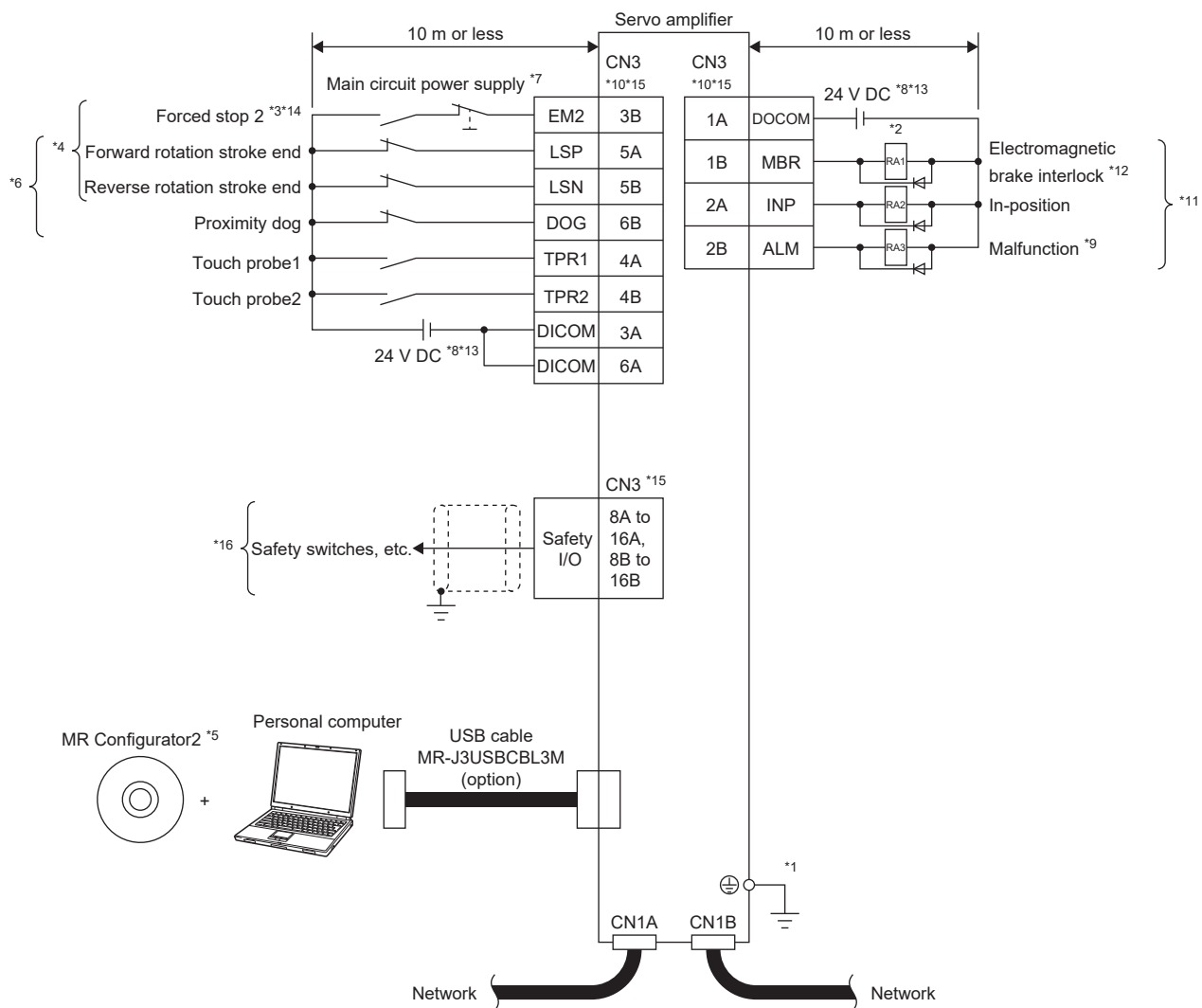
- \*1 To prevent an electric shock, connect the protective earth (PE) terminal (the terminal marked with the  $\oplus$  symbol) of the servo amplifier to the protective earth (PE) of the cabinet.
- \*2 Connect the diode in the correct direction. If it is connected reversely, the servo amplifier may malfunction 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 main circuit 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. This value is applicable when all I/O signals are used. Reducing the number of I/O points decreases the current capacity. For the current required for interfaces, refer to the following.
  -  Page 68 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 If installing an external brake mechanism for a linear servo motor, use MBR (Electromagnetic brake interlock).
- \*13 For source interfaces, the positive and negative outputs of the power supply are reversed as compared with sink interfaces.
- \*14 This device is used for forced stop of the servo amplifier. Perform an emergency stop of the whole system on the controller side.
- \*15 Since the frame of the CN3 connector is not connected to the protective earth (PE) terminal, using a cable clamp fitting or shield connection clamp for grounding is recommended.
  - Refer to the following for details.
  -  Page 149 Cable clamp fitting AERSBAN\_-SET
  -  Page 164 SCC 15-F Shield connection clamp
- \*16 Refer to the following for the connection of these pins.
  -  Page 177 Example I/O signal connections

## Source I/O interface

### Precautions

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

☞ Page 36 Sink I/O interface



## 3.3 Explanation of power supply system

### Explanation of signals (200 V)

#### Point

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

☞ Page 72 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. P+ and C are connected from the factory.

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.

## Explanation of signals (400 V)

### Point

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

☞ Page 72 DIMENSIONS

### L1/L2/L3 (Connection destination: Main circuit power supply)

Supply the following power to L1, L2, and L3.

Power supply	Servo amplifier
	MR-JET-60_4_ to MR-JET-700_4_
3-phase 380 V AC to 480 V AC, 50 Hz/60 Hz	L1/L2/L3

### P3/P4

Do not remove the wire between P3 and P4.

### P+/C/D (Connection destination: Regenerative option)

If using a servo amplifier built-in regenerative resistor, connect P+ and D. P+ and D are connected from the factory.

If using a regenerative option, disconnect P+ and D, and connect the regenerative option between P+ and C.

### L11/L21 (Connection destination: Control circuit power supply)

Supply the following power to L11 and L21.

Power supply	Servo amplifier
	MR-JET-60_4_ to MR-JET-700_4_
1-phase 380 V AC to 480 V AC, 50 Hz/60 Hz	L11/L21

### 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.

### N-

Do not use N-.

### ⏏ (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 (200 V)



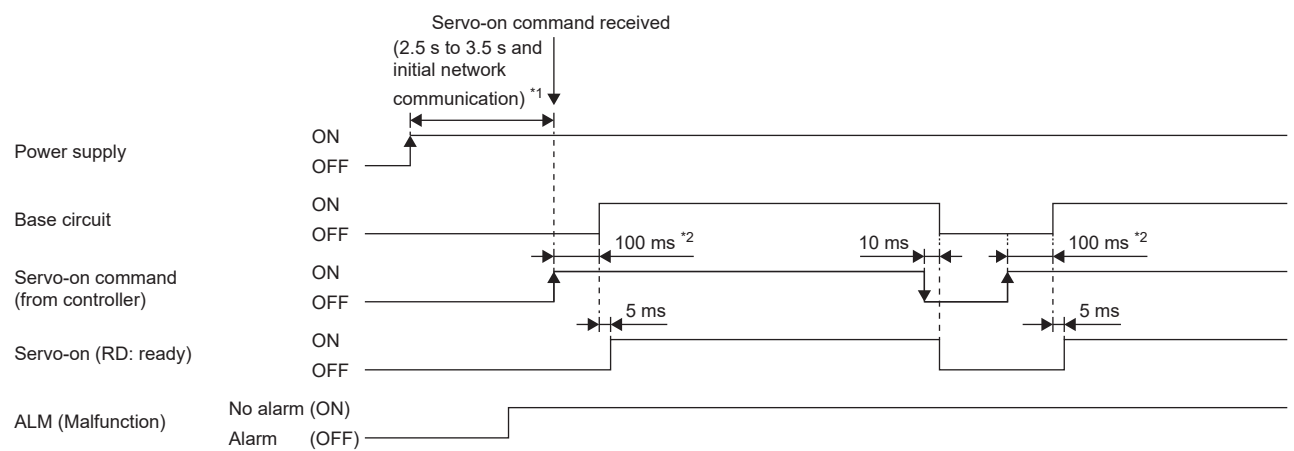
Signals such as output signals may be unstable at power-on.

## 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 27 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.

3

## Timing chart



\*1 For a linear servo system and a fully closed loop system, this time is 2 s longer.


\*2 The time will be longer in the magnetic pole detection of a linear servo motor.

# Power-on procedure (400 V)



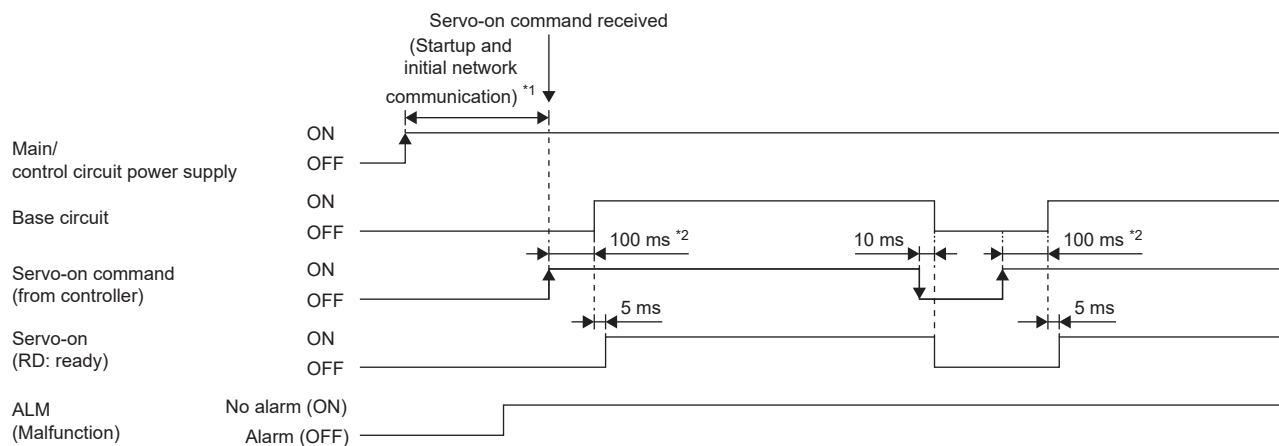
Signals such as output signals may be unstable at power-on.

## Power-on procedure

1. Wire the power supply using a magnetic contactor for the main circuit power supply (L1/L2/L3) by referring to the following. Switch off the magnetic contactor as soon as an alarm occurs.  
 Page 27 Example power circuit connections
2. Switch on the control circuit power supply (L11 and L21) simultaneously with the main circuit power supply or before switching on the main circuit power supply. If the control circuit power supply is turned on and the servo-on command is transmitted while the main circuit power supply is off, [AL. 0E9 Main circuit off warning] will occur. Turning on the main circuit power supply stops the warning and starts the operation properly.
3. When the main circuit power supply is switched on, the servo amplifier will receive the servo-on command after startup and initial network communication.

The startup time for the servo amplifier is 2.5 s to 3.5 s.

## Timing chart



\*1 For a linear servo system and a fully closed loop system, this time is 2 s longer.

\*2 The time will be longer in the magnetic pole detection of a linear servo motor.



# Wiring CNP1 (200 V)

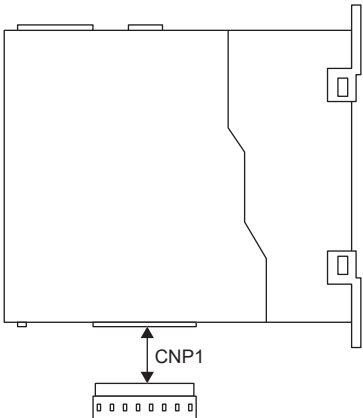
## Point

- For the wire sizes, refer to the following.  
    ☞ Page 133 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.

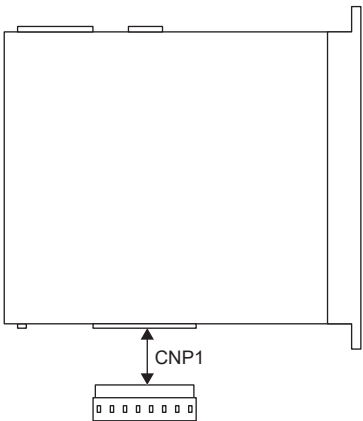
## Connector

### ■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\_



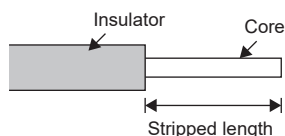
Connector	Receptacle assembly	Applicable wire		Stripped length [mm]	Open tool	Manufacturer
		Size	Insulator OD			
CNP1	1-2349825-8	AWG 16 to 10	4.7 mm or less	10.5 ± 0.5	2349891-1	TE Connectivity

## Connecting wires

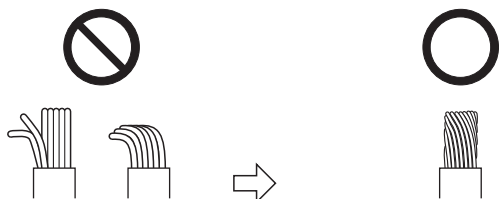
### ■Fabricating the wire insulator

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 43 Connector



Twist the core wires lightly and straighten them as follows.



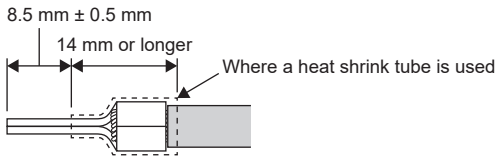
Loose and bent strands

Twist and straighten the strands.

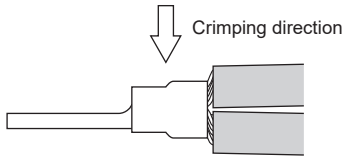
A ferrule can also be used when connecting to the connectors. If using a ferrule, choose from one of the ferrules and the crimping tools shown below.

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 6 (Phoenix Contact) CRIMPFOX ZA 3 (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)		

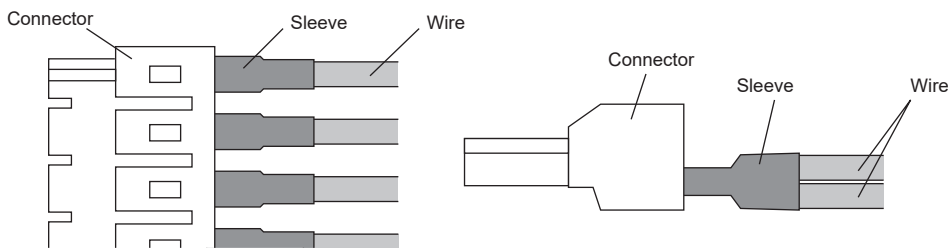
- \*1 If using the ferrule manufactured by DAIDO SOLDERLESS TERMINAL MFG., leave the stripped wire end  $8.5 \text{ mm} \pm 0.5 \text{ mm}$  from the ferrule tip and insulate the wire using a heat shrink tube with a length of 14 mm or more.



- \*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.



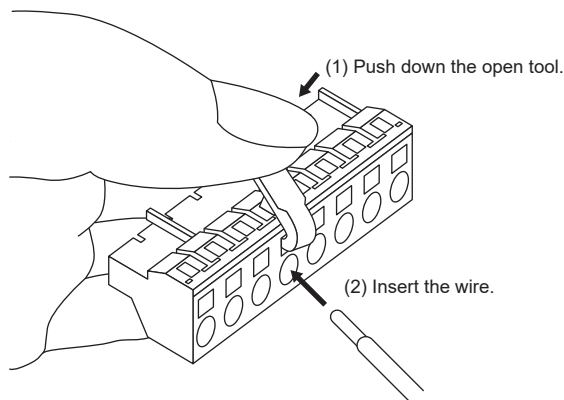
### ■Inserting a wire

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.



## Wiring CNP1, CNP2, and CNP3 (400 V)

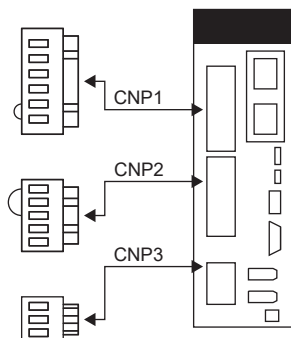
### Point

- For the wire sizes, refer to the following.
- ☞ Page 133 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.

To wire to CNP1, CNP2 and CNP3, use the servo amplifier power connectors that came with the amplifier.

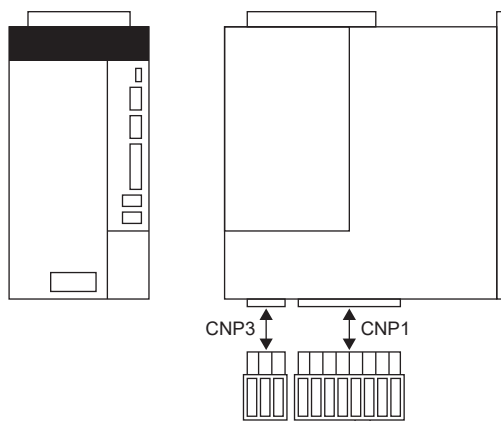
### Connector

#### ■MR-JET-60\_4\_ to MR-JET-350\_4\_



Connector	Receptacle assembly	Applicable wire		Stripped length [mm]	Open tool	Manufac turer
		Size	Insulator OD			
CNP1	06JFAT-SAXGDK-HT10.5 (LA)	AWG 18 to 14	3.9 mm or less	9	J-FAT-OT-XL	JST
CNP2	05JFAT-SAXGDK-HT7.5 (LA)					
CNP3	03JFAT-SAXGDK-HT10.5 (LA)					

#### ■MR-JET-500\_4\_, MR-JET-700\_4\_



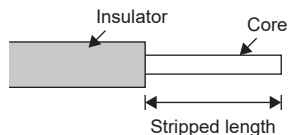
Connector	Receptacle assembly	Applicable wire		Stripped length [mm]	Open tool	Manufac turer
		Size	Insulator OD			
CNP1	831-1108/MNC	AWG 20 to 8	6.6 mm or less	11 to 13	—	WAGO
CNP3	831-1103/MNA					

## Connecting wires

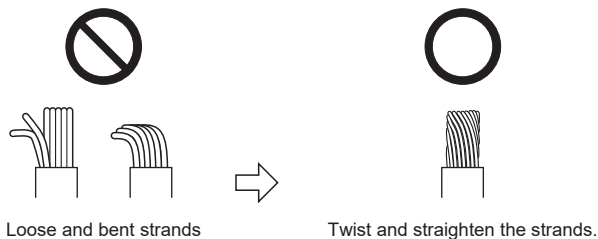
### ■Fabricating the wire insulator

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 43 Connector



Twist the core wires lightly and straighten them as follows.



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.

- For the ferrule by Phoenix Contact

Servo amplifier	Wire size	Ferrule model		Crimping tool
		For one wire <sup>*1</sup>	For two wires <sup>*1</sup>	
MR-JET-60_4_ to MR-JET-350_4_	AWG 16	AI 1, 5 -10_	AI-TWIN 2X 1, 5 -10_	CRIMPFOX 6 CRIMPFOX ZA 3
	AWG 14	AI 2, 5 -10_	—	
MR-JET-500_4_ to MR-JET-700_4_	AWG 14	AI 2, 5 -12_	—	
	AWG 12	AI 4 -12_	—	
	AWG 10	AI 6 -12_	—	

<sup>\*1</sup> A symbol (2 alphabetic characters) indicating the color code is placed in "\_" in the ferrule model. Refer to the catalog by the manufacturer for details of the color code.

- For the ferrule by WAGO

Servo amplifier	Wire size	Ferrule model	Crimping tool
		For one wire	
MR-JET-500_4_ to MR-JET-700_4_	AWG 14	216-266	Variocrimp 4
	AWG 12	216-267	
	AWG 10	216-208	Variocrimp 16

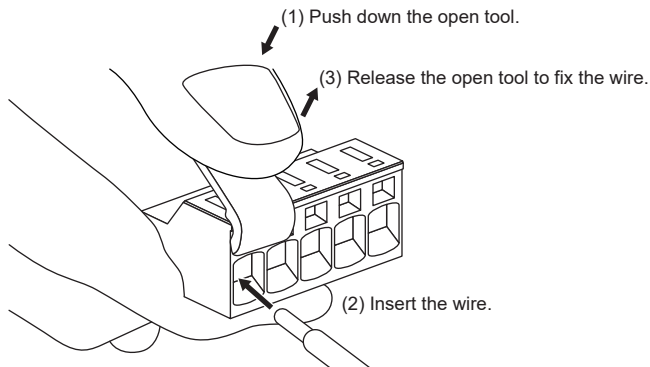
### ■Inserting a wire (MR-JET-60\_4\_ to MR-JET-350\_4\_)

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.

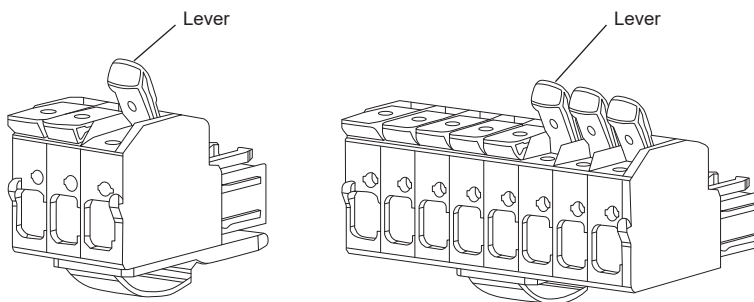


### ■Inserting a wire (MR-JET-500\_4\_, MR-JET-700\_4\_)

- For stranded wire connection

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

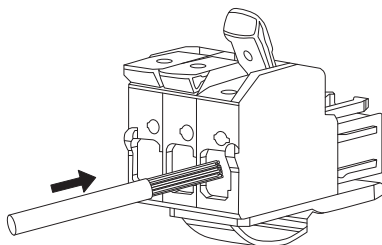
1. Push the lever up until it clicks.



2. Insert a properly stripped wire into the wire insertion hole.

The recommended wire strip length is 11 mm to 13 mm.

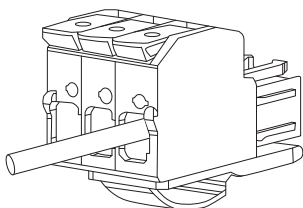
Check the wire insertion depth so that the wire insulator is not caught by the spring and that the conductive part of the stripped wire is not exposed.



**3.** Push the lever down until it clicks 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.

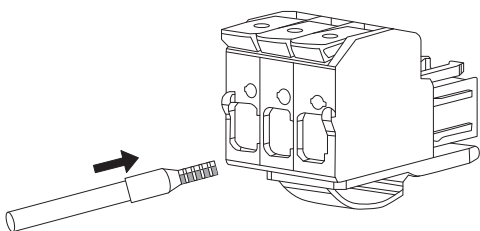


• For solid wire or treated-tip wire

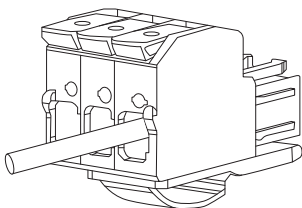
A solid wire or treated-tip wire can be inserted with the lever closed.

If the wiring cannot be performed as shown in the following procedure, perform the wiring following "For stranded wire connection".

**1.** Insert a solid wire or a wire with a treated tip all the way into the wire insertion hole.



**2.** Pull the wire lightly to confirm that the wire is surely connected.

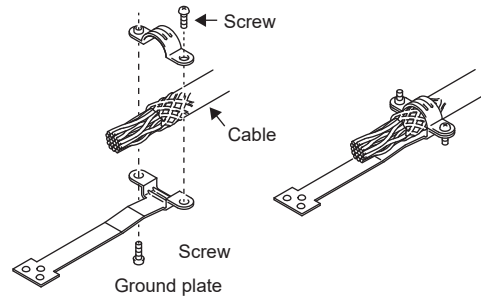


## 3.4 Connectors and pin assignments

### 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

## MR-JET-\_G(-N1)

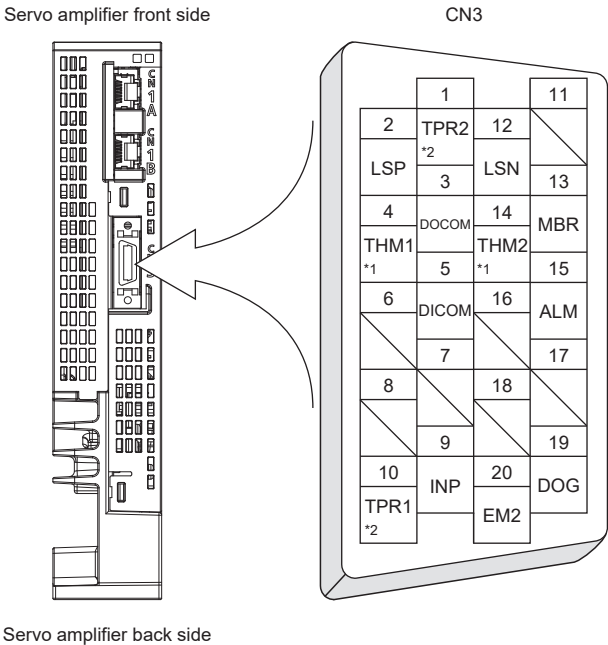
The front view of the servo amplifier shown below is of MR-JET-\_G\_ servo amplifier with a rated capacity symbol of 40 or less. Refer to the following for the appearance and connector layout of the other servo amplifiers.

➡ Page 72 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.

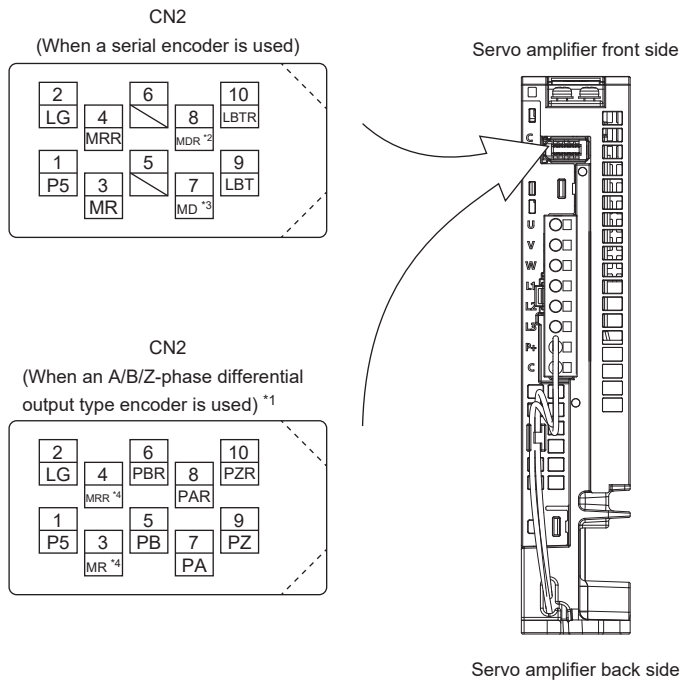


\*1 THM1 and THM2 are for connecting a servo motor thermistor. These signals can be used on servo amplifiers with firmware version B2 or later.

\*2 This signal can be used on servo amplifiers with firmware version C4 or later and manufactured in July 2022 or later.

- Assignment of CN2 connector pins

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



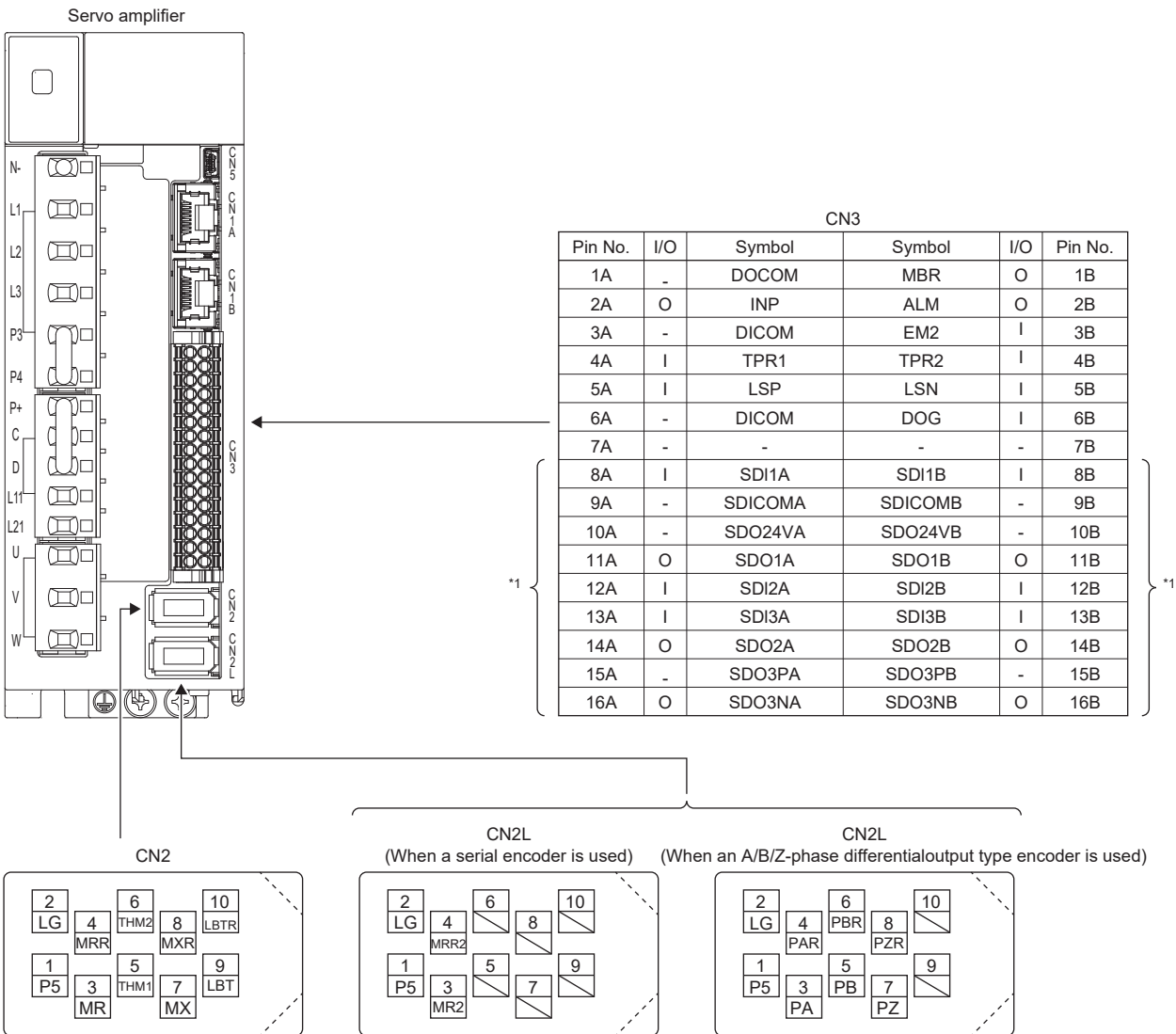
- \*1 When using an A/B/Z-phase differential output type encoder, set [Pr. PC26.0 A/B/Z-phase input encoder connection setting selection] to "2 (enabled)". [Pr. PC26.0] can be used on servo amplifiers with firmware version B2 or later.
- \*2 For a fully closed loop system, this pin is MXR.
- \*3 For a fully closed loop system, this pin is MX.
- \*4 This signal can be used on servo amplifiers with firmware version E4 or later.

MR-JET- G \_-HS(N1)

The front view of the servo amplifier shown below is of MR-JET-60G4-HS servo amplifiers. Refer to the following for the appearance and connector layout of the other servo amplifiers.

Page 72 DIMENSIONS

The frames of the CN2 and CN2L connectors are connected to the protective earth terminal in the servo amplifier.



\*1 Refer to the following for details on these I/O signals.

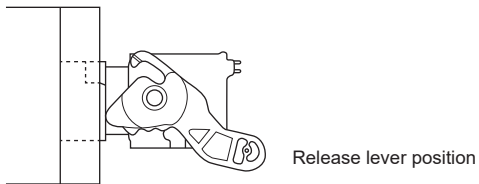
Page 176 Connectors and pin assignments

## ■ Mounting/removing the CN3 connector

- Lock/release lever position

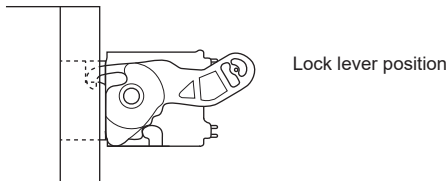
To facilitate the mounting/removal of the CN3 connector, a three-step positioning stopper is provided to prevent the lever from rotating freely.

When mounting or removing the CN3 connector, move the lever to the lock/release position.



### ■ Release lever position

When the lever is at this position, the connector is completely pulled out of the unit. Rotate the lever from the lock position to the release position to lift the terminal block off the unit.



### ■ Lock lever position

When the lever is at this position, the connector is fully mated with the unit. Check the lock lever position and lightly pull the connector to confirm that the servo amplifier and connector are fully mated.

- Mounting procedure

Set the lever to the release position and push it to the terminal block. When the lever is fully pushed in, the tab on the lever engages the unit and they mate with the terminal block.

- Removal procedure

Rotate the lever to the release position and remove the connector from the unit.

## Precautions

When mounting the CN3 connector, confirm that the lever is at the release position. If the mounting is performed with the lever at the lock position, the lever may be damaged.

## ■Inserting a wire to the CN3 connector

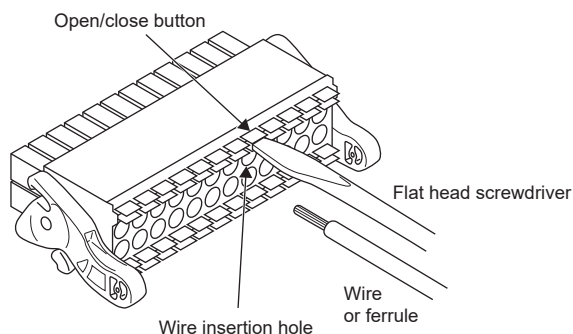
Since the CN3 connector is a push-in type, wiring can be performed without tools simply by inserting the connection terminal into the wire insertion hole.

When stranded wires are used, tools are required for wire connection since push-in is not supported.

- Inserting a wire

Fully insert a stripped wire or ferrule into the wire insertion hole.

If they cannot be inserted with this method, use a flat head screwdriver with a tip width of 2.0 mm to 2.5 mm to hold down the open/close button and push the wire or ferrule all the way seated in the hole. When the wire or ferrule is fully inserted, remove the driver.



## Precautions

Pull the wire or ferrule lightly to confirm that the wire or ferrule is securely connected.

When performing wiring using thick wires, do not expose the conductive parts to the front surface.

## ■Removing the wire from the CN3 connector

- Removing the wire

Using a flat head screwdriver with a tip width of 2.0 mm to 2.5 mm, hold down the open/close button and pull out the wire or ferrule.

## 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 68 Detailed explanation of interfaces

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

### Input device

#### Input device pins

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

##### ■MR-JET-\_G(-N1)

Connector pin No.	Servo parameter	Initially assigned device	TPR assignment	I/O signal interface type
CN3-1 *1	[Pr. PD39]	—	Possible	DI-1
CN3-2	[Pr. PD03]	LSP	Impossible	
CN3-10 *1	[Pr. PD38]	—	Possible	
CN3-12	[Pr. PD04]	LSN	Impossible	
CN3-19	[Pr. PD05]	DOG	Impossible	
CN3-20	—	EM2	Impossible	

\*1 This pin can be used on servo amplifiers with firmware version C4 or later and manufactured in July 2022 or later.

##### ■MR-JET-\_G\_-HS(N1)

Connector pin No.	Servo parameter	Initially assigned device	TPR assignment	I/O signal interface type
CN3-3B	—	EM2	Impossible	DI-1
CN3-4A	[Pr. PD38]	—	Possible	
CN3-4B	[Pr. PD39]	—	Possible	
CN3-5A	[Pr. PD03]	LSP	Impossible	
CN3-5B	[Pr. PD04]	LSN	Impossible	
CN3-6B	[Pr. PD05]	DOG	Impossible	

#### Input device explanation



When using the MR-JET-\_G\_-HS(N1), refer to the following for details on the devices used in functional safety.

 Page 176 Connectors and pin assignments

## ■EM2 (Forced stop 2)

When EM2 is turned off (open between commons), the servo motor decelerates to a stop with commands.

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.

For details, refer to "Forced stop deceleration function" in the following manual.

📖MR-JET User's Manual (Function)

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.

For details, refer to "GAIN SWITCHING FUNCTION" in the following manual.

MR-JET User's Manual (Adjustment)

### ■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.

For details, refer to "GAIN SWITCHING FUNCTION" in the following manual.

MR-JET User's Manual (Adjustment)

### ■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



### ■CLD (fully closed loop selection)

This device can be used when the semi closed/fully closed loop control switching is enabled by [Pr. PE01].

The semi closed loop control is selected when CLD is turned off, and fully closed loop control is selected when CLD is turned on. The input device is available on servo amplifiers with firmware version C4 or later.

 Page 223 USING A FULLY CLOSED LOOP SYSTEM

### ■TPR1 (Touch probe 1)/TPR2 (Touch probe 2)/TPR3 (Touch probe 3)

These are available on servo amplifiers with firmware version C4 or later and manufactured in July 2022 or later.

These devices enable the touch probe function, which latches the current position with sensor input or by other means.

Turning on this device latches the current position.

For details, refer to "Touch probe" in the following manual.

 MR-JET User's Manual (Function)

# Output device

## Output device pins

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

### ■MR-JET-\_G(-N1)

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	

### ■MR-JET-\_G\_-HS(N1)

Connector pin No.	Servo parameter	Initially assigned device	I/O signal interface type
CN3-1B	[Pr. PD07]	MBR	DO-1
CN3-2A	[Pr. PD08]	INP	
CN3-2B	[Pr. PD09]	ALM	

## Output device explanation



When using the MR-JET-\_G\_-HS(N1), refer to the following for details on the devices used in functional safety.

Page 176 Connectors and pin assignments

### ■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.

For details, refer to "Alarm function" in the following manual.

MR-JET User's Manual (Function)

### ■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.

For details, refer to "In-position range setting" in the following manual.

MR-JET User's Manual (Function)

### ■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 (mm/s) 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.

 Page 166 ABSOLUTE POSITION DETECTION SYSTEM

### ■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. For details, refer to "Instantaneous power failure tough drive" in the following manual.

 MR-JET User's Manual (Function)

### ■CLDS (Fully closed loop control in progress)

When the fully closed loop control is in progress, the CLDS is on.

The output device is available on servo amplifiers with firmware version C4 or later.

### ■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.

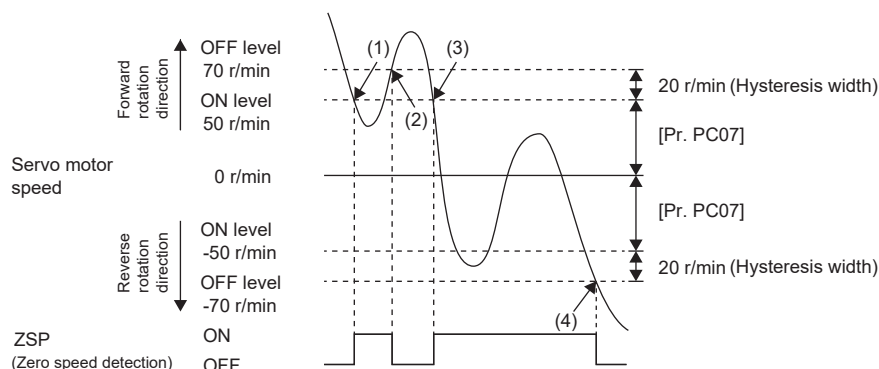
The device cannot be used in the position mode or the velocity mode.

For details, refer to "Speed limit" in the following manual.

 MR-JET User's Manual (Function)

## ■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.

If using a linear servo motor, replace [r/min] with [mm/s].

## ■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.

For details, refer to "Torque limit" in the following manual.

MR-JET User's Manual (Function)

## ■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.

## Internal connection diagram

**Servo amplifier wiring diagram**

The diagram illustrates the internal wiring of a servo amplifier, showing the connection between the servo motor, encoder, and various control inputs.

**Key Components and Connections:**

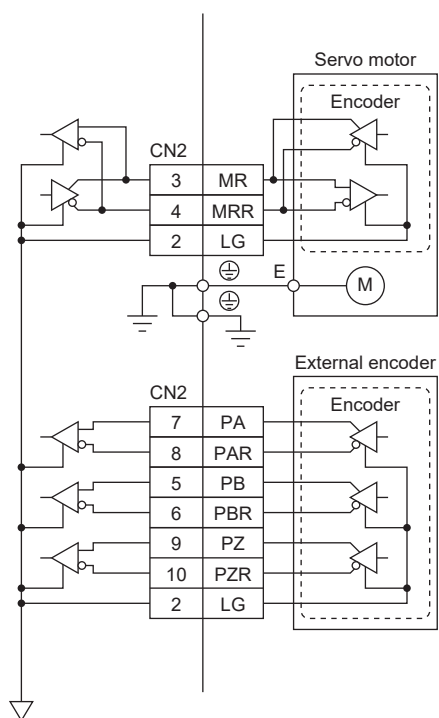
- Servo Motor & Encoder:** The servo motor (M) is connected to the encoder. The encoder's output is connected to the servo amplifier's CN2 connector.
- Servo Amplifier (CN3):** The servo amplifier's internal components include:
  - MD<sup>\*7</sup>** (Pin 7) and **MDR<sup>\*6</sup>** (Pin 8): Connected to the encoder's output.
  - MR** (Pin 3), **MRR** (Pin 4), and **LG** (Pin 2): Connected to the encoder's output.
  - DOCOM** (Pin 3), **MBR** (Pin 13), **INP<sup>\*3</sup>** (Pin 9), and **ALM** (Pin 15): Connected to the encoder's output.
  - RA1**, **RA2**, and **RA3**: Resistors connected to the encoder's output.
- USB Connection (CN5):** The USB connection is made to the servo amplifier's CN5 connector:
  - D-** (Pin 2)
  - D+** (Pin 3)
  - GND** (Pin 5)
- Forced Stop 2 (CN3):** The forced stop inputs are connected to the servo amplifier's CN3 connector:
  - EM2** (Pin 20)
  - LSP** (Pin 2)
  - LSN** (Pin 12)
  - DOG** (Pin 19)
  - TPR1** (Pin 10<sup>\*5</sup>)
  - TPR2** (Pin 1<sup>\*5</sup>)
  - DICOM** (Pin 5)
- Resistors:** Various resistors are used throughout the circuit, including RA1, RA2, RA3, and several 6.2 kΩ and 4.3 kΩ resistors.

The diagram is labeled with various components and their connections, including pin numbers and component values.

👉 Page 69 Source I/O interface

\*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.



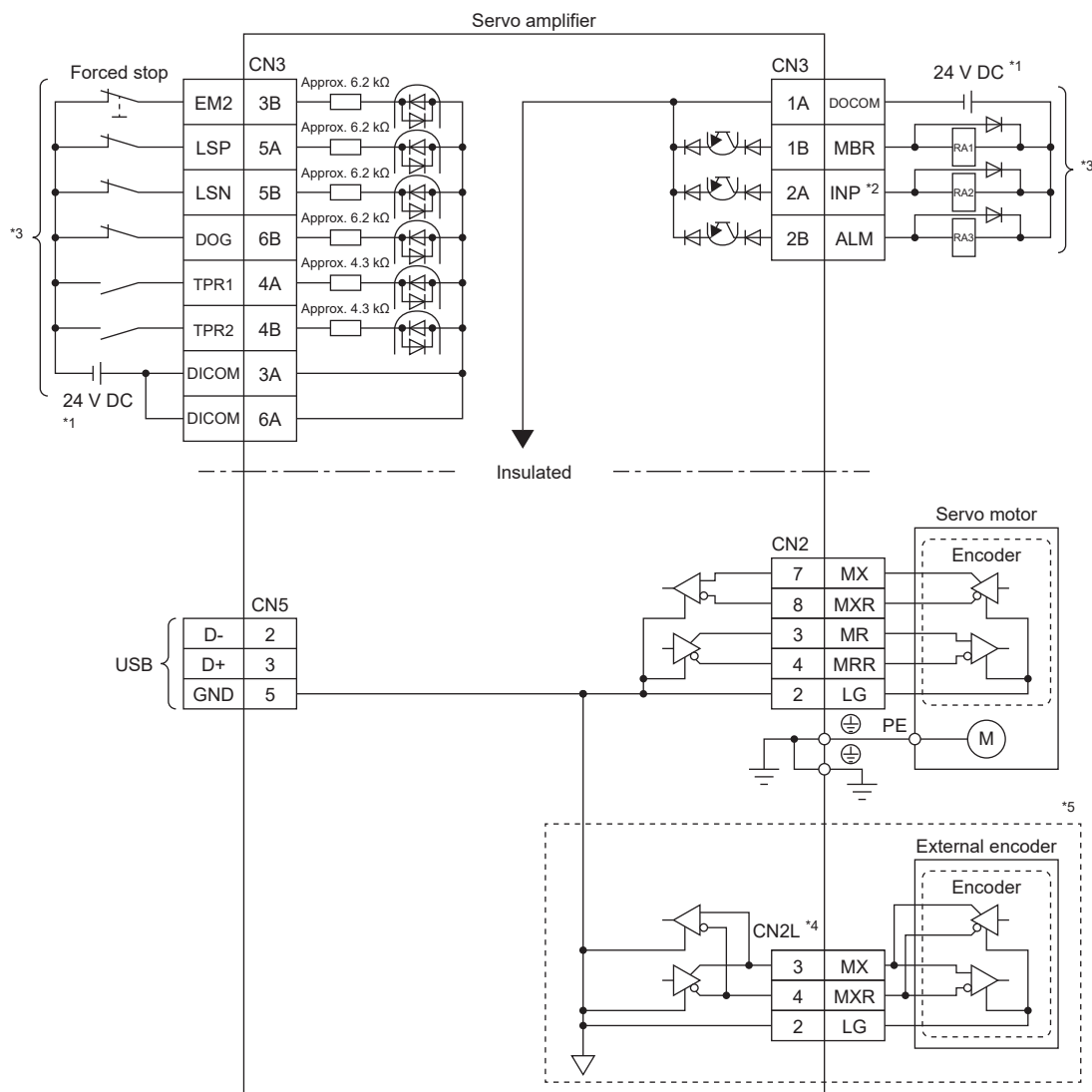
\*5 This pin can be used on servo amplifiers with firmware version C4 or later and manufactured in July 2022 or later.

\*6 For a fully closed loop system, this pin is MXR.

\*7 For a fully closed loop system, this pin is MX.

Refer to the following for 8A to 16A and 8B to 16B of the CN3 connector.

Page 172 USING FUNCTIONAL SAFETY



<sup>\*1</sup> 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.

<sup>\*2</sup> The signal cannot be used in the velocity mode and torque mode.

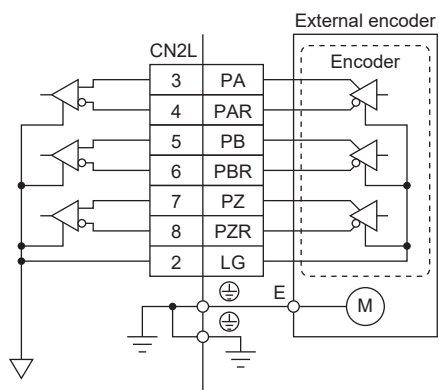
<sup>\*3</sup> This diagram shows a sink I/O interface. For the source I/O interface, refer to the following.

Page 69 Source I/O interface

<sup>\*4</sup> Refer to "Parts identification" in User's Manual (Introduction) for connecting an external encoder.



\*5 The internal wiring diagram shown below should be used when connecting an A/B/Z-phase differential output type encoder to CN2L.



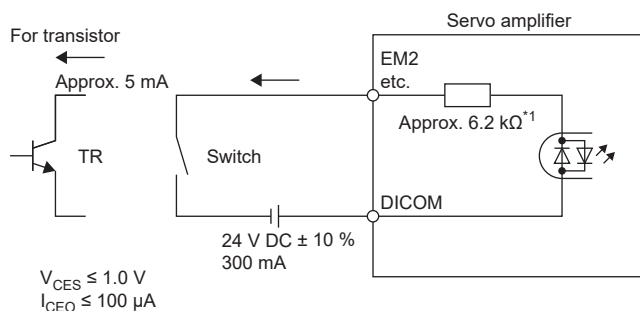
## Detailed explanation of interfaces

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 56 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.



\*<sup>1</sup> For interfaces of the CN3-4A pin and CN3-4B pin of the MR-JET-\_G\_-HS(N1), it is approximately 4.3 k $\Omega$ .

Refer to the following for source input.

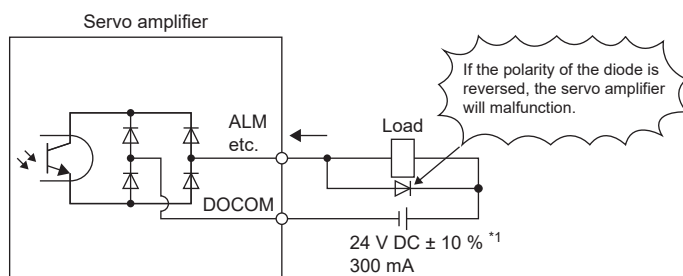
☞ Page 69 Source I/O interface

### 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.



\*<sup>1</sup> 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.

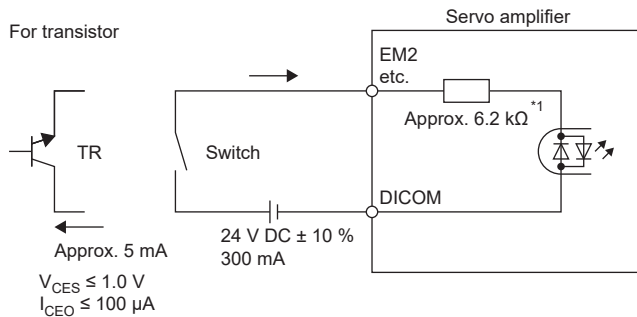
☞ Page 69 Source I/O interface

## 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.

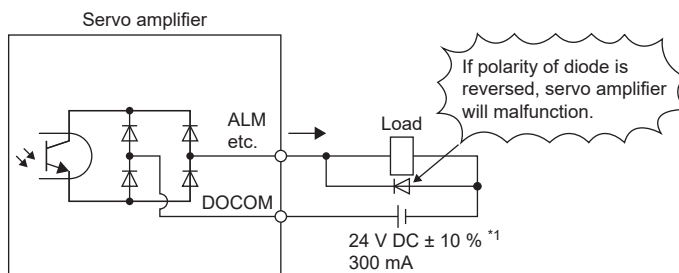


\*1 For interfaces of the CN3-4A pin and CN3-4B pin of the MR-JET-\_G\_-HS(N1), it is approximately 4.3 kΩ.

### 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

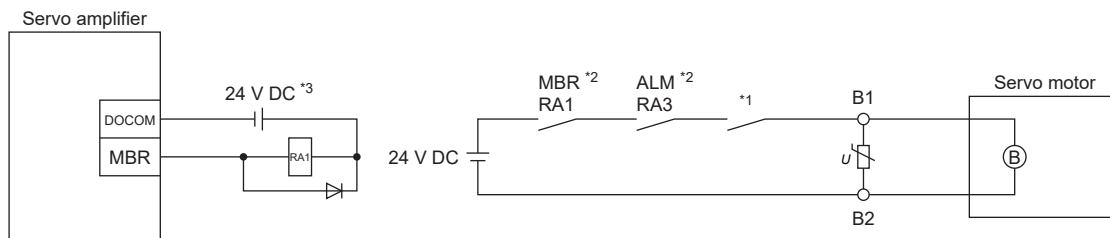
### Precautions

- 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 (For MR-JET)

- 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.
- Malfunction of MBR (Electromagnetic brake interlock) or ALM (Malfunction) causes malfunction of the brake.
- 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 Malfunction of MBR or ALM causes malfunction of the brake.

\*3 Do not use the 24 V DC interface power supply for the electromagnetic brake.

## 3.8 Grounding

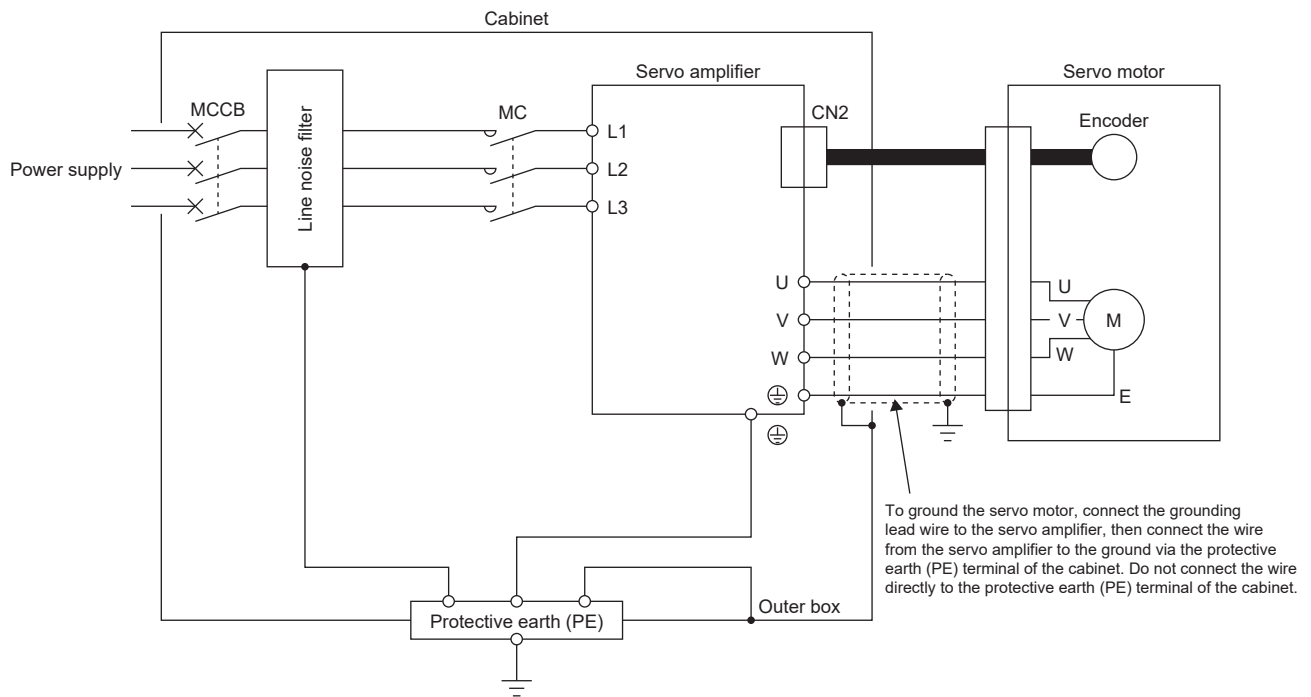
The servo amplifier supplies power to the servo motor by switching on and off a power transistor. Depending on the wiring and ground wire routing, the servo amplifier may be affected by the switching noise (due to  $di/dt$  and  $dv/dt$ ) of the transistor. To prevent such a fault, refer to the following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

For information on how to comply with the EMC Directive, refer to the following guidelines.

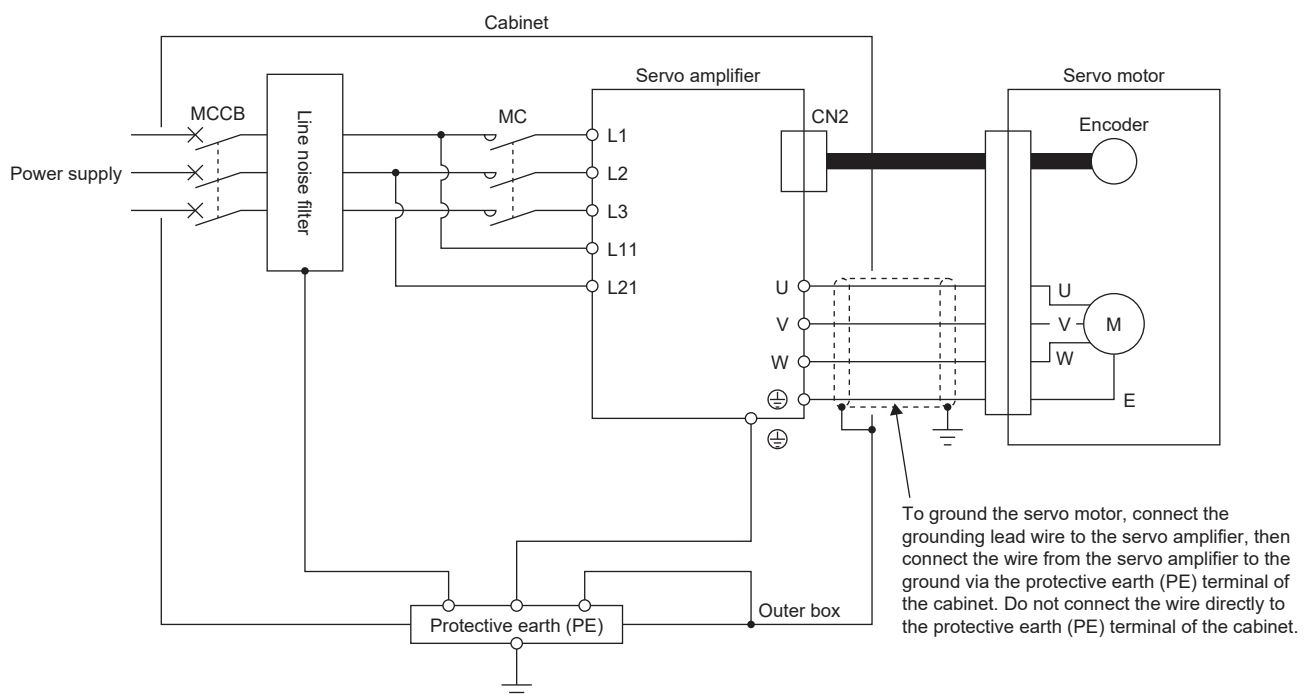
📖 EMC Installation Guidelines

3

### 200 V



### 400 V

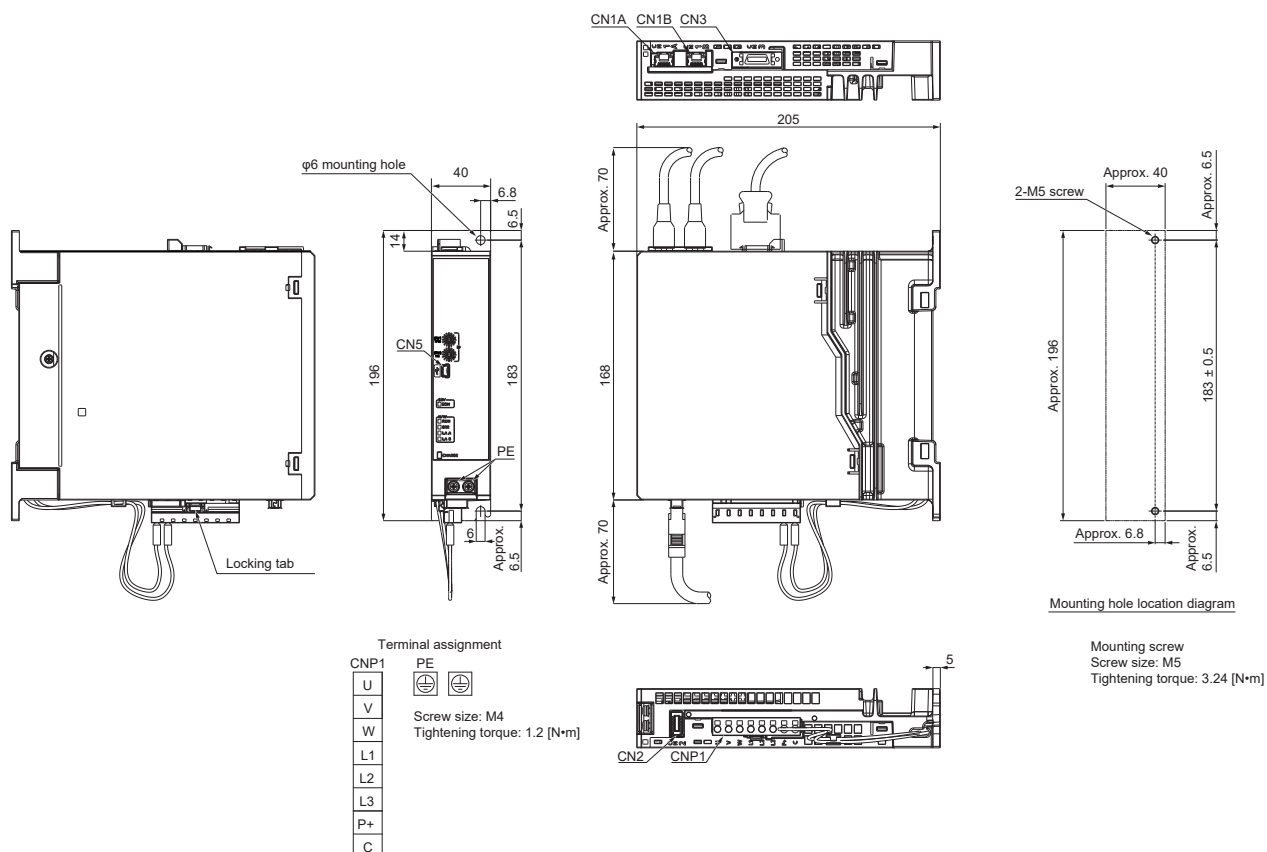


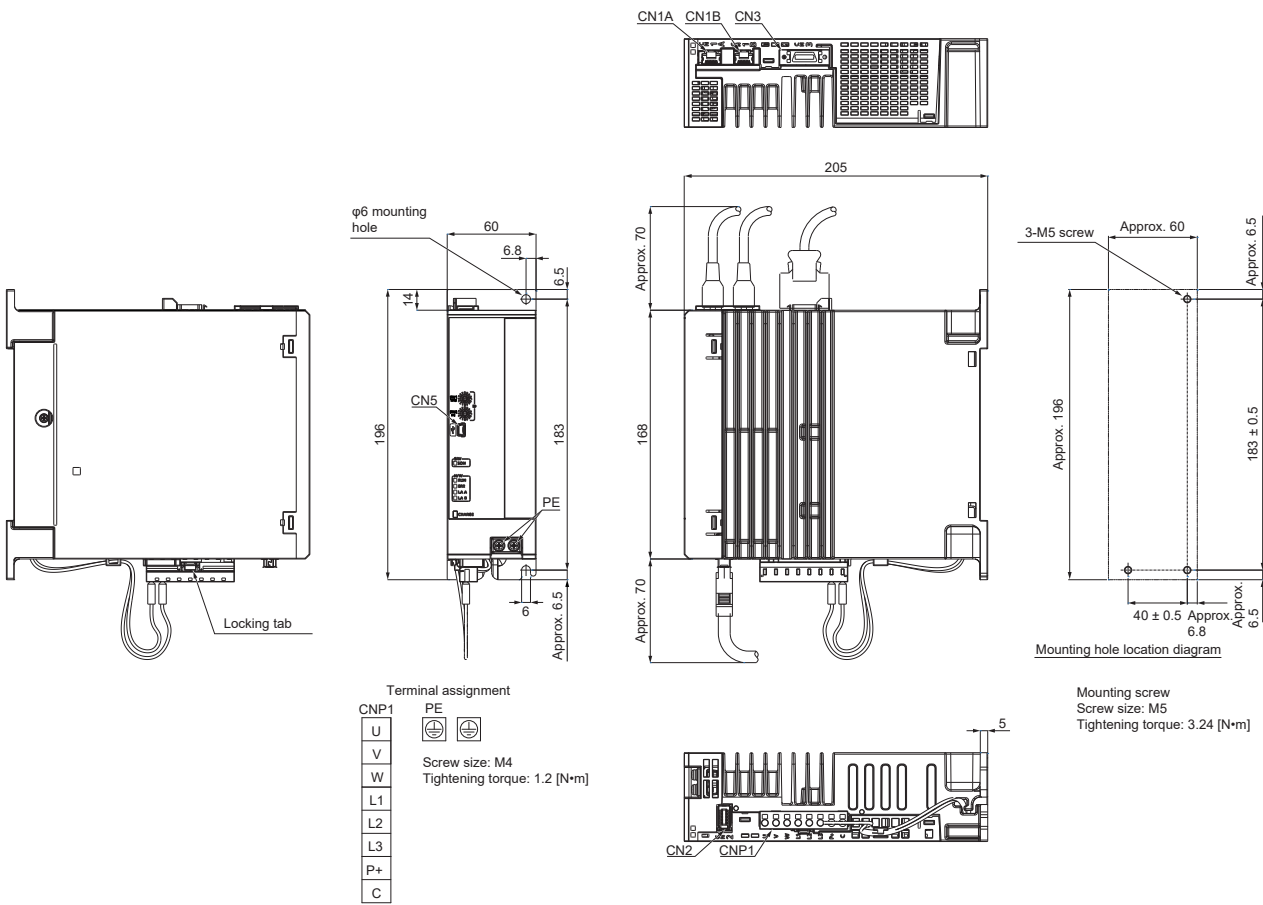
# 4 DIMENSIONS

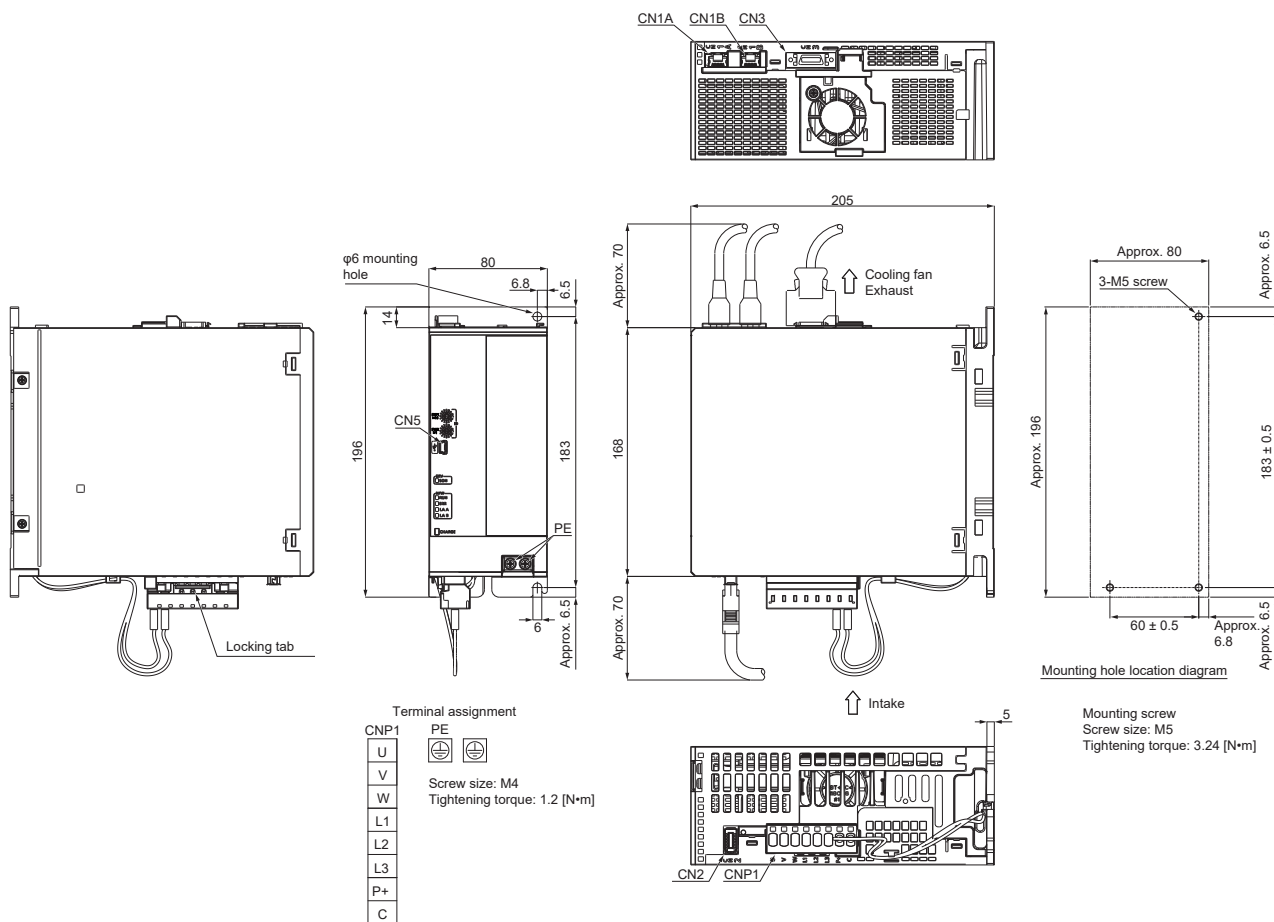
## 4.1 Servo amplifier

200 V

MR-JET-10G\_/MR-JET-20G\_/MR-JET-40G\_





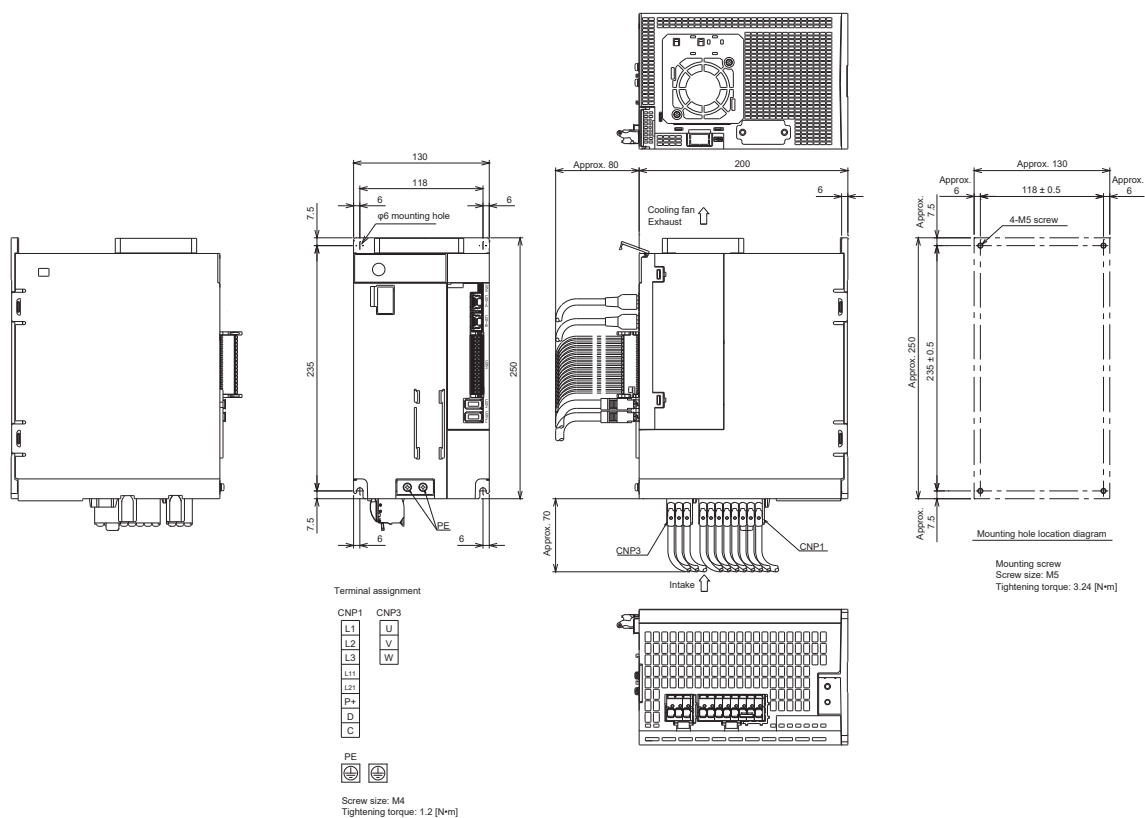






# MR-JET-500G4-HS(N1)/MR-JET-700G4-HS(N1)

[Unit: mm]



# 4.2 Connector

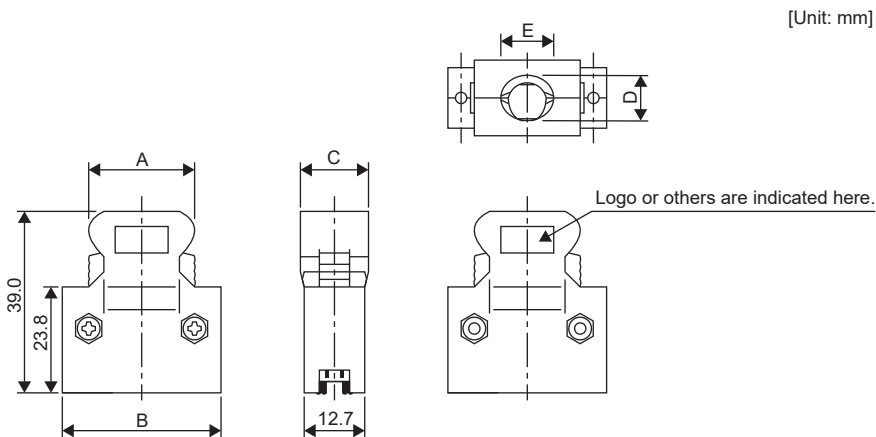
## Precautions

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

## CN3 connector

### Miniature delta ribbon (MDR) system (3M)

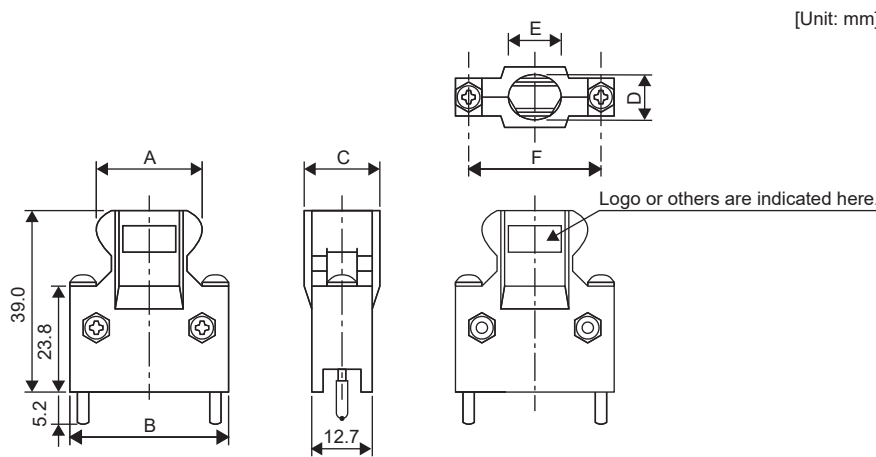
#### One-touch lock type



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.



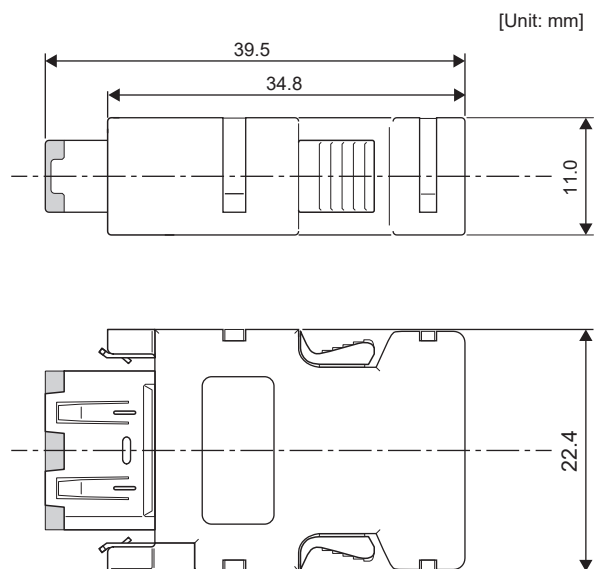
Connector	Shell kit	Variable dimensions					
		A	B	C	D	E	F
10120-3000PE	10320-52A0-008	22.0	33.3	14.0	10.0	12.0	27.4

## CN2 connector

### SCR connector system (3M)

Receptacle: 36210-0100PL

Shell kit: 36310-3200-008



## CN2L connector

Page 78 CN2 connector

# 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. In this section, overload protection characteristics refer to the overload protection characteristics of servo amplifiers and servo motors.

Operation exceeding the overload protection characteristics described in this section will cause [AL. 050 Overload 1] or [AL. 051 Overload 2]. 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 120 % of the rated current (full load current).)

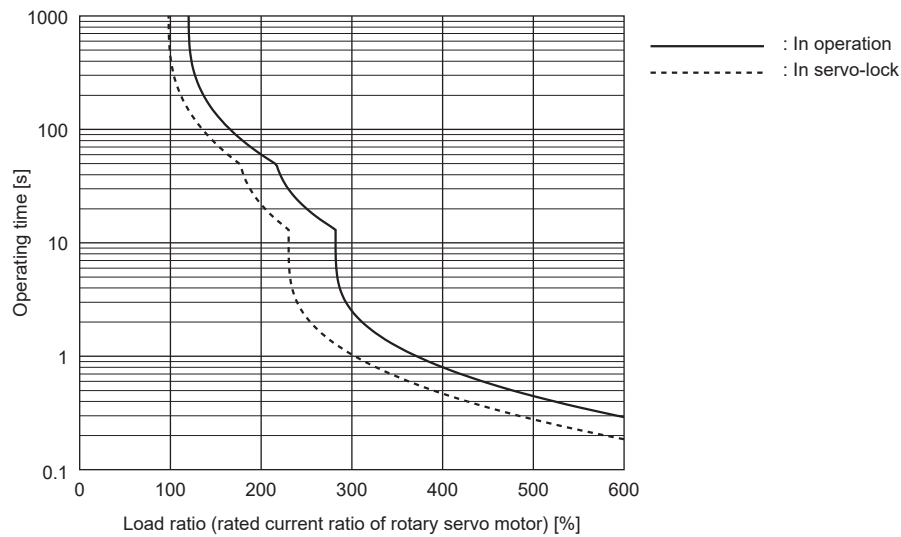
The servo amplifier may malfunction regardless of the electronic thermal protection if torque exceeding 100 % of the rated torque is generated too frequently while the servo motor is stopped (servo-lock status) or being operated at low speeds of 50 r/min or less.

### Graph of overload protection characteristics

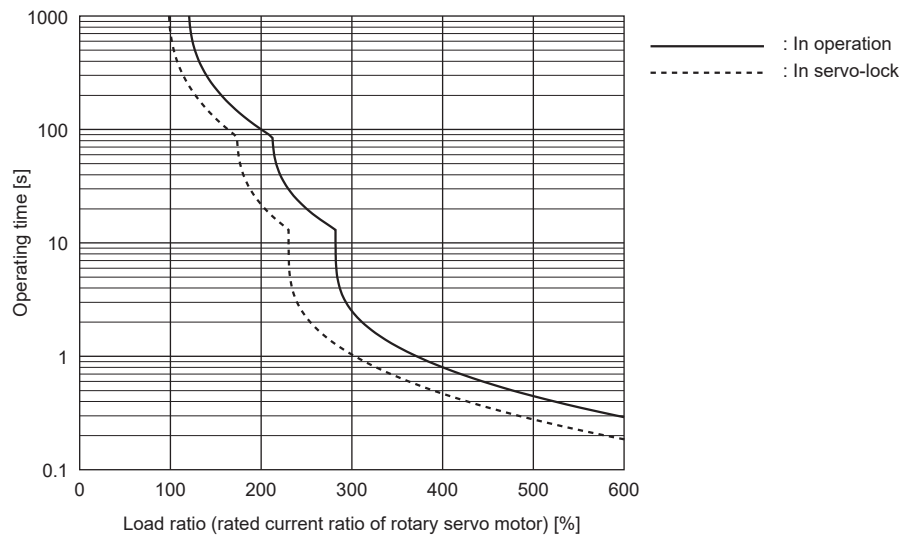
The following table lists servo motors and corresponding graphs of overload protection characteristics. The overload protection characteristics depend on the servo motor.

Rotary servo motor						Graph of overload protection characteristics
HK-KN	HK-KN_4	HK-FN	HK-SN_4	HG-KNS	HG-SNS	
—	—	—	—	13_	—	☞ Page 80 Characteristic a
—	—	—	—	23_ 43_ 73_	52_ 102_	☞ Page 80 Characteristic b
—	—	—	—	—	152_ 202_ 302_	☞ Page 80 Characteristic c
053_ 13_	134_	—	—	—	—	☞ Page 81 Characteristic d
1M3_ 23_ 43_ 63_ 7M3_ 103_	234_ 434_ 634_ 7M34_ 1034_	13_ 23_ 43_ 7M3_ 102_	—	—	—	☞ Page 81 Characteristic e
153_ 203_ 202_	1534_ 2034_	152_ 202_ 301M_	3534_ 5034_ 7034_	—	—	☞ Page 81 Characteristic f

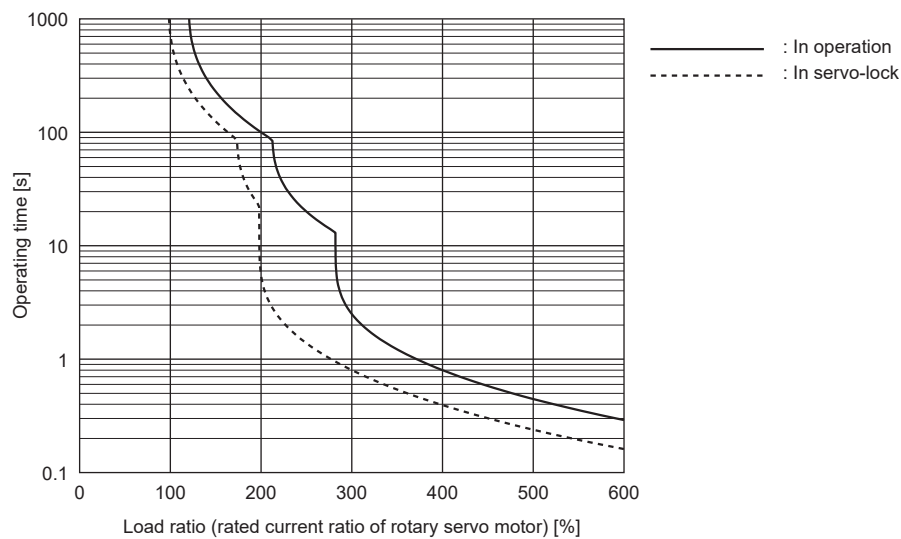
■Characteristic a



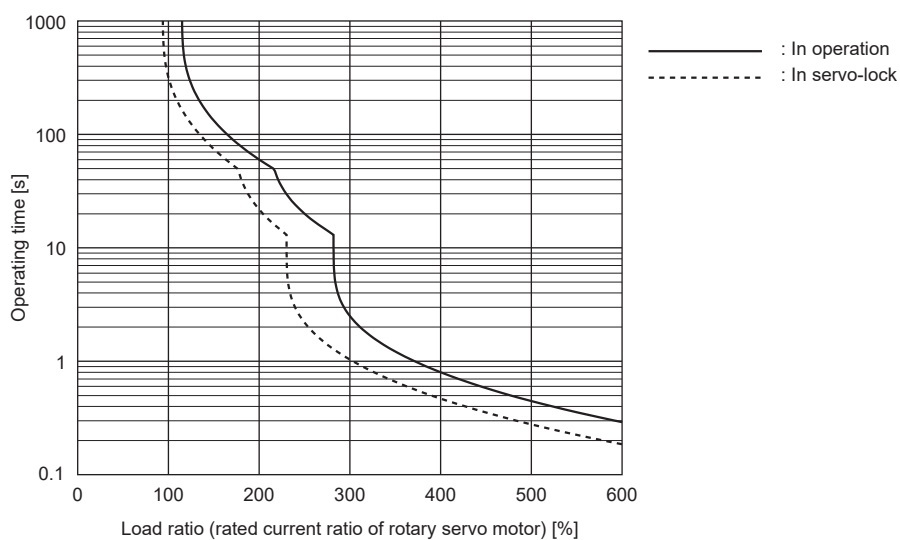
■Characteristic b



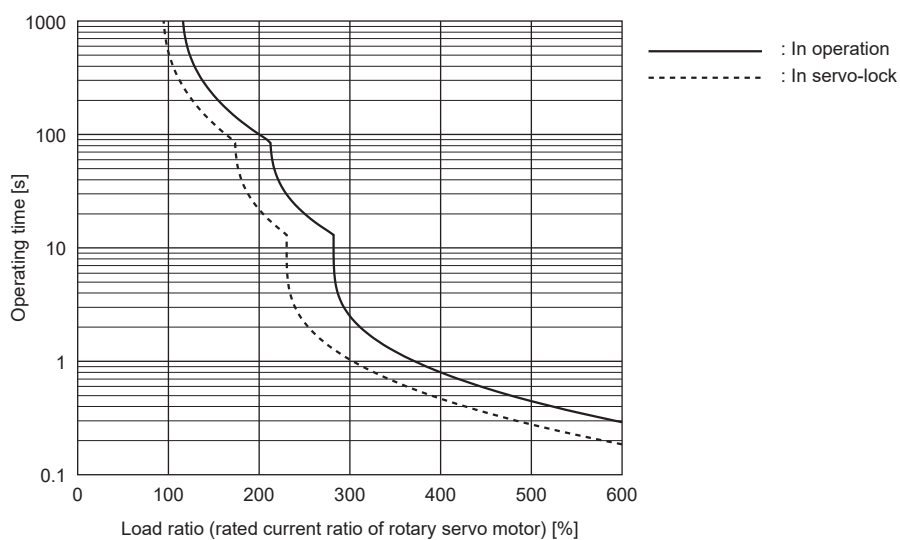
■Characteristic c



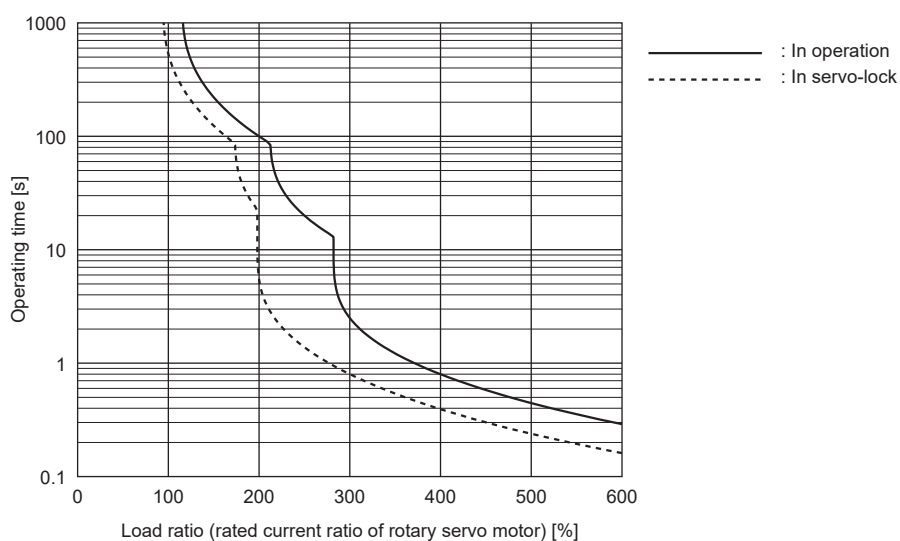
### Characteristic d



### Characteristic e



### Characteristic f



## 5.2 Power supply capacity and generated loss

### Power supply capacity

The following table indicates power supply capacities of servo amplifiers. The power supply capacity of the servo amplifier is the same as that for the 3-phase power supply input and the 1-phase power supply input.

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

#### 200 V

##### ■HK-KN series

Rotary servo motor	Servo amplifier	Power supply capacity [kVA] *1
HK-KN053_	MR-JET-10_	0.3
HK-KN13_	MR-JET-10_	0.3
HK-KN1M3_	MR-JET-20_	0.5
HK-KN23_	MR-JET-20_	0.5
HK-KN43_	MR-JET-40_	0.9
HK-KN63_	MR-JET-70_	1.3
HK-KN7M3_	MR-JET-70_	1.3
HK-KN103_	MR-JET-100_	1.9
HK-KN153_	MR-JET-200_	2.6
HK-KN203_	MR-JET-200_	3.2
HK-KN202_	MR-JET-200_	3.3

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

##### ■HK-FN series

Rotary servo motor	Servo amplifier	Power supply capacity [kVA] *1
HK-FN13_	MR-JET-10_	0.3
HK-FN23_	MR-JET-20_	0.5
HK-FN43_	MR-JET-40_	0.9
HK-FN7M3_	MR-JET-70_	1.4
HK-FN102_	MR-JET-100_	1.8
HK-FN152_	MR-JET-200_	2.5
HK-FN202_	MR-JET-200_	3.1
HK-FN301M_	MR-JET-300_	3.1

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

##### ■HG-KNS series

Rotary servo motor	Servo amplifier	Power supply capacity [kVA] *1
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

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

##### ■HG-SNS series

Rotary servo motor	Servo amplifier	Power supply capacity[kVA] *1
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.



## 400 V

### ■HK-KN series

Rotary servo motor	Servo amplifier	Power supply capacity [kVA] *1
HK-KN134_	MR-JET-60_4_	0.4
HK-KN234_	MR-JET-60_4_	0.6
HK-KN434_	MR-JET-60_4_	1.1
HK-KN634_	MR-JET-60_4_	1.3
HK-KN7M34_	MR-JET-100_4_	1.8
HK-KN1034_	MR-JET-100_4_	2.3
HK-KN1534_	MR-JET-200_4_	3.1
HK-KN2034_	MR-JET-200_4_	4.0

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

### ■HK-SN series

Rotary servo motor	Servo amplifier	Power supply capacity [kVA] *1
HK-SN3534_	MR-JET-350_4_	5.5
HK-SN5034_	MR-JET-500_4_	7.5
HK-SN7034_	MR-JET-700_4_	10

\*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 harshest conditions with regard to the environment and operation pattern. 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.

#### ■200 V

Servo amplifier	Servo amplifier-generated heat [W] *1		Area required for heat dissipation [m <sup>2</sup> ]
	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 108 Regenerative option

#### ■400 V

Servo amplifier	Servo amplifier-generated heat [W] *1		Area required for heat dissipation [m <sup>2</sup> ]
	At rated output	At servo-off	
MR-JET-60_4_	50	18	1.0
MR-JET-100_4_	60	18	1.2
MR-JET-200_4_	90	20	1.8
MR-JET-350_4_	160	20	2.7
MR-JET-500_4_	195	25	3.9
MR-JET-700_4_	300	25	6.0

\*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 108 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.

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

A: Heat dissipation area [m<sup>2</sup>]

P: Loss generated in the cabinet [W]

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

K: Heat dissipation coefficient [5 to 6]

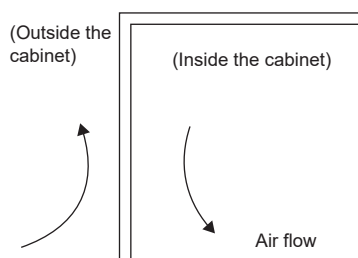
When calculating the heat dissipation area with the equation (5.1), assume that P is the sum of all losses generated in the cabinet. Refer to the following for details about the heat generated by the servo amplifier.

☞ Page 84 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 84 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 " $\tau$ " 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
HK-KN	HK-KN053_/HK-KN13_/HK-KN1M3_/HK-KN23_/HK-KN43_
HG-KNS	HG-KNS13_/HG-KNS23_/HG-KNS43_
HG-SNS	HG-SNS52_

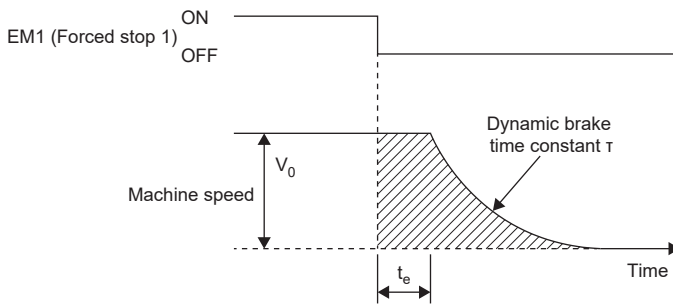
# Dynamic brake operation

## 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  $\tau$  varies with the servo motor and machine operation speeds.

☞ Page 88 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·m<sup>2</sup>]

$J_L$ : Load moment of inertia converted into equivalent value on servo motor shaft [ $\times 10^{-4}$  kg·m<sup>2</sup>]

$\tau$ : Dynamic brake time constant [s]

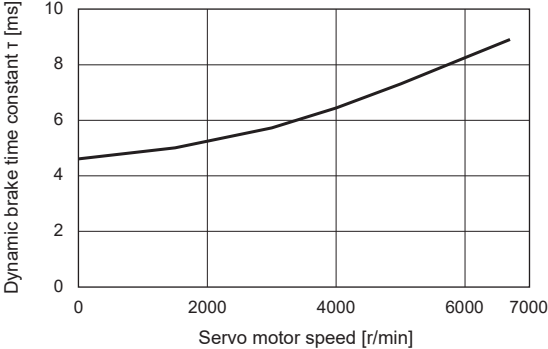
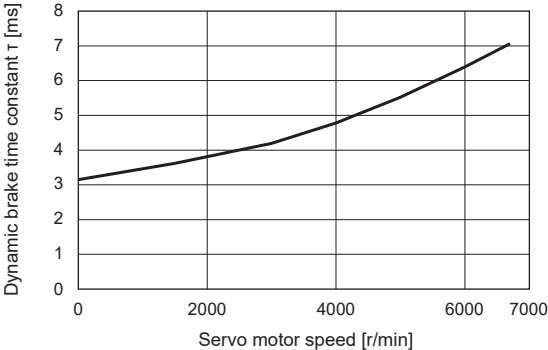
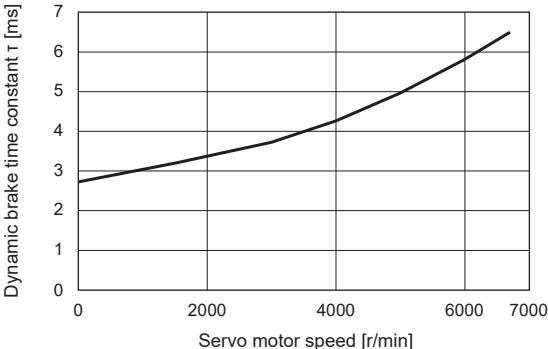
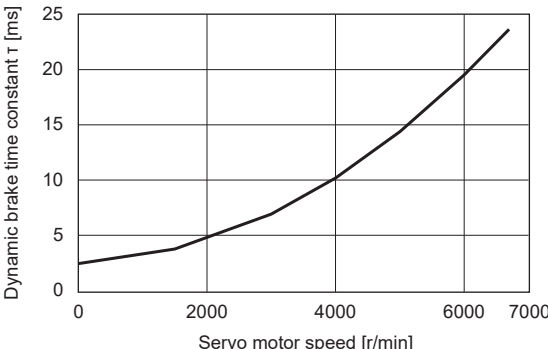
$t_e$ : Delay time of control section [s]

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

Dynamic brake time constant

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

- 200 V
- HK-KN/HK-FN series

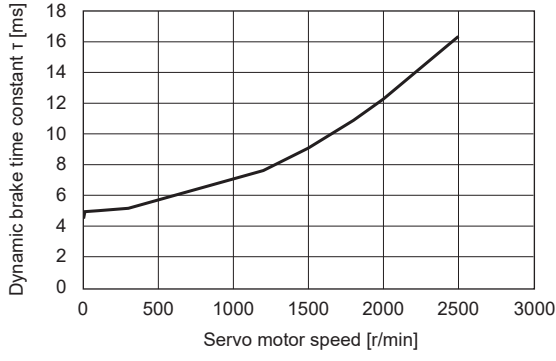
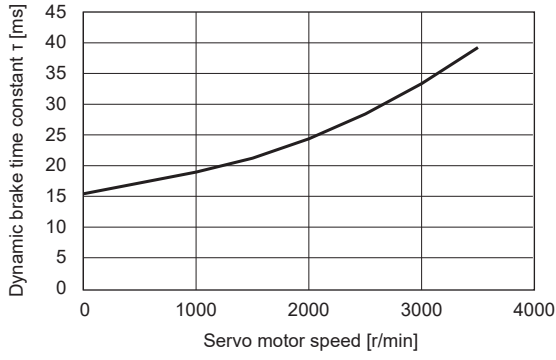
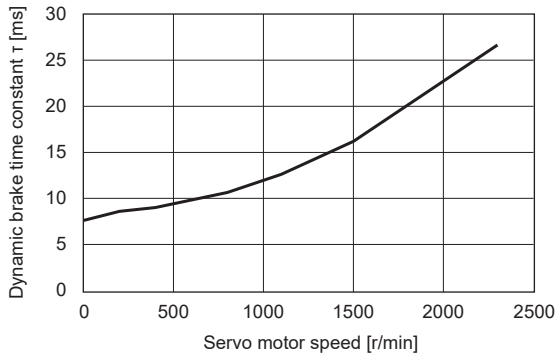
Servo motor	Waveform												
HK-KN053_	 <table border="1"><caption>Approximate data for HK-KN053_</caption><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>4.5</td></tr><tr><td>2000</td><td>5.2</td></tr><tr><td>4000</td><td>6.5</td></tr><tr><td>6000</td><td>8.2</td></tr><tr><td>7000</td><td>9.0</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	4.5	2000	5.2	4000	6.5	6000	8.2	7000	9.0
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	4.5												
2000	5.2												
4000	6.5												
6000	8.2												
7000	9.0												
HK-KN13_	 <table border="1"><caption>Approximate data for HK-KN13_</caption><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>3.2</td></tr><tr><td>2000</td><td>3.8</td></tr><tr><td>4000</td><td>4.8</td></tr><tr><td>6000</td><td>6.5</td></tr><tr><td>7000</td><td>7.2</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	3.2	2000	3.8	4000	4.8	6000	6.5	7000	7.2
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	3.2												
2000	3.8												
4000	4.8												
6000	6.5												
7000	7.2												
HK-KN1M3_	 <table border="1"><caption>Approximate data for HK-KN1M3_</caption><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>2.8</td></tr><tr><td>2000</td><td>3.5</td></tr><tr><td>4000</td><td>4.5</td></tr><tr><td>6000</td><td>5.8</td></tr><tr><td>7000</td><td>6.5</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2.8	2000	3.5	4000	4.5	6000	5.8	7000	6.5
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	2.8												
2000	3.5												
4000	4.5												
6000	5.8												
7000	6.5												
HK-KN23_	 <table border="1"><caption>Approximate data for HK-KN23_</caption><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>2.5</td></tr><tr><td>2000</td><td>5.0</td></tr><tr><td>4000</td><td>10.0</td></tr><tr><td>6000</td><td>18.0</td></tr><tr><td>7000</td><td>24.0</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2.5	2000	5.0	4000	10.0	6000	18.0	7000	24.0
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	2.5												
2000	5.0												
4000	10.0												
6000	18.0												
7000	24.0												

Servo motor	Waveform												
HK-KN43_	<p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-KN43_. The curve starts at approximately 2 ms at 0 r/min and increases to about 23 ms at 7000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>2</td></tr> <tr><td>2000</td><td>4</td></tr> <tr><td>4000</td><td>10</td></tr> <tr><td>6000</td><td>18</td></tr> <tr><td>7000</td><td>23</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2	2000	4	4000	10	6000	18	7000	23
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	2												
2000	4												
4000	10												
6000	18												
7000	23												
HK-KN63_	<p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-KN63_. The curve starts at approximately 10 ms at 0 r/min and increases to about 14 ms at 7000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>10</td></tr> <tr><td>2000</td><td>11</td></tr> <tr><td>4000</td><td>12</td></tr> <tr><td>6000</td><td>13</td></tr> <tr><td>7000</td><td>14</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	10	2000	11	4000	12	6000	13	7000	14
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	10												
2000	11												
4000	12												
6000	13												
7000	14												
HK-KN7M3_	<p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-KN7M3_. The curve starts at approximately 15 ms at 0 r/min and increases to about 24 ms at 7000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>15</td></tr> <tr><td>2000</td><td>17</td></tr> <tr><td>4000</td><td>19</td></tr> <tr><td>6000</td><td>22</td></tr> <tr><td>7000</td><td>24</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	15	2000	17	4000	19	6000	22	7000	24
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	15												
2000	17												
4000	19												
6000	22												
7000	24												
HK-KN103_	<p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-KN103_. The curve starts at approximately 22 ms at 0 r/min and increases to about 28 ms at 7000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>22</td></tr> <tr><td>2000</td><td>24</td></tr> <tr><td>4000</td><td>25</td></tr> <tr><td>6000</td><td>27</td></tr> <tr><td>7000</td><td>28</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	22	2000	24	4000	25	6000	27	7000	28
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	22												
2000	24												
4000	25												
6000	27												
7000	28												

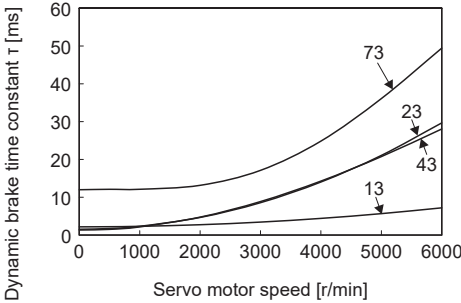
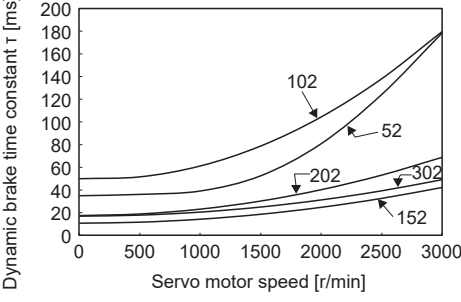
Servo motor	Waveform												
HK-KN153_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds as a function of servo motor speed in revolutions per minute (r/min) for the HK-KN153_ model. The y-axis ranges from 0 to 16 ms with increments of 2. The x-axis ranges from 0 to 7000 r/min with major ticks every 2000 units. The curve starts at approximately 5.5 ms at 0 r/min and increases non-linearly to about 14.5 ms at 7000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>5.5</td></tr> <tr><td>2000</td><td>7.0</td></tr> <tr><td>4000</td><td>9.0</td></tr> <tr><td>6000</td><td>12.5</td></tr> <tr><td>7000</td><td>14.5</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	5.5	2000	7.0	4000	9.0	6000	12.5	7000	14.5
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	5.5												
2000	7.0												
4000	9.0												
6000	12.5												
7000	14.5												
HK-KN203_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds as a function of servo motor speed in revolutions per minute (r/min) for the HK-KN203_ model. The y-axis ranges from 0 to 14 ms with increments of 2. The x-axis ranges from 0 to 7000 r/min with major ticks every 2000 units. The curve starts at approximately 5.5 ms at 0 r/min and increases non-linearly to about 12.5 ms at 7000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>5.5</td></tr> <tr><td>2000</td><td>7.0</td></tr> <tr><td>4000</td><td>9.0</td></tr> <tr><td>6000</td><td>11.5</td></tr> <tr><td>7000</td><td>12.5</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	5.5	2000	7.0	4000	9.0	6000	11.5	7000	12.5
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	5.5												
2000	7.0												
4000	9.0												
6000	11.5												
7000	12.5												
HK-KN202_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds as a function of servo motor speed in revolutions per minute (r/min) for the HK-KN202_ model. The y-axis ranges from 0 to 7 ms with increments of 1. The x-axis ranges from 0 to 4000 r/min with major ticks every 1000 units. The curve starts at approximately 3.0 ms at 0 r/min and increases non-linearly to about 5.8 ms at 3500 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>3.0</td></tr> <tr><td>1000</td><td>3.5</td></tr> <tr><td>2000</td><td>4.5</td></tr> <tr><td>3000</td><td>5.5</td></tr> <tr><td>3500</td><td>5.8</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	3.0	1000	3.5	2000	4.5	3000	5.5	3500	5.8
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	3.0												
1000	3.5												
2000	4.5												
3000	5.5												
3500	5.8												
HK-FN13_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds as a function of servo motor speed in revolutions per minute (r/min) for the HK-FN13_ model. The y-axis ranges from 0 to 7 ms with increments of 1. The x-axis ranges from 0 to 7000 r/min with major ticks every 2000 units. The curve starts at approximately 2.8 ms at 0 r/min and increases non-linearly to about 6.5 ms at 7000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>2.8</td></tr> <tr><td>2000</td><td>3.5</td></tr> <tr><td>4000</td><td>4.5</td></tr> <tr><td>6000</td><td>6.0</td></tr> <tr><td>7000</td><td>6.5</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2.8	2000	3.5	4000	4.5	6000	6.0	7000	6.5
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	2.8												
2000	3.5												
4000	4.5												
6000	6.0												
7000	6.5												



Servo motor	Waveform																
HK-FN23_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds on the y-axis (0 to 25) against servo motor speed in r/min on the x-axis (0 to 7000). The curve starts at approximately 2 ms at 0 r/min and increases steadily to about 23 ms at 7000 r/min.</p> <table border="1"><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>2</td></tr><tr><td>2000</td><td>4</td></tr><tr><td>4000</td><td>10</td></tr><tr><td>6000</td><td>18</td></tr><tr><td>7000</td><td>23</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2	2000	4	4000	10	6000	18	7000	23				
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]																
0	2																
2000	4																
4000	10																
6000	18																
7000	23																
HK-FN43_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds on the y-axis (0 to 30) against servo motor speed in r/min on the x-axis (0 to 7000). The curve starts at approximately 2 ms at 0 r/min and increases to about 24 ms at 7000 r/min.</p> <table border="1"><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>2</td></tr><tr><td>2000</td><td>4</td></tr><tr><td>4000</td><td>10</td></tr><tr><td>6000</td><td>18</td></tr><tr><td>7000</td><td>24</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2	2000	4	4000	10	6000	18	7000	24				
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]																
0	2																
2000	4																
4000	10																
6000	18																
7000	24																
HK-FN7M3_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds on the y-axis (0 to 25) against servo motor speed in r/min on the x-axis (0 to 7000). The curve starts at approximately 12 ms at 0 r/min and increases to about 22 ms at 7000 r/min.</p> <table border="1"><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>12</td></tr><tr><td>2000</td><td>13</td></tr><tr><td>4000</td><td>16</td></tr><tr><td>6000</td><td>20</td></tr><tr><td>7000</td><td>22</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	12	2000	13	4000	16	6000	20	7000	22				
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]																
0	12																
2000	13																
4000	16																
6000	20																
7000	22																
HK-FN102_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds on the y-axis (0 to 120) against servo motor speed in r/min on the x-axis (0 to 5000). The curve starts at approximately 95 ms at 0 r/min, rises to 110 ms by 500 r/min, and then remains relatively flat, reaching about 115 ms at 5000 r/min.</p> <table border="1"><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>95</td></tr><tr><td>500</td><td>110</td></tr><tr><td>1000</td><td>110</td></tr><tr><td>2000</td><td>112</td></tr><tr><td>3000</td><td>113</td></tr><tr><td>4000</td><td>114</td></tr><tr><td>5000</td><td>115</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	95	500	110	1000	110	2000	112	3000	113	4000	114	5000	115
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]																
0	95																
500	110																
1000	110																
2000	112																
3000	113																
4000	114																
5000	115																

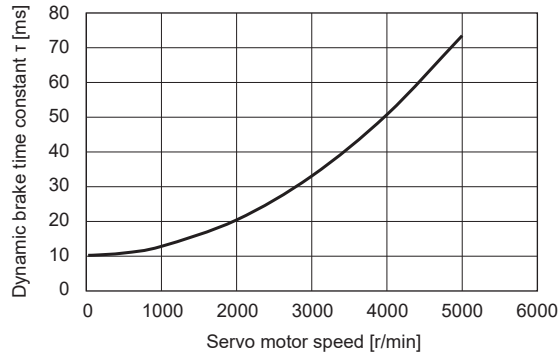
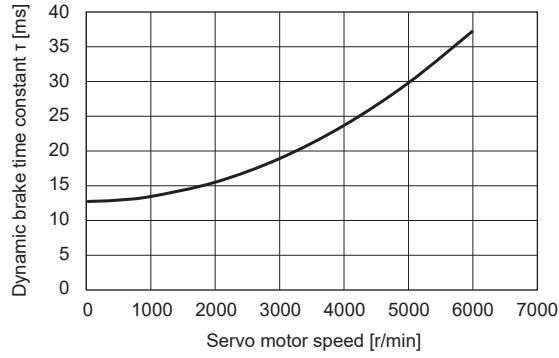
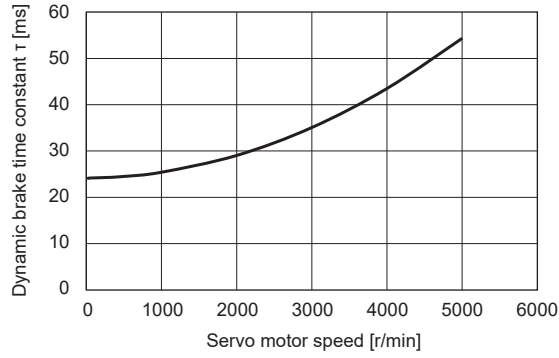
Servo motor	Waveform														
HK-FN152_	 <table border="1"><caption>Data for HK-FN152_ graph</caption><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>5</td></tr><tr><td>500</td><td>5.5</td></tr><tr><td>1000</td><td>7</td></tr><tr><td>1500</td><td>9</td></tr><tr><td>2000</td><td>12</td></tr><tr><td>2500</td><td>16</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	5	500	5.5	1000	7	1500	9	2000	12	2500	16
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]														
0	5														
500	5.5														
1000	7														
1500	9														
2000	12														
2500	16														
HK-FN202_	 <table border="1"><caption>Data for HK-FN202_ graph</caption><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>15</td></tr><tr><td>1000</td><td>18</td></tr><tr><td>2000</td><td>25</td></tr><tr><td>3000</td><td>35</td></tr><tr><td>3500</td><td>40</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	15	1000	18	2000	25	3000	35	3500	40		
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]														
0	15														
1000	18														
2000	25														
3000	35														
3500	40														
HK-FN301M_	 <table border="1"><caption>Data for HK-FN301M_ graph</caption><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>8</td></tr><tr><td>500</td><td>9</td></tr><tr><td>1000</td><td>12</td></tr><tr><td>1500</td><td>16</td></tr><tr><td>2000</td><td>22</td></tr><tr><td>2250</td><td>27</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	8	500	9	1000	12	1500	16	2000	22	2250	27
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]														
0	8														
500	9														
1000	12														
1500	16														
2000	22														
2250	27														

• HG-KNS series/HG-SNS series

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

Servo motor	Waveform												
HK-KN134_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds on the y-axis (0 to 6) against the servo motor speed in r/min on the x-axis (0 to 8000). The curve starts at approximately 2.8 ms at 0 r/min, remains relatively flat until 2000 r/min, and then increases steadily to about 5.2 ms at 6500 r/min.</p> <table border="1"><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>2.8</td></tr><tr><td>2000</td><td>2.8</td></tr><tr><td>4000</td><td>3.5</td></tr><tr><td>6000</td><td>4.8</td></tr><tr><td>6500</td><td>5.2</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2.8	2000	2.8	4000	3.5	6000	4.8	6500	5.2
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	2.8												
2000	2.8												
4000	3.5												
6000	4.8												
6500	5.2												
HK-KN234_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds on the y-axis (0 to 9) against the servo motor speed in r/min on the x-axis (0 to 8000). The curve starts at approximately 3.0 ms at 0 r/min and increases steadily to about 7.8 ms at 6500 r/min.</p> <table border="1"><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>3.0</td></tr><tr><td>2000</td><td>3.5</td></tr><tr><td>4000</td><td>4.8</td></tr><tr><td>6000</td><td>6.8</td></tr><tr><td>6500</td><td>7.8</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	3.0	2000	3.5	4000	4.8	6000	6.8	6500	7.8
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	3.0												
2000	3.5												
4000	4.8												
6000	6.8												
6500	7.8												
HK-KN434_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds on the y-axis (0 to 12) against the servo motor speed in r/min on the x-axis (0 to 8000). The curve starts at approximately 1.8 ms at 0 r/min and increases steadily to about 11.0 ms at 6500 r/min.</p> <table border="1"><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>1.8</td></tr><tr><td>2000</td><td>2.8</td></tr><tr><td>4000</td><td>5.2</td></tr><tr><td>6000</td><td>9.2</td></tr><tr><td>6500</td><td>11.0</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	1.8	2000	2.8	4000	5.2	6000	9.2	6500	11.0
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	1.8												
2000	2.8												
4000	5.2												
6000	9.2												
6500	11.0												
HK-KN634_	<p>The graph shows the dynamic brake time constant <math>\tau</math> in milliseconds on the y-axis (0 to 9) against the servo motor speed in r/min on the x-axis (0 to 8000). The curve starts at approximately 2.0 ms at 0 r/min, remains flat until 1000 r/min, and then increases steadily to about 8.5 ms at 6500 r/min.</p> <table border="1"><thead><tr><th>Servo motor speed [r/min]</th><th>Dynamic brake time constant <math>\tau</math> [ms]</th></tr></thead><tbody><tr><td>0</td><td>2.0</td></tr><tr><td>2000</td><td>2.8</td></tr><tr><td>4000</td><td>4.2</td></tr><tr><td>6000</td><td>7.2</td></tr><tr><td>6500</td><td>8.5</td></tr></tbody></table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2.0	2000	2.8	4000	4.2	6000	7.2	6500	8.5
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	2.0												
2000	2.8												
4000	4.2												
6000	7.2												
6500	8.5												

Servo motor	Waveform												
HK-KN7M34_	<p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-KN7M34_. The curve starts at approximately 3.5 ms at 0 r/min and increases to about 12.5 ms at 6500 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>3.5</td></tr> <tr><td>2000</td><td>4.5</td></tr> <tr><td>4000</td><td>7.0</td></tr> <tr><td>6000</td><td>10.5</td></tr> <tr><td>6500</td><td>12.5</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	3.5	2000	4.5	4000	7.0	6000	10.5	6500	12.5
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	3.5												
2000	4.5												
4000	7.0												
6000	10.5												
6500	12.5												
HK-KN1034_	<p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-KN1034_. The curve starts at approximately 2 ms at 0 r/min and increases to about 22 ms at 6500 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>2.0</td></tr> <tr><td>2000</td><td>3.5</td></tr> <tr><td>4000</td><td>8.5</td></tr> <tr><td>6000</td><td>18.5</td></tr> <tr><td>6500</td><td>22.0</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	2.0	2000	3.5	4000	8.5	6000	18.5	6500	22.0
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	2.0												
2000	3.5												
4000	8.5												
6000	18.5												
6500	22.0												
HK-KN1534_	<p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-KN1534_. The curve starts at approximately 5.5 ms at 0 r/min and increases to about 15 ms at 6500 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>5.5</td></tr> <tr><td>2000</td><td>6.5</td></tr> <tr><td>4000</td><td>9.0</td></tr> <tr><td>6000</td><td>13.0</td></tr> <tr><td>6500</td><td>15.0</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	5.5	2000	6.5	4000	9.0	6000	13.0	6500	15.0
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	5.5												
2000	6.5												
4000	9.0												
6000	13.0												
6500	15.0												
HK-KN2034_	<p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-KN2034_. The curve starts at approximately 5.5 ms at 0 r/min and increases to about 12 ms at 6000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>5.5</td></tr> <tr><td>2000</td><td>6.5</td></tr> <tr><td>4000</td><td>8.5</td></tr> <tr><td>6000</td><td>12.0</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	5.5	2000	6.5	4000	8.5	6000	12.0		
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]												
0	5.5												
2000	6.5												
4000	8.5												
6000	12.0												

Servo motor	Waveform																
HK-SN3534_	 <p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-SN3534_. The curve starts at approximately 10 ms at 0 r/min and increases to about 75 ms at 5000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>10</td></tr> <tr><td>1000</td><td>12</td></tr> <tr><td>2000</td><td>20</td></tr> <tr><td>3000</td><td>32</td></tr> <tr><td>4000</td><td>48</td></tr> <tr><td>5000</td><td>75</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	10	1000	12	2000	20	3000	32	4000	48	5000	75		
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]																
0	10																
1000	12																
2000	20																
3000	32																
4000	48																
5000	75																
HK-SN5034_	 <p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-SN5034_. The curve starts at approximately 12 ms at 0 r/min and increases to about 38 ms at 6000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>12</td></tr> <tr><td>1000</td><td>14</td></tr> <tr><td>2000</td><td>18</td></tr> <tr><td>3000</td><td>22</td></tr> <tr><td>4000</td><td>28</td></tr> <tr><td>5000</td><td>32</td></tr> <tr><td>6000</td><td>38</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	12	1000	14	2000	18	3000	22	4000	28	5000	32	6000	38
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]																
0	12																
1000	14																
2000	18																
3000	22																
4000	28																
5000	32																
6000	38																
HK-SN7034_	 <p>Graph showing Dynamic brake time constant <math>\tau</math> [ms] versus Servo motor speed [r/min] for HK-SN7034_. The curve starts at approximately 24 ms at 0 r/min and increases to about 55 ms at 5000 r/min.</p> <table border="1"> <thead> <tr> <th>Servo motor speed [r/min]</th> <th>Dynamic brake time constant <math>\tau</math> [ms]</th> </tr> </thead> <tbody> <tr><td>0</td><td>24</td></tr> <tr><td>1000</td><td>26</td></tr> <tr><td>2000</td><td>30</td></tr> <tr><td>3000</td><td>36</td></tr> <tr><td>4000</td><td>44</td></tr> <tr><td>5000</td><td>55</td></tr> </tbody> </table>	Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]	0	24	1000	26	2000	30	3000	36	4000	44	5000	55		
Servo motor speed [r/min]	Dynamic brake time constant $\tau$ [ms]																
0	24																
1000	26																
2000	30																
3000	36																
4000	44																
5000	55																

## 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.

### ■200 V

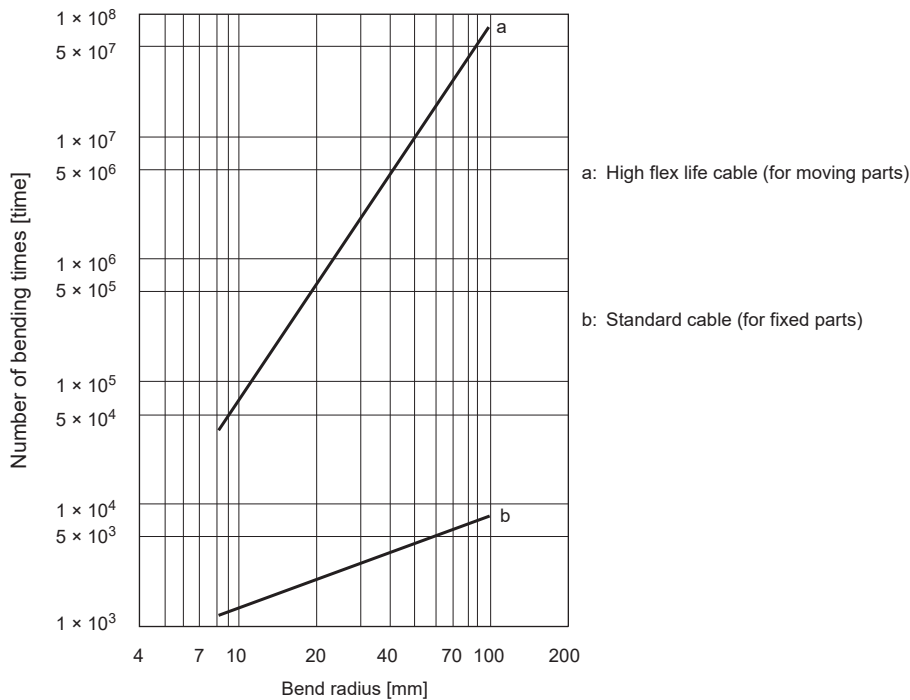
Servo motor	Permissible load to motor inertia ratio [multiplier]
HK-KN053_	34
HK-KN13_	
HK-KN1M3_	25
HK-KN23_	23 (6000 r/min or less: 28)
HK-KN43_	23
HK-KN63_	30
HK-KN7M3_	20
HK-KN103_	30
HK-KN153_	
HK-KN203_	
HK-KN202_	
HK-FN13_	21 (3000 r/min or less: 23)
HK-FN23_	12
HK-FN43_	15
HK-FN7M3_	20
HK-FN102_	12
HK-FN152_	30
HK-FN202_	14
HK-FN301M_	25
HG-KNS13_	30
HG-KNS23_	
HG-KNS43_	
HG-KNS73_	
HG-SNS52_	
HG-SNS102_	
HG-SNS152_	
HG-SNS202_	24
HG-SNS302_	16

### ■400 V

Servo motor	Permissible load to motor inertia ratio [multiplier]
HK-KN134_	20
HK-KN234_	23
HK-KN434_	30
HK-KN634_	20 (3000 r/min or less: 30)
HK-KN7M34_	9 (3000 r/min or less: 20)
HK-KN1034_	7 (3000 r/min or less: 30)
HK-KN1534_	11 (3000 r/min or less: 30)
HK-KN2034_	10 (3000 r/min or less: 30)
HK-SN3534_	10 (3000 r/min or less: 30)
HK-SN5034_	10 (3000 r/min or less: 21)
HK-SN7034_	6

## 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 135 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.

### 200 V

This section shows the inrush currents (reference data) that will flow when the following voltages are applied.

- 3-phase 240 V AC
- 1-phase 240 V AC

The 1-phase 240 V AC power supply input is available only on servo amplifiers that support the voltage.

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)

### 400 V

The following shows the inrush currents (reference data) that will flow when 480 V AC is applied.

Servo amplifier	Inrush currents ( $A_{0-P}$ )	
	Main circuit power supply (L1/L2/L3)	Control circuit power supply (L11/L21)
MR-JET-60_4_ MR-JET-100_4_	21 A (attenuated to 4 A in 10 ms)	40 A to 50 A (attenuated to 0 A in 20 ms)
MR-JET-200_4_	26 A (attenuated to approx. 10 A in 10 ms)	
MR-JET-350_4_	78 A (attenuated to approx. 10 A in 10 ms)	
MR-JET-500_4_	50 A (attenuated to approx. 28 A in 10 ms) (attenuated to 3 A in 20 ms)	20 A to 30 A (attenuated to approx. 0 A in 3 ms)
MR-JET-700_4_	55 A (attenuated to approx. 36 A in 10 ms) (attenuated to 16 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 the cables provided by Mitsubishi Electric and Mitsubishi Electric System & Service Co., Ltd. When fabricating a cable, select a wire suitable for the application. 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.

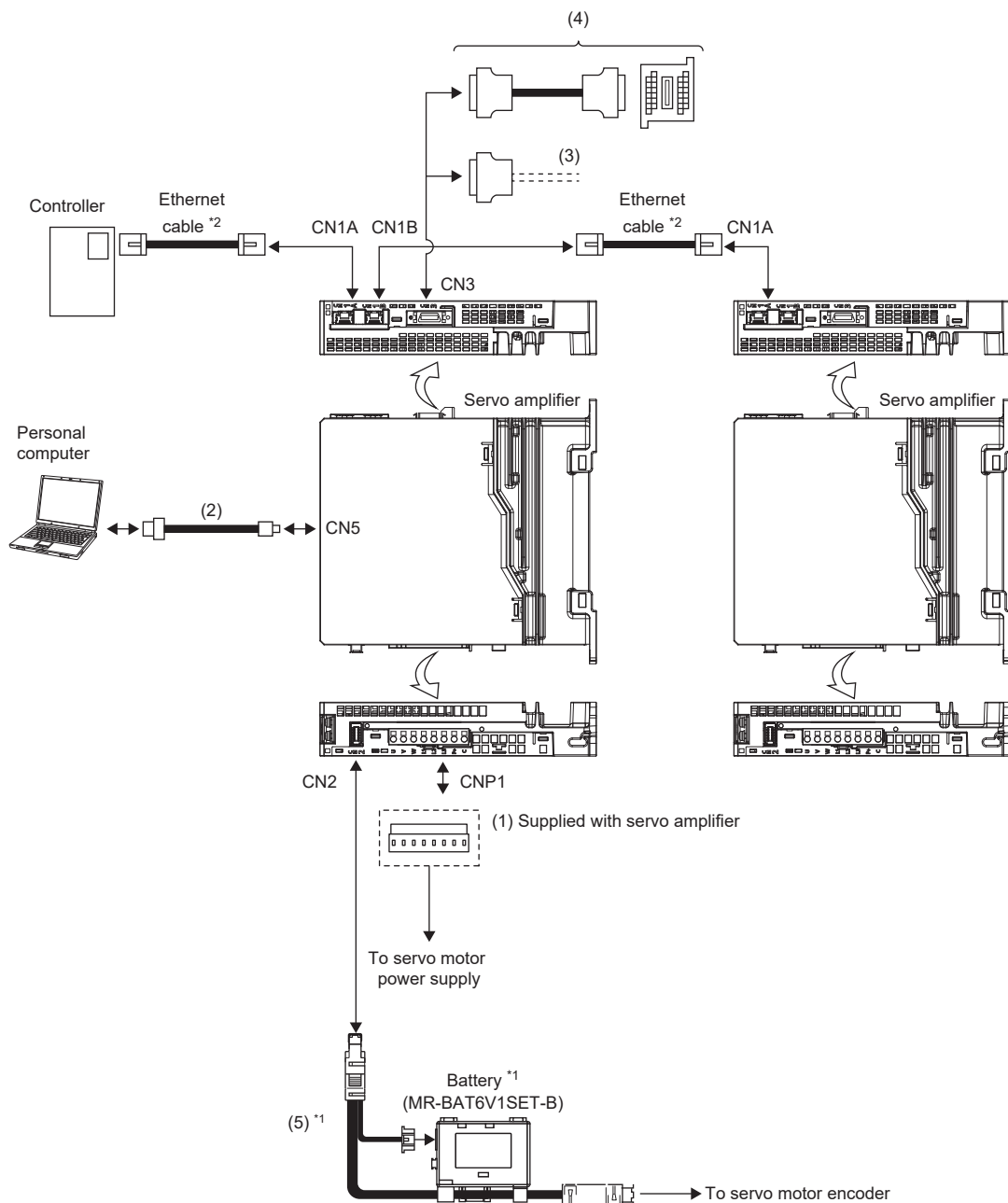
 Rotary Servo Motor User's Manual (For MR-JET)

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

## MR-JET-\_G(-N1)



\*1 Whether the battery is required or not depends on the system to be configured. Refer to the following.

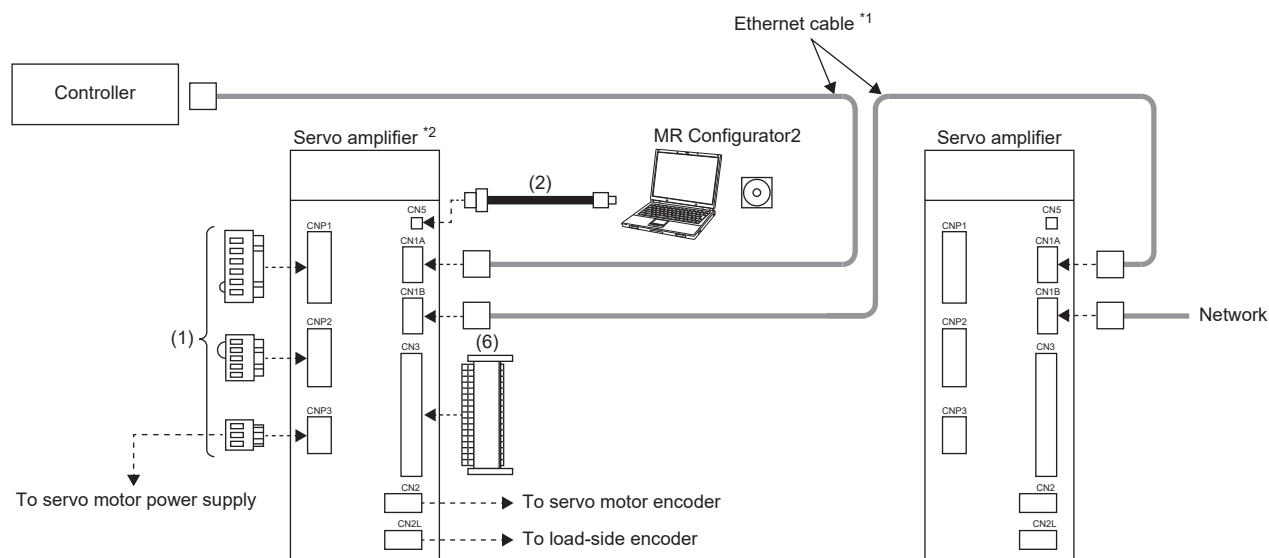
☞ Page 125 Battery

For configuration of an absolute position detection system, refer to the following.

☞ Page 166 ABSOLUTE POSITION DETECTION SYSTEM

\*2 Refer to the following page for information on Ethernet cable specifications.

☞ Page 107 Ethernet cable




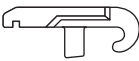

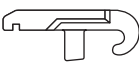
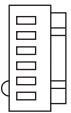


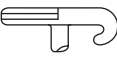


\*1 Refer to the following page for information on Ethernet cable specifications.



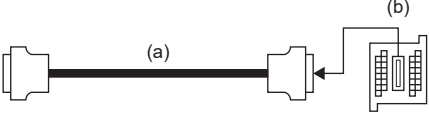
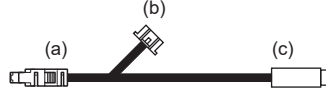
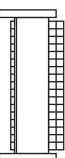
☞ Page 107 Ethernet cable

\*2 The shape and position of the power connector differ from the description depending on the capacity of the servo amplifier. Refer to the following for details.

☞ Page 72 DIMENSIONS

## 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 mm<sup>2</sup> to 2.1 mm<sup>2</sup> (AWG 18 to 14) Insulator OD: Up to 3.9 mm</p>	Supplied with servo amplifiers of 1 kW or less
		—	 <p>Open tool: 1981045-1 (TE Connectivity)</p>	
		—	 <p>CNP1 connector 1-2349825-8 (TE Connectivity) Applicable wire size: 1.25 mm<sup>2</sup> to 5.5 mm<sup>2</sup> (AWG 16 to 10) Insulator OD: Up to 4.7 mm</p>	Supplied with servo amplifiers of 2 kW and 3 kW
		—	 <p>Open tool: 2349891-1 (TE Connectivity)</p>	
		—	<div>  <p>CNP1 connector 06JFAT-SAXGDKHT10.5 (LA) (JST) Applicable wire size: 0.8 mm<sup>2</sup> to 2.1 mm<sup>2</sup> (AWG 18 to 14) Insulator OD: Up to 3.9 mm</p> </div> <div>  <p>CNP2 connector 05JFAT-SAXGDKHT7.5 (LA) (JST) Applicable wire size: 0.8 mm<sup>2</sup> to 2.1 mm<sup>2</sup> (AWG 18 to 14) Insulator OD: Up to 3.9 mm</p> </div> <div>  <p>CNP3 connector 03JFAT-SAXGDKHT10.5 (LA) (JST) Applicable wire size: 0.8 mm<sup>2</sup> to 2.1 mm<sup>2</sup> (AWG 18 to 14) Insulator OD: Up to 3.9 mm</p> </div>	Supplied with 400 V servo amplifiers with a capacity of 3.5 kW or less
		—	 <p>Open tool: J-FAT-OT-XL (JST)</p>	
		—	<div>  <p>CNP1 connector 831-1108/MNC (WAGO) Applicable wire size: 0.5 mm<sup>2</sup> to 10 mm<sup>2</sup> (AWG 20 to 8) Insulator OD: Up to 6.6 mm</p> </div> <div>  <p>CNP3 connector 831-1103/MNA (WAGO) Applicable wire size: 0.5 mm<sup>2</sup> to 10 mm<sup>2</sup> (AWG 20 to 8) Insulator OD: Up to 6.6 mm</p> </div>	Supplied with 400 V servo amplifiers with capacities of 5 kW and 7 kW

No.	Product name	Model	Description	Remark
(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 105 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
(6)	Connector set	—	 <p>CN3 connector 15EDGKNHG-3.5-32P (Degson) or equivalent Applicable wire size: 0.2 mm<sup>2</sup> to 1.5 mm<sup>2</sup> (AWG 24 to 16)</p>	Supplied with the MR-JET-_G_-HS(N1) amplifiers.

# Battery branch cable

Whether the battery is required or not depends on the system to be configured. Refer to the following.

📖 Page 125 Battery

For configuration of an absolute position detection system, refer to the following.

📖 Page 166 ABSOLUTE POSITION DETECTION SYSTEM

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

📖 Page 125 Battery

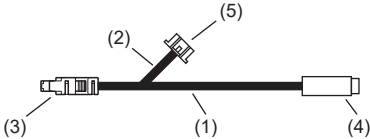
When fabricating cables, refer to "Fabrication of the encoder cable" in the following manual.

📖 Rotary Servo Motor User's Manual (For MR-JET)

## Model explanations

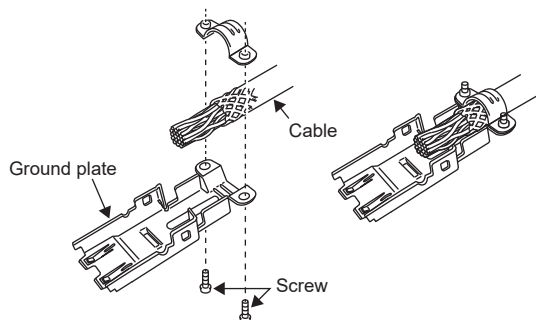
Cable model	Cable length	Flex life	Application/remark
MR-BT6V4CBL03M	(1) Encoder-side cable: 0.3 m (2) Battery-side cable: 0.1 m	Standard	For connecting to MR-BAT6V1SET-B

## Appearance

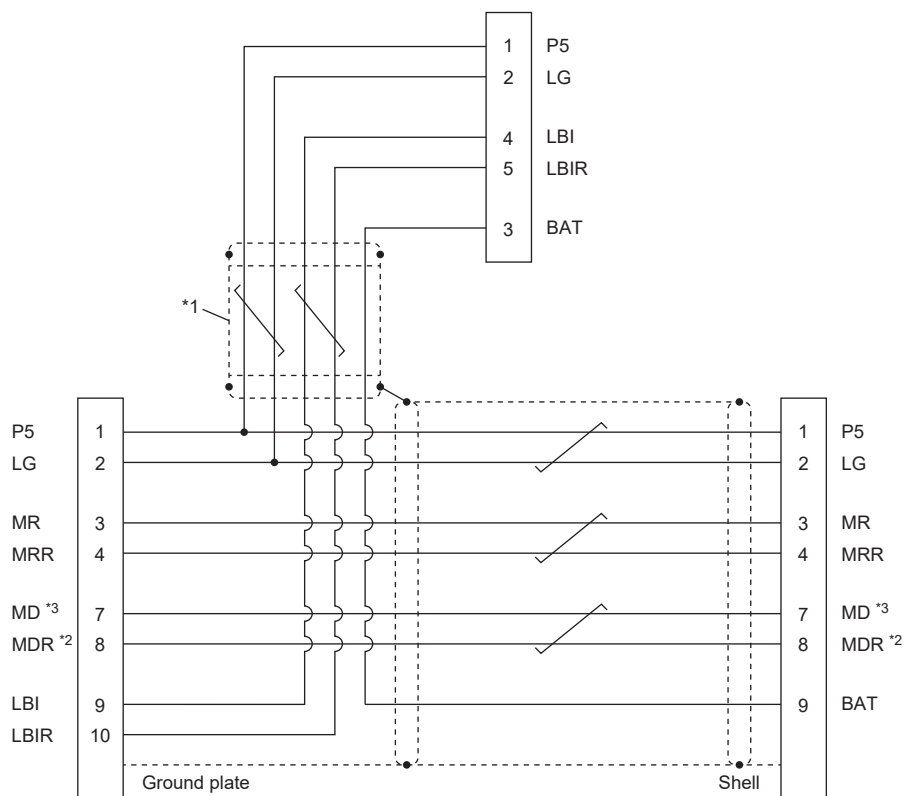
Figure	Components	Description
	(1) Encoder-side cable	20276 VSVP AWG#28 × 4P
	(2) Battery-side cable	
	(3) Amplifier-side connector	Receptacle: 36210-0100PL (3M) Shell kit: 36310-3200-008 (3M)
	(4) Encoder-side connector	Plug: 36110-3000FD (3M) Shell kit: 36310-F200-008 (3M)
	(5) Battery-side connector	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.

\*2 For a fully closed loop system, this pin is MXR.

\*3 For a fully closed loop system, this pin is MX.



## 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 cable (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

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.

#### 400 V

Servo amplifier	Regenerative power [W]										
	Built-in regenerative resistor	MR-RB1H-4 [82 Ω]	MR-RB3M-4 [120 Ω] *1	MR-RB3G-4 [47 Ω] *1	MR-RB5G-4 [47 Ω] *1	MR-RB3Y-4 [36 Ω] *1	MR-RB5Y-4 [36 Ω] *1	MR-RB34-4 [26 Ω] *1	MR-RB54-4 [26 Ω] *1	MR-RB3U-4 [22 Ω] *1	MR-RB5U-4 [22 Ω] *1
MR-JET-60_4_	15	100	300	—	—	—	—	—	—	—	—
MR-JET-100_4_	15	100	300	—	—	—	—	—	—	—	—
MR-JET-200_4_	100	—	—	300	500	—	—	—	—	—	—
MR-JET-350_4_	120	—	—	—	—	300	500	—	—	—	—
MR-JET-500_4_	130	—	—	—	—	—	—	300	500	—	—
MR-JET-700_4_	170	—	—	—	—	—	—	—	—	300	500

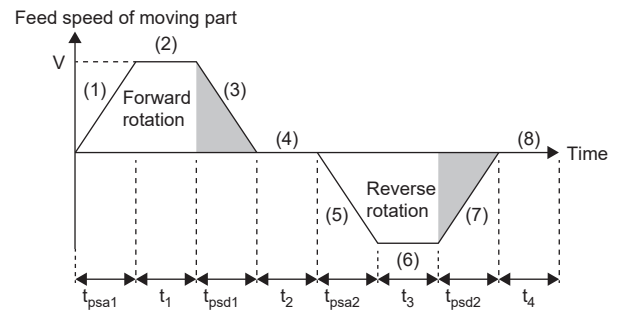
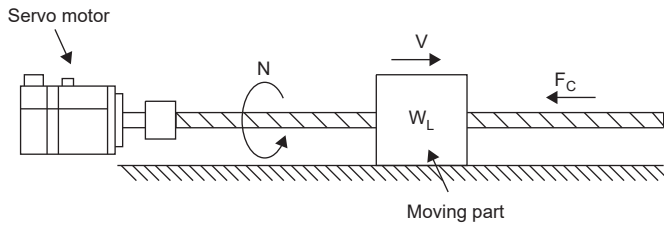
\*1 Install a cooling fan.

## 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 Drive System Sizing Software.

### For rotary servo motors

#### ■Regenerative energy calculation



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

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

$\Delta S$ : 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 [ $N \cdot m$ ]

$\eta$ : Drive system efficiency

$\mu$ : Friction coefficient

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

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

$\pi$ : 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
MR-JET-60_4_	85	12
MR-JET-100_4_	85	12
MR-JET-200_4_	85	25
MR-JET-350_4_	85	35
MR-JET-500_4_	90	45
MR-JET-700_4_	90	70

Inverse efficiency ( $\eta_m$ ): 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.

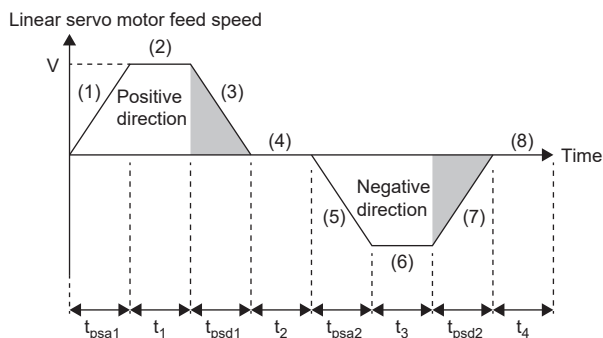
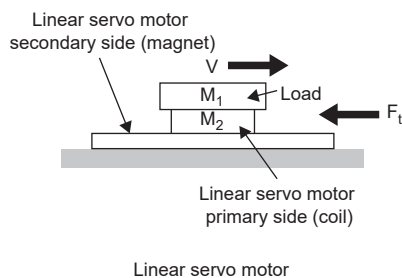
$$ER [J] = \eta_m \cdot E_s - E_c$$

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 tf [s].

$$PR [W] = ER/tf$$

## For linear servo motors

### ■Thrust and energy calculation



The following shows formulas of the linear servo motor thrust and energy at the operation pattern above.

Section	Thrust F of linear servo motor [N]	Energy E [J]
(1)	$F_1 = (M_1 + M_2) \cdot V/t_{psa1} + F_t$	$E_1 = V/2 \cdot F_1 \cdot t_{psa1}$
(2)	$F_2 = F_1$	$E_2 = V \cdot F_2 \cdot t_1$
(3)	$F_3 = -(M_1 + M_2) \cdot V/t_{psd1} + F_t$	$E_3 = V/2 \cdot F_3 \cdot t_{psd1}$
(4), (8)	$F_4, F_8 = 0$	$E_4, E_8 = 0$ (No regeneration)
(5)	$F_5 = (M_1 + M_2) \cdot V/t_{psa2} + F_t$	$E_5 = V/2 \cdot F_5 \cdot t_{psa2}$
(6)	$F_6 = F_t$	$E_6 = V \cdot F_6 \cdot t_3$
(7)	$F_7 = -(M_1 + M_2) \cdot V/t_{psd2} + F_t$	$E_7 = V/2 \cdot F_7 \cdot t_{psd2}$

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

For inverse efficiency and capacitor charging energy, refer to the following.

☞ Page 110 Losses of servo motor and servo amplifier in regenerative mode

### ■Regenerative energy calculation

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 resistor.

$$ER [J] = \eta \cdot E_s - E_c$$

From the total of ERs whose subtraction results are positive and one-cycle period, the power consumption PR [W] of the regenerative resistor can be calculated with the following equation.

$$PR [W] = \text{total of positive ERs/one-cycle operation period (tf)}$$

Select a regenerative option based on the PR value. The regenerative option is not required when the energy consumption is equal to or less than the regenerative power of the regenerative resistor built into the servo amplifier.

## Setting servo parameters

---

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

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

## Connection of regenerative option

---

### For MR-JET-\_G(-N1)


---

#### 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 133 Selection example of wires

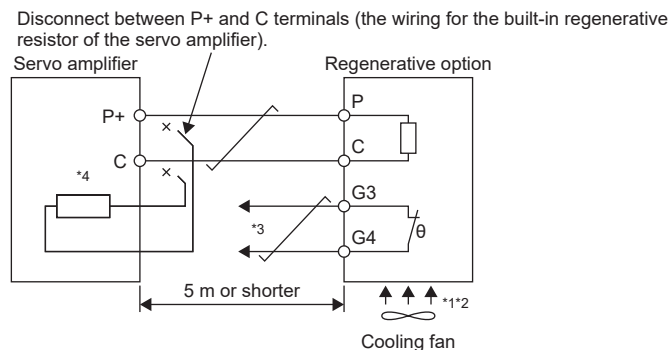
The built-in regenerative resistor should not be mounted/removed frequently.

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

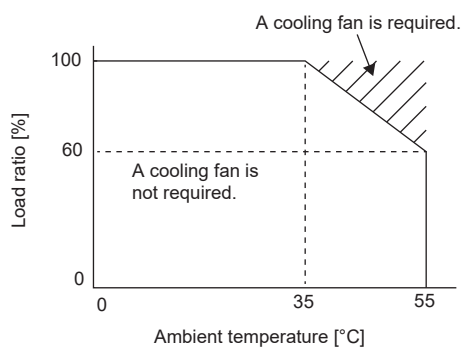
---

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 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 m<sup>3</sup>/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 m<sup>3</sup>/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\_.

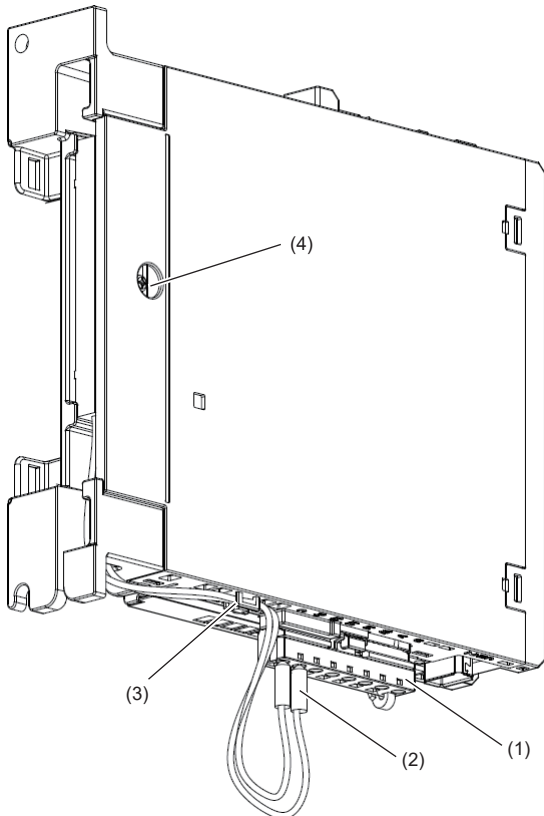
(1) Pull out the power connector (CNP1). Do not forcibly pull the lead wires of the built-in regenerative resistor or the CNP1 connector. Doing so may snap the lead wires.

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

☞ Page 43 Wiring CNP1 (200 V)

(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.





## For MR-JET-\_G\_-HS(N1)

### Point

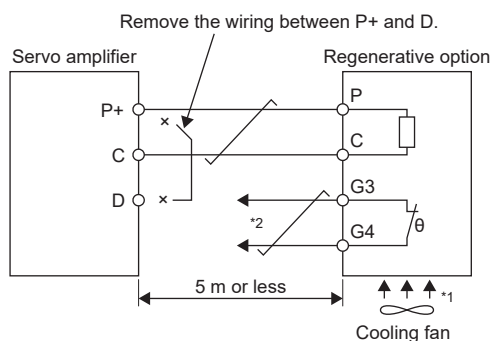
If using the MR-RB3M-4, MR-RB3G-4, MR-RB5G-4, MR-RB3Y-4, MR-RB5Y-4, MR-RB34-4, MR-RB54-4, MR-RB3U-4, or MR-RB5U-4, cool it with a cooling fan. The cooling fan should be prepared by the customer.

For the wire sizes, refer to the following.

☞ Page 133 Selection example of wires

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.

Remove the wiring between P+ and D and install 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-RB3M-4, MR-RB3G-4, MR-RB5G-4, MR-RB3Y-4, MR-RB5Y-4, MR-RB34-4, MR-RB54-4, MR-RB3U-4, or MR-RB5U-4, forcibly cool it with a cooling fan (1.0 m<sup>3</sup>/min or more, 92 mm × 92 mm).

\*2 Configure a sequence which will switch off the magnetic contactor when abnormal heating occurs.

G3-G4 contact specifications

Maximum voltage: 120 V AC/DC

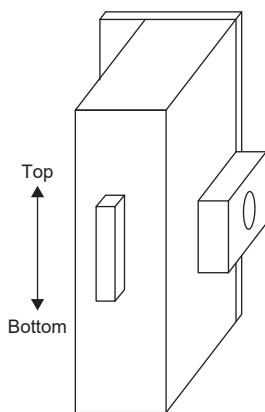
Maximum current: 0.5 A/4.8 V DC

Maximum capacity: 2.4 VA

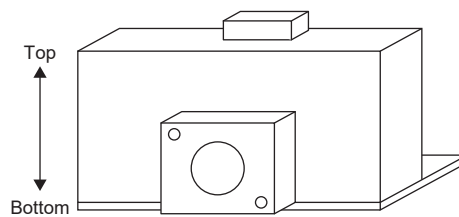
# Mounting direction

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
MR-RB1H-4	Vertical mounting
MR-RB3M-4 (A cooling fan is required.)	Vertical mounting
MR-RB3G-4 (A cooling fan is required.)	Vertical mounting
MR-RB5G-4 (A cooling fan is required.)	Vertical mounting/horizontal mounting
MR-RB34-4 (A cooling fan is required.)	Vertical mounting
MR-RB54-4 (A cooling fan is required.)	Vertical mounting/horizontal mounting
MR-RB3U-4 (A cooling fan is required.)	Vertical mounting
MR-RB5U-4 (A cooling fan is required.)	Vertical mounting/horizontal mounting
MR-RB3Y-4 (A cooling fan is required.)	Vertical mounting
MR-RB5Y-4 (A cooling fan is required.)	Vertical mounting/horizontal mounting



Vertical mounting

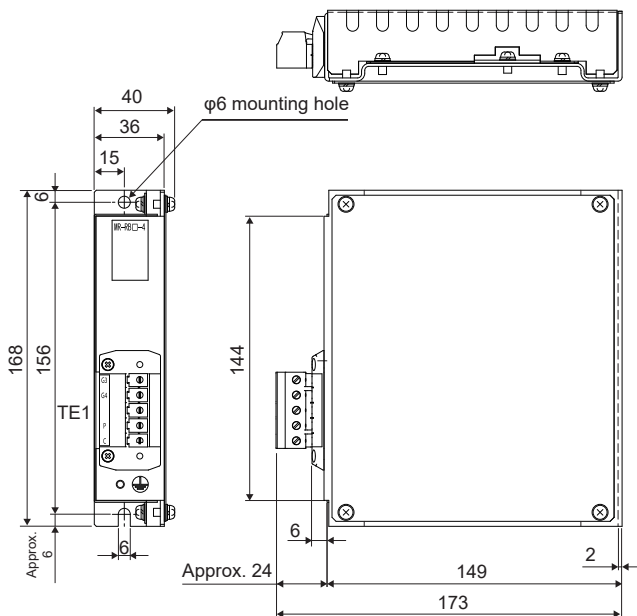


Horizontal mounting

## Dimensions

### MR-RB1H-4

[Unit: mm]



Mass: 1.1 [kg]

- Terminal TE1

G3
G4
P
C

Applicable wire size: AWG 24 to 10

Tightening torque: 0.5 to 0.6 [N•m]

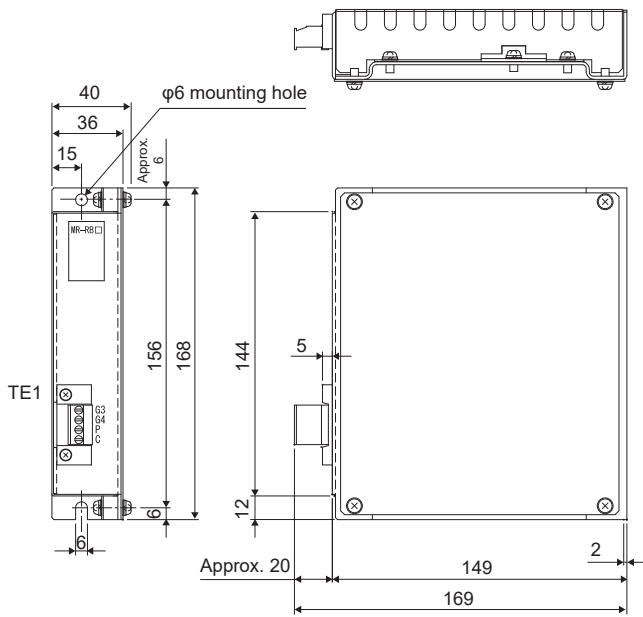
- Mounting screw

Screw size: M5

Tightening torque: 3.24 [N•m]

## MR-RB12/MR-RB14

[Unit: mm]



Mass: 1.1 [kg]

- Terminal TE1

G3
G4
P
C

Applicable wire size: 0.2 mm<sup>2</sup> to 2.5 mm<sup>2</sup> (AWG 24 to 12)

Tightening torque: 0.5 to 0.6 [N•m]

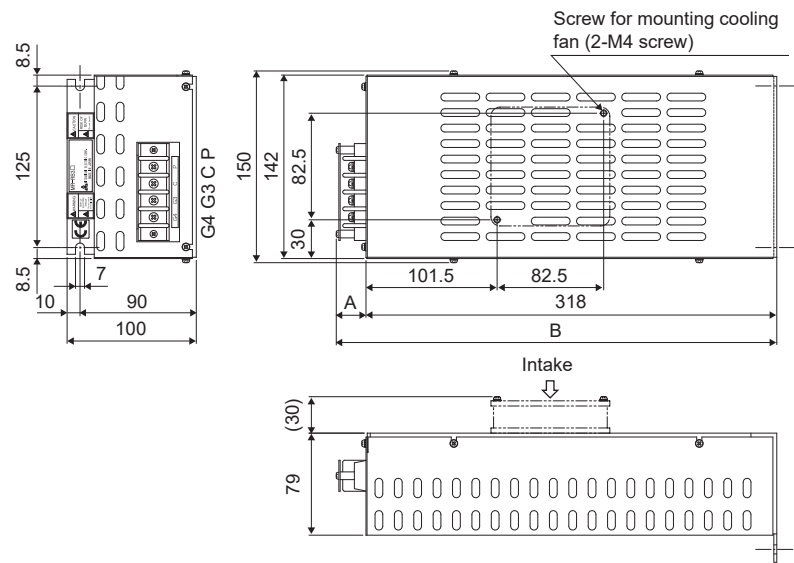
- Mounting screw

Screw size: M5

Tightening torque: 3.24 [N•m]

MR-RB30/MR-RB34/MR-RB3Y-4/MR-RB3G-4/MR-RB3M-4/MR-RB34-4/MR-RB3U-4

[Unit: mm]



- Terminal block

P
C
G3
G4

Screw size: M4

Tightening torque: 1.2 [N•m]

- Mounting screw

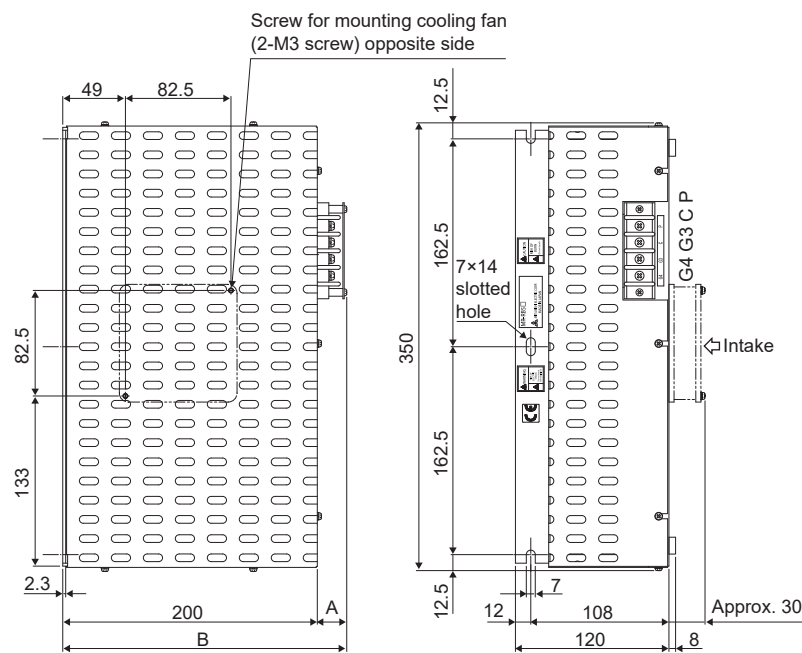
Screw size: M6

Tightening torque: 5.4 [N•m]

Regenerative option	Variable dimensions		Mass [kg]
	A	B	
MR-RB30	17	335	2.9
MR-RB34			
MR-RB34-4	23	341	
MR-RB3Y-4			
MR-RB3G-4			
MR-RB3M-4			
MR-RB3U-4			

MR-RB50/MR-RB5G-4/MR-RB5Y-4/MR-RB54-4/ MR-RB5U-4

[Unit: mm]



- Terminal block

P
C
G3
G4

Screw size: M4

Tightening torque: 1.2 [N•m]

- Mounting screw

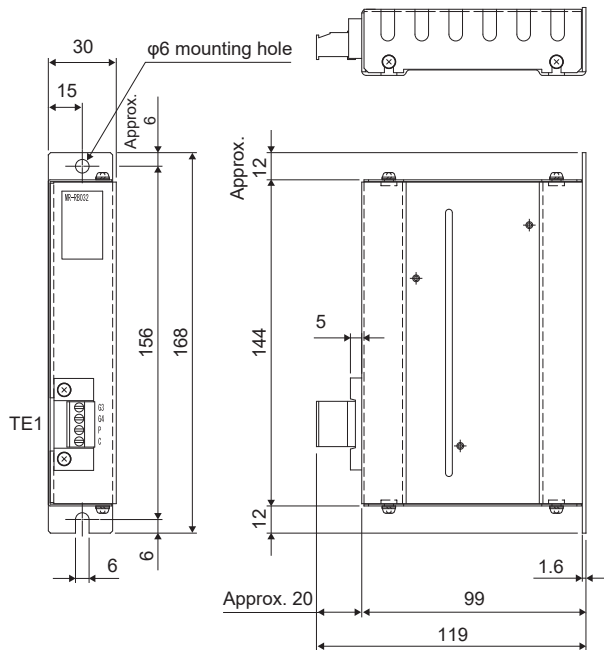
Screw size: M6

Tightening torque: 5.4 [N•m]

Regenerative option	Variable dimensions		Mass [kg]
	A	B	
MR-RB50	17	217	5.6
MR-RB5G-4	23	223	
MR-RB54-4			
MR-RB5Y-4			
MR-RB5U-4			

## MR-RB032

[Unit: mm]



Mass: 0.5 [kg]

- Terminal TE1

G3
G4
P
C

Applicable wire size: 0.2 mm<sup>2</sup> to 2.5 mm<sup>2</sup> (AWG 24 to 12)

Tightening torque: 0.5 to 0.6 [N•m]

- Mounting screw

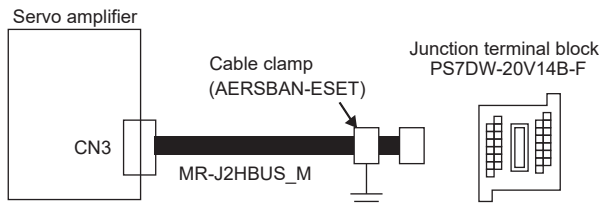
Screw size: M5

Tightening torque: 3.24 [N•m]

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

### Usage

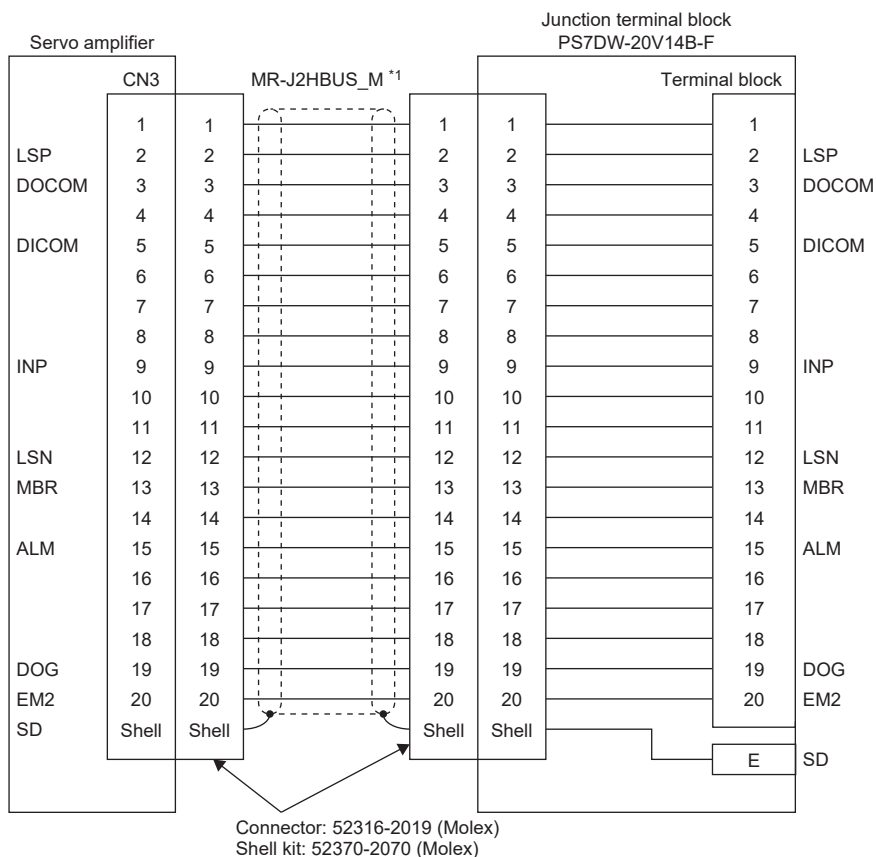
Use the junction terminal block (PS7DW-20V14B-F) with the option cable (MR-J2HBUS\_M) as a set. A connection example is shown below.



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 149 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

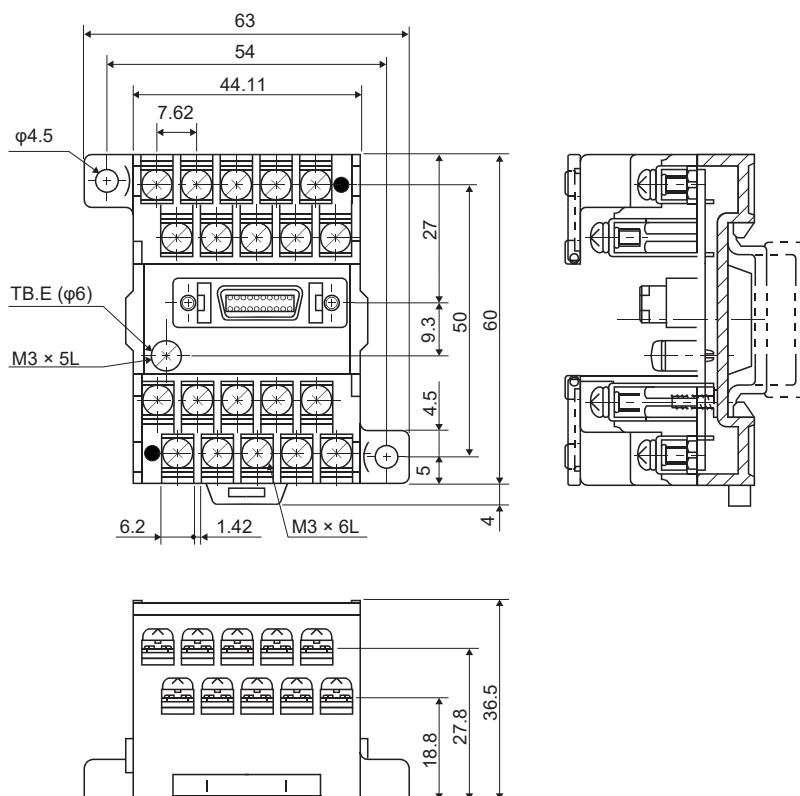
1: 1 m

5: 5 m



## Dimensions of junction terminal block

[Unit: mm]



## 6.4 MR Configurator2

### Engineering software

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

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

### 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 of the personal computer has been disconnected from the AC power socket, then 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 AND REGULATIONS" in User's Manual (Introduction).

Use a battery when configuring an absolute position detection system by using a battery backup type absolute position encoder. For configuration of an absolute position detection system, refer to the following.

☞ Page 166 ABSOLUTE POSITION DETECTION SYSTEM

Whether the battery is used or not depends on the system to be configured. Refer to the following table.

Motor side	Semi closed loop control system	Fully closed loop control system		
		Load side		
		Servo motor with battery-less absolute position encoder	Battery backup type absolute position encoder	Linear encoder
Servo motor with battery-less absolute position encoder	Not required	Not required	Required	Not required
Servo motor with a battery backup type absolute position encoder	Required	Not required	Required	Not required
Linear servo motor	Not required	Not supported	Not supported	Not supported

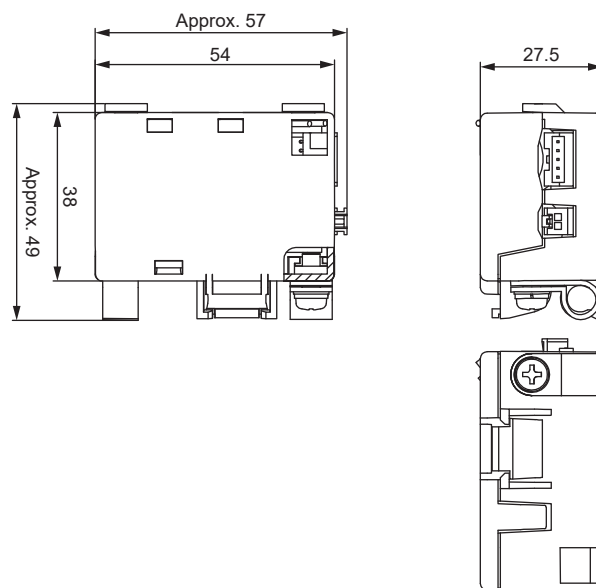
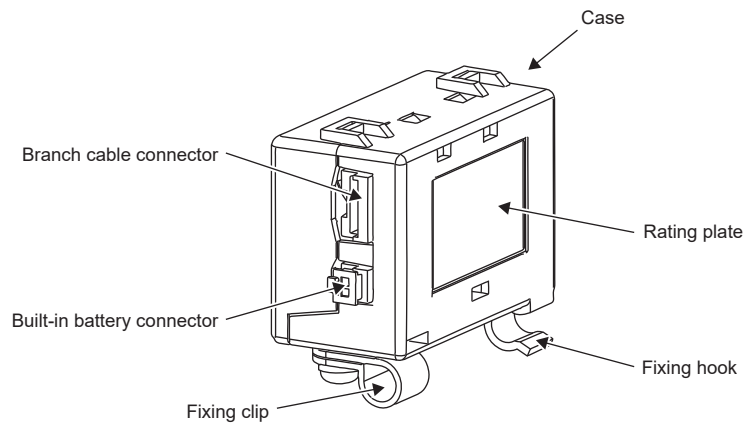
## MR-BAT6V1SET-B battery

**Point**

- For the specifications and the date of manufacture of the built-in MR-BAT6V1 battery, refer to the following.
- ☞ Page 132 MR-BAT6V1 battery

## Parts identification and dimensions

[Unit: mm]



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

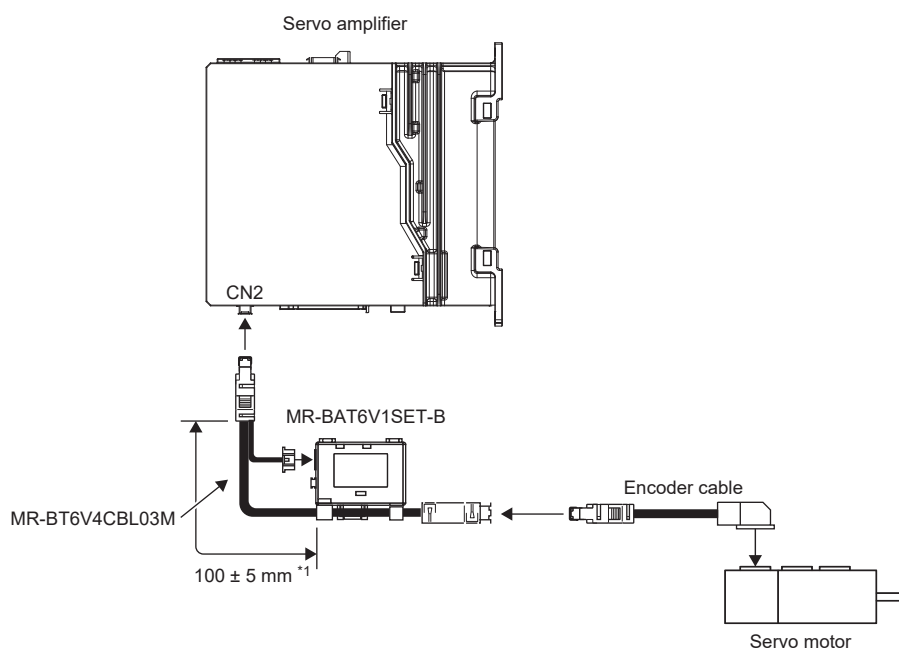
- Mounting screw

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.

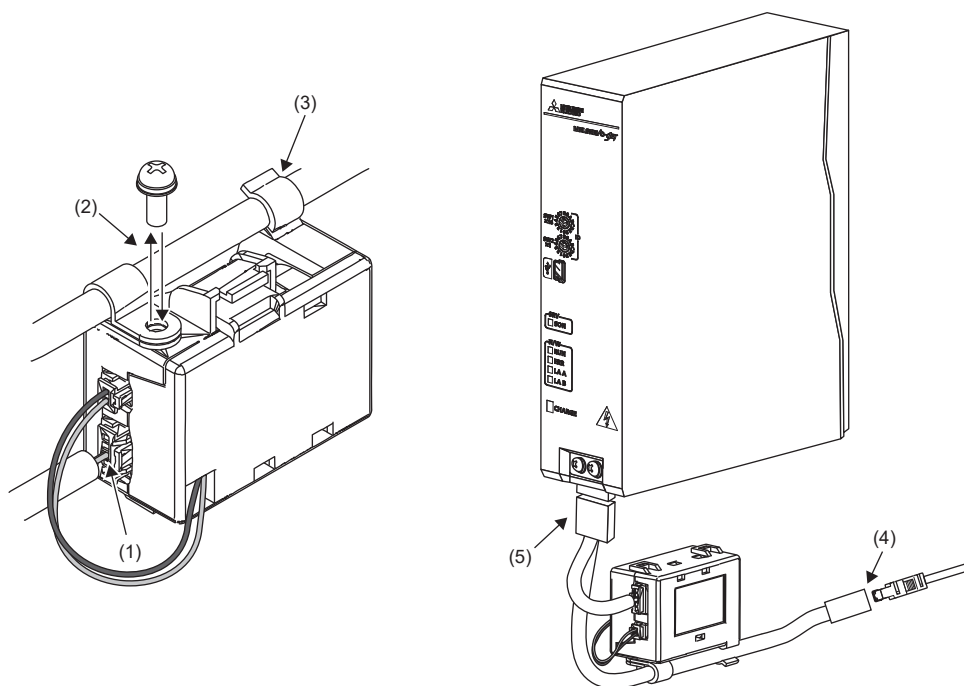
- Ensure that the work bench and your body are grounded.
- Do not directly touch conductive areas such as the connector pins and electrical parts.

Replacing batteries will erase the absolute position data.

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

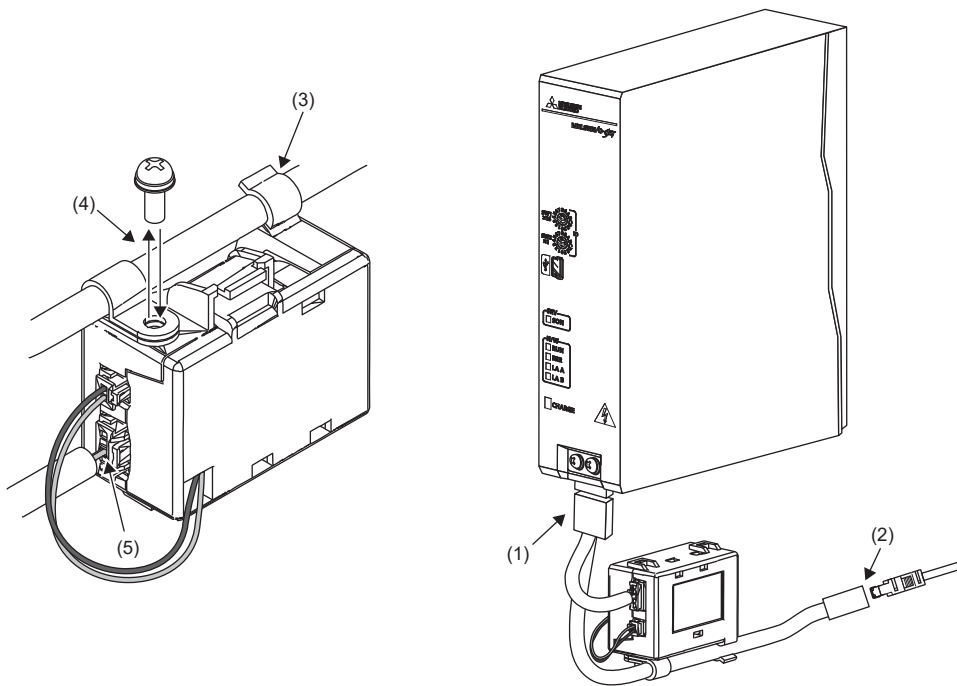
### ■ Battery installation and removal procedure

- 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)

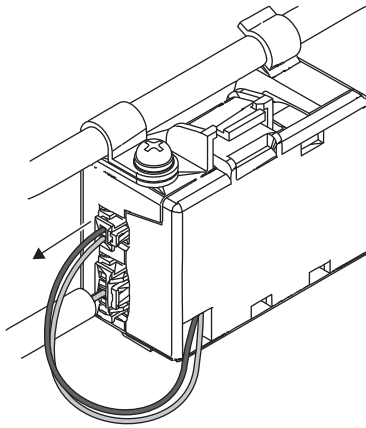
- Removal procedure



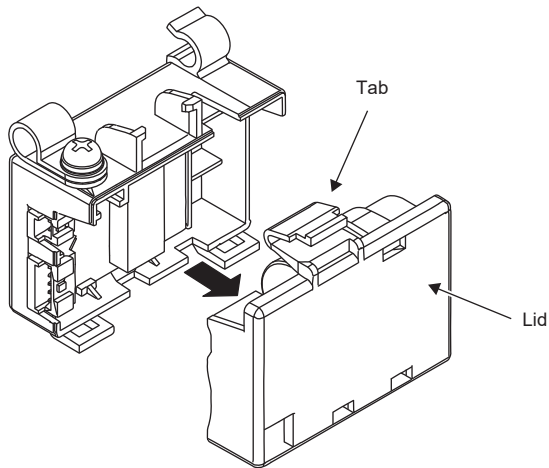
1. Remove the servo amplifier-side connector of the battery branch cable from CN2 on the servo amplifier. (1)
2. Remove the encoder cable from the encoder-side connector of the battery branch cable. (2)
3. Unclip the encoder-side cable of the battery branch cable from the retainer clip. (3)
4. Remove 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

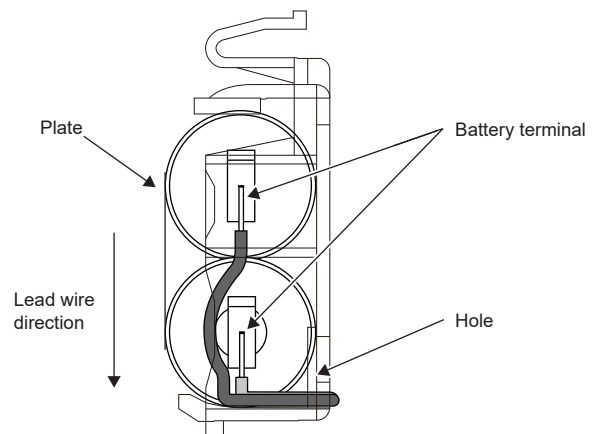
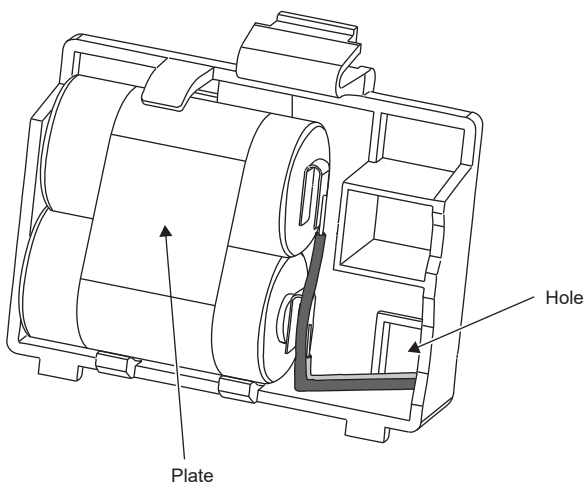
1. Remove the built-in battery connector from the built-in battery connector of the battery.



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

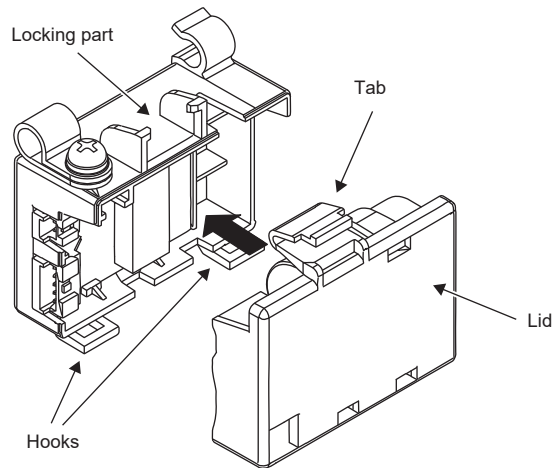


3. Pull the battery leads through the hole in the lid, then remove the battery and replace it with a new MR-BAT6V1 battery. Once the battery has been replaced, pull the battery leads through the hole in the lid. Insert the new MR-BAT6V1 battery into the case lid so that the label is visible.

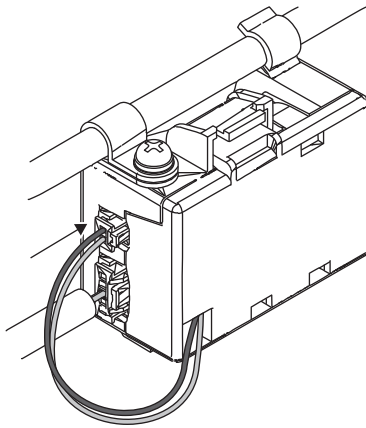




- 4.** Hook the lid to the tabs on the case, then push the two parts of the case together so that tab clips into lock.

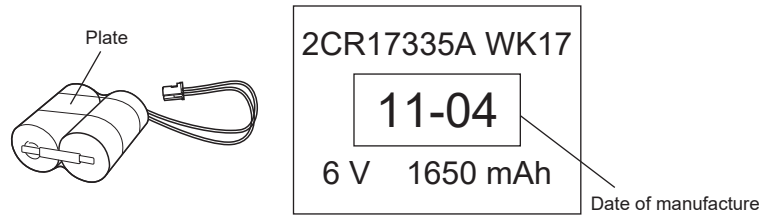


- 5.** Connect the built-in battery connector to the built-in battery connector of the battery.



# 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

### Precautions

- For wiring, use the wires given in this section or equivalent wires. Otherwise, the wires may become hot and ignite.

### Point

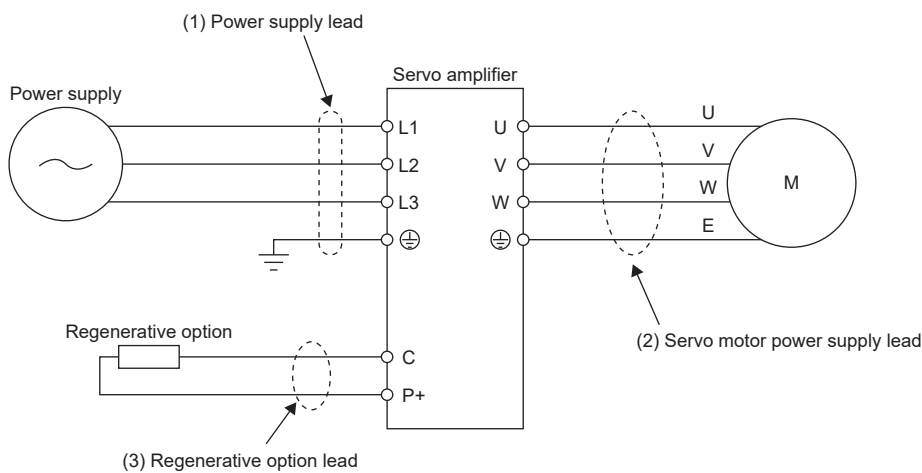
To comply with the IEC/EN/UL/CSA standard for wiring, use the wires described in the MR-JET Safety Instructions and Precautions for AC Servos (IB(NA)-0300492). To comply with other standards, use wires that comply with each standard.

Selection requirements for the wire size are as follows.

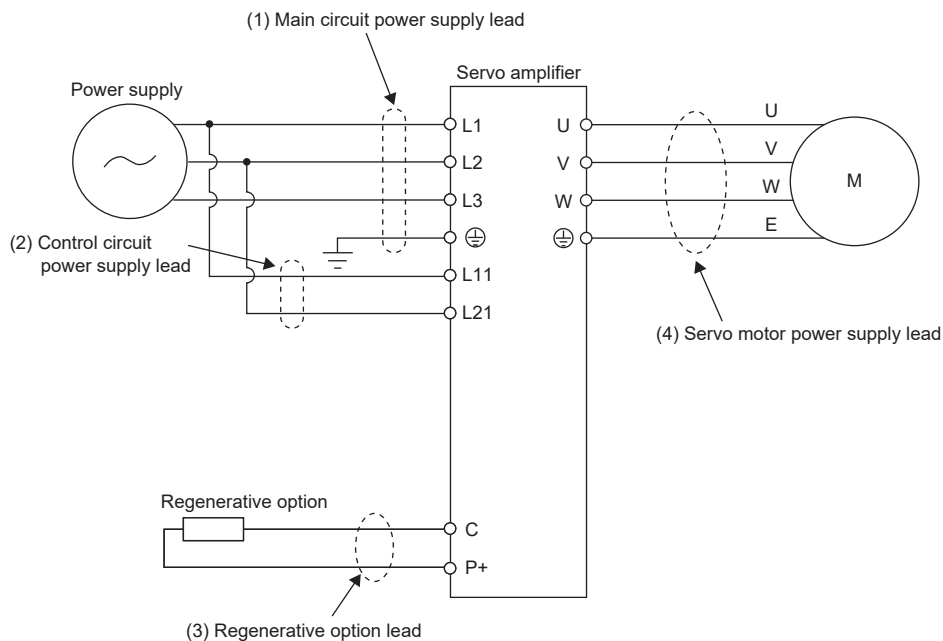
Construction requirements: Single wire set in midair

Wiring length: 30 m or less

- 200 V



- 400 V



## Wire size selection examples

Use 600 V Grade heat-resistant polyvinyl chloride insulated wires (HIV wires) for wiring. The following shows the wire size selection examples.

The wire size can be selected in accordance with the rated input of the servo motor used.

For some combinations of servo amplifiers and servo motors, thinner wires than the ones listed in the table can be used.

### ■200 V

Servo amplifier	Wire [mm <sup>2</sup> ]		
	(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)
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 (For MR-JET)

### ■400 V

Servo amplifier	Wire [mm <sup>2</sup> ] *1			
	(1) L1/L2/L3/⊕	(2) L11/L21	(3) P+/C	(4) U/V/W/E *3
MR-JET-60_4_	2 (AWG 14): a	1.25 to 2 (AWG 16 to 14) *2	2 (AWG 14)	0.75 to 2 (AWG 18 to 14)
MR-JET-100_4_				
MR-JET-200_4_				
MR-JET-350_4_				
MR-JET-500_4_	2 (AWG 14): a	1.25 to 2 (AWG 16 to 14) *2	2 (AWG 14)	0.5 to 10 (AWG 20 to 8)
MR-JET-700_4_	3.5 (AWG 12): b	1.25 to 2 (AWG 16 to 14) *2	2 (AWG 14)	0.5 to 10 (AWG 20 to 8)

\*1 The alphabetical letters in the table indicate the symbols of the selection example of crimp terminals.

📖 Page 134 Selection example of crimp terminals

\*2 Use the size of 2 mm<sup>2</sup> for compliance with the IEC/EN/UL/CSA standard.

\*3 The wire size shows applicable size of the servo amplifier connector and terminal block. For wires connecting to the servo motor, refer to the user's manual of each servo motor.

## Selection example of crimp terminals

### Precautions

- Crimp terminals are used only for ground wiring.

Symbol	Servo amplifier-side crimp terminal		Manufacturer
	Crimp terminal	Applicable tool	
a	R2-4	YHT-2210	JST
b	3.5-R4	YHT-2210	

## 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.

### Selection example

#### 200 V

Servo amplifier	Molded-case circuit breaker <sup>*1</sup>			Fuse			Magnetic contactor <sup>*2</sup>	
	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			30
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			

<sup>\*1</sup> Refer to the following page for compliance with IEC/EN/UL/CSA standards.

☞ Page 137 Example settings that comply with IEC/EN/UL 61800-5-1 and CSA C22.2 No.274

<sup>\*2</sup> 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 <sup>*2</sup>	Motor circuit breaker (Type E combination motor controller)			SCCR [kA] <sup>*1</sup>
			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	25

<sup>\*1</sup> The values of the SCCR vary depending on the combination with the servo amplifier.


<sup>\*2</sup> 1-phase input is not supported.

## 400 V

### ■For main circuit power supply

Servo amplifier	Molded-case circuit breaker * <sup>1</sup>			Fuse			Magnetic contactor * <sup>2</sup>
	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-60_4_	30 to 125 A frame 5 A	30 to 125 A frame 5 A	480	T	10	600	S-T10
MR-JET-100_4_	30 to 125 A frame 10 A	30 to 125 A frame 5 A			15		
MR-JET-200_4_	30 to 125 A frame 15 A	30 to 125 A frame 10 A			25		
MR-JET-350_4_	30 to 125 A frame 20 A	30 to 125 A frame 15 A			35		S-T21
MR-JET-500_4_	30 to 125 A frame 20 A	30 to 125 A frame 20 A			50		
MR-JET-700_4_	30 to 125 A frame 30 A	30 to 125 A frame 30 A			65		

\*1 Refer to the following page for compliance with IEC/EN/UL/CSA standards.

 Page 137 Example settings that comply with IEC/EN/UL 61800-5-1 and CSA C22.2 No.274

\*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.

### ■For control circuit power supply

When the wiring for the control circuit power supply (L11/L21) is thinner than that for the main circuit power supply (L1/L2/L3), install an overcurrent protection device (molded-case circuit breaker, fuse, etc.) to protect the branch circuit.

Servo amplifier	Molded-case circuit breaker *1		Fuse (Class T)		Fuse (Class K5)	
	Frame, rated current	Voltage AC [V]	Current [A]	Voltage AC [V]	Current [A]	Voltage AC [V]
MR-JET-60_4_	30 A frame 5 A	480	1	600	1	600
MR-JET-100_4_						
MR-JET-200_4_						
MR-JET-350_4_						
MR-JET-500_4_						
MR-JET-700_4_						

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

### ■Driving on/off of main circuit power supply with DC power supply

Use the magnetic contactor with an operation delay time (interval between current being applied to the coil until closure of contacts) of 90 ms or less.

Servo amplifier	Magnetic contactor
MR-JET-60_4_ to MR-JET-200_4_	SD-T12
MR-JET-350_4_	SD-T21
MR-JET-500_4_, MR-JET-700_4_	SD-T21

## 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

#### ■200 V

Servo amplifier	Molded-case circuit breaker (240 V AC) SCCR 50 kA	Semiconductor fuse (700 V) SCCR 100 kA (BUSSMANN)
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_		

#### ■400 V

Servo amplifier	Molded-case circuit breaker (480 V AC) SCCR 30 kA	Semiconductor fuse (700 V) SCCR 100 kA (Bussmann)
MR-JET-60_4_	NF125-SVU-15A *1 (125 A frame 15 A)	170M1408 (10 A)
MR-JET-100_4_		
MR-JET-200_4_	NF125-SVU-15A *1 (125 A frame 15 A)	170M1409 (16 A)
MR-JET-350_4_	NF125-SVU-15A *1 (125 A frame 15 A)	170M1412 (32 A)
MR-JET-500_4_	NF125-SVU-20A *1 (125 A frame 20 A)	170M1413 (40 A)
MR-JET-700_4_	NF125-SVU-30A *1 (125 A frame 30 A)	170M1414 (50 A)

\*1 When using it under the UL LISTED authentication conditions, select a semiconductor fuse.

## Recommended wire

### ■200 V

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)	12		
MR-JET-200_ (1-phase power supply input)			
MR-JET-300_			

### ■400 V

Servo amplifier	75 °C Stranded wire [AWG]			
	L1/L2/L3/⊕	L11/L21	P+/C	U/V/W/E
MR-JET-60_4_	14	14	14	14
MR-JET-100_4_				
MR-JET-200_4_				
MR-JET-350_4_				
MR-JET-500_4_	12			12
MR-JET-700_4_				10



## 6.8 Power factor improving AC reactor

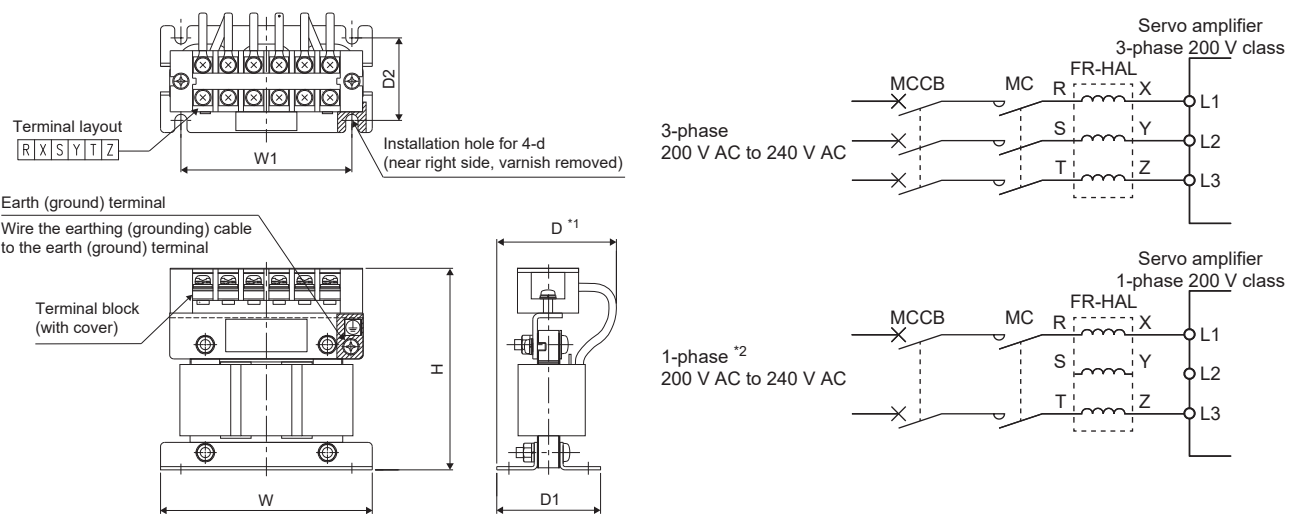
### Advantages

- 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.

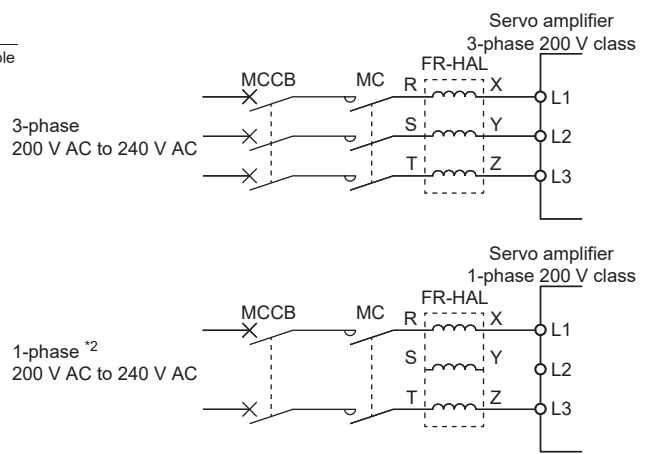
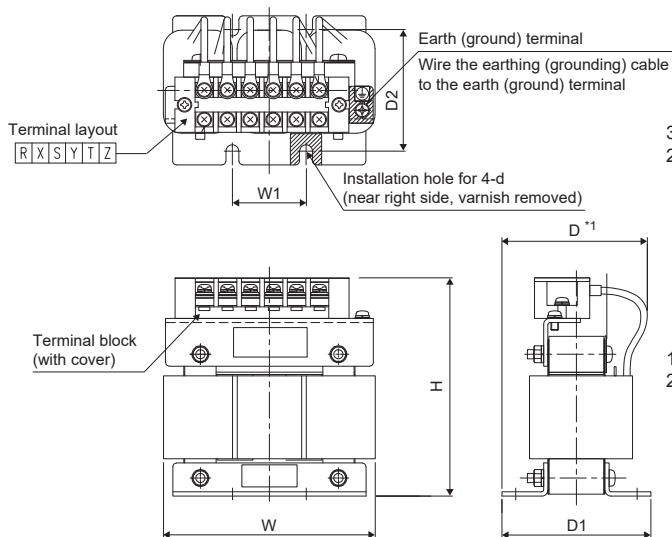
#### ■200 V



Servo amplifier	Power factor improving AC reactor	Dimensions [mm]							Terminal size	Mass [kg]
		W	W1	H	D *1	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

\*1 Maximum dimensions. The dimensions vary depending on the curvature of the input/output lines.

\*2 For 1-phase 200 V AC to 240 V AC power supply, connect the power supply to L1 and L3. Leave L2 open.

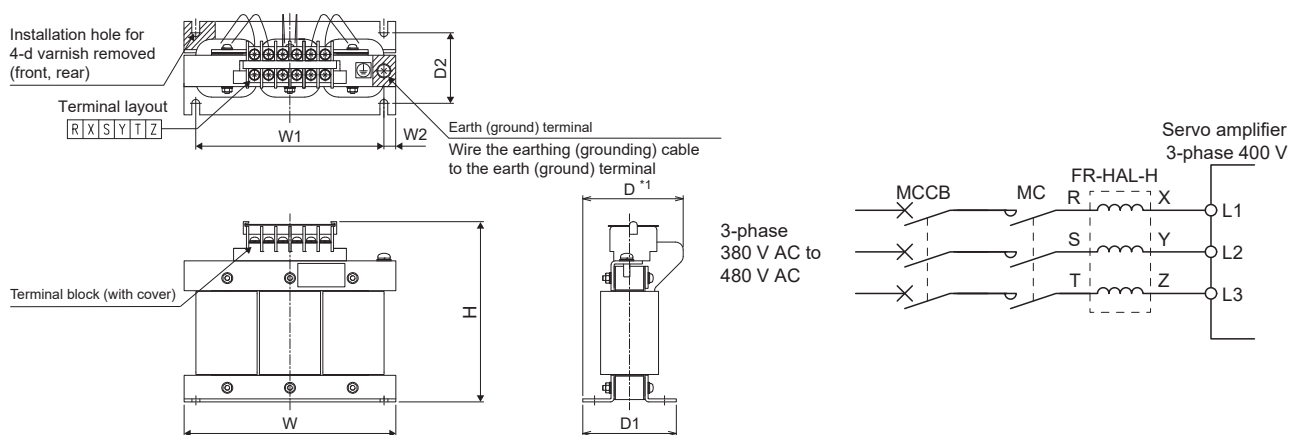


Servo amplifier	Power factor improving AC reactor	Dimensions [mm]							Terminal size	Mass [kg]
		W	W1	H	D *1	D1	D2	d		
MR-JET-100_ (3-phase power supply input)	FR-HAL-2.2K	115	40	115	77	71	57	M6	M4	1.5
MR-JET-100_ (1-phase power supply input) MR-JET-200_ (3-phase power supply input)	FR-HAL-3.7K	115	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	40	115	83	81	67	M6	M4	2.3

\*1 Maximum dimensions. The dimensions vary depending on the curvature of the input/output lines.

\*2 For 1-phase 200 V AC to 240 V AC power supply, connect the power supply to L1 and L3. Leave L2 open.

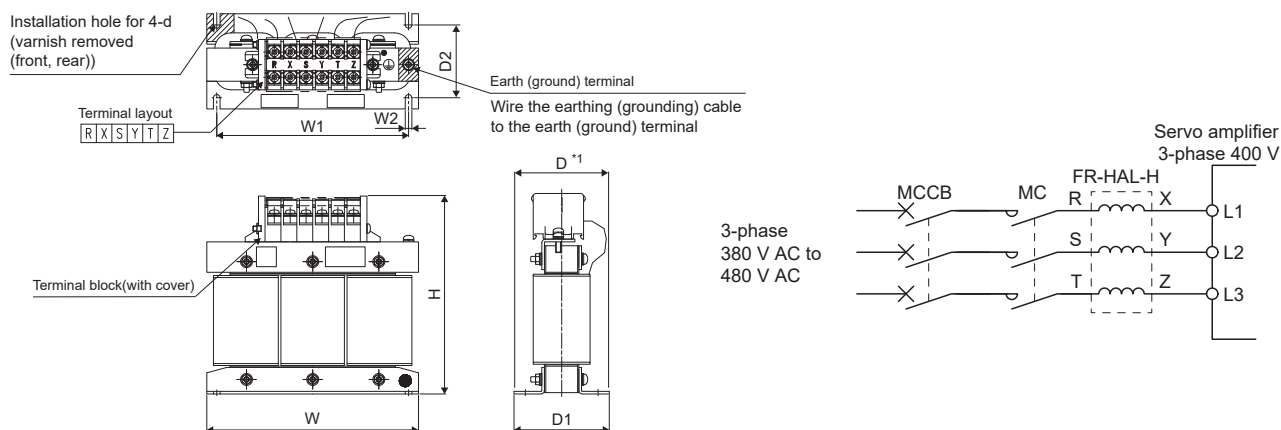
## ■400 V



Servo amplifier	Power factor improving AC reactor	Dimensions [mm]								Terminal size	Mass [kg]
		W	W1	W2	H	D *1	D1	D2	d		
MR-JET-60_4_	FR-HAL-H1.5K	135	120	8	115	59	59.6	45	M4	M3.5	1.5
MR-JET-100_4_	FR-HAL-H2.2K	135	120	8	115	59	59.6	45	M4	M3.5	1.5
MR-JET-200_4_	FR-HAL-H3.7K	135	120	8	115	69	70.6	57	M4	M3.5	2.5

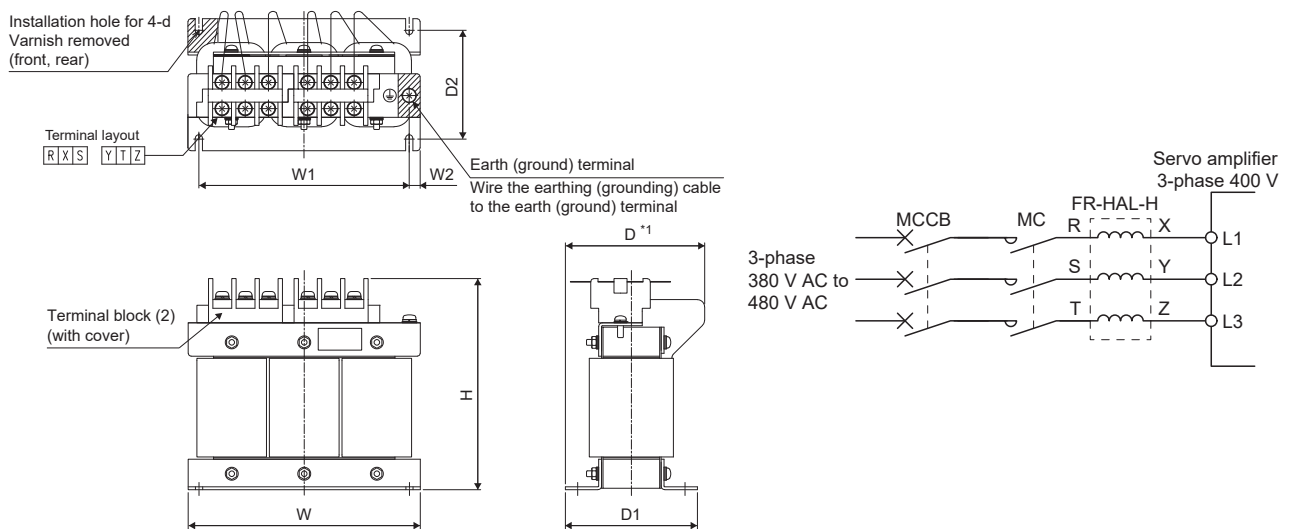
\*1 Maximum dimensions. The dimensions vary depending on the curvature of the input/output lines.

6



Servo amplifier	Power factor improving AC reactor	Dimensions [mm]								Terminal size	Mass [kg]
		W	W1	W2	H	D *1	D1	D2	d		
MR-JET-350_4_	FR-HAL-H7.5K	160	145	8	150	91	91	75	M4	M4	5.0

\*1 Maximum dimensions. The dimensions vary depending on the curvature of the input/output lines.



Servo amplifier	Power factor improving AC reactor	Dimensions [mm]								Terminal size	Mass [kg]
		W	W1	W2	H	D *1	D1	D2	d		
MR-JET-500_4_	FR-HAL-H11K	160	145	8	146	91	91	75	M4	M5	6.0
MR-JET-700_4_	FR-HAL-H15K	220	200	10	195	105	90	70	M5	M5	9.0

\*1 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 71 Grounding

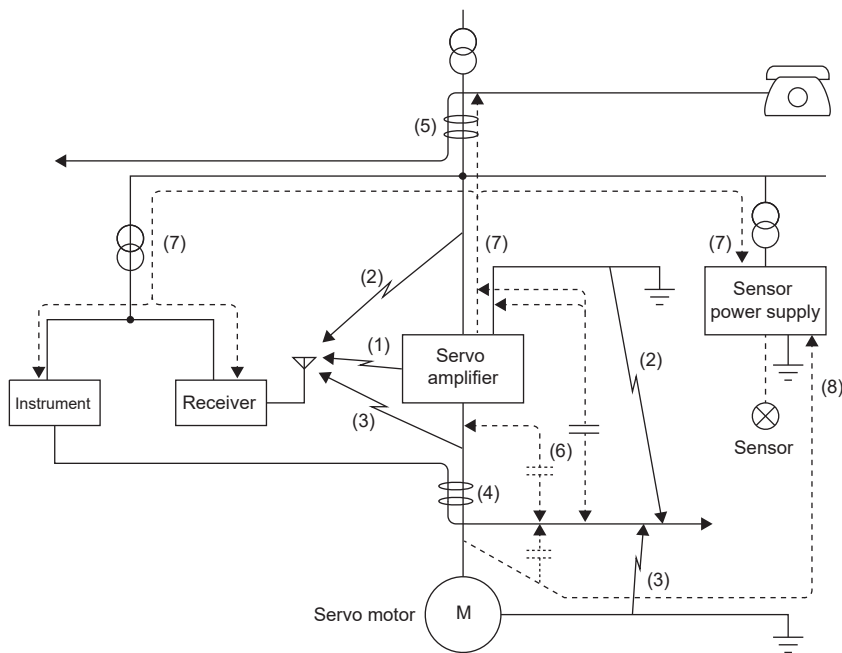
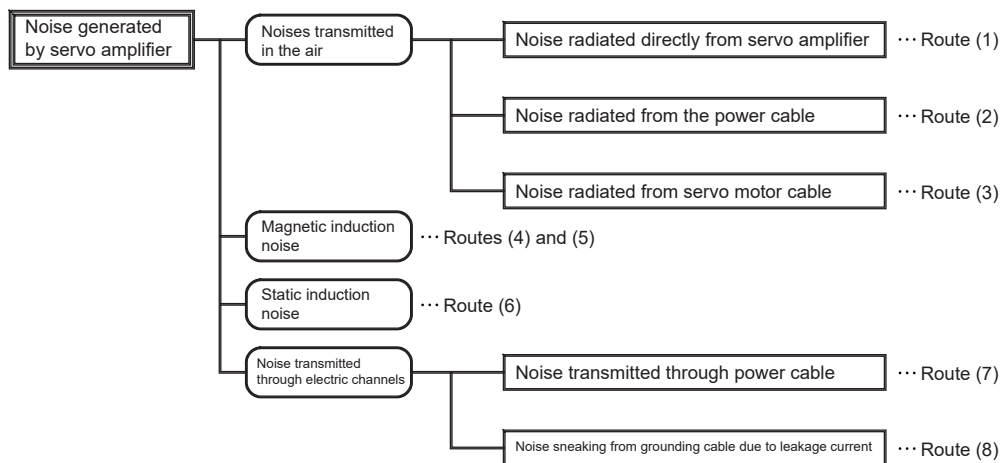
#### Reduction techniques for external noises that cause the servo amplifier to malfunction

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"> <li>• Provide maximum clearance between easily affected devices and the servo amplifier.</li> <li>• Provide maximum clearance between easily affected signal cables and the I/O cables of the servo amplifier.</li> <li>• Avoid bundling power lines (input/output lines of the servo amplifier) and signal cables together or running them in parallel to each other.</li> <li>• 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.</li> <li>• Use shielded wires for the signal and power lines, or put the lines in separate metal conduits.</li> </ul>
(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"> <li>• Provide maximum clearance between easily affected devices and the servo amplifier.</li> <li>• Provide maximum clearance between easily affected signal cables and the I/O cables of the servo amplifier.</li> <li>• Avoid bundling power lines (input/output lines of the servo amplifier) and signal cables together or running them in parallel to each other.</li> <li>• Use shielded wires for the signal and power lines, or put the lines in separate metal conduits.</li> </ul>
(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"> <li>• Install the radio noise filter (FR-BIF) on the power lines (input lines) of the servo amplifier.</li> <li>• Install the line noise filter (FR-BSF01) on the power lines of the servo amplifier.</li> </ul>
(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



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

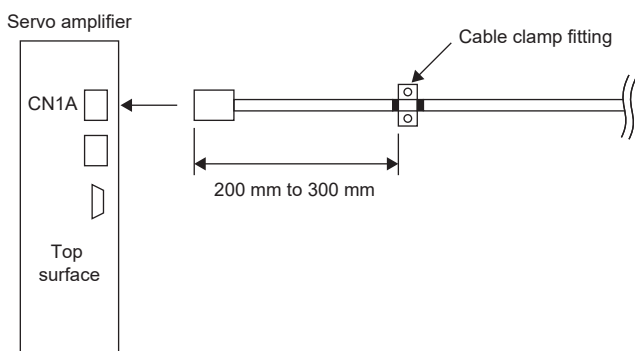
If using the network cable in an environment with excessive noise, directly connect the shield of the cable to the ground plate with cable clamp fittings at a place 200 mm to 300 mm from the servo amplifier.

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.

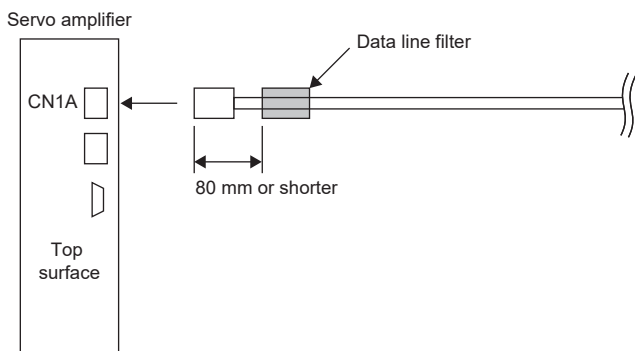
To reinforce noise reduction techniques, installing a data line filter (TDK ZCAT1730-0730) to the network cable is recommended. Install the data line filter to a place 80 mm or less from the servo amplifier.

### ■Inside the cabinet

- When using cable clamp fittings



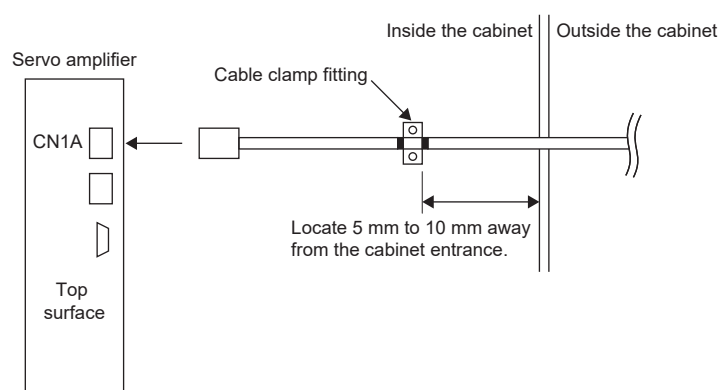
- When using a data line filter



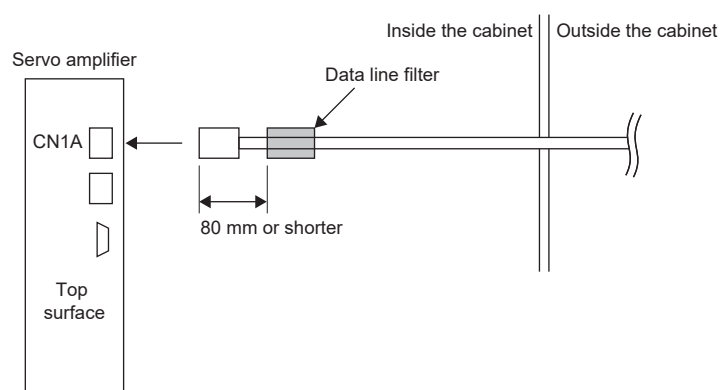


## ■ Outside the cabinet

- When using cable clamp fittings



- When using a data line filter



# Noise reduction products

## Data line filter (recommended)

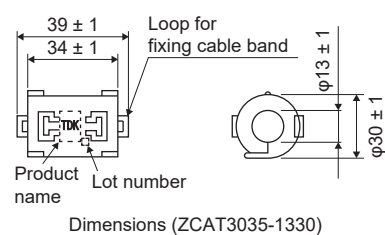
Noise can be prevented by installing a data line filter onto cables such as the encoder cable.

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.

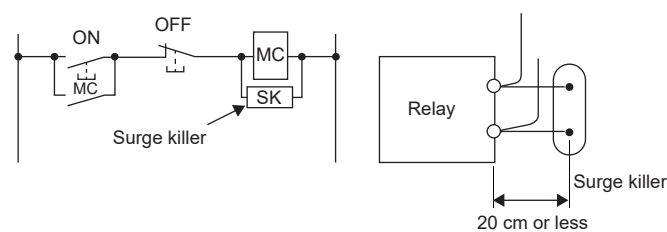
Impedance [ $\Omega$ ]	
10 MHz to 100 MHz	100 MHz to 500 MHz
80	150

[Unit: mm]



## 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.

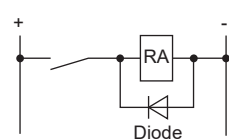
CR-50500 (Okaya Electric Industries)

Rated voltage AC [V]	C [ $\mu$ 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

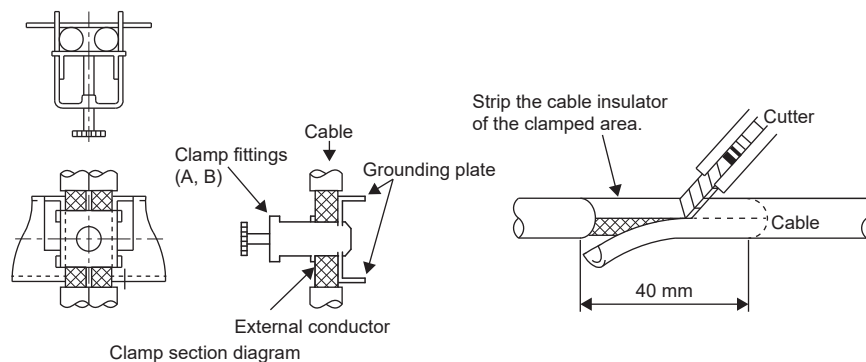
Maximum current: Not less than two times the drive current of the relay or the like



## Cable clamp fitting AERSBAN-\_SET

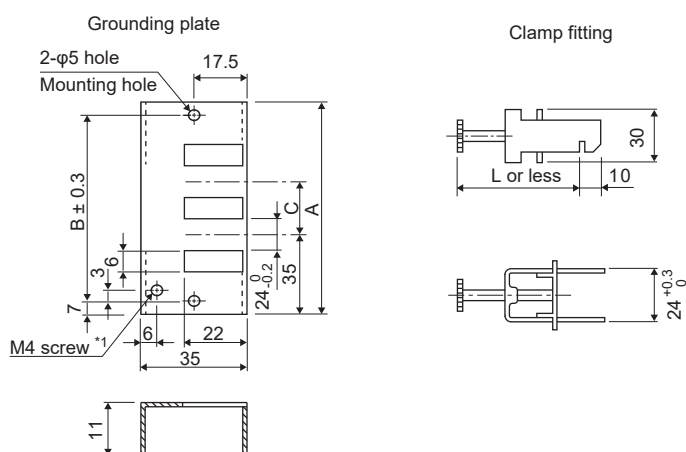
Generally, connecting the grounding wire of the shielded wire to the SD terminal of the connector provides a sufficient effect. However, the effect can be increased when the shielded wire is connected directly to the ground plate as shown below. Install the ground plate near the servo amplifier for the 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.

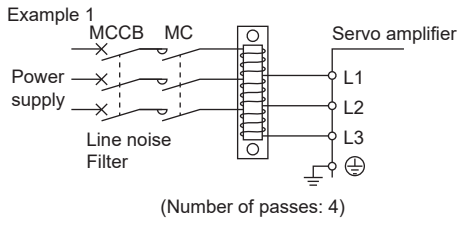
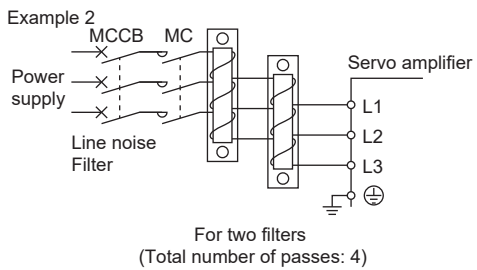
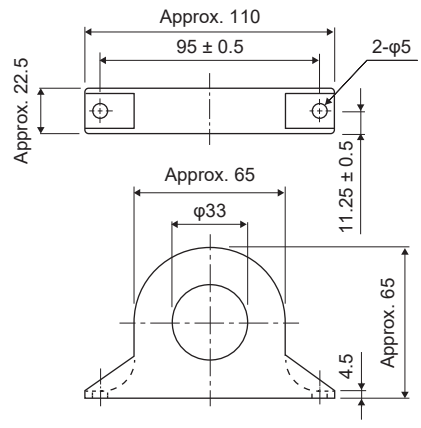
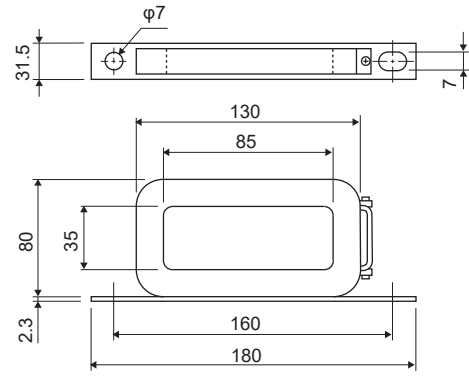
Model	A	B	C	Accessory fittings
AERSBAN-DSET	100	86	30	Clamp A: 2 pcs.
AERSBAN-ESET	70	56	—	Clamp B: 1 pc.
Clamp fitting		L		
A		70		
B		45		

## Precautions

The motor cable (single cable type) has no shield on the outermost circumference. Therefore, to ground the motor cable with a cable clamp, use a motor cable (dual cable type).

## Line noise filter (FR-BSF01/FR-BLF)

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.

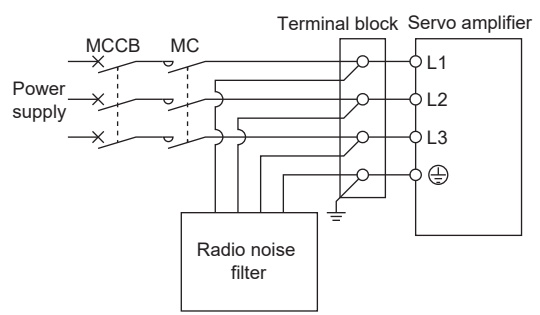
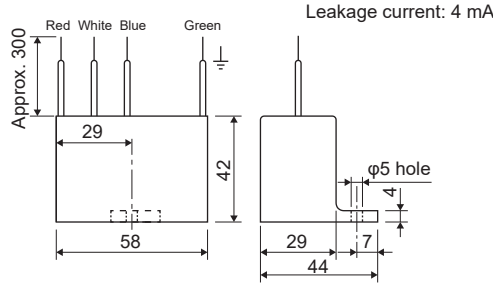
Connection diagram	Dimensions [Unit: mm]
<p>The line noise filters can be mounted on lines of the power supply (L1/L2/L3) and of the servo motor power (U/V/W). Pass each of the wires through the line noise filter the same number of times in the same direction. For wires of the power supply, the effect 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> <p><b>Example 1</b></p>  <p>(Number of passes: 4)</p> <p><b>Example 2</b></p>  <p>For two filters (Total number of passes: 4)</p>	<p><b>FR-BSF01</b> (for wire size 3.5 mm<sup>2</sup> (AWG 12) or less)</p>  <p><b>FR-BLF</b> (for wire size 5.5 mm<sup>2</sup> (AWG 10) or more)</p> 

## Radio noise filter (FR-BIF(-H))

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.

200 V: FR-BIF

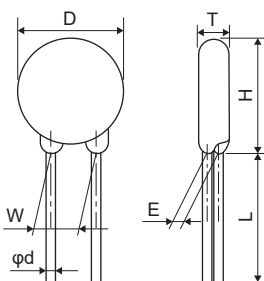
400 V: FR-BIF-H

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><b>Dimensions [Unit: mm]</b></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 μs [A]	2 ms [J]	[W]			[pF]	[V]
200 V	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)
400 V	TND20V-102K	625	825	7500/1 times 6500/2 times	400	1.0	100	1650	560	1000 (900 to 1100)



[Unit: mm]

Model	D Max.	H Max.	T Max.	E $\pm 1.0$	L Min.*1	$\phi d \pm 0.05$	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			
TND20V-102K	22.5	25.5	9.5	6.4	20	0.8	10.0

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

## 6.11 Earth-leakage current breaker

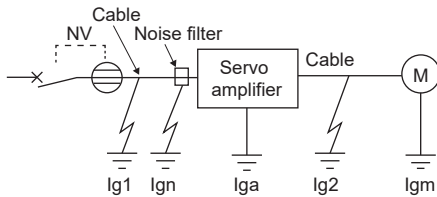
### Selection method

High-frequency chopper currents controlled by pulse width modulation flow in the AC servo circuits. Leakage currents containing harmonics 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.

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



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

I<sub>g1</sub>: Leakage current on the electric channel from the earth-leakage current breaker to the input terminals of the servo amplifier

☞ Page 153 Example of leakage current (I<sub>g1</sub>, I<sub>g2</sub>) per km of CV cable run in metal conduit

I<sub>g2</sub>: Leakage current on the electric channel from the output terminals of the servo amplifier to the servo motor

☞ Page 153 Example of leakage current (I<sub>g1</sub>, I<sub>g2</sub>) per km of CV cable run in metal conduit

I<sub>gn</sub>: Leakage current when a filter is connected to the input side (4.4 mA per FR-BIF(-H))

I<sub>ga</sub>: Servo amplifier leakage current

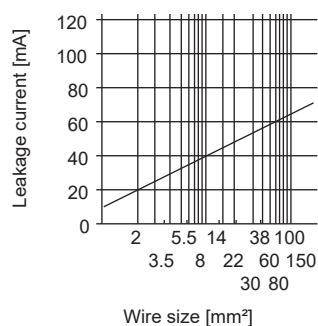
☞ Page 153 Servo amplifier leakage current example (I<sub>ga</sub>)

I<sub>gm</sub>: Servo motor leakage current

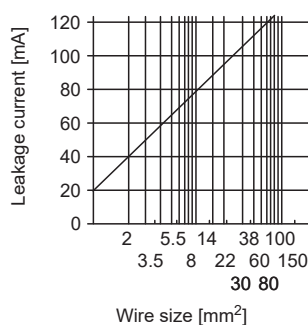
☞ Page 153 Servo motor leakage current example (I<sub>gm</sub>)

## Example of leakage current (lg1, lg2) per km of CV cable run in metal conduit

- 200 V



- 400 V



## Servo motor leakage current example (lgm)

Servo motor output [kW]	Leakage current [mA]
0.05 to 1	0.1
1.5 to 2	0.2
3 to 3.5	0.3
4.2 to 5	0.5
6 to 7	0.7

## Servo amplifier leakage current example (lga)

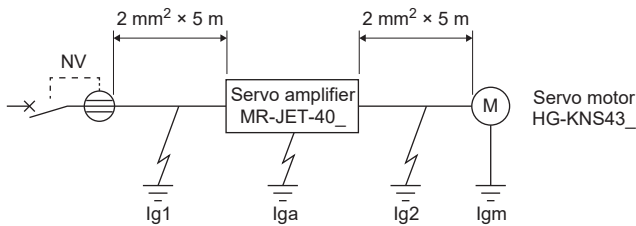
Servo amplifier	Leakage current [mA]
MR-JET-10_ MR-JET-20_ MR-JET-40_	0.1
MR-JET-70_ MR-JET-100_ MR-JET-200_ MR-JET-300_	0.15
MR-JET-60_4_ MR-JET-100_4_ MR-JET-200_4_ MR-JET-350_4_	0.38
MR-JET-500_4_ MR-JET-700_4_	2

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
MR-JET-60_4_ to MR-JET-350_4_	15
MR-JET-500_4_	100
MR-JET-700_4_	100

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.

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

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

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

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

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

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 with a 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)

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.

When connecting one or more servo amplifiers to one EMC filter, satisfy the following conditions:

- Rated voltage of the EMC filter [V]  $\geq$  Rated voltage of the servo amplifiers [V]
- Rated current of the EMC filter [A]  $\geq$  Total rated current of the servo amplifiers connected to the EMC filter [A]

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 *4	50 m or less	FSB-10-254-HU	10	250	-40 to 85	1.8	COSEL
		FSB-20-254-HU	20				
		FSB-30-254-HU	30				
		FSB-10-355	10	500	-40 to 85	1.8	
		FSB-20-355	20				
		FN3288-16-44-C35-R65 *3	16	530	-40 to 50	1.0	Schaffner EMC K.K.
IEC/EN 61800-3 Category C3 *1	50 m or less *2	HF3010C-SZB	10	500	-20 to 50	0.9	Soshin Electric
		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)

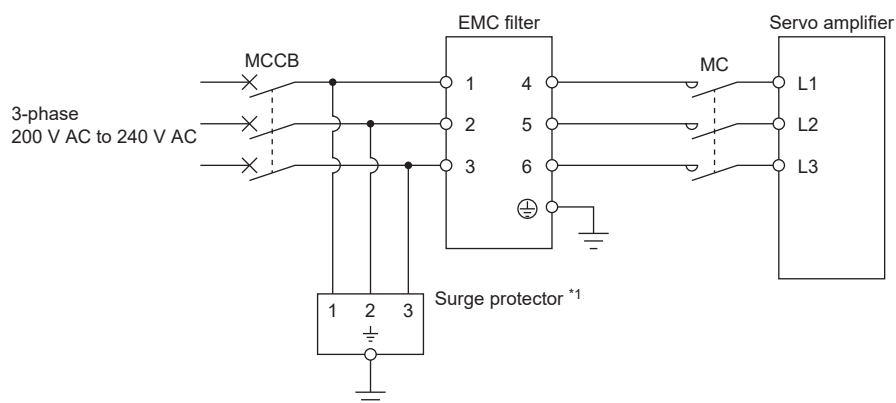
\*2 Install the radio noise filter (FR-BIF) on the input power lines of the servo amplifier if the power cable length is over 20 m.

\*3 For 200 V servo amplifiers, FN3288-16-44-C17-R65 whose leakage current from the EMC filter is suppressed can be used.

\*4 When using MR-JET-60G4-HS to MR-JET-350G4-HS in category C2, install data line filters on the input part and output part of the servo amplifier.

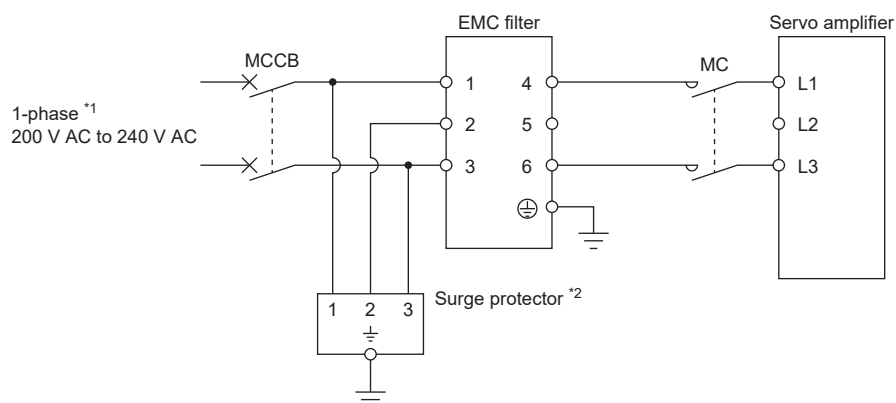
## Connection example

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



\*1 When a surge protector is used

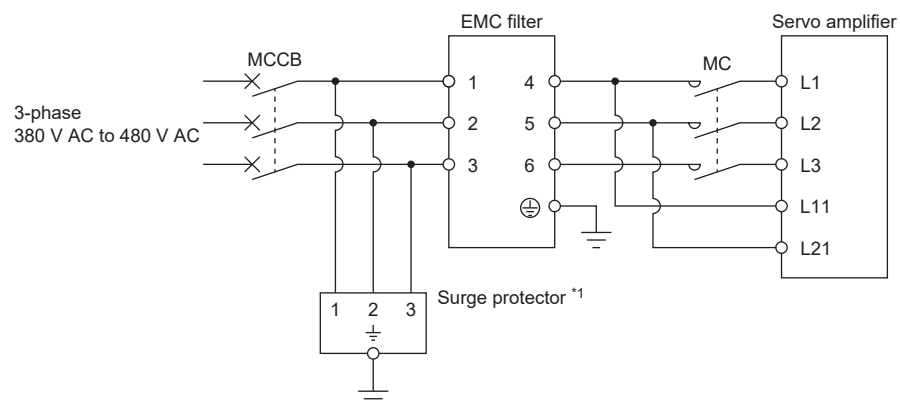
### ■For 1-phase 200 V AC to 240 V AC power supply



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

\*2 When a surge protector is used

### ■For 3-phase 380 V AC to 480 V AC power supply



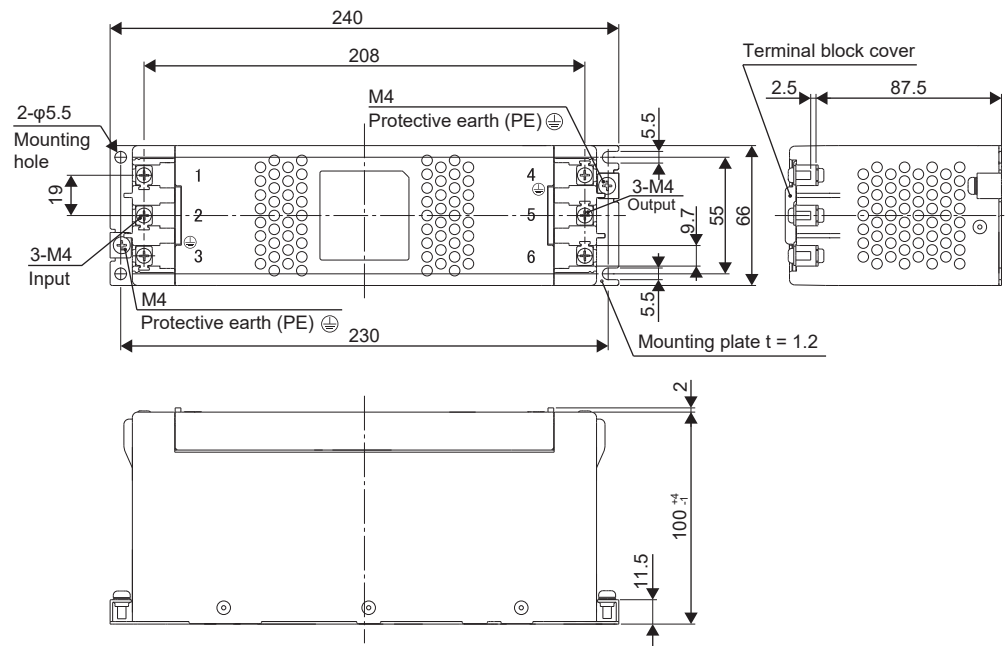
\*1 When a surge protector is used

# Dimensions

## ■EMC filter

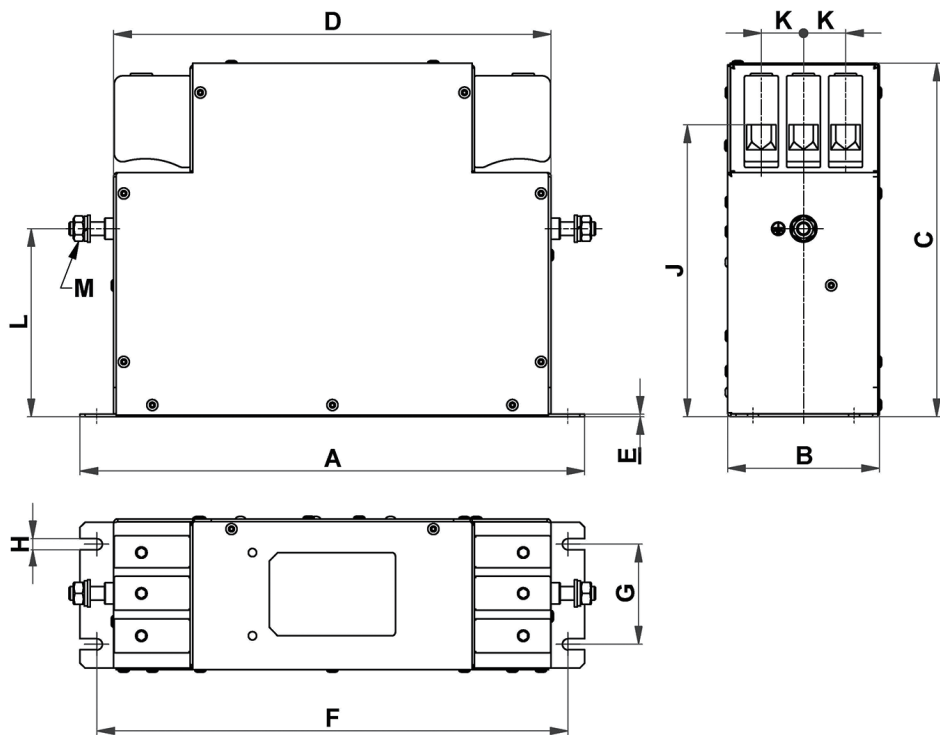
- FSB-10-254-HU/FSB-20-254-HU/FSB-30-254-HU/FSB-10-355/FSB-20-355

[Unit: mm]



- FN3288-16-44-C35-R65

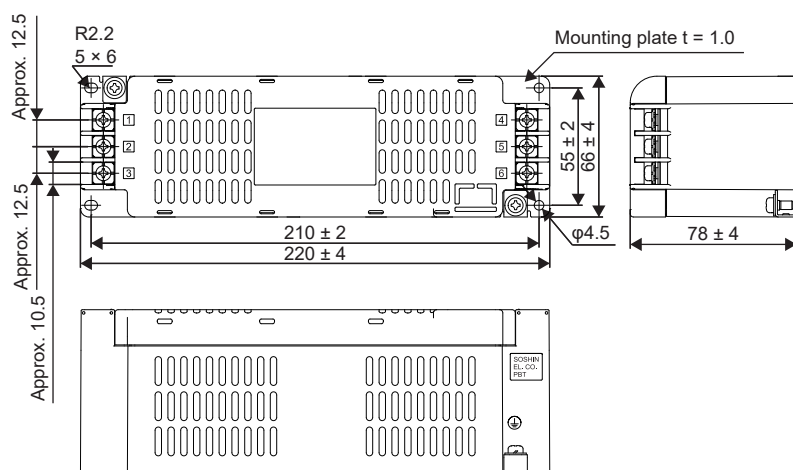
[Unit: mm]



Model	A	B	C	D	E	F	G	H	J	K	L	M
FN3288-16-44-C35-R65	195	45	140	164	0.8	180	25	5.4	122	11	93	M5

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

[Unit: mm]



## ■ Surge protector (recommended)



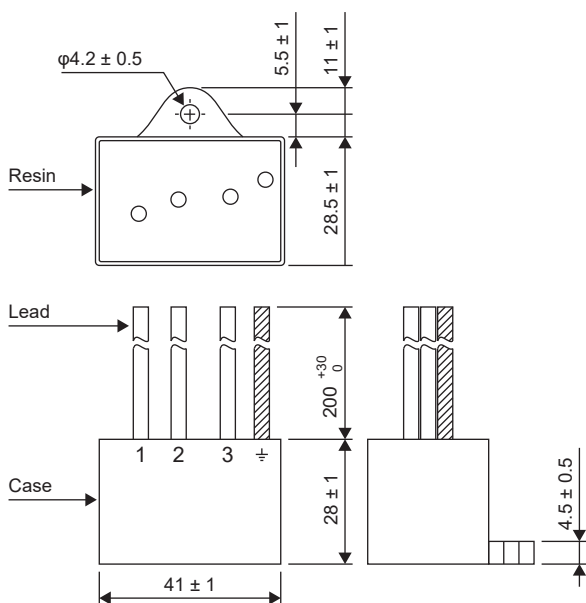
To use an EMC filter on the servo amplifier, a surge protector is required.

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).

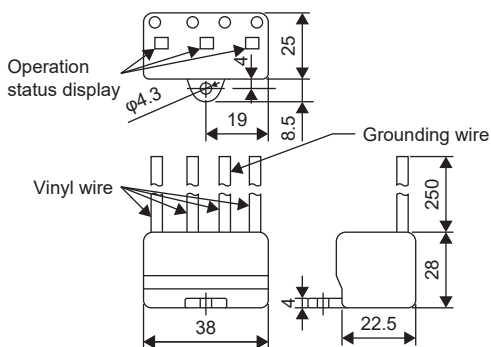
Surge protector model	Maximum continuous operating voltage 50/60 Hz	DC operating start voltage	Voltage protection level	Nominal discharge current 8/20 $\mu$ s	Maximum discharge current 8/20 $\mu$ s	Impulse current life 8/20 $\mu$ s - 1000 A	Manufacturer
RSPD-250-U4	3-phase 250 V AC	700 V $\pm$ 25 %	1300 V	2500 A	5000 A	About 300 times	Okaya Electric Industries
RSPD-500-U4	3-phase 500 V AC	1300 V $\pm$ 25 %	2000 V	2500 A	5000 A	About 300 times	Okaya Electric Industries
LT-CS32G801WS	3-phase 275 V AC	660 V $\pm$ 10 %	1400 V	5000 A	8000 A	About 1000 times	Soshin Electric

- RSPD series (Okaya Electric Industries)

[Unit: mm]



- LT-CS-WS series (Soshin Electric)



## 6.13 Shield clamp attachment

This is an attachment for grounding the shield of the servo motor power cable at the bottom of the servo amplifier.

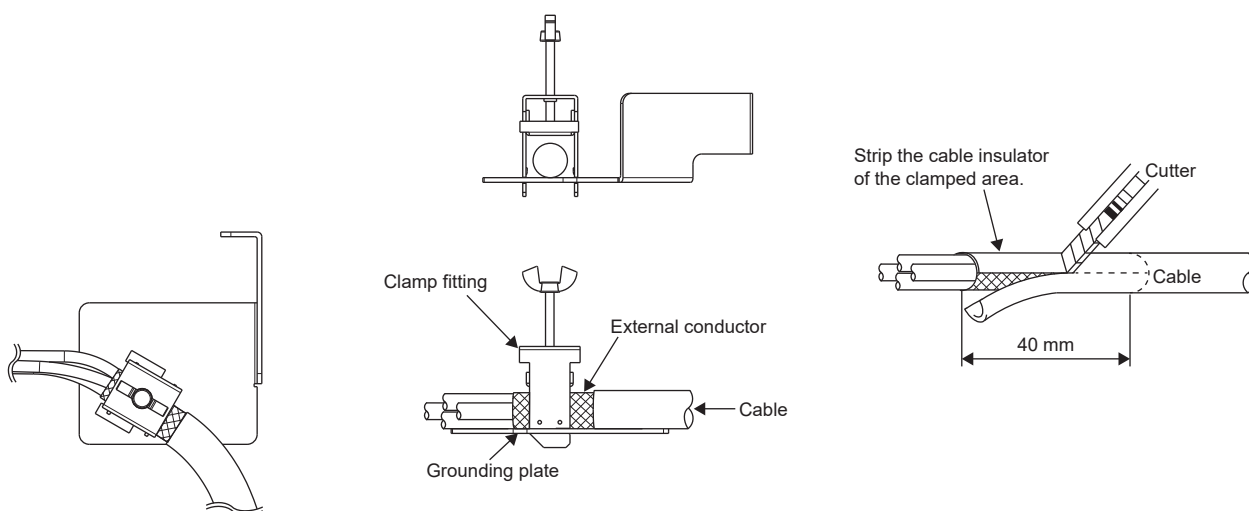
### Compatible models

- MR-JET-500\_4\_/MR-JET-700\_4\_

### Cable connection method

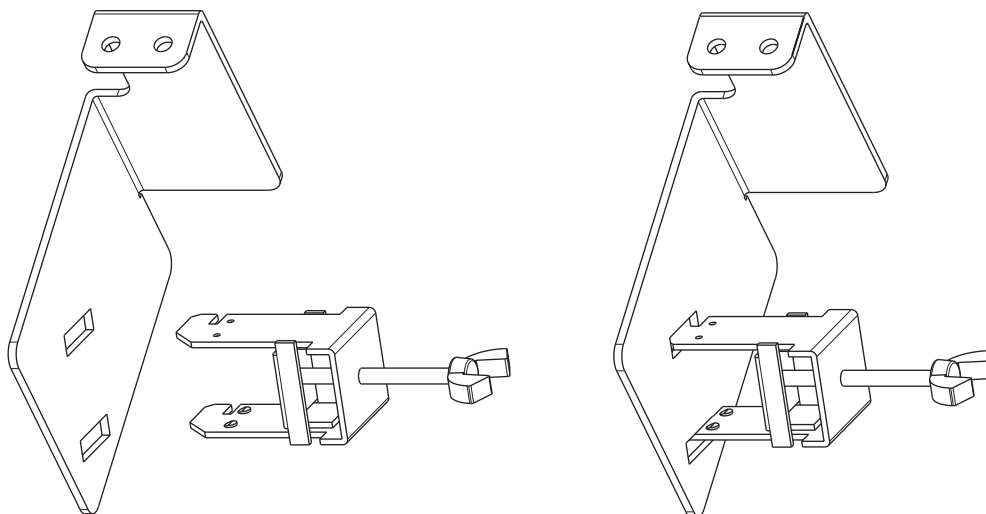
Peel a part of the cable insulator to expose the external conductor as shown in the following figure, and press that part against the ground plate with the cable clamp.

The shield clamp attachment consists of the grounding plate and clamp fitting.



# MR-ASCHP06

## Appearance

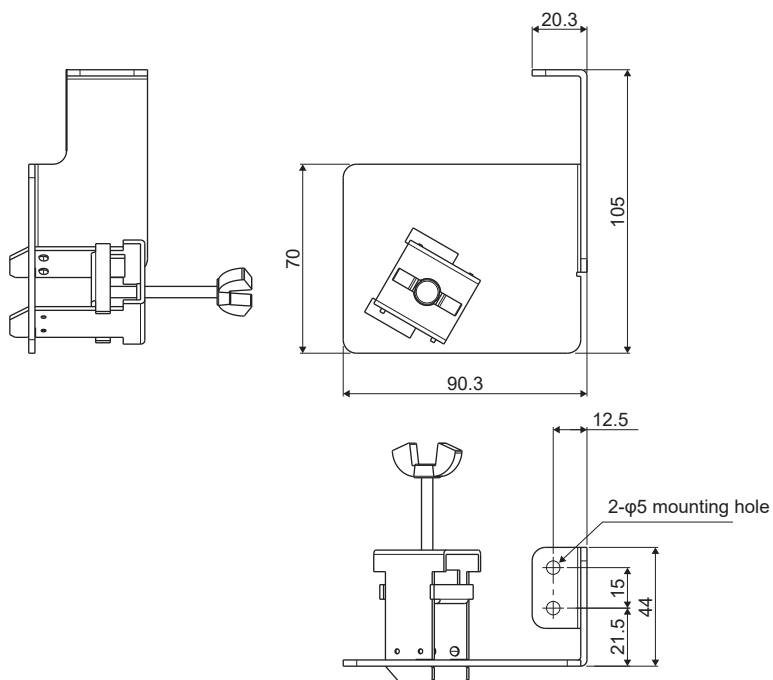


Material: SPHC-P

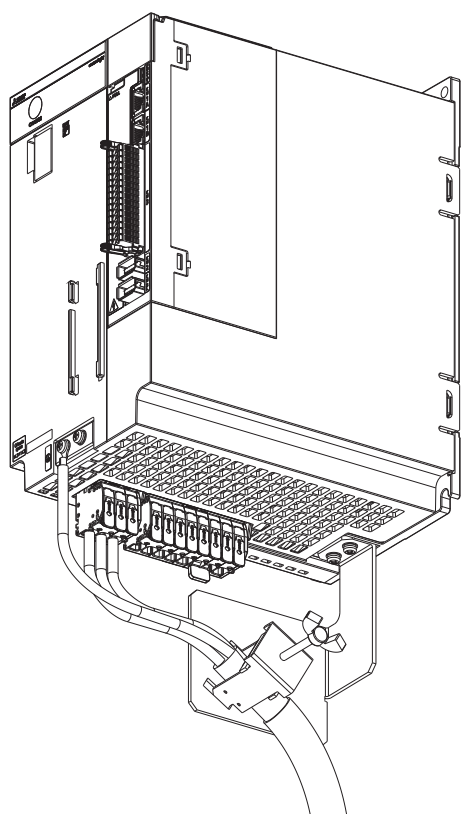
Plating: Trivalent chrome plated

## Dimensions

[Unit: mm]



**View when installed**



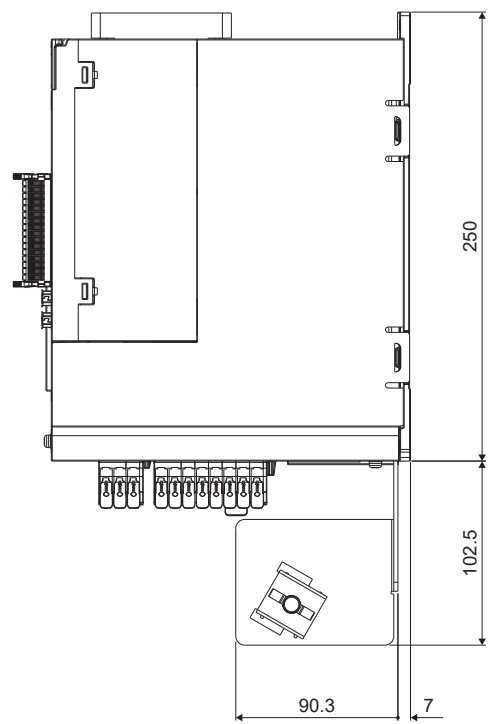
**Components**

Components are listed in the following table. The attachment, cable clamp, and screws come pre-installed.

Packed articles	Quantity
Shield clamp attachment	1
Cable clamp	1
Flat head screw (M4)	2



Installation dimensions



## 6.14 SCC 15-F Shield connection clamp

This component is a terminal block for grounding the shield of the servo motor power cable on the top of the servo amplifier.

### Point

For details of the component, contact Phoenix Contact.

To install the component, two screws of M4 × 6 to 12 are required.

### Compatible models

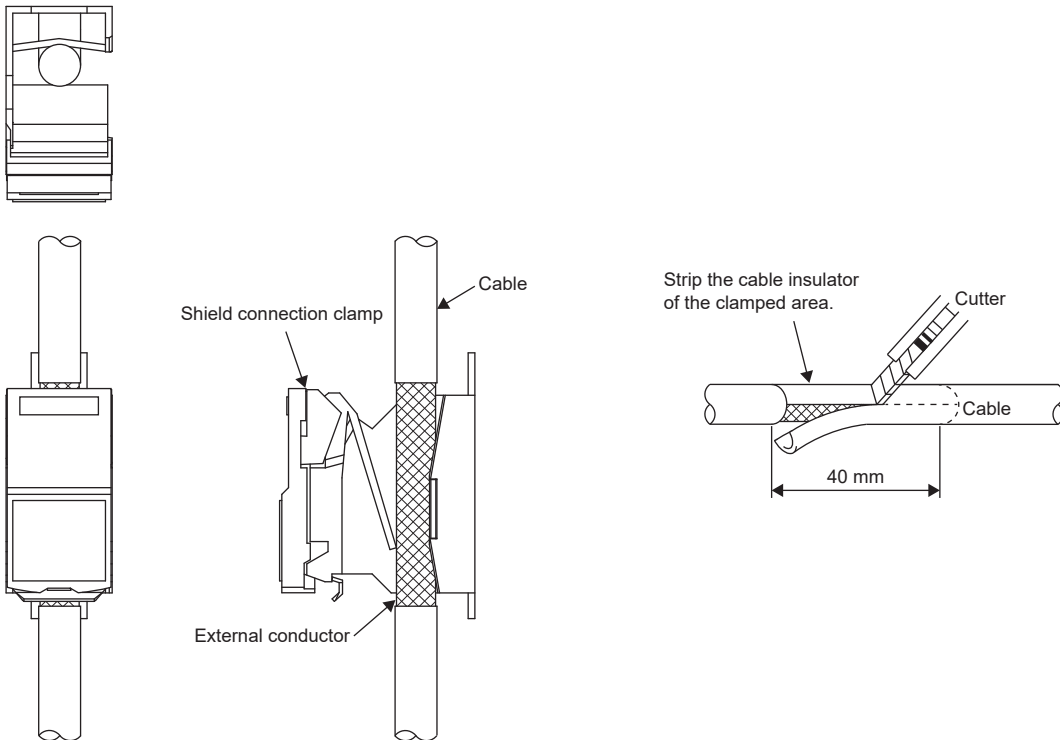
- MR-JET-500\_4\_/MR-JET-700\_4\_

### Applicable wire diameter

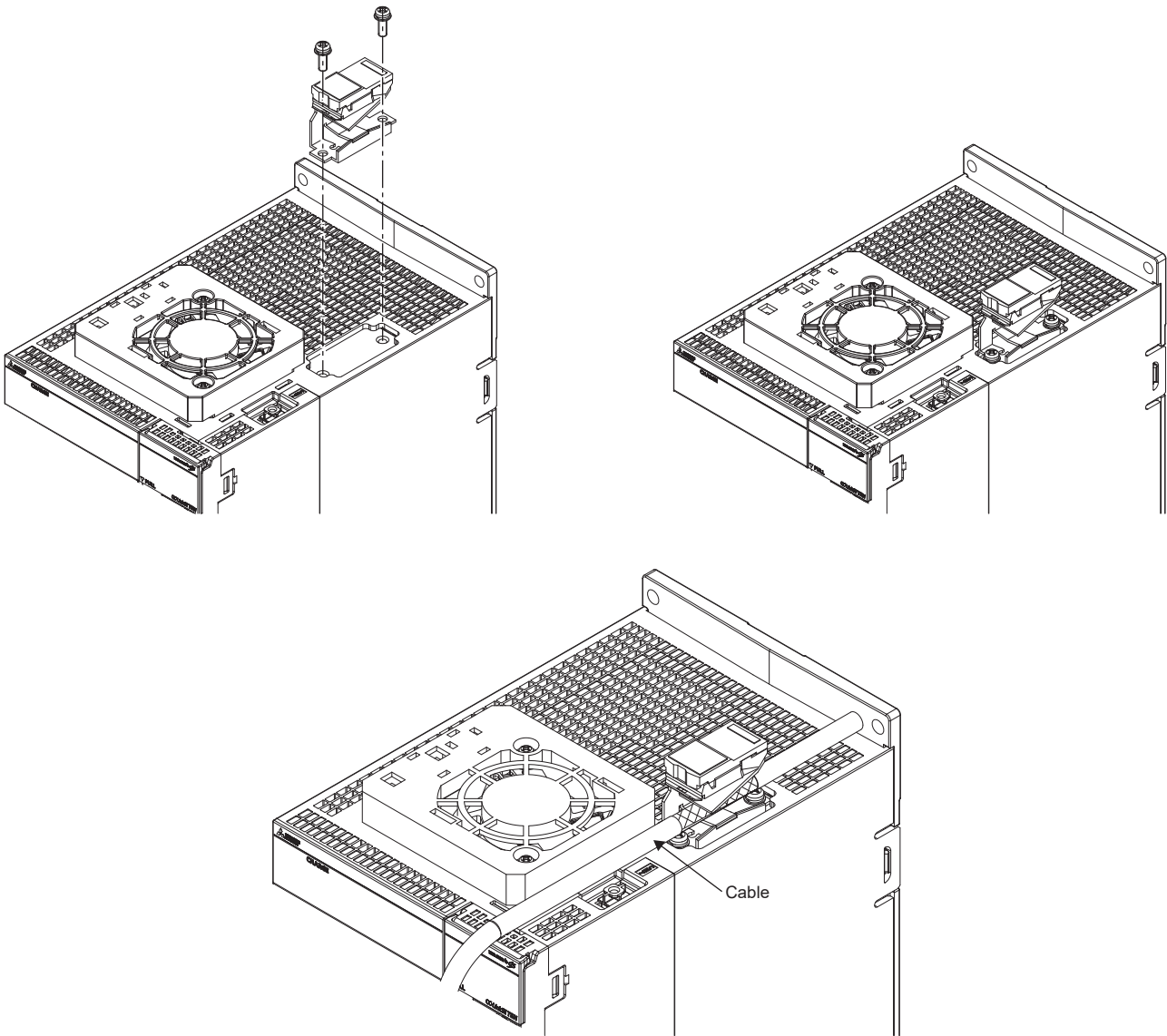
- 8 mm to 15 mm

### Cable connection method

Peel a part of the cable insulator to expose the external conductor as shown in the following figure, and secure that part by putting it into the shield connection clamp.



# View when installed



# 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 125 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.
- When the servo motor that requires a battery for the absolute position detection system is used, replacing the battery 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
- When semi closed/fully closed switching is enabled
- Stroke-less coordinate system for infinite positioning and the like in combination with a controller other than a Mitsubishi Electric controller

### Precautions

Even when using a servo motor with battery-less absolute position encoder, absolute position data is erased (ABSV turns on) under the following conditions. If the absolute position data is erased, perform homing again.

- The servo motor or servo amplifier is replaced.
- The incremental system is enabled.
- [Pr. PA01 Operation mode selection] is changed.
- [AL. 025 Absolute position erased] occurs.
- [AL. 0E3 Absolute position counter warning] occurs.
- [AL. 02B Encoder counter error] occurs.
- [AL. 069 Command error] occurs while [Pr. PD61.2 [AL. 069 Command error] output selection with absolute position erased] is "1" (enabled).

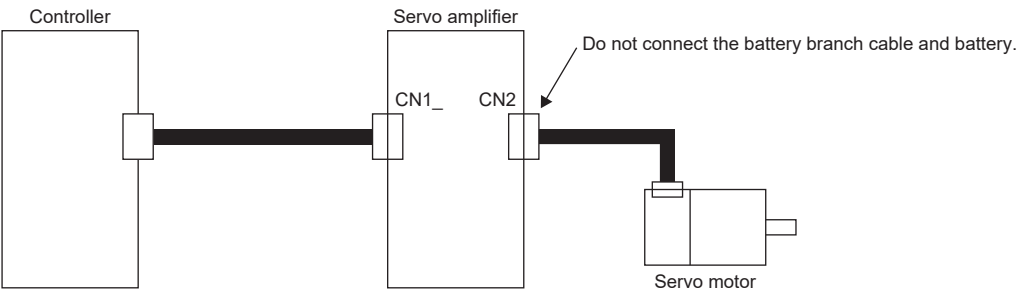
Connecting a servo motor other than the one that was connected at the startup of the absolute position detection system triggers [AL. 01A Servo motor combination error]. In such cases, reconnect the servo motor that was connected at the startup of the absolute position detection system to operate without losing the absolute position data.

☞ Page 169 Procedure of replacing a servo motor with battery-less absolute position encoder

# System architecture

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

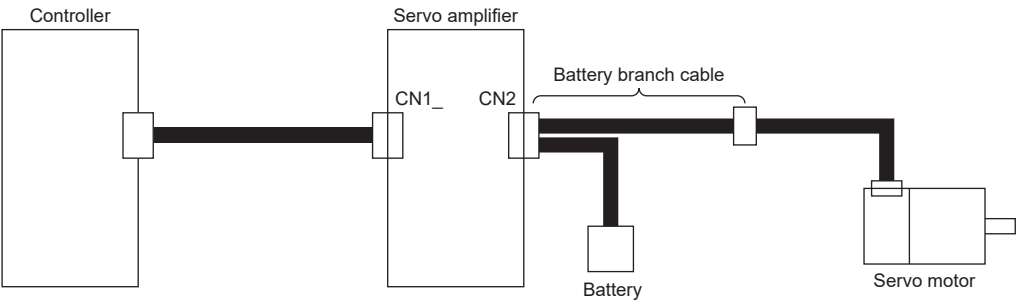
## When connecting the battery-less absolute position encoder



## When connecting the battery backup type absolute position encoder

For battery connection, refer to the following.

📖 Page 125 Battery



# Setting servo parameters

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

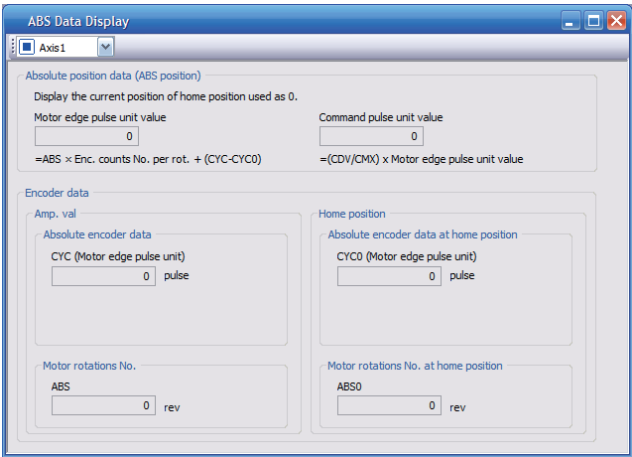
## Homing

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 the value in the unit of the servo motor side pulses from the servo amplifier of the specified axis and displays it.
(2)	Command pulse unit value	Current position	Acquires the command pulse unit value from the servo amplifier for the specified axis and displays it.
(3)	CYC	1X	Acquires the position within one revolution in the unit of the servo motor side pulses from the servo amplifier of the specified axis and displays it.
(4)	ABS	LS	Acquires the multi-revolution counter travel distance from the absolute home position from the servo amplifier of the specified axis and displays it.
(5)	CYC0	1XO	Acquires the home position within one revolution in the unit of the servo motor side pulses from the servo amplifier of the specified axis and displays it.
(6)	ABS0	LSO	Acquires the multi-revolution counter value of the absolute home position from the servo amplifier of the specified axis and displays it.

\*1 Refer to the following for the system architecture.  
📖 Page 171 Connecting the battery backup type absolute position encoder

# Procedure of replacing a servo motor with battery-less absolute position encoder

To replace a servo motor with battery-less absolute position encoder, use the procedure described in this section.

## Precautions

When [Pr. PF63.0 [AL. 01A.5 Servo motor combination error 3] selection] is "1" (disabled), connecting a servo motor that had not been connected at the startup of the absolute position detection system will cause [AL. 025.1 Servo motor absolute position erased], erasing absolute position data. Therefore, check if a correct servo motor is connected.

## Servo motor replacement procedure

### Point

- When the power of the servo amplifier is cycled or the software reset is performed after [Pr. PA03.1 Servo motor replacement preparation] is set to "1" (enabled), [Pr. PA03.1] automatically changes to "0" (disabled) and absolute position data is erased. Therefore, check if a correct servo parameter is set.

### 1. Replacing the servo motor

Turn off the power supply of the servo amplifier and replace the servo motor.

### 2. Canceling [AL. 01A Servo motor combination error]

When the power supply of the servo amplifier is turned on, [AL. 01A.5 Servo motor combination error 3] occurs.

After setting [Pr. PA03.1 Servo motor replacement preparation] to "1" (enabled), cycle the power of the servo amplifier or perform the software reset and then deactivate [AL. 01A.5].

### 3. Homing

The absolute position data is erased by servo motor replacement. Before starting operation, perform homing.

## Procedure of replacing the servo motor without changing the servo parameter setting

By setting [Pr. PF63.0 [AL. 01A.5 Servo motor combination error 3] selection] to "1" (disabled) while the absolute position detection system is enabled, an in-use servo motor with a batteryless absolute position encoder can be replaced without changing the setting value of [Pr. PA03.1 Servo motor replacement preparation].

To replace the servo motor without changing the servo parameter setting, refer to the following procedure. Set [Pr. PF63.0] to "1" (disabled) in advance, and reset the controller or cycle the power.

### 1. Replacing the servo motor

Turn off the power supply of the servo amplifier and replace the servo motor.

### 2. Canceling [AL. 025 Absolute position erased]

When the power supply of the servo amplifier is turned on, [AL. 025.1 Servo motor encoder absolute position erased] occurs. Cycle the power of the servo amplifier to deactivate [AL. 025.1].

### 3. Homing

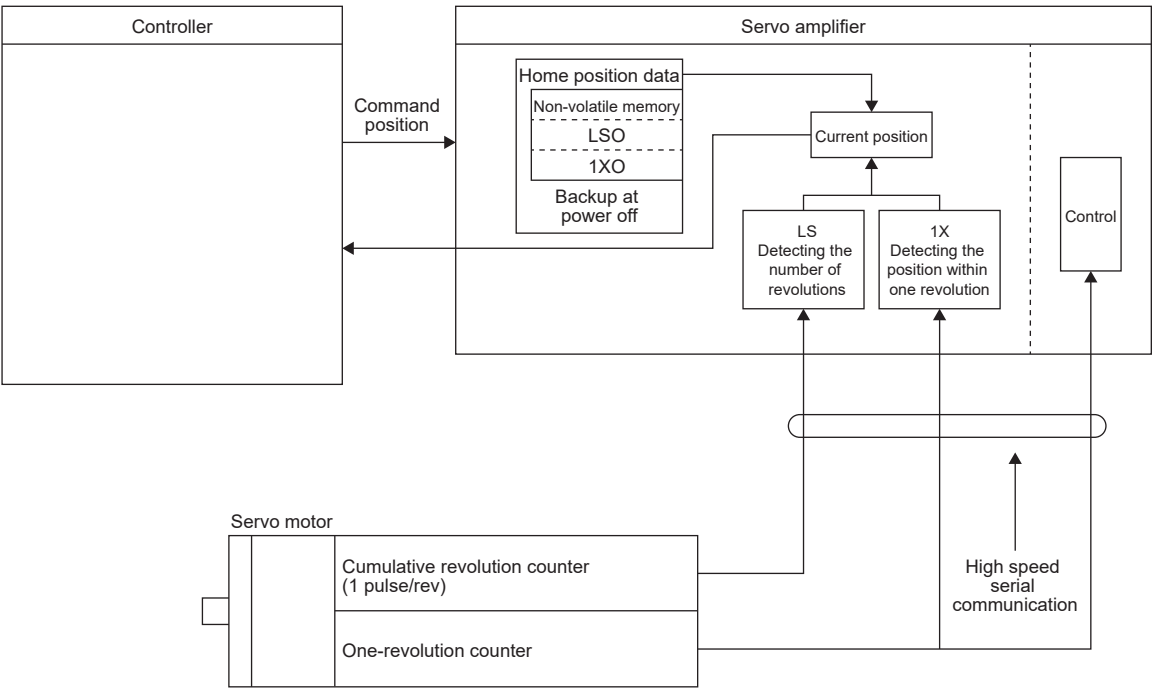
When [AL. 025] occurs, the absolute position data is erased. Before starting operation, perform homing.

# 7.2 Configuration and specifications

## Connecting the battery-less encoder

The following shows an example of battery-less encoder connection.

### System architecture



### Specification list

Item		Description
System		Electronic, battery backup type
Maximum revolution range		Home position ± 32767 rev
Maximum speed at power failure [r/min] *1	Rotary servo motor manufactured by Mitsubishi Electric	8000 (only when the acceleration/deceleration time until 8000 r/min is 0.2 s or longer)

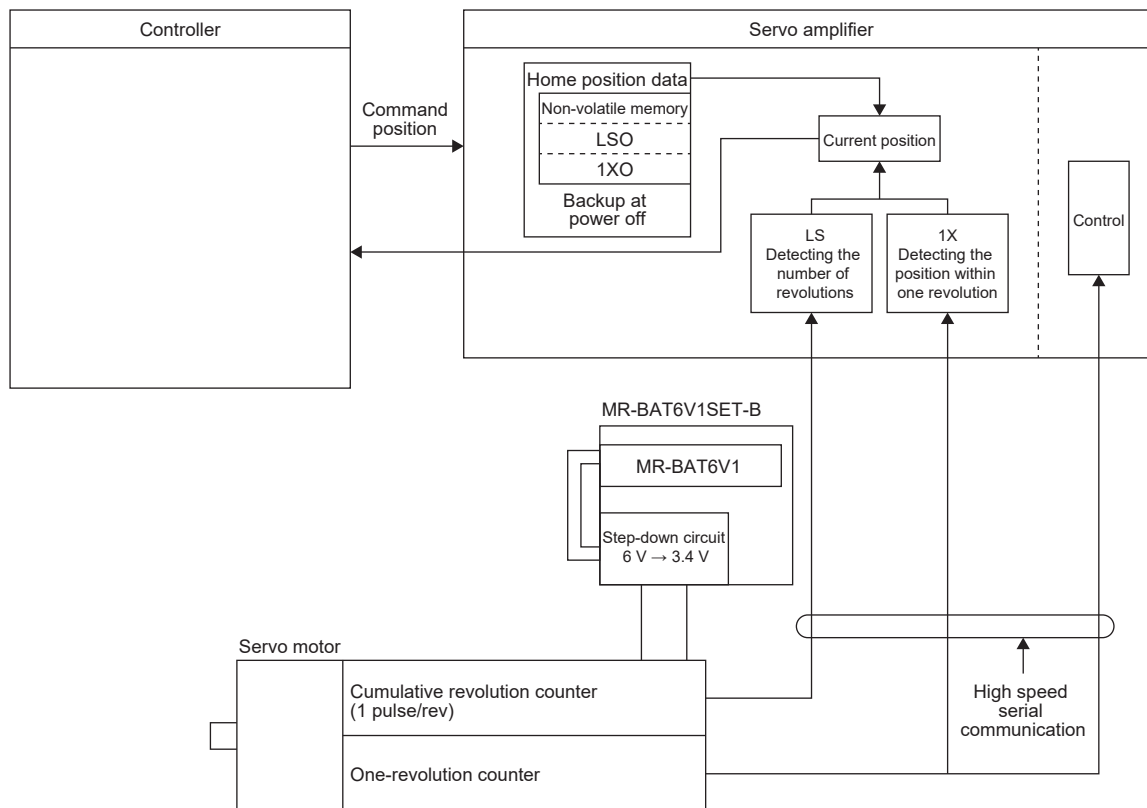
\*1 Maximum speed available when the shaft is rotated by external force at the time of power failure. Also, if power is switched on when the servo motor is rotated by an external force at a speed of 3000 r/min or higher, position mismatch may occur.



# Connecting the battery backup type absolute position encoder

The following shows an example of absolute position encoder connection.

## System architecture



## Specification list

Item	Description
System	Electronic, battery backup type
Maximum revolution range	Home position $\pm 32767$ rev
Maximum speed at power failure [r/min] <sup>*1</sup>	6000 (only when the acceleration/deceleration time until 6000 r/min is 0.2 s or longer)
Battery backup time <sup>*2</sup>	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) <sup>*3</sup>

<sup>\*1</sup> 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.

<sup>\*2</sup> 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.

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


# 8 USING FUNCTIONAL SAFETY

---

## **Point**

Functional safety is not available for the MR-JET-\_G\_-HS(N1) in the factory settings.

When using the functional safety, refer to the following manual and set the functional safety parameters.

 MR-JET User's Manual (Function)

---

## 8.1 Introduction

---

For the setting to use functional safety, refer to Chapter 6 in the following user's manual.

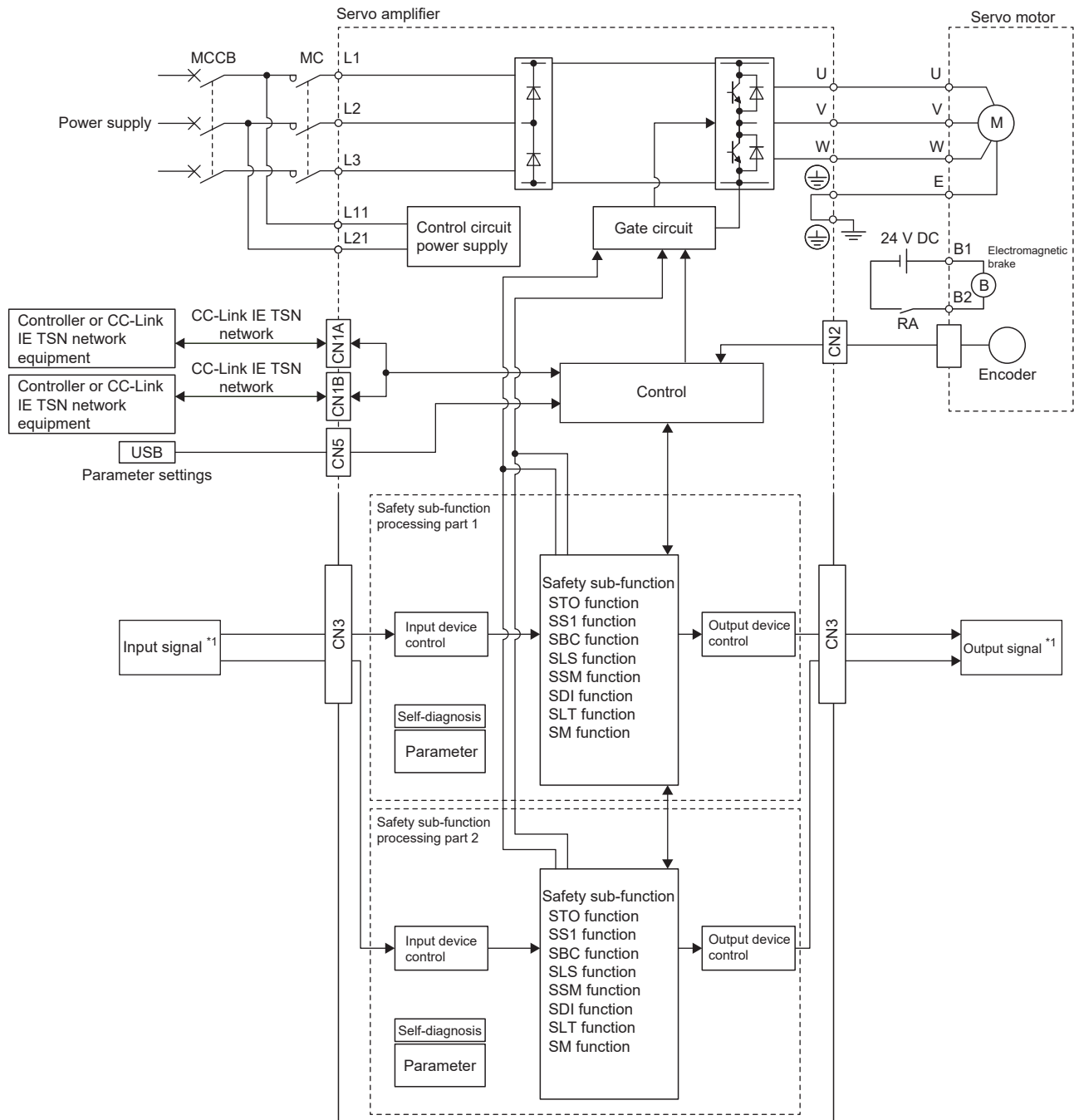
 MR-JET User's Manual (Function)

## 8.2 Function Block Diagram

### Safety sub-function control by input device

This figure shows a function block configured to allow input devices assigned to the CN3 connector pins to execute safety sub-functions.

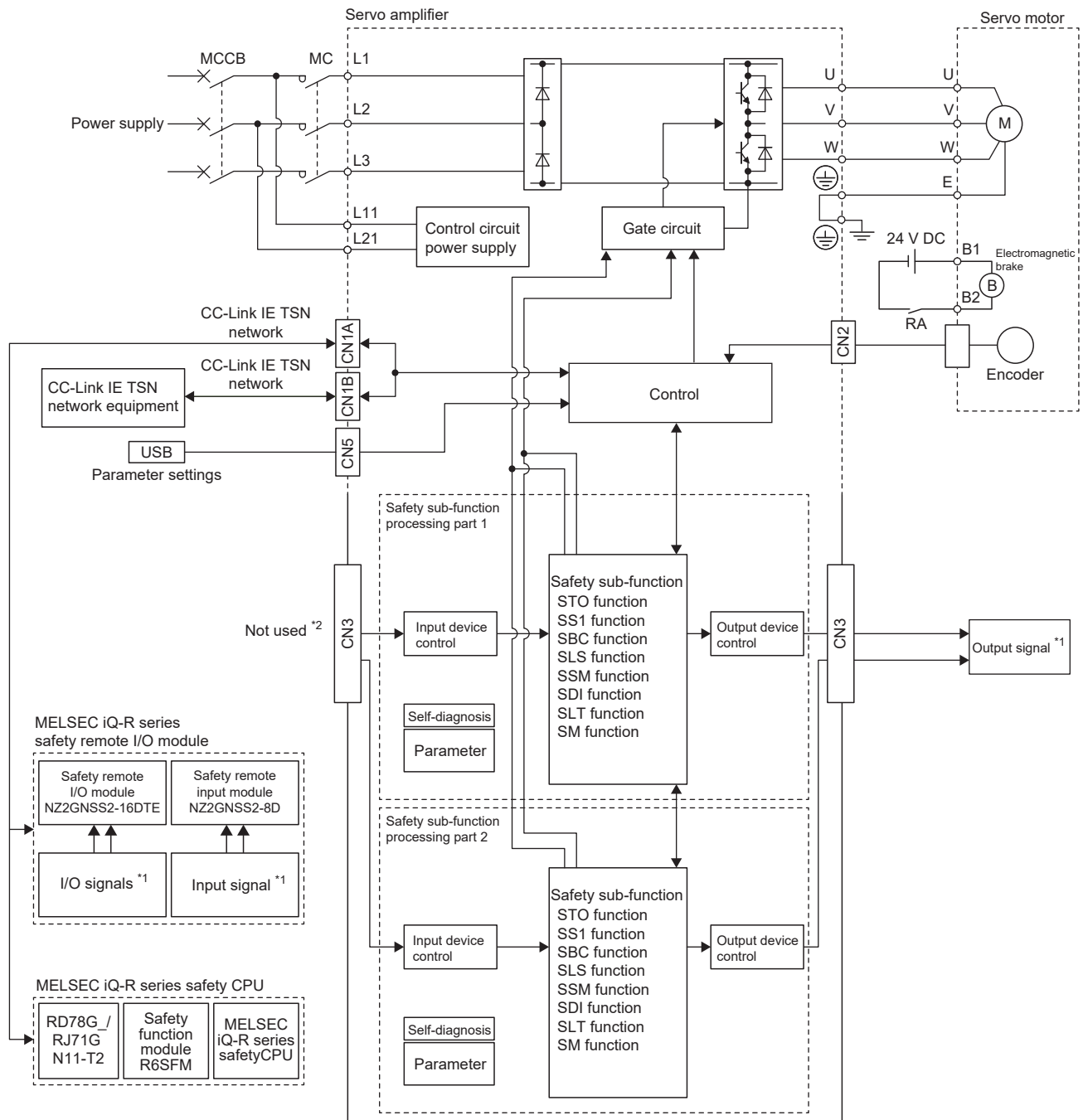
The safety level Category 4 PL e, SIL 3 can be achieved with input signal diagnostics.



\*1 Safety switches, safety relays, etc.

# Safety sub-function control by network

This figure shows a function block configured to allow safety sub-functions to be executed via CC-Link IE TSN Network. Wiring can be reduced using this method.



\*1 Safety switches, safety relays, etc.

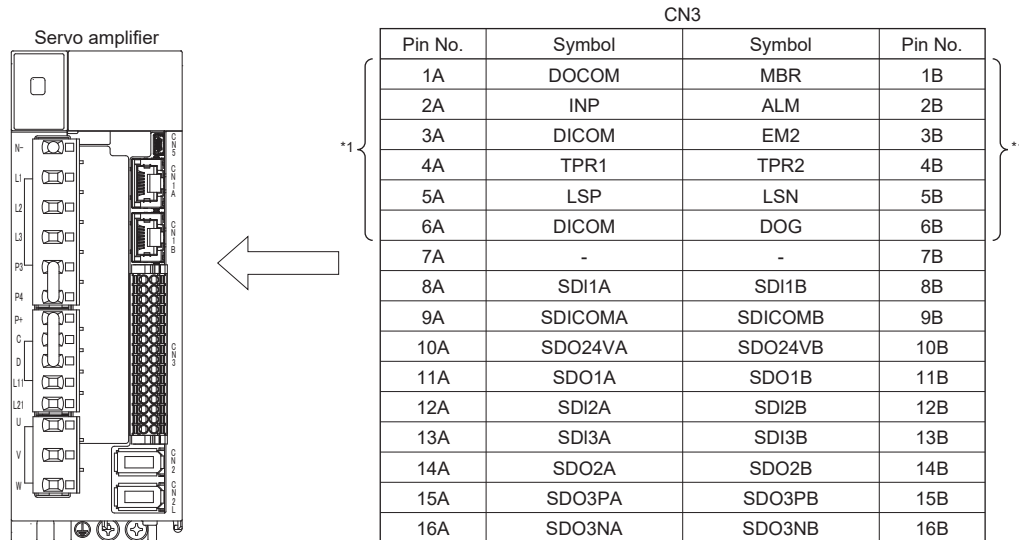
\*2 Signal input from CN3 is disabled when using the safety sub-functions over a network. Wire the block so that signals can be input from a controller. CN3 output signals can be used.



## 8.4 Specifications

For information on safety sub-function specifications, refer to "Functional safety" in the User's Manual (Introduction).

## 8.5 Connectors and pin assignments



\*1 Refer to the following for details on these I/O signals.

Page 51 Connectors and pin assignments

• Signal device explanations

Signal name	Connector pin No.	Description	I/O signal interface type
SDICOMA	CN3-9A	Common terminal for the SDI1A, SDI2A, and SDI3A input signals	SDI-2
SDICOMB	CN3-9B	Common terminal for the SDI1B, SDI2B, and SDI3B input signals	SDI-2
SDI1A	CN3-8A	Input the status of SDI1A.	SDI-2
SDI2A	CN3-12A	Input the status of SDI2A.	SDI-2
SDI3A	CN3-13A	Input the status of SDI3A.	SDI-2
SDI1B	CN3-8B	Input the status of SDI1B.	SDI-2
SDI2B	CN3-12B	Input the status of SDI2B.	SDI-2
SDI3B	CN3-13B	Input the status of SDI3B.	SDI-2
SDO24VA	CN3-10A	Common terminal for the SDO1A and SDO2A output signals Connect the positive side of the 24 V DC power supply.	SDO-2
SDO24VB	CN3-10B	Common terminal for the SDO1B and SDO2B output signals Connect the positive side of the 24 V DC power supply.	SDO-2
SDO1A	CN3-11A	This signal outputs the status assigned to SDO1A. Connect the negative side of the 24 V DC power supply.	SDO-2
SDO2A	CN3-14A	This signal outputs the status assigned to SDO2A. Connect the negative side of the 24 V DC power supply.	SDO-2
SDO1B	CN3-11B	This signal outputs the status assigned to SDO1B. Connect the negative side of the 24 V DC power supply.	SDO-2
SDO2B	CN3-14B	This signal outputs the status assigned to SDO2B. Connect the negative side of the 24 V DC power supply.	SDO-2
SDO3PA	CN3-15A	Common terminal for the SDO3A output signal Connect the positive side of the 24 V DC power supply.	SDO-3
SDO3NA	CN3-16A	This signal outputs the status assigned to SDO3A. Connect the negative side of the 24 V DC power supply.	SDO-3
SDO3PB	CN3-15B	Common terminal for the SDO3B output signal Connect the positive side of the 24 V DC power supply.	SDO-3
SDO3NB	CN3-16B	This signal outputs the status assigned to SDO3B. Connect the negative side of the 24 V DC power supply.	SDO-3

## 8.6 Example I/O signal connections

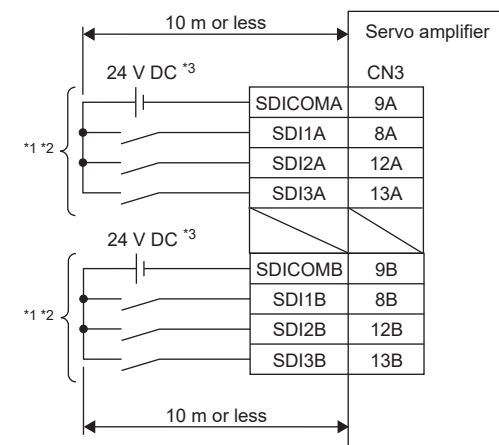
The following shows only the connection examples related to functional safety. Refer to the following for other connection examples.

☞ Page 34 Example I/O signal connections

### Input signal

There is a delay of up to 5 ms from input to output.

**When the external device uses the source output (positive common, PNP transistor output, etc.)**



\*1 Make double wiring (SDI1A/SDI2A/SDI3A, SDI1B/SDI2B/SDI3B) for the external input wiring.

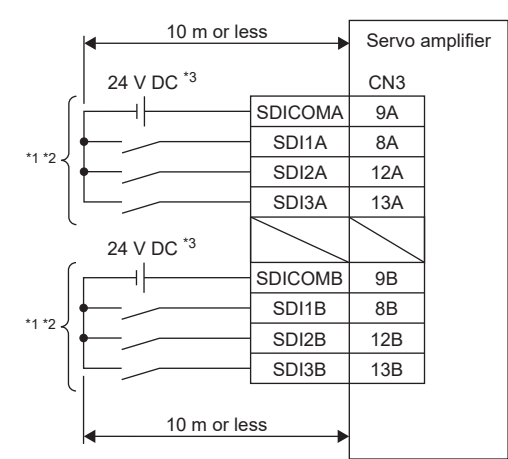
\*2 Assign each input device to the connector pin of the combinations shown in the following table.

Combination	A-system	B-system	Device details
Safety input 1	SDI1A (CN3-8A)	SDI1B (CN3-8B)	☞ Page 181 Connecting safety I/O interfaces
Safety input 2	SDI2A (CN3-12A)	SDI2B (CN3-12B)	☞ Page 181 Connecting safety I/O interfaces
Safety input 3	SDI3A (CN3-13A)	SDI3B (CN3-13B)	☞ Page 181 Connecting safety I/O interfaces

\*3 Supply 24 V DC  $\pm 10\%$  to safety input signals from an external source. If all the I/O points have been used, there must be a total current capacity of 0.6 A remaining. Reducing the number of I/O points decreases the current capacity. Refer to the following for current values. Although the diagram shows the safety input signal and the safety 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.

☞ Page 181 Connecting safety I/O interfaces

**When the external device uses the sink output (negative common, NPN transistor output, etc.)**



- \*1 Make double wiring (SDI1A/SDI2A/SDI3A, SDI1B/SDI2B/SDI3B) for the external input wiring.
- \*2 Assign each input device to the connector pin of the combinations shown in the following table.

Combination	A-system	B-system	Device details
Safety input 1	SDI1A (CN3-8A)	SDI1B (CN3-8B)	Page 181 Connecting safety I/O interfaces
Safety input 2	SDI2A (CN3-12A)	SDI2B (CN3-12B)	Page 181 Connecting safety I/O interfaces
Safety input 3	SDI3A (CN3-13A)	SDI3B (CN3-13B)	Page 181 Connecting safety I/O interfaces

- \*3 Supply 24 V DC  $\pm$  10 % to safety input signals from an external source. If all the I/O points have been used, there must be a total current capacity of 0.6 A remaining. Reducing the number of I/O points decreases the current capacity. Refer to the following for current values. Although the diagram shows the safety input signal and the safety 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.
- Page 181 Connecting safety I/O interfaces

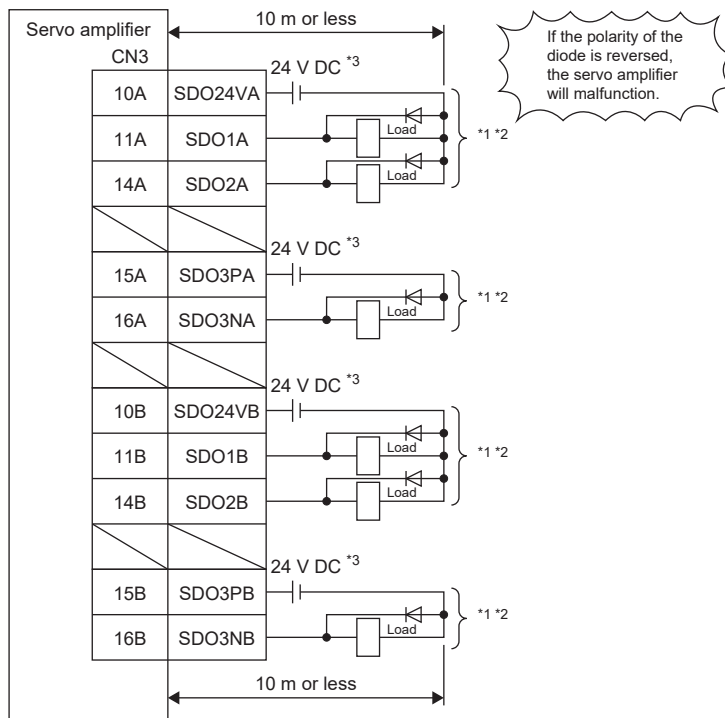


# Output signal

SDO3PA/SDO3NA and SDO3PB/SDO3NB support both source and sink outputs. Different output methods can also be used in combination, such as SDO3NA as a source output and SDO3PB as a sink output. Refer to the following for details.

📖 Page 184 Source/sink output

## For source output



\*1 Make double wiring (SDO1A/SDO2A/SDO3PA/SDO3NA, SDO1B/SDO2B/SDO3PB/SDO3NB) for the external output wiring.

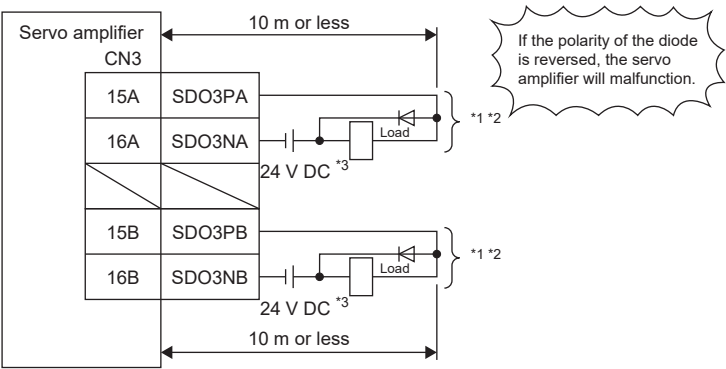
\*2 Assign each output device to the connector pin of the combinations shown in the following table.

Combination	A-system	B-system	Device details
Safety output 1	SDO1A (CN3-11A)	SDO1B (CN3-11B)	📖 Page 181 Connecting safety I/O interfaces
Safety output 2	SDO2A (CN3-14A)	SDO2B (CN3-14B)	📖 Page 181 Connecting safety I/O interfaces
Safety output 3	SDO3NA (CN3-16A)	SDO3NB (CN3-16B)	📖 Page 181 Connecting safety I/O interfaces


\*3 Supply 24 V DC  $\pm 10\%$  to safety output signals from an external source. If all the I/O points have been used, there must be a total current capacity of 0.6 A remaining. Reducing the number of I/O points decreases the current capacity. Refer to the following for current values. Although the diagram shows the safety input signal and the safety 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.


📖 Page 181 Connecting safety I/O interfaces

For sink output



- \*1 Make double wiring (SDO3PA/SDO3NA, SDO3PB/SDO3NB) for the external output wiring.  
\*2 Assign each output device to the connector pin of the combinations shown in the following table.

Combination	A-system	B-system	Device details
Safety output 3	SDO3NA (CN3-16A)	SDO3NB (CN3-16B)	 Page 181 Connecting safety I/O interfaces

- \*3 Supply 24 V DC  $\pm 10\%$  to safety output signals from an external source. If all the I/O points have been used, there must be a total current capacity of 0.6 A remaining. Reducing the number of I/O points decreases the current capacity. Refer to the following for current values. Although the diagram shows the safety input signal and the safety 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.  
 Page 181 Connecting safety I/O interfaces

## 8.7 Connecting safety I/O interfaces

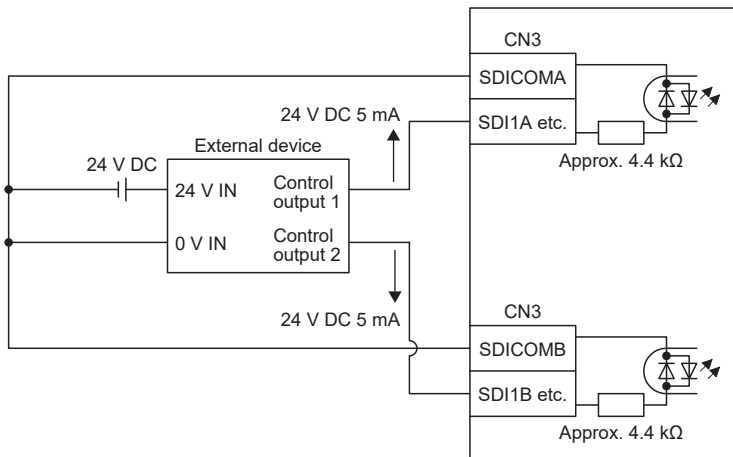
Refer to this section before connecting I/O interfaces to external devices.

### Source input

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.

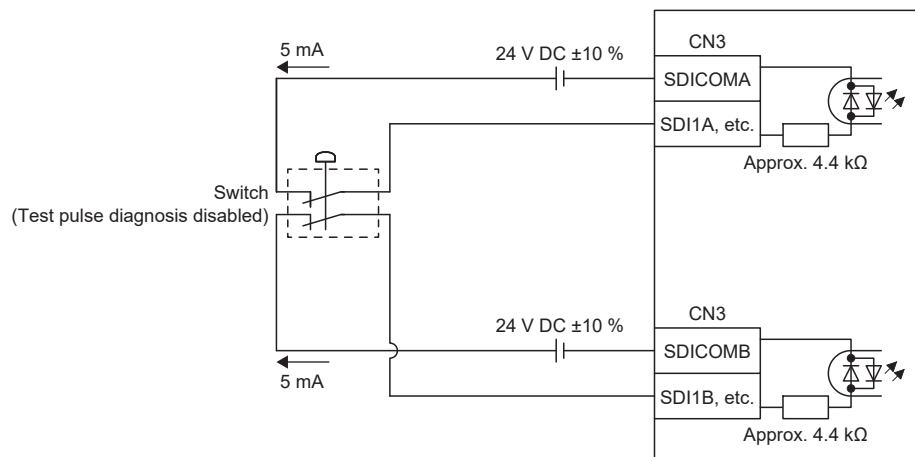
#### Connecting an external device

Connect the output signals of the external device to SDI\_ \_.



#### Connecting a switch

Connect a switch so that signals from each common terminal for input signals pass through the switch and are input to SDI\_ \_.

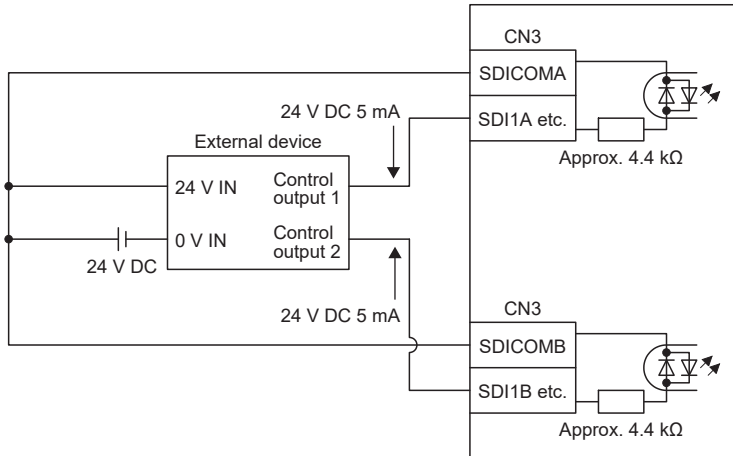


## Sink input

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.

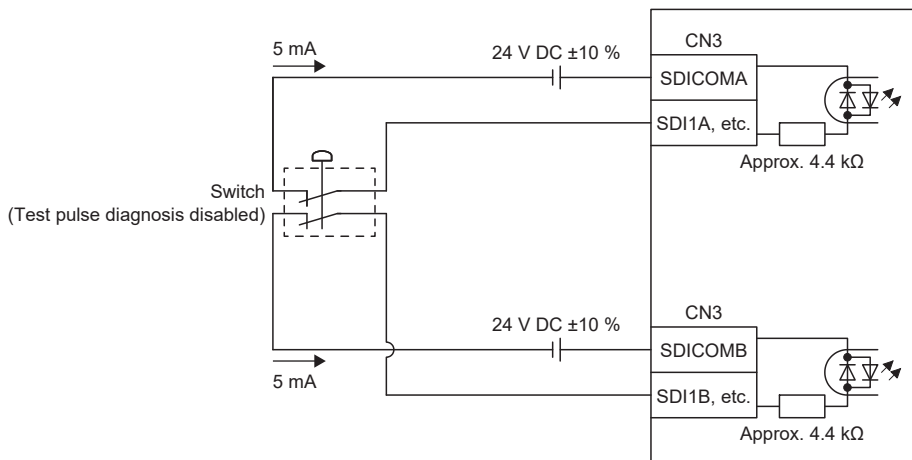
### Connecting an external device

Connect the output signals of the external device to SDI\_ \_.



### Connecting a switch

Connect a switch so that signals from each common terminal for input signals pass through the switch and are input to SDI\_ \_.

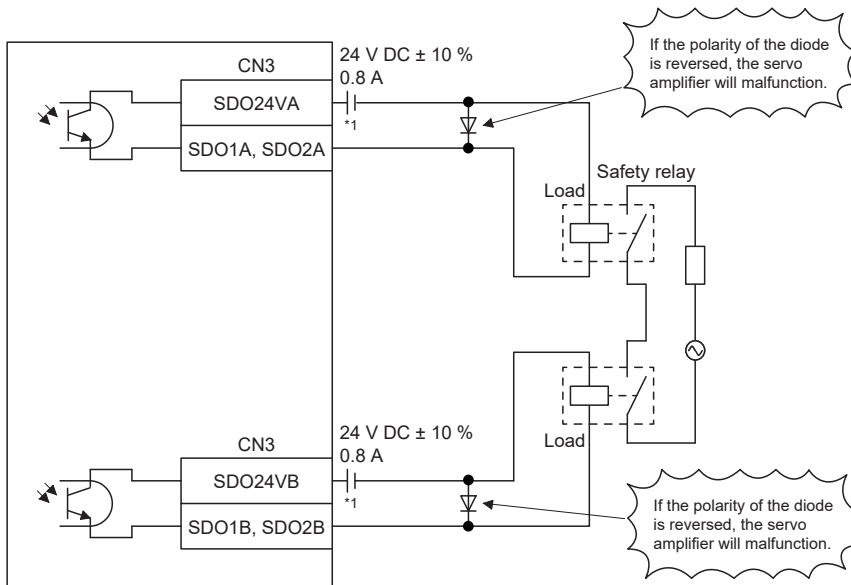


## Source output

When the output transistor is turned on, the current flows from the output terminal to a load using SDO24V\_ as a positive common.

A lamp, relay, or photocoupler can be driven. Connect a diode to the path for an inductive load, or connect an inrush resistor suppression resistor to the path for a lamp load. (Rated current 5 mA to 40 mA, maximum current 50 mA, inrush current 100 mA)

A voltage drop of 2.4 V occurs in the MR-JET-\_G\_-HS(N1).



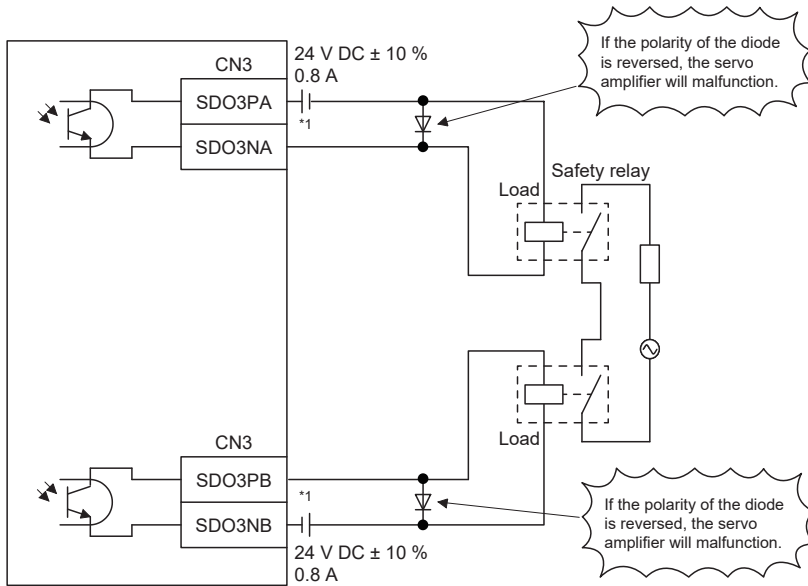
\*1 Incorrect polarity of the power supply causes malfunction of the safety relay.

## Source/sink output

For SDO3PA/SDO3NA and SDO3PB/SDO3NB, different output methods can also be used in combination in A-system and B-system, such as SDO3NA as a source output and SDO3PB as a sink output. SDO3N\_ is the source output type (when the output transistor is turned on, the current flows from the output terminal to a load). SDO3P\_ is the sink output type (when the output transistor is turned on, the current flows from a load to the output terminal).

A lamp, relay, or photocoupler can be driven. Connect a diode to the path for an inductive load, or connect an inrush resistor suppression resistor to the path for a lamp load. (Rated current 5 mA to 40 mA, maximum current 50 mA, inrush current 100 mA)

A voltage drop of 2.4 V occurs in the MR-JET-\_G\_-HS(N1).



\*1 Incorrect polarity of the power supply causes malfunction of the safety relay.

## 8.8 Wiring the SBC output

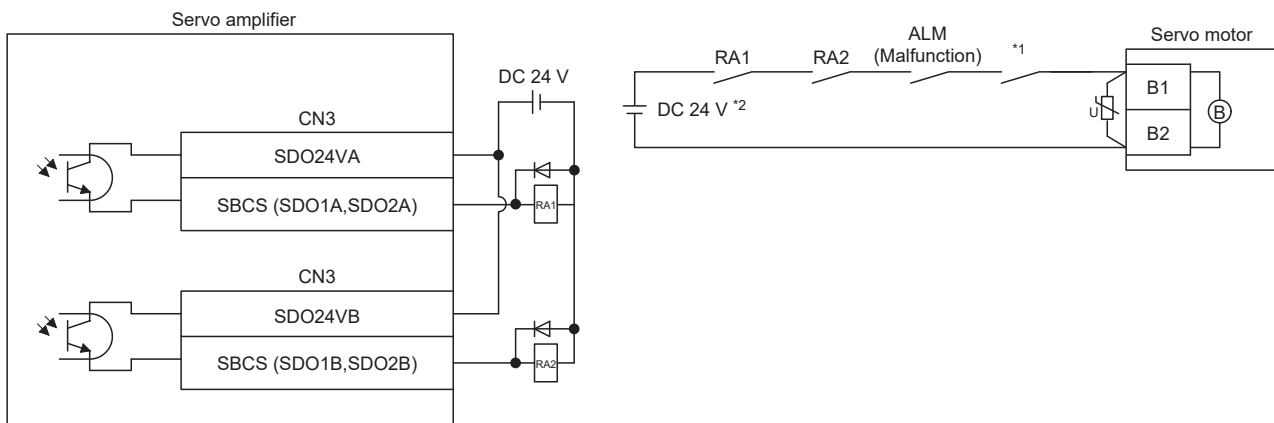
### Point

This function only guarantees that the power supply for the mechanical brake is correct. It cannot detect brake wear. Check the mechanical brake periodically to ensure it is functioning correctly.

To use SBCS (SBC output), connect it to the electromagnetic brake of the servo motor. Wire the system so that the electromagnetic brake activates when SBCS (SBC output) turns off. There is no need to use the MBR (Electromagnetic brake interlock) of the servo amplifier. For information on the operation sequence when the SBC function is used, refer to "SBC function" in the following manual.

MR-JET User's Manual (Function)

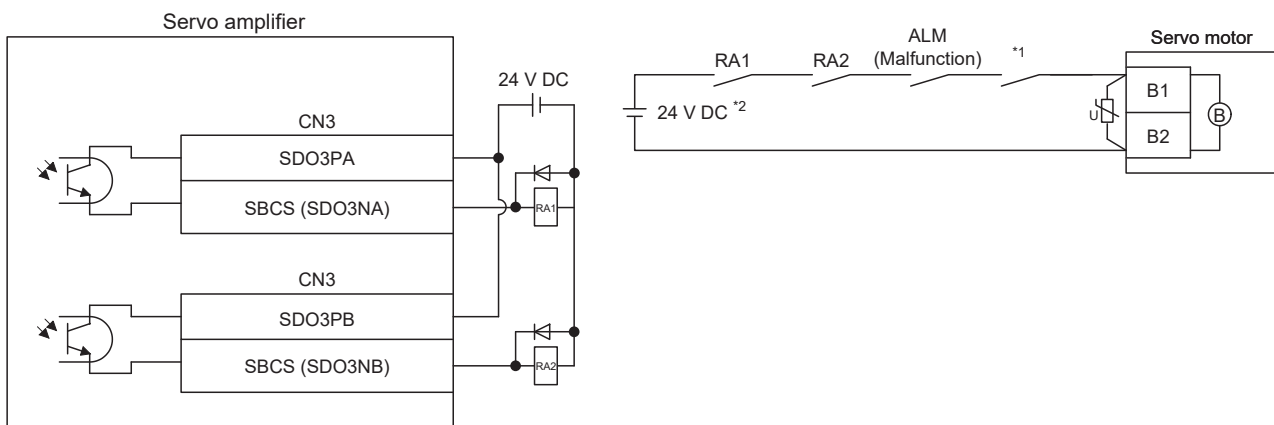
### Using SDO1\_ and SDO2\_ for SBCS



\*1 The circuit should be shut off in conjunction with the emergency stop switch.

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

### Using SDO3\_ for SBCS



\*1 The circuit should be shut off in conjunction with the emergency stop switch.

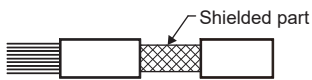
\*2 Do not use the 24 V DC interface power supply for the electromagnetic brake.

## 8.9 Noise reduction techniques

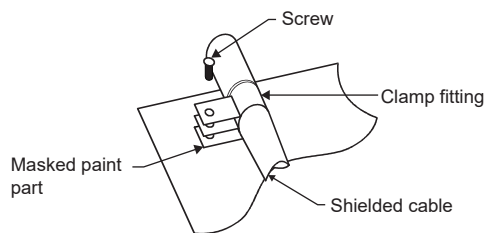
This section provides information on measures that prevent the servo amplifier malfunctioning when it is installed next to peripheral devices that emit a large amount of noise.

Ground shielded cables close to the servo amplifier. Ensure that the part of the cable before the grounding point does not induce electromagnetic noise to the section of the cable after the grounding point. Strip part of the shielded cable, then ground the exposed portion of the cable on a large surface of the cabinet. A metal cable clamp can also be used to ground the cable (shown below). Mask the painted internal wall of the cabinet that touches the cable clamp.

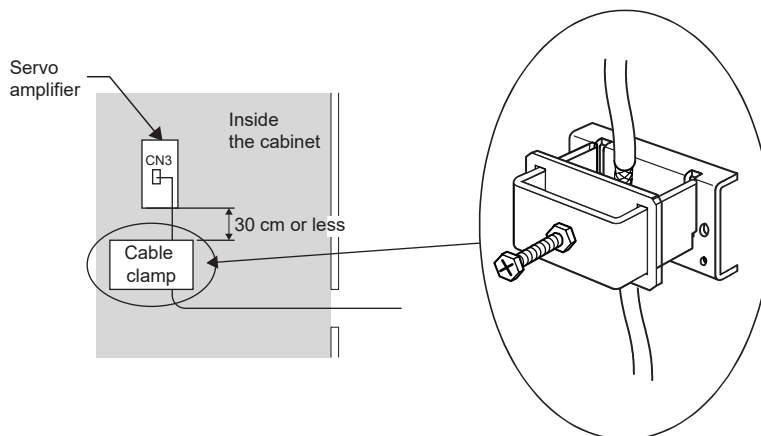
- Exposed shield



- Grounding the shield



Ground both ends of the cable of the CN3 safety signal with the cable clamp. The shield length from the servo amplifier to the cable clamp should be within 30 cm.



For the grounding of the shield of the I/O signal cable, SCC 15-F (Phoenix Contact) can be used. Refer to the following for details.

📖 Page 164 SCC 15-F Shield connection clamp

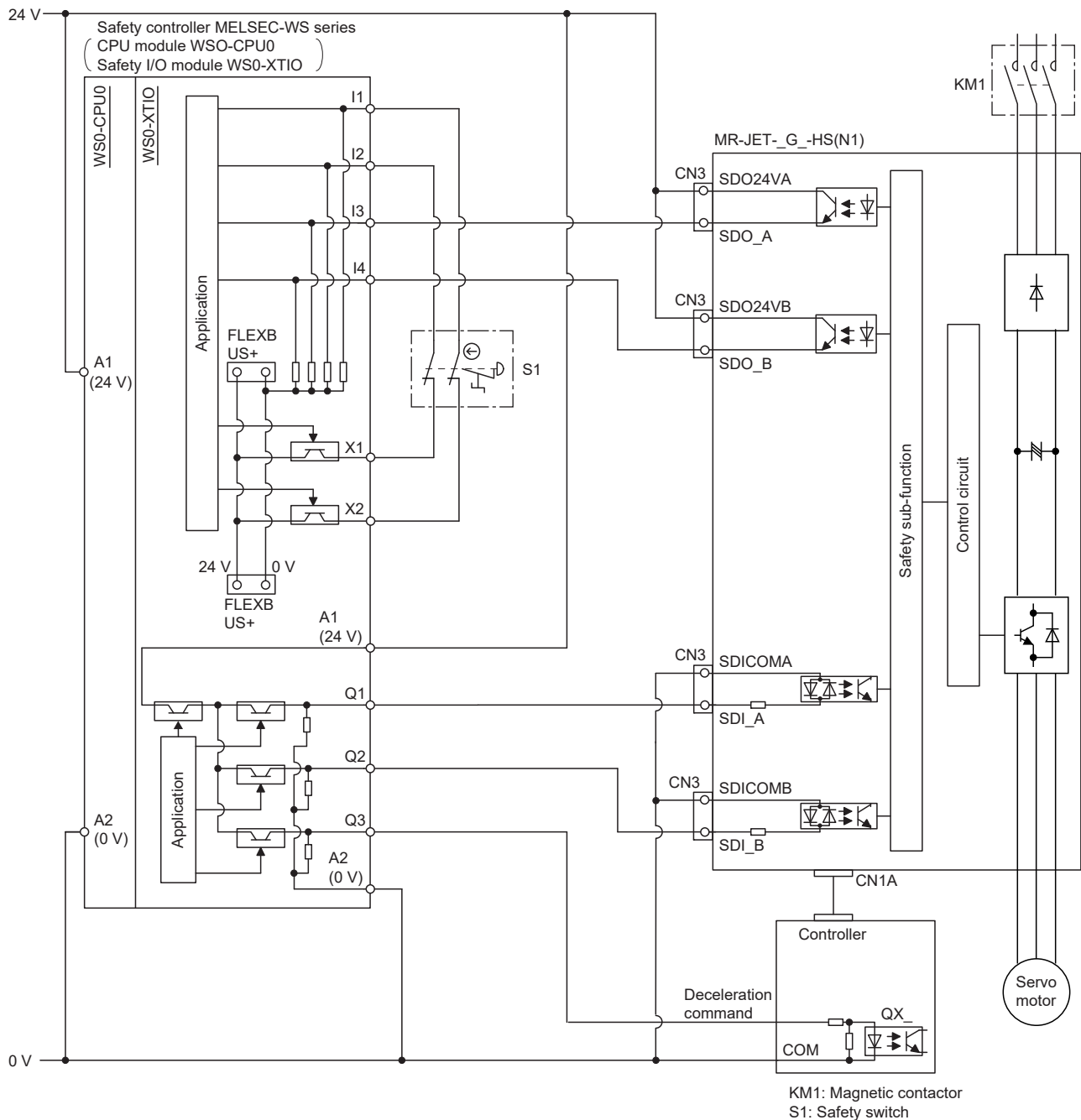


## 8.10 Example of connection with other devices

### Safety sub-function control by input device

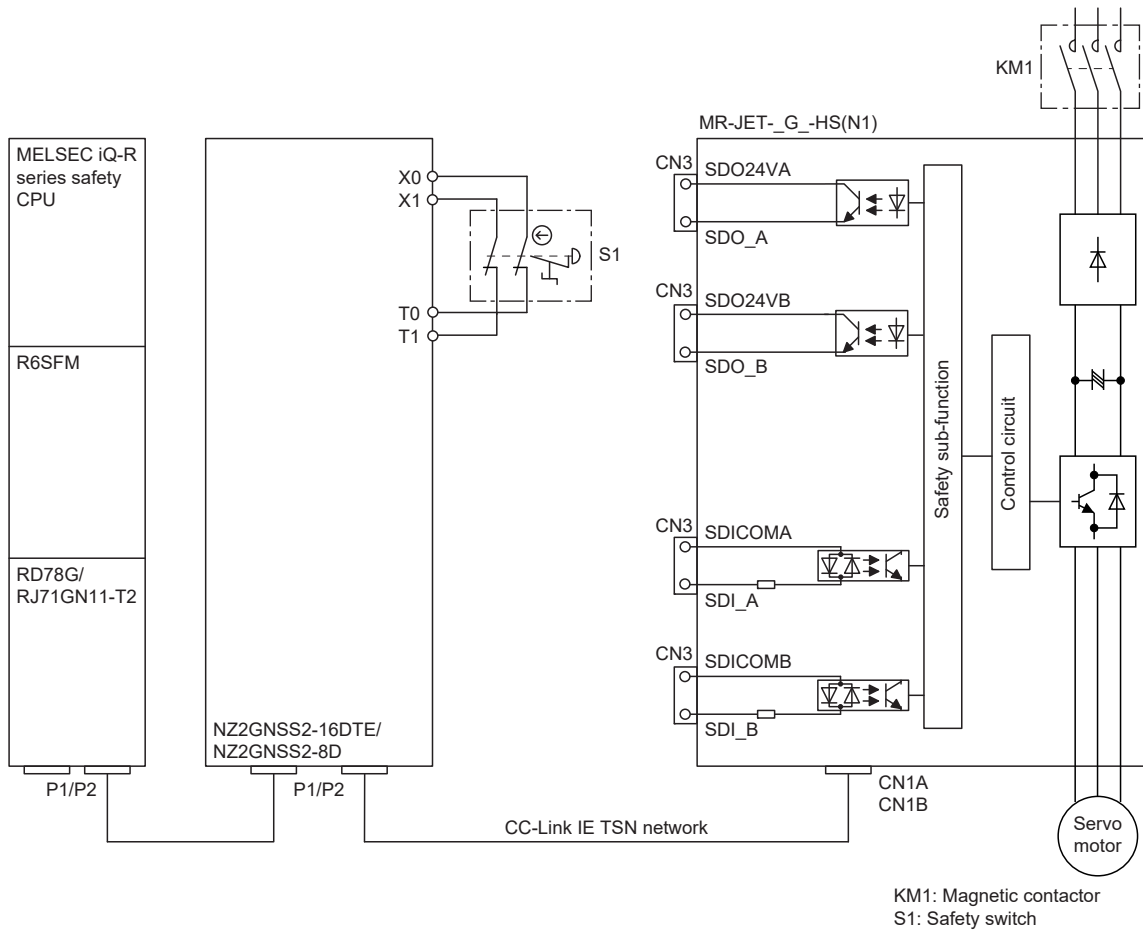
This figure shows the connection that allows execution of safety sub-functions from the safety controller using the input device assigned to pins of the CN3 connector.

The safety level Category 4 PL e, SIL 3 can be achieved with input signal diagnostics.



## Safety sub-function control by network

This figure shows connection that allows execution of safety sub-functions via CC-Link IE TSN Network.  
Wiring can be reduced using this method.



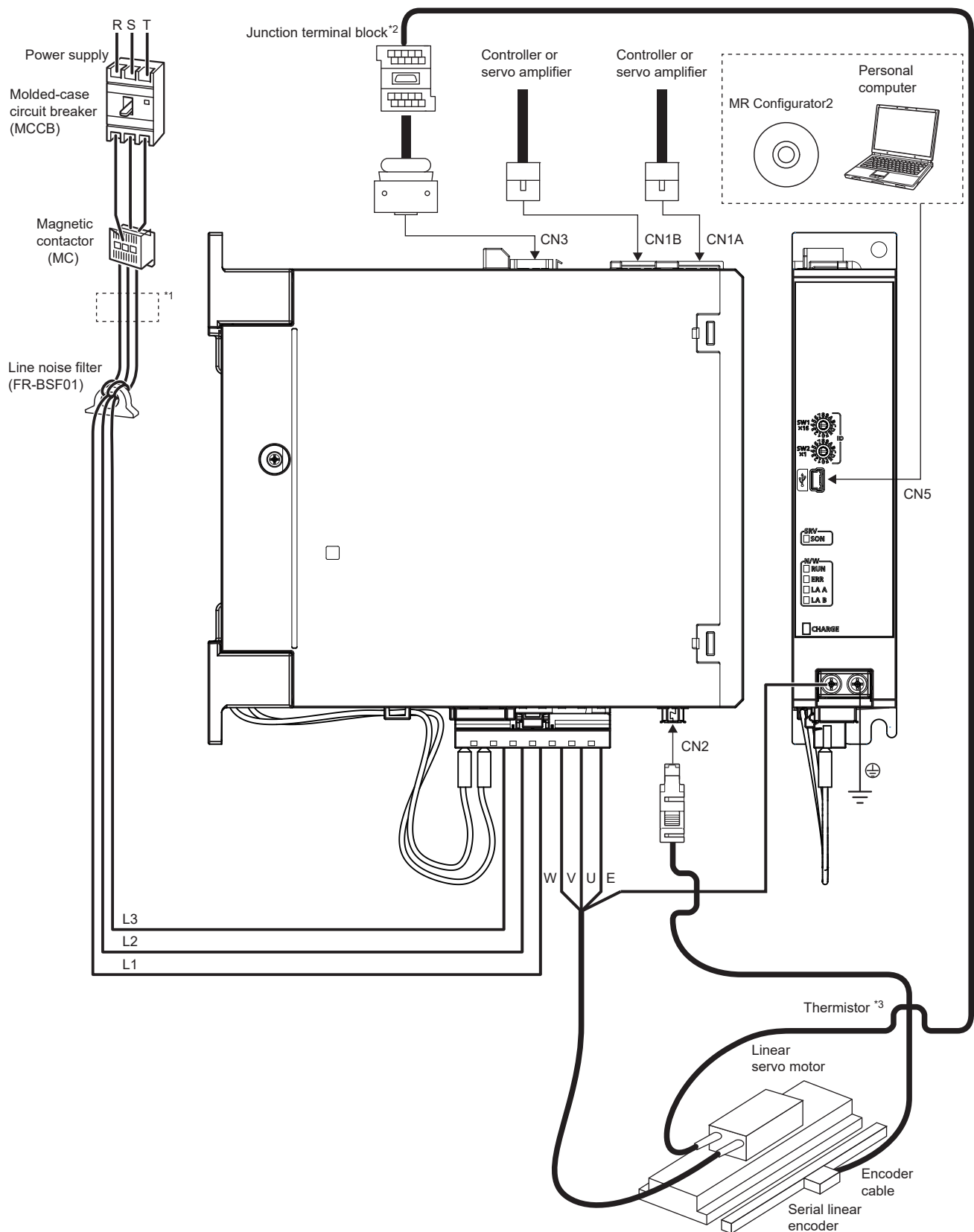
## 9.1 Functions and configuration

### 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 198 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 198 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. • [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 and LM-AU series do not have a thermistor. For wiring thermal protectors of the LM-AJ series and LM-AU series, refer to "Servo motor power supply cable wiring diagrams" in the following manual.

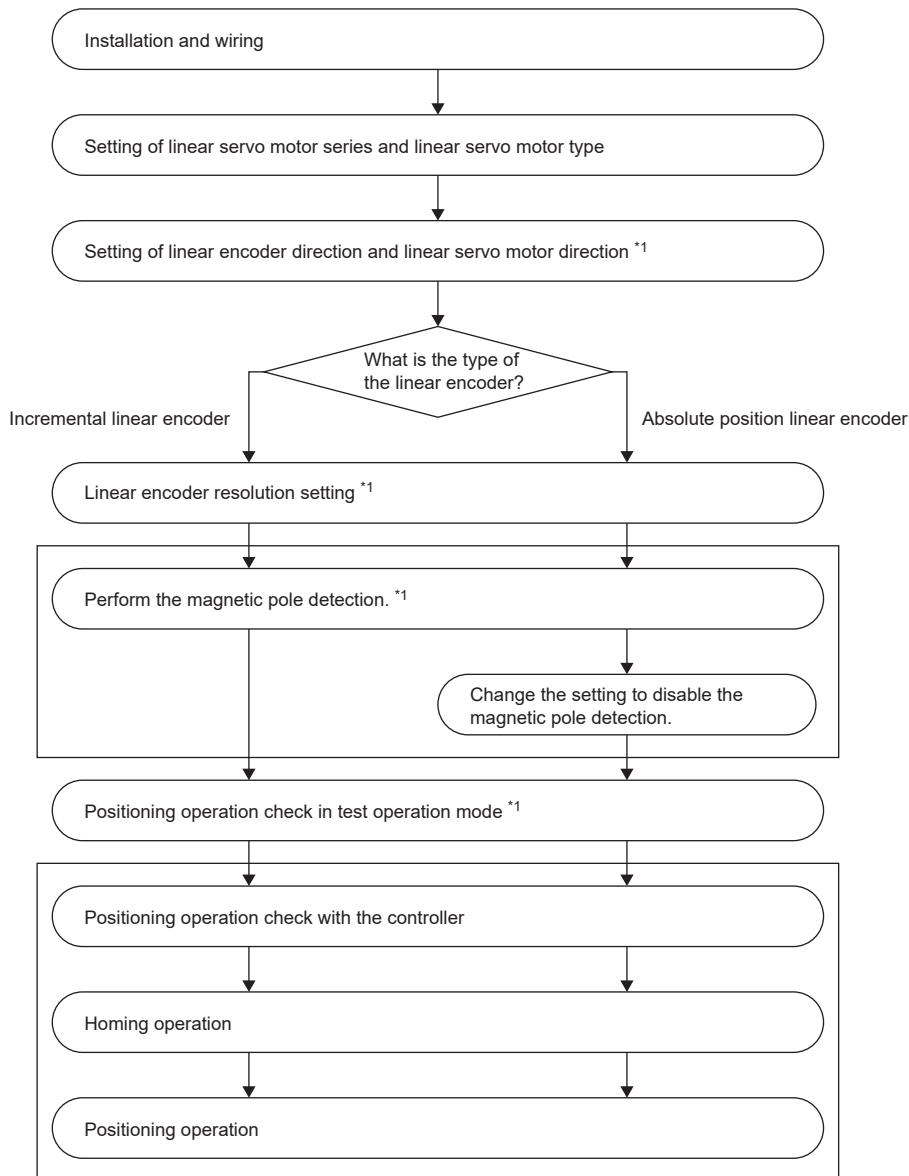
Linear Servo Motor User's Manual (LM-AJ/LM-AU)

## 9.2 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.

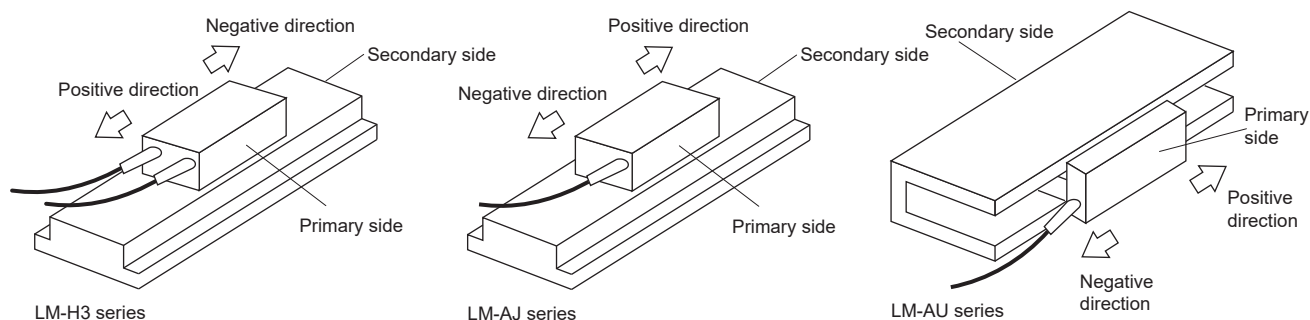
Servo parameter	Description
PC27.0	Encoder pulse count polarity selection 0: Encoder pulse increasing direction in the servo motor CCW or positive direction 1: Encoder pulse decreasing direction in the servo motor CCW or positive direction Initial value: 0 (encoder pulse increasing direction in the servo 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  $\mu\text{m}$

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

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

—		Linear encoder resolution [ $\mu\text{m}$ ]							
		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/LM-AU series

The LM-AJ series and LM-AU series are not equipped with a thermistor that can be connected to a servo amplifier. They are equipped only with a thermal protector that can be connected to an external relay. Configure a relay circuit that shuts off the power supply when the thermal switch opens due to overheating.

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

## Precautions on magnetic pole detection

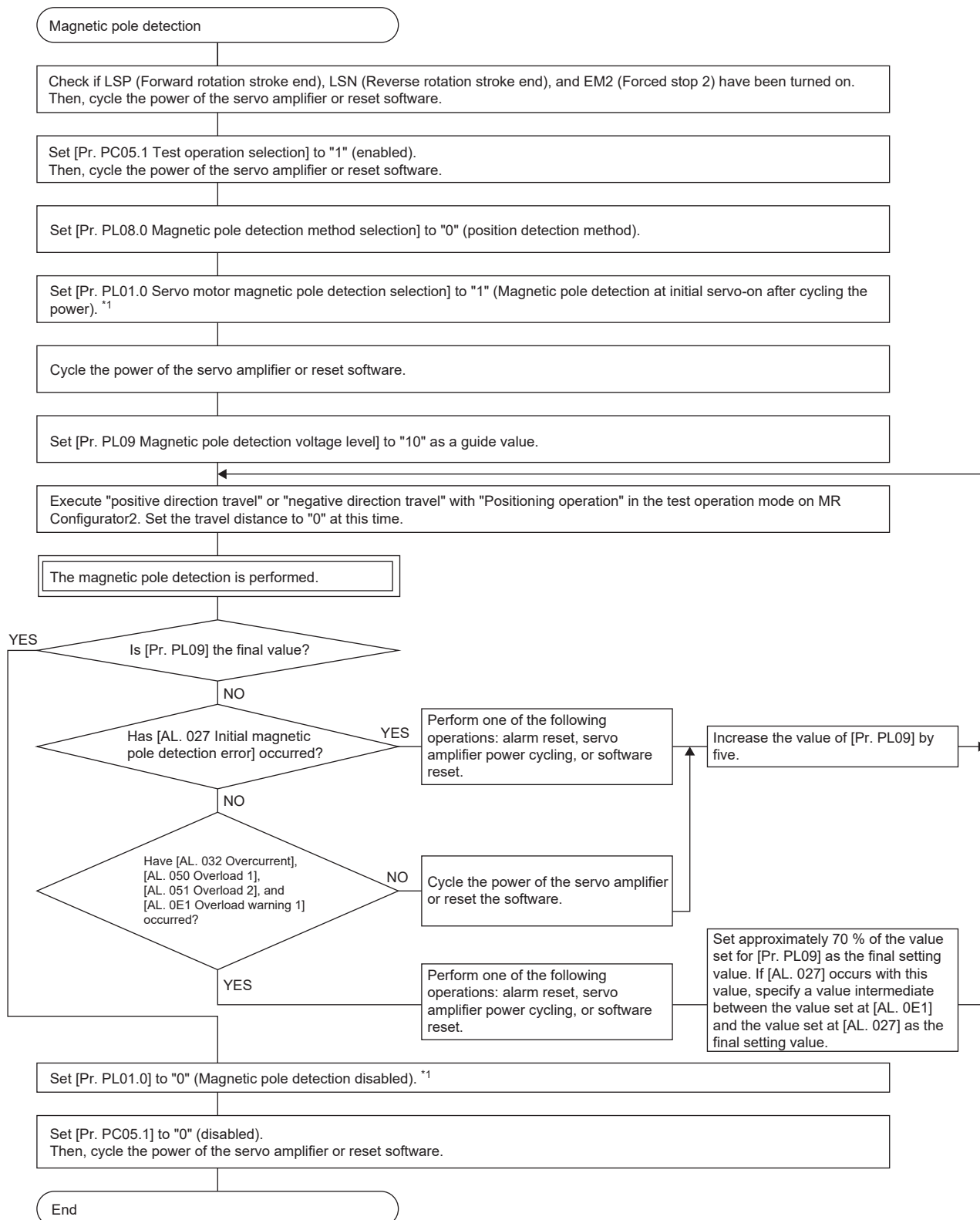
- For the magnetic pole detection, the linear servo motor automatically starts to move simultaneously with turning-on of the servo-on command.
- If the magnetic pole detection is not executed properly, the linear servo motor may operate unexpectedly.
- Establish the machine configuration to use LSP (Forward 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



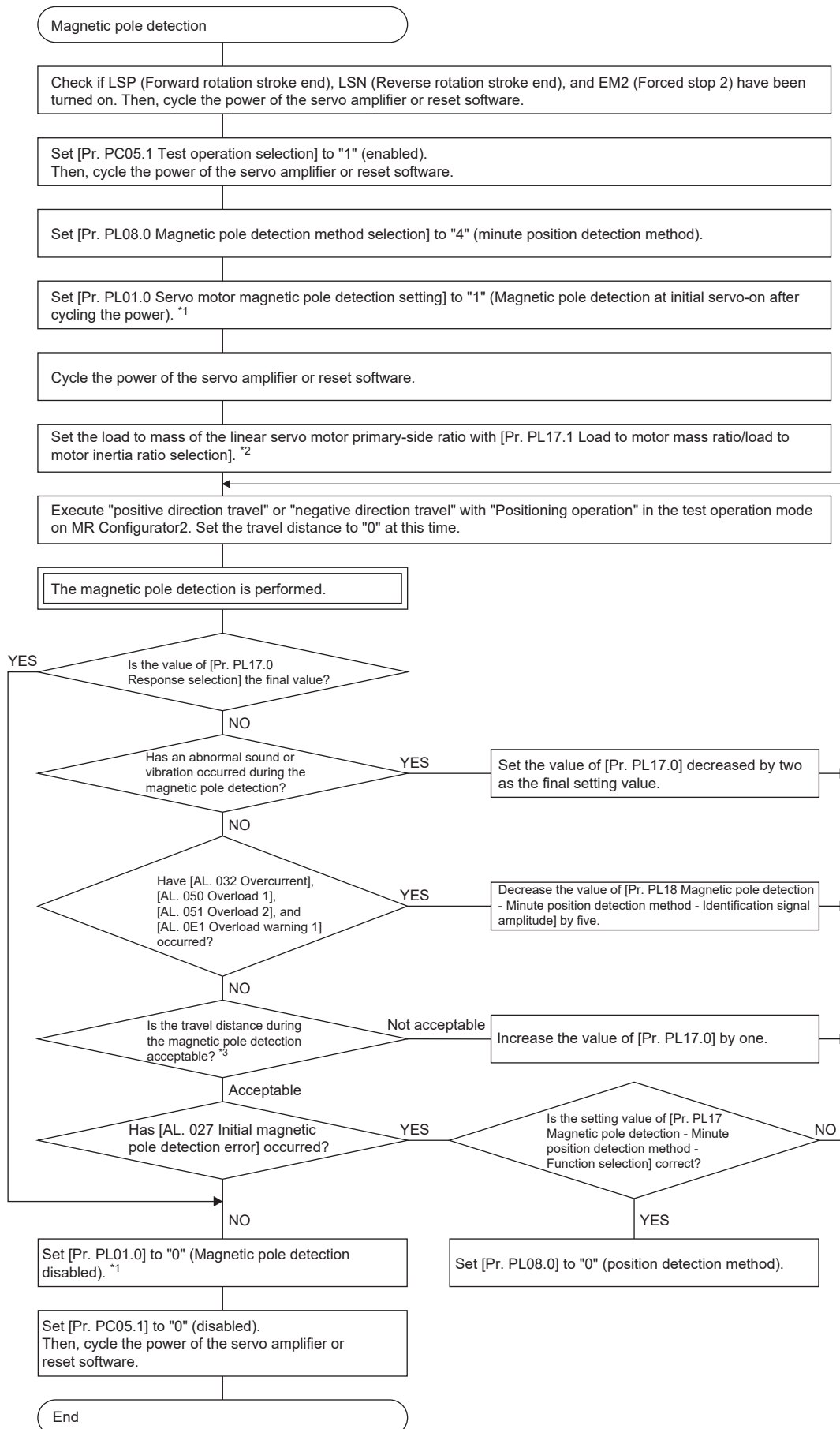
When using a controller manufactured by Mitsubishi Electric, the servo parameter setting values are overwritten from the controller. Once magnetic pole detection is complete, note down the changed servo parameter setting values, and set the same values in the controller.

### ■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

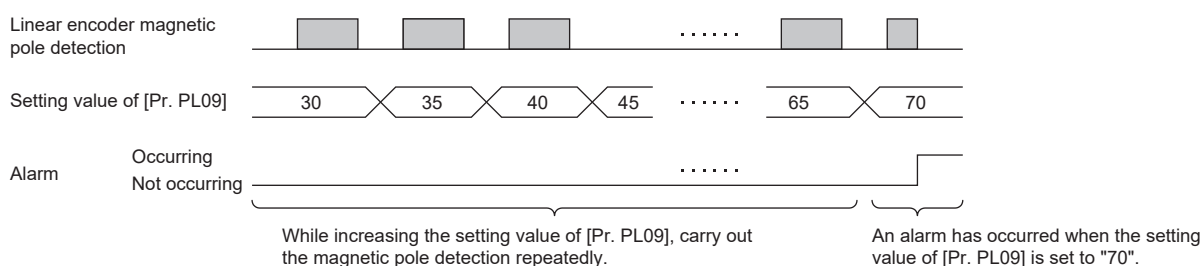
Set the parameters by referring to the following table.

Servo status	Small ← Medium → Large (10 or less (initial value) 50 or more)	
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 =  $70 \times 0.7$ ).

## 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

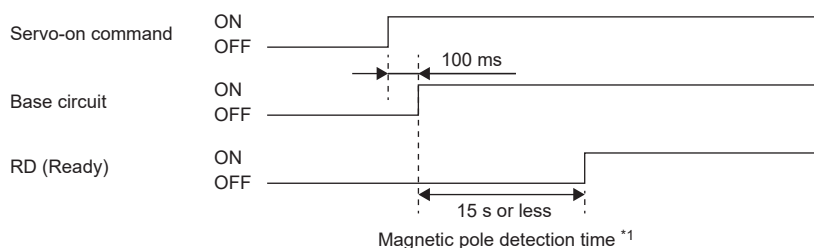
- After the magnetic pole detection, check the positioning accuracy with the test operation (positioning operation function) of MR Configurator2.
- When the absolute position linear encoder is used, if a gap is generated to the positional relation between the linear encoder and the linear servo motor, 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.

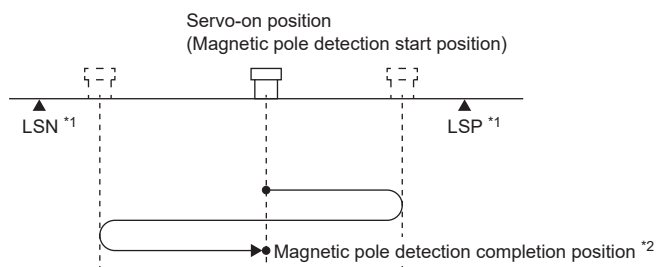
By turning on the servo-on command from the controller after the power-on, the magnetic pole detection is automatically carried out. Therefore, there is no need to set [Pr. PL01.0 Servo motor magnetic pole detection selection] for executing magnetic pole detection.

- Timing chart



\*1 The magnetic pole detection time indicates the operating 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.

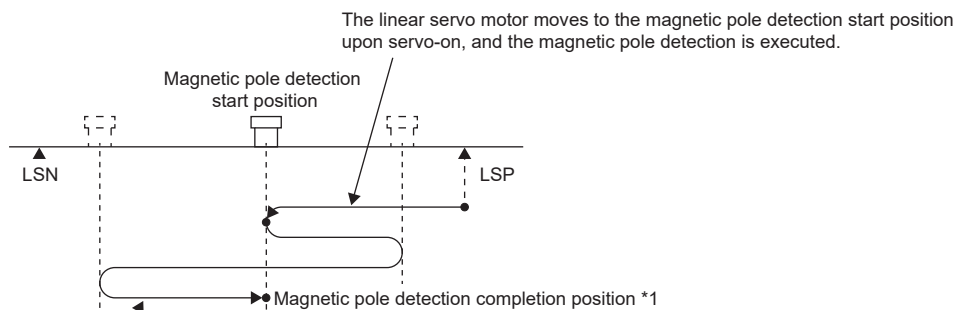
When both LSP and LSN are off, [AL. 027 Initial magnetic pole detection error] occurs.

\*2 The following shows the pitch against the magnetic pole.

Linear servo motor series	LM-H3	LM-AJ	LM-AU
Pitch against magnetic pole [mm]	48	20	60

- 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	LM-AU
Pitch against magnetic pole [mm]	48	20	60


## ■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 200 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

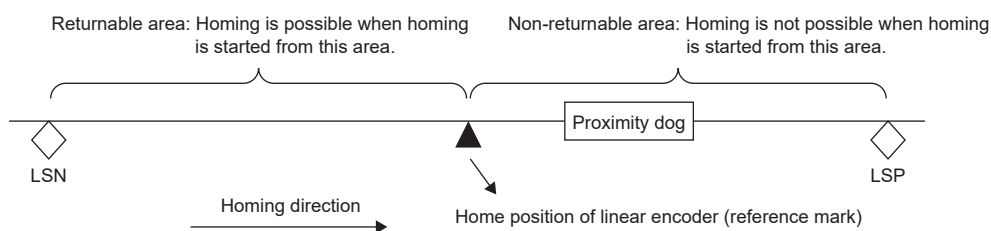
1. Open the project in MR Configurator2 and select the model.
2. Check that the personal computer is connected with the servo amplifier, and select "Diagnosis" and then "Linear diagnosis".
3. Click "Magnetic Pole Information" to open the magnetic pole information window.
4. To data 1 of the magnetic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

## 9.3 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) pulse 1: $2^{17}$ (= 131072) pulse 2: $2^{18}$ (= 262144) pulse 3: $2^{20}$ (= 1048576) pulse 4: $2^{22}$ (= 4194304) pulse 5: $2^{24}$ (= 16777216) pulse 6: $2^{26}$ (= 67108864) pulse 7: $2^{30}$ (= 1073741824) pulse Initial value: 3 ( $2^{20}$ (= 1048576) pulse)

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  $\mu\text{m}$  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 $\mu\text{m}$	0.005 $\mu\text{m}$	0.01 $\mu\text{m}$	0.02 $\mu\text{m}$	0.05 $\mu\text{m}$
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	671.09	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 $\mu\text{m}$	0.2 $\mu\text{m}$	0.5 $\mu\text{m}$	1 $\mu\text{m}$	2 $\mu\text{m}$
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 205 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

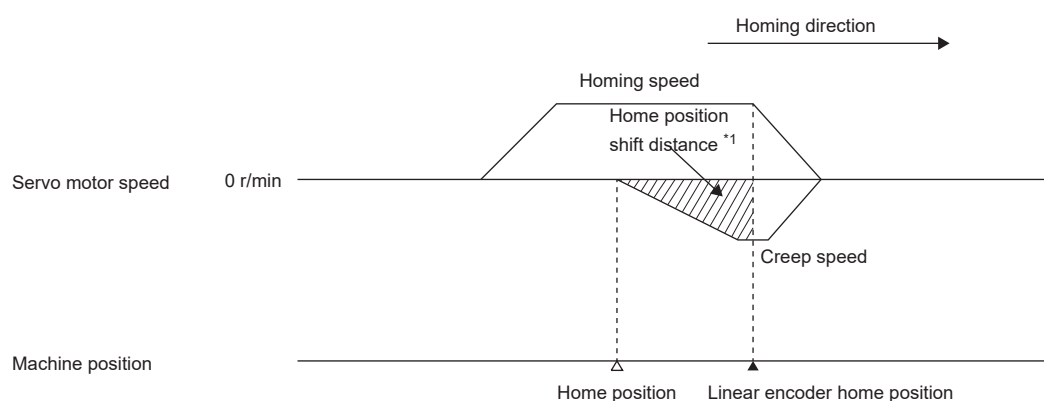
- When the linear encoder home position (reference mark) exists in the homing direction

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.**

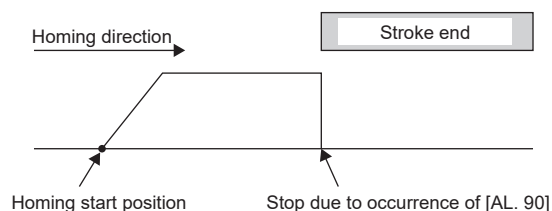
Homing methods 33 and 34

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



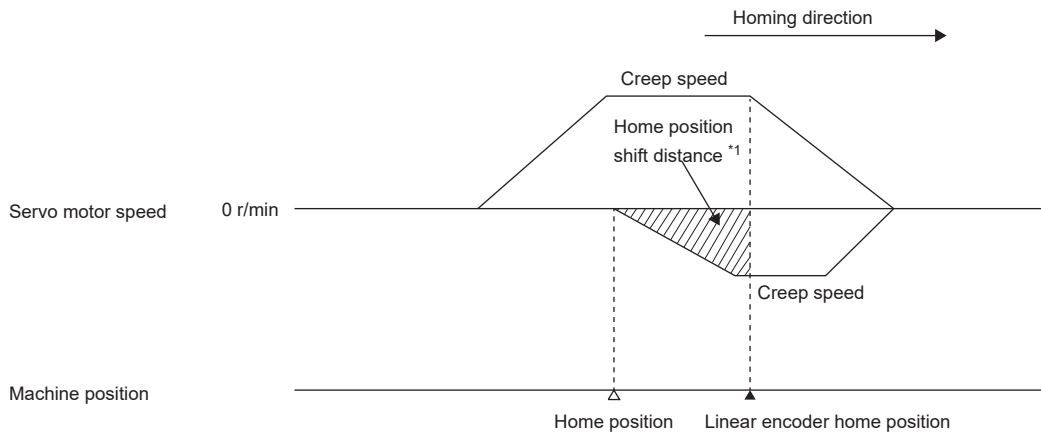
\*1 Home position shift distance can be changed with [Pr. PT07 Home position shift distance].

When the stroke end is detected



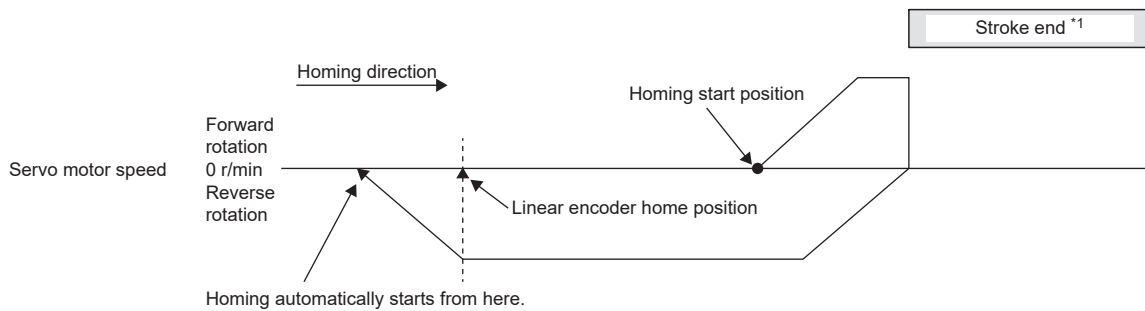
**Ex.****Homing methods -11 and -43**

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].

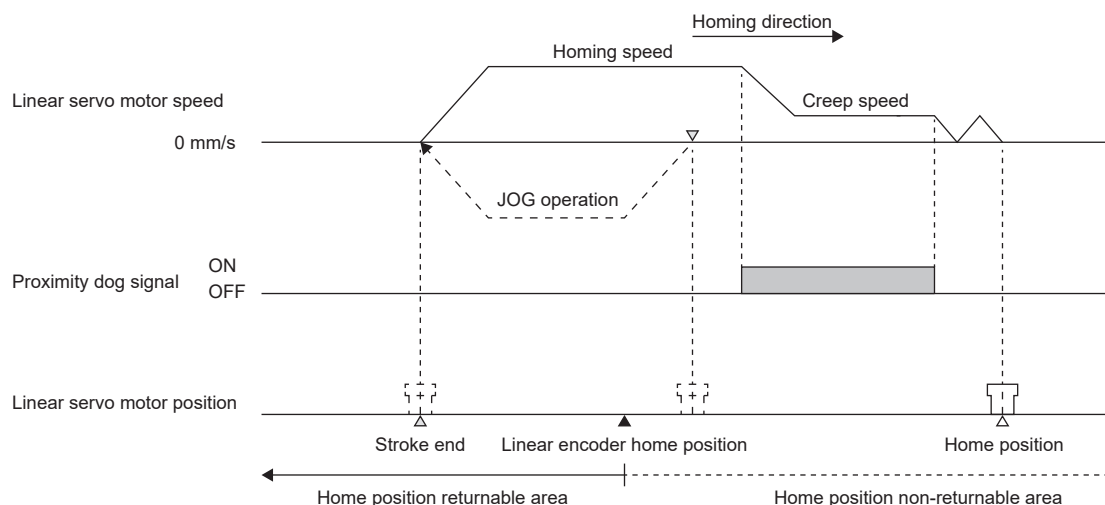
When the servo motor returns at the stroke end



\*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.

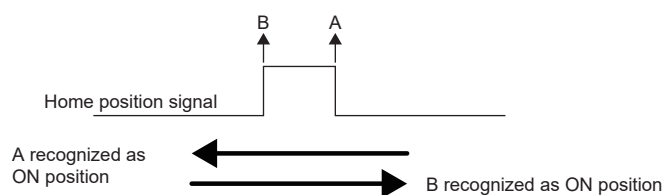


- Caution for passing the home position (reference mark)

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)

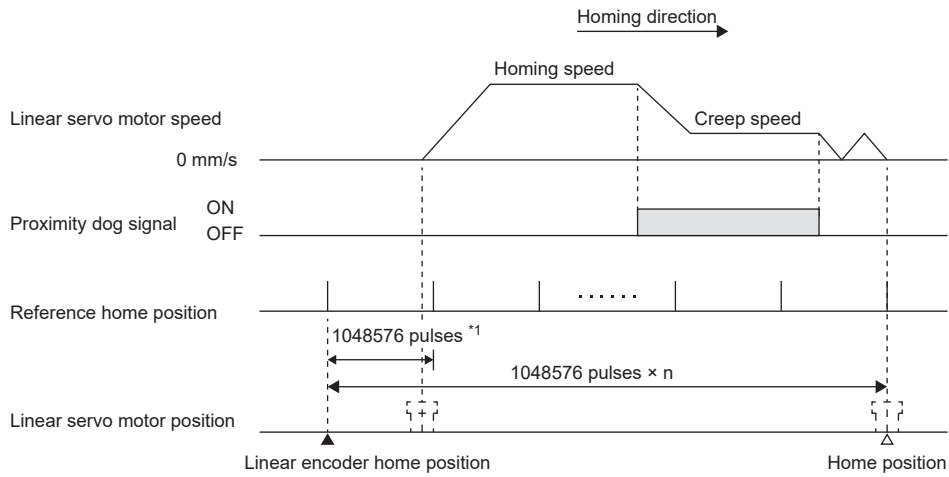
For the linear encoder without home position (reference mark), LZ (Encoder Z-phase pulse) of the servo amplifier is not output. Check the specifications of the controller for whether LZ (Encoder Z-phase pulse) is necessary or not for homing.

## ■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 output 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

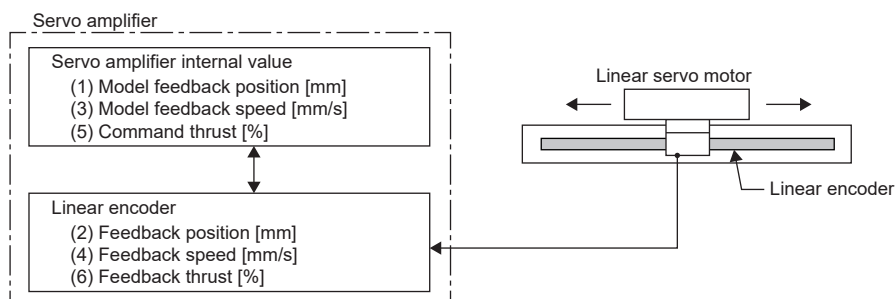
Select the linear servo control error detection function.

- [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 212 Position deviation error detection

☞ Page 212 Speed deviation error detection

☞ Page 212 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.

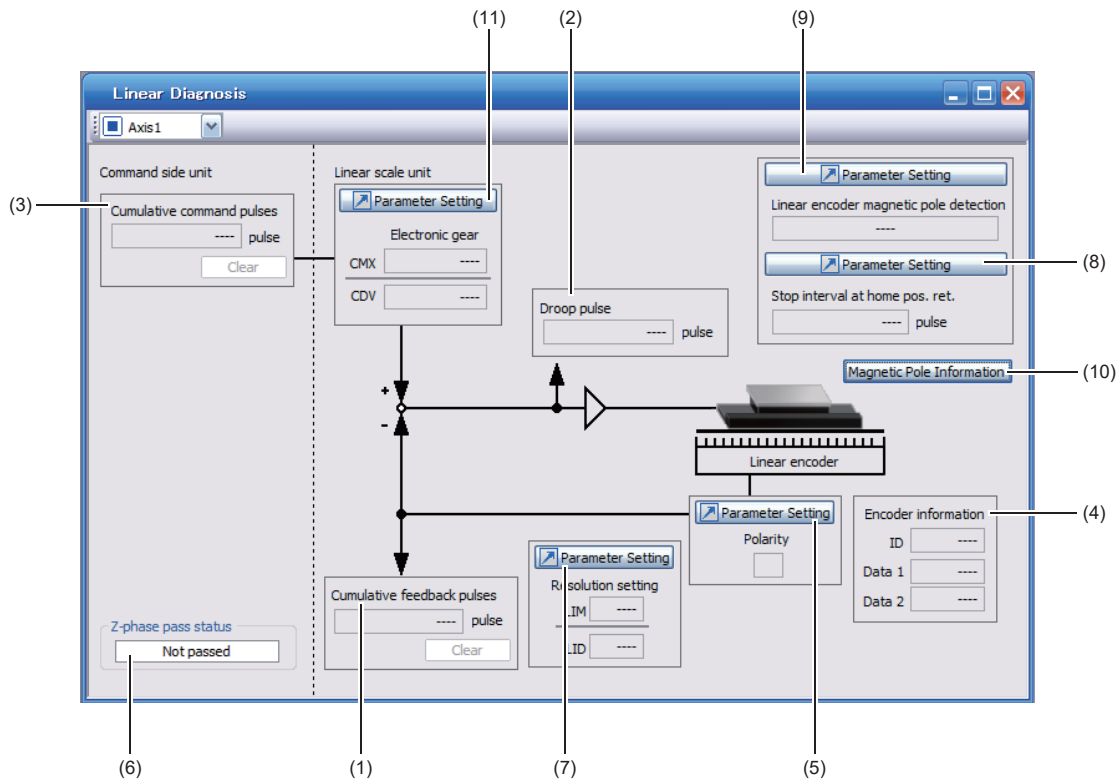
Servo parameter	Description
PL04.3	[AL. 042 Servo control error] detection controller reset condition selection 0: Reset disabled (reset by powering off/on or software reset enabled) 1: Reset enabled Initial value: 0 (reset disabled)

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 "999999999" 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. • 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. <a href="#">Page 194 Servo parameter setting</a>	—
(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.	—

## 9.4 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

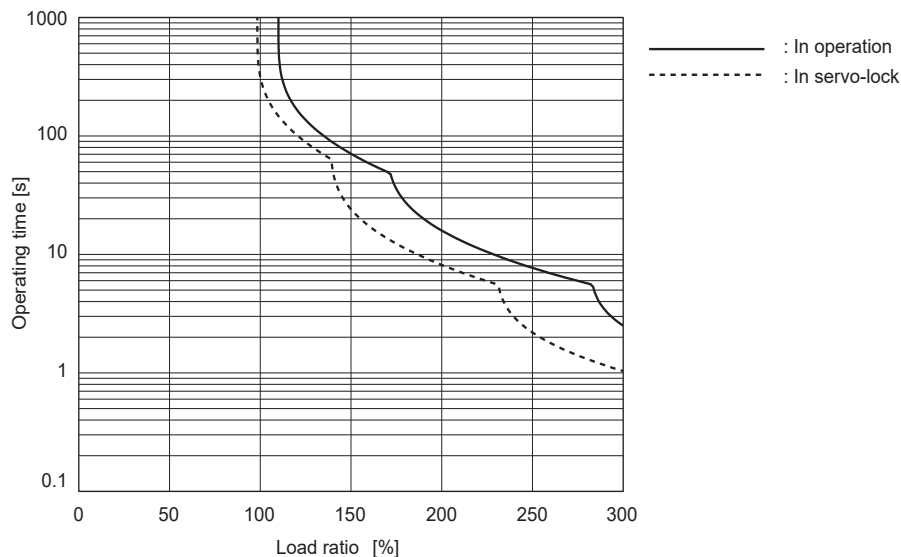
Perform the machine analyzer function after the magnetic pole detection. If the magnetic pole detection is not performed, the machine analyzer function may not operate properly.

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

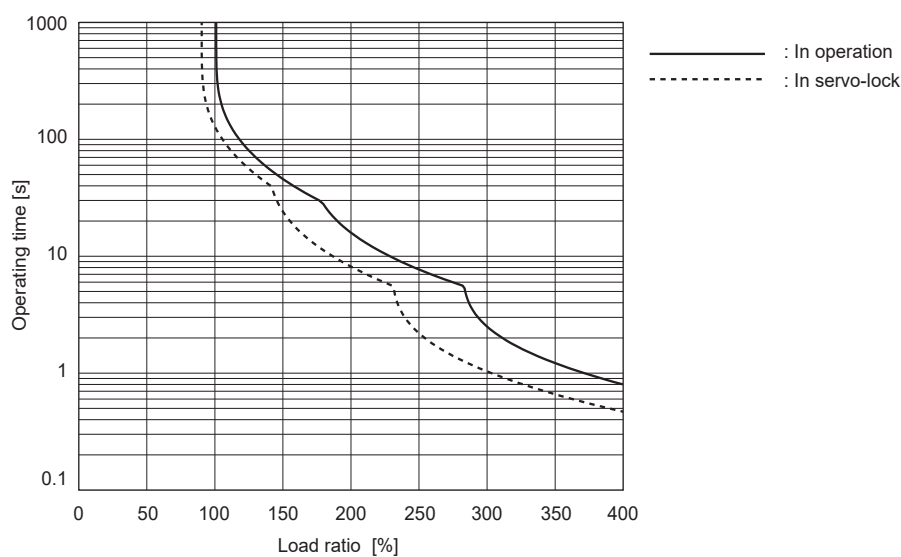
## 9.5 Characteristics

### Overload protection characteristics

#### LM-H3 series





#### LM-AJ series



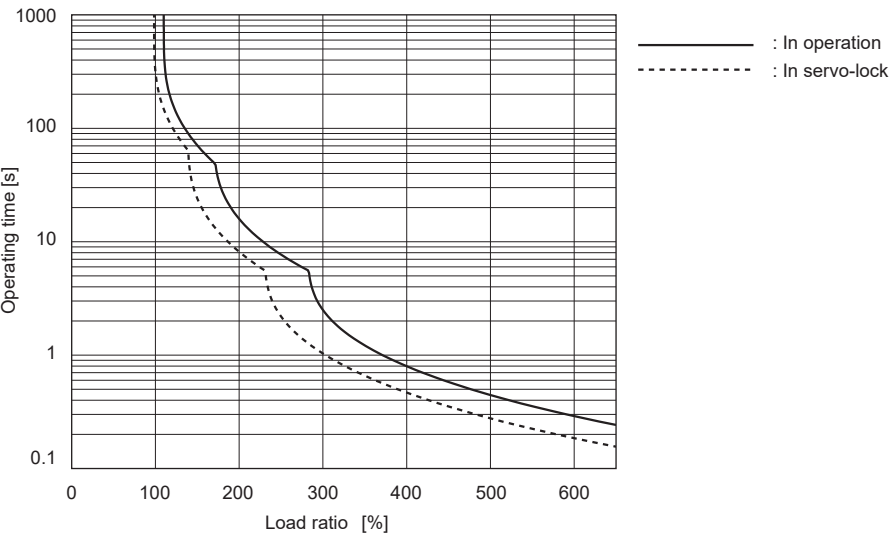
LM-AU series

■Graph of overload protection characteristics

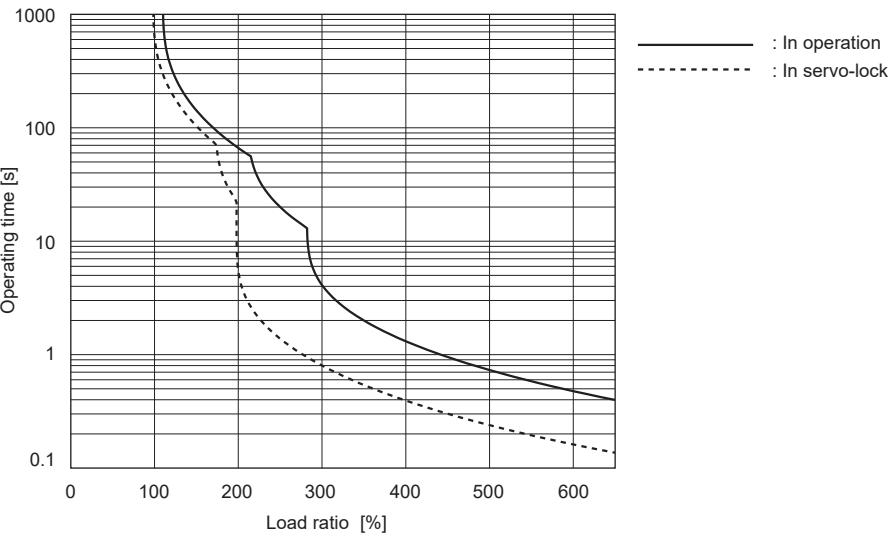
The following table lists the LM-AU series and corresponding graphs of overload protection characteristics. The overload protection characteristics depend on the linear servo motor.

LM-AU (primary side)	Graph of overload protection characteristics
LM-AUP3A-03V-JSS0 LM-AUP3B-06V-JSS0 LM-AUP3C-09V-JSS0 LM-AUP3D-11R-JSS0 LM-AUP4A-04R-JSS0 LM-AUP4B-09R-JSS0 LM-AUP4C-13P-JSS0 LM-AUP4D-18M-JSS0	 Page 218 Characteristic a
LM-AUP4F-26P-JSS0 LM-AUP4H-35M-JSS0	 Page 218 Characteristic b

■Characteristic a



■Characteristic b





## 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 <sup>2</sup> ]
			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
LM-AUP3A-03V-JSS0	MR-JET-40_	0.9	35	15	0.7
LM-AUP3B-06V-JSS0		0.9	35	15	0.7
LM-AUP3C-09V-JSS0		0.9	35	15	0.7
LM-AUP3D-11R-JSS0		1.2	35	15	0.7
LM-AUP4A-04R-JSS0	MR-JET-70_	1.3	50	15	1.0
LM-AUP4B-09R-JSS0		1.3	50	15	1.0
LM-AUP4C-13P-JSS0		1.3	50	15	1.0
LM-AUP4D-18M-JSS0		1.3	50	15	1.0
LM-AUP4F-26P-JSS0	MR-JET-200_	3.5	90	20	1.8
LM-AUP4H-35M-JSS0		3.5	90	20	1.8

## 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	$7.15 \times 10^{-3}$	$2.94 \times 10^{-3}$
LM-H3P3A-12P-CSS0	$2.81 \times 10^{-3}$	$1.47 \times 10^{-3}$
LM-H3P3B-24P-CSS0	$7.69 \times 10^{-3}$	$2.27 \times 10^{-4}$
LM-H3P3C-36P-CSS0	$7.22 \times 10^{-3}$	$1.13 \times 10^{-4}$
LM-H3P3D-48P-CSS0	$1.02 \times 10^{-3}$	$2.54 \times 10^{-4}$
LM-H3P7A-24P-ASS0	$7.69 \times 10^{-3}$	$2.14 \times 10^{-4}$
LM-H3P7B-48P-ASS0	$9.14 \times 10^{-4}$	$2.59 \times 10^{-4}$
LM-H3P7C-72P-ASS0	$7.19 \times 10^{-4}$	$1.47 \times 10^{-4}$
LM-AJP1B-07K-JSS0	$6.85 \times 10^{-3}$	$3.70 \times 10^{-3}$
LM-AJP1D-14K-JSS0	$4.08 \times 10^{-2}$	$3.42 \times 10^{-4}$
LM-AJP2B-12S-JSS0	$3.42 \times 10^{-3}$	$2.06 \times 10^{-3}$
LM-AJP2D-23T-JSS0	$1.35 \times 10^{-2}$	$2.48 \times 10^{-4}$
LM-AJP3B-17N-JSS0	$2.24 \times 10^{-3}$	$1.47 \times 10^{-3}$
LM-AJP3D-35R-JSS0	$6.61 \times 10^{-3}$	$2.23 \times 10^{-4}$
LM-AJP4B-22M-JSS0	$1.65 \times 10^{-3}$	$1.12 \times 10^{-3}$
LM-AJP4D-45N-JSS0	$4.03 \times 10^{-3}$	$1.94 \times 10^{-4}$
LM-AUP3A-03V-JSS0	$2.80 \times 10^{-2}$	$4.60 \times 10^{-5}$
LM-AUP3B-06V-JSS0	$1.36 \times 10^{-2}$	$2.30 \times 10^{-5}$
LM-AUP3C-09V-JSS0	$9.10 \times 10^{-3}$	$1.49 \times 10^{-5}$
LM-AUP3D-11R-JSS0	$6.70 \times 10^{-3}$	$1.13 \times 10^{-5}$
LM-AUP4A-04R-JSS0	$5.89 \times 10^{-2}$	$7.86 \times 10^{-6}$
LM-AUP4B-09R-JSS0	$1.76 \times 10^{-2}$	$5.77 \times 10^{-6}$
LM-AUP4C-13P-JSS0	$9.01 \times 10^{-2}$	$4.62 \times 10^{-6}$
LM-AUP4D-18M-JSS0	$5.76 \times 10^{-3}$	$3.77 \times 10^{-6}$
LM-AUP4F-26P-JSS0	$7.13 \times 10^{-4}$	$1.10 \times 10^{-6}$
LM-AUP4H-35M-JSS0	$5.15 \times 10^{-4}$	$8.86 \times 10^{-7}$

## 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
LM-AUP3A-03V-JSS0	35
LM-AUP3B-06V-JSS0	35
LM-AUP3C-09V-JSS0	25
LM-AUP3D-11R-JSS0	20
LM-AUP4A-04R-JSS0	35
LM-AUP4B-09R-JSS0	35
LM-AUP4C-13P-JSS0	35
LM-AUP4D-18M-JSS0	35
LM-AUP4F-26P-JSS0	35
LM-AUP4H-35M-JSS0	35

## 9.6 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.

# 10 USING A FULLY CLOSED LOOP SYSTEM

## 10.1 Precautions

10

- A fully closed loop system can be used on servo amplifiers with firmware version C4 or later and manufactured in July 2022 or later.
- A fully closed loop system can be used in the position mode and positioning mode.
- The MR-J4FCCBL03M branch cable is required for the two-wire type communication method.
- Select a load-side encoder of which the number of load-side encoder pulses per servo motor revolution satisfies the following conditions.

$$4096 (2^{12}) \leq \text{Number of load-side encoder pulses per servo motor revolution} \leq 67108864 (2^{26})$$

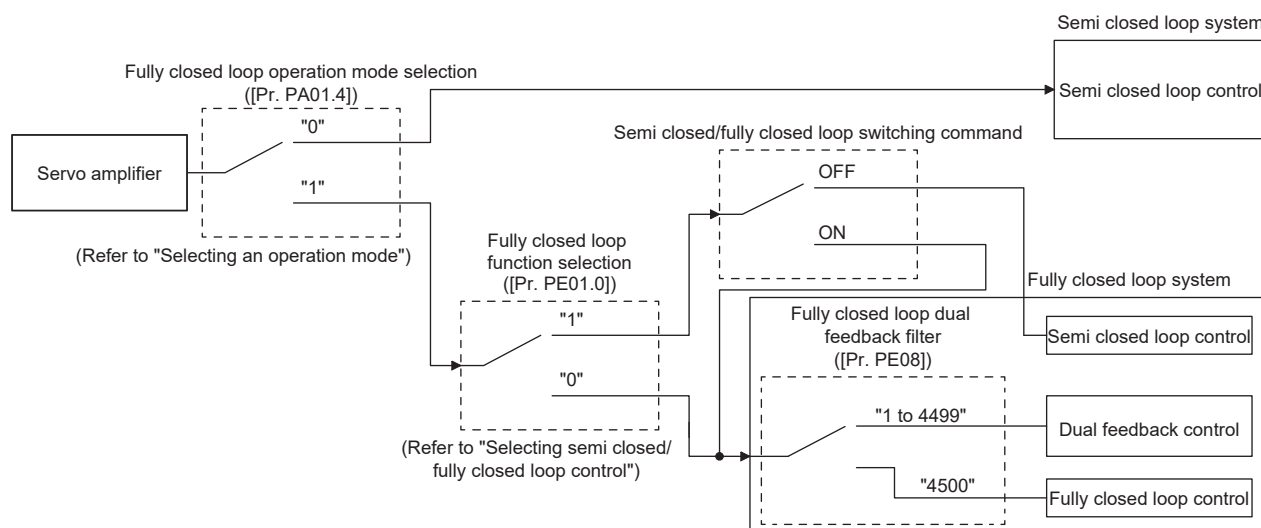
- Load-side encoders support HK series servo motors, HG series servo motors, and linear scales. For the load-side encoders that can be used with the MR-JET servo amplifier, contact your local sales office.
- Only the load-side encoders and servo motor encoders with the two-wire type communication method can be used. The load-side encoders and servo motor encoders with the four-wire type communication method cannot be used.
- When HK series servo motors or HG series servo motors are used for drive and load-side encoders, four-wire type encoder cables cannot be used.

When the servo amplifier is in the factory settings and the controller is connected to it for the first time, turning on the power in the fully closed loop control mode with the absolute position detection system enabled may trigger [AL. 1A.5 Servo motor combination error 3]. After setting [Pr. PA03.1 Servo motor replacement preparation] to "1" (enabled), cycle the power and then deactivate [AL. 1A.5]. After deactivating [AL. 1A.5], perform homing again.

# 10.2 Functions and configuration

## Outline

Either a semi closed loop system or a fully closed loop system can be selected as a control method for this servo amplifier. In addition, the semi closed loop control, fully closed loop control, or dual feedback control can be selected by the setting of [Pr. PE08 Fully closed loop dual feedback filter] in the fully closed loop system.



The following table lists the characteristics of each control method.

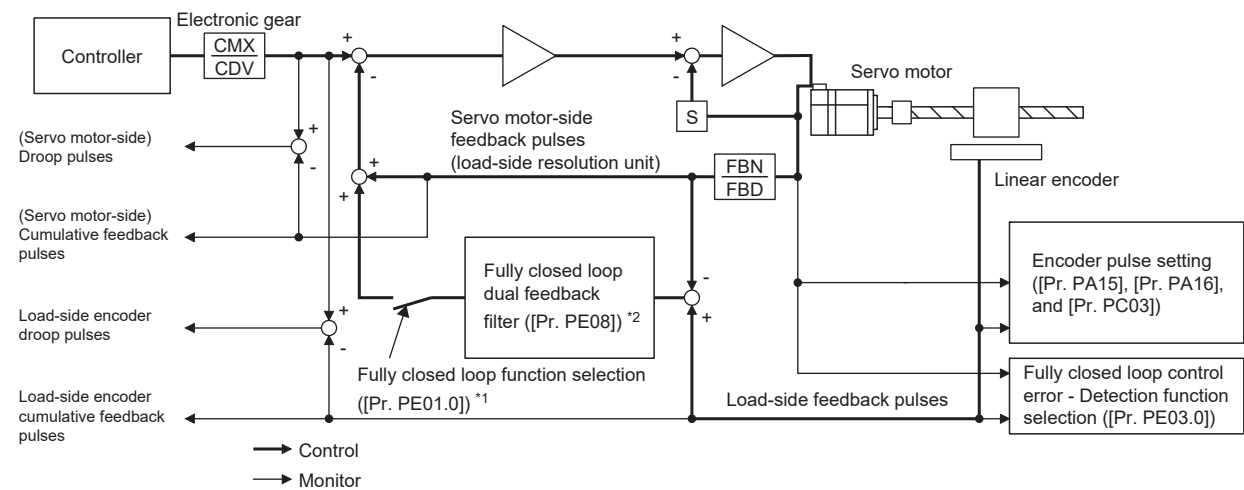
Control	Description	
Semi closed loop control	Feature	The position is controlled with servo motor-side information.
	Advantage	Because this control method is not susceptible to machine resonance, it can increase the gain of the servo amplifier and shorten the settling time.
	Disadvantage	Even when the servo motor side is stopped, the load side may vibrate or accuracy at the load side may not be achieved.
Dual feedback control	Feature	The position is controlled with servo motor-side information and load-side information.
	Advantage	The gain during operation can be increased and thus the settling time can be shortened by switching the information type to control the position as follows: the servo motor-side information during operation and the load-side information during stops. When the servo motor stops, it stops with the accuracy at the load side.
Fully closed loop control	Feature	The position is controlled with load-side information.
	Advantage	Accuracy at the load side is achieved not only during stops, but also during operation.
	Disadvantage	Because this control method is susceptible to machine resonance, it may be unable to increase the gain of the servo amplifier.

# Function block diagram

## Fully closed loop system block diagram

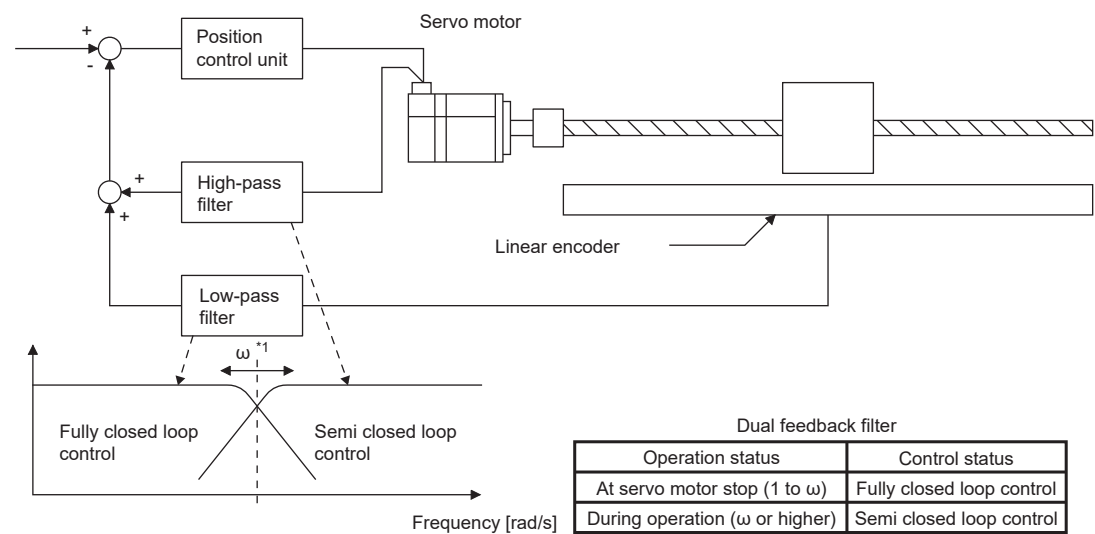
A fully closed loop system block diagram is shown below. For a fully closed loop system, the position is controlled in the units of the load-side encoder.

10



## Dual feedback filter equivalent block diagram

The following shows a dual feedback filter equivalent block diagram for dual feedback control.



\*1 Set "ω" (dual feedback filter band) with [Pr. PE08 Fully closed loop dual feedback filter].

# Operation mode and load-side encoder combinations

Refer to the following table for availability of the fully closed loop system.

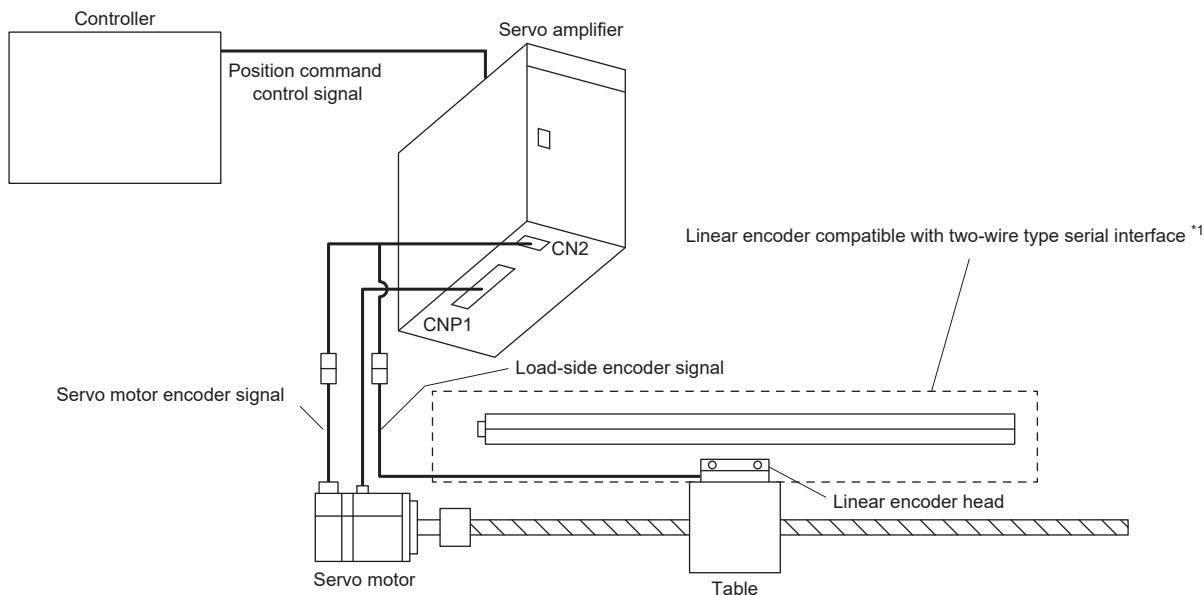
Load-side encoder	[Pr. PA01.1 Operation mode selection]	
	"0" Standard control mode	"4" Linear servo motor control mode
Linear encoder	○	[AL. 037.2]
Rotary servo motor manufactured by Mitsubishi Electric	○	[AL. 037.2]
A/B/Z-phase differential output linear encoder	○	[AL. 037.2]
A/B/Z-phase differential output rotary encoder	○	[AL. 037.2]

Use a two-wire type encoder cable. Note that four-wire type serial interface-compatible encoders and A/B/Z-phase pulse train interface-compatible encoders cannot be used.

## System architecture

### For linear encoders

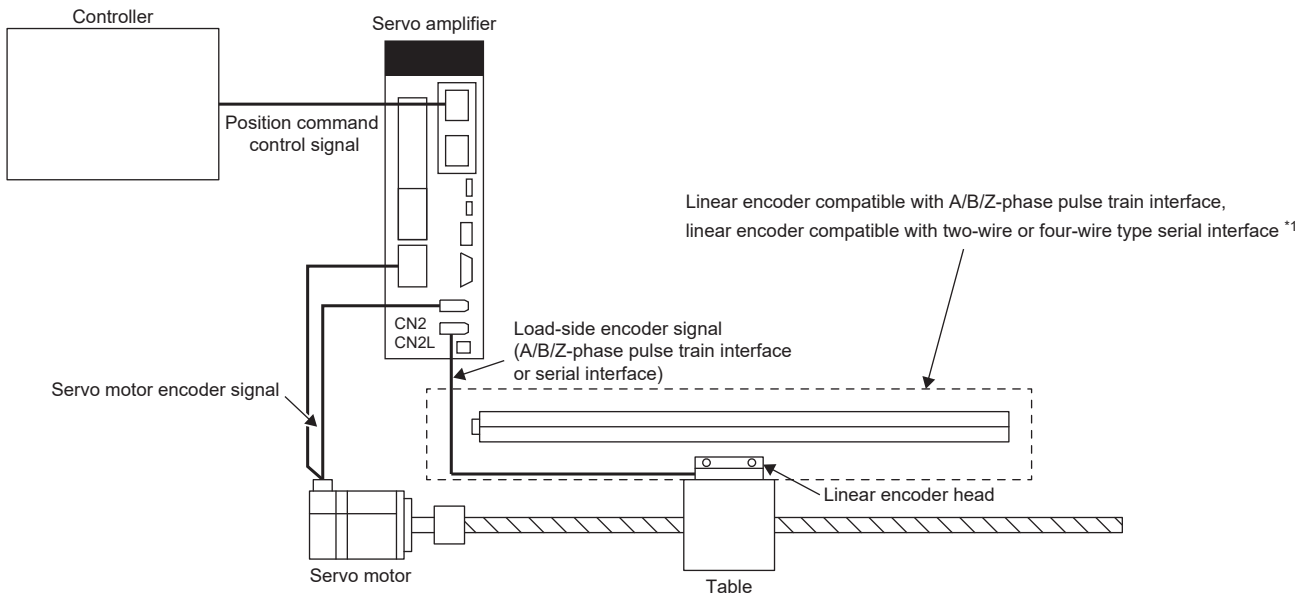
#### ■Servo amplifier without CN2L



\*1 When using an absolute position linear encoder, an absolute position detection system can be supported.  
In that case, batteries are unnecessary.  
In addition, the MR-J4FCCBL03M branch cable is required.



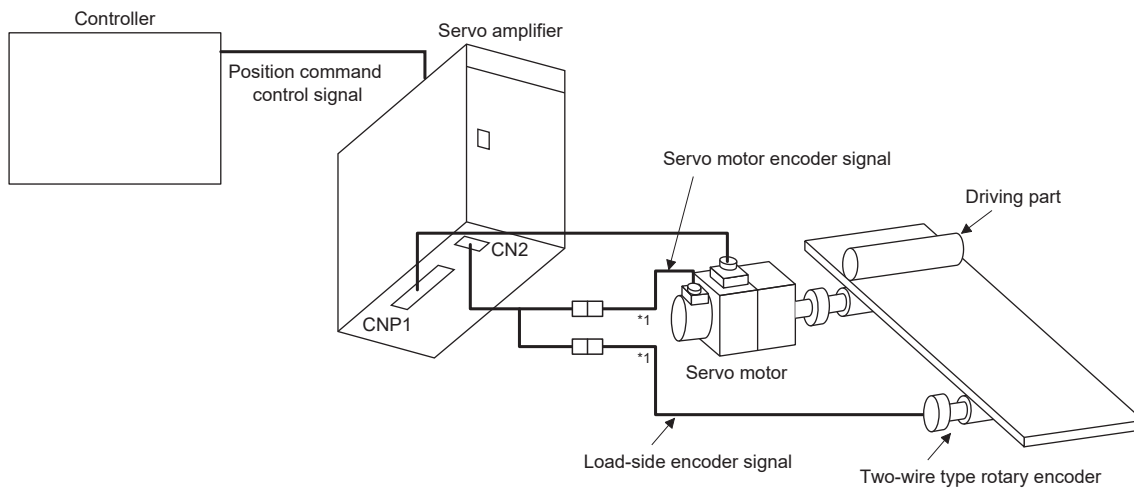
## ■ Servo amplifier with CN2L



<sup>\*1</sup> When using an absolute position linear encoder, an absolute position detection system can be supported. In that case, batteries are unnecessary.

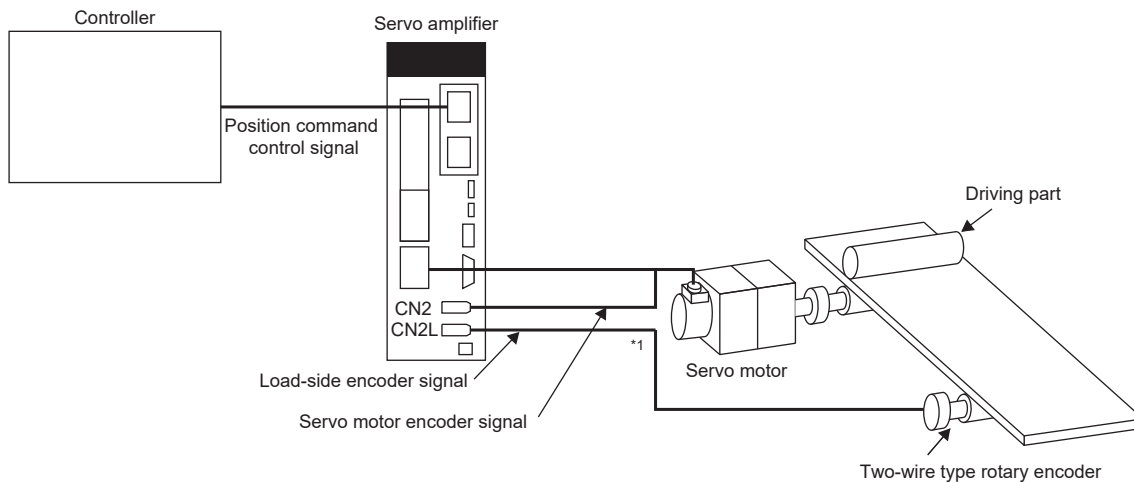
## For rotary encoders

### ■ Servo amplifier without CN2L



\*1 Use a two-wire type encoder cable. A four-wire type encoder cable cannot be used.

### ■ Servo amplifier with CN2L



\*1 When using an HK-KN servo motor, an absolute position detection system can be supported without using batteries.

## 10.3 Signals and wiring

### Point

- Use the load side encoder cables specified in this section. Using products other than those specified may cause a malfunction.
- Contact the manufacturer of the load-side encoder being used for information on specifications, performance, and guarantees.

### Encoder cable configuration diagram

Configuration diagrams of the servo amplifier and load-side encoder are shown below. The cable to be used differs depending on the load-side encoder.

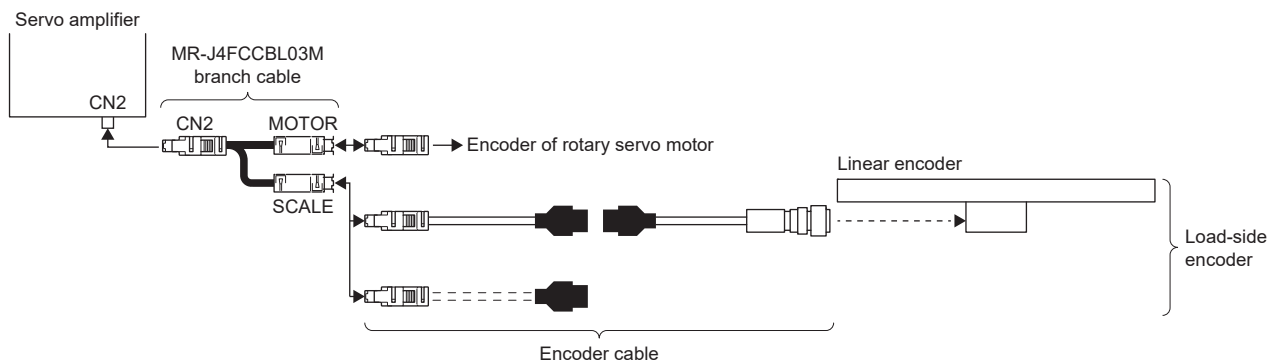
#### Encoder cable configuration diagram for linear encoders

For connection of linear encoder cables, refer to the following manual.

MR-JET Partner's Encoder User's Manual

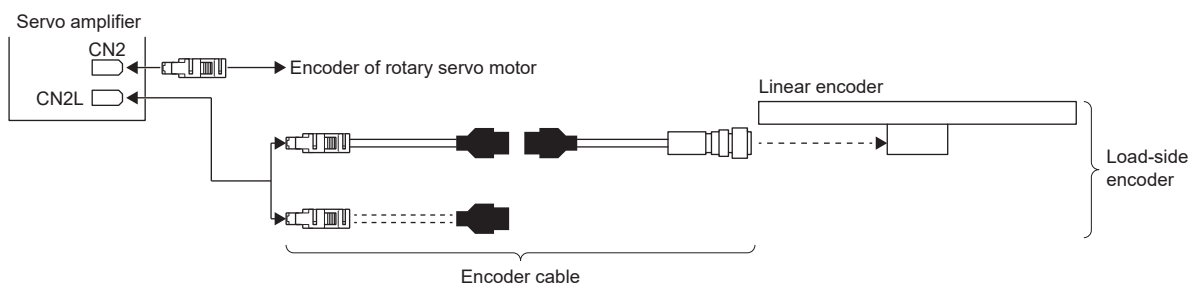
The encoder cable to be used differs depending on the load-side encoder.

##### ■ Servo amplifier without CN2L



##### ■ Servo amplifier with CN2L

The linear encoder can be connected without using an MR-J4FCCBL03M branch cable. A four-wire type linear encoder cannot be used.



## Encoder cable configuration diagram for rotary encoders



- When using a rotary encoder as the load-side encoder, use an HK-KN servo motor or HG-KNS servo motor as the encoder.
- Use a two-wire type encoder cable.

For cables for rotary encoders, refer to "Motor cables/connector sets" and "Encoder cable" in the following manual.

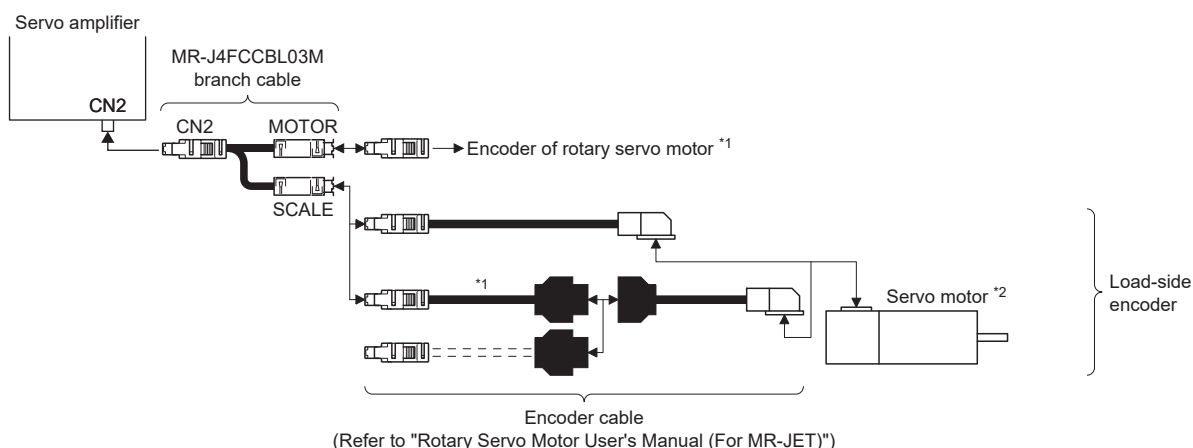
📖 Rotary Servo Motor User's Manual (For MR-JET)

Refer to the following for the MR-J4FCCBL03M branch cable.

📄 Page 246 MR-J4FCCBL03M branch cable

### ■ Servo amplifier without CN2L

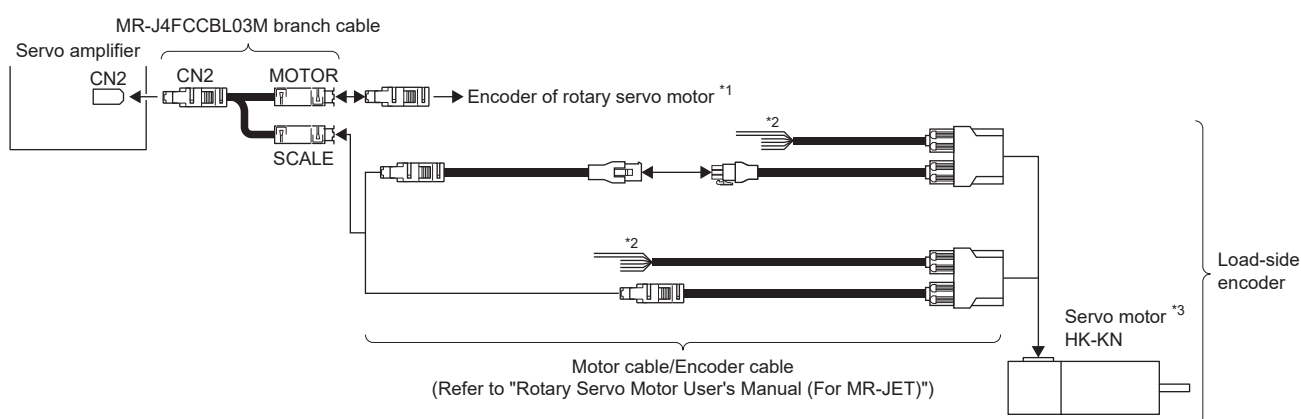
- When using an HG-KNS servo motor



\*1 Use a two-wire type encoder cable. A four-wire type encoder cable cannot be used.

\*2 Use the servo motor in the range not exceeding the maximum servo motor speed described in "Standard specifications list" in the "Rotary Servo Motor User's Manual (For MR-JET)".

- When using an HK-KN servo motor



\*3 Use a two-wire type encoder cable. A four-wire type encoder cable cannot be used.

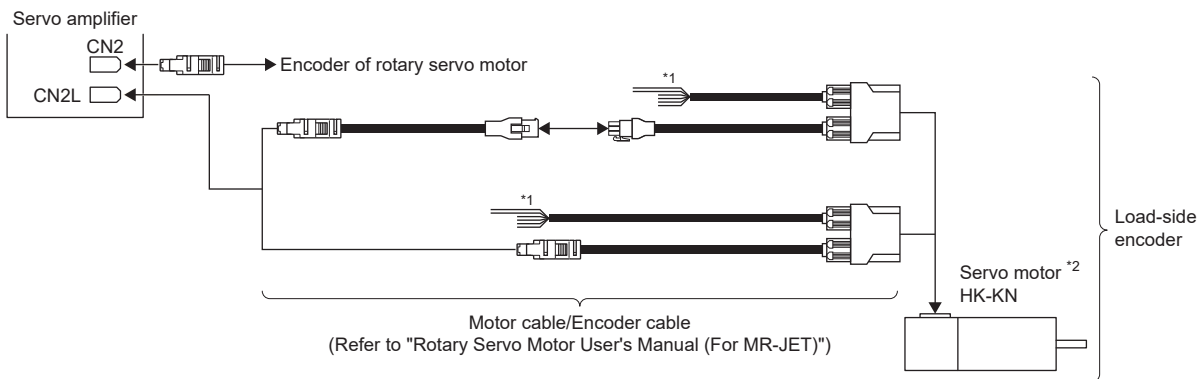
\*4 When the motor type of the servo motor is "HK-KN\_", a maximum of 240 V is output from the power cable, and when the motor type is "HK-KN\_4\_", a maximum of 480 V is output. Insulation is therefore required. Apply insulation protection according to the maximum voltage to U, V, W, and each grounding wire. Do not disconnect the power cable during the insulation protection.

\*5 Use the servo motor in the range not exceeding the maximum servo motor speed described in "Standard specifications list" in the following manual.

📖 Rotary Servo Motor User's Manual (For MR-JET)

## ■ Servo amplifier with CN2L

The rotary encoder can be connected without using an MR-J4FCCBL03M branch cable.



\*1 When the motor type of the servo motor is "HK-KN\_", a maximum of 240 V is output from the power cable, and when the motor type is "HK-KN\_4\_", a maximum of 480 V is output. Insulation is therefore required. Apply insulation protection according to the maximum voltage to U, V, W, and each grounding wire. Do not disconnect the power cable during the insulation protection.

\*2 Use the servo motor in the range not exceeding the maximum servo motor speed described in "Standard specifications list" in the following manual.

Rotary Servo Motor User's Manual (For MR-JET)

# 10.4 Startup

## Servo parameter setting

### Selecting a fully closed loop system

With the settings of [Pr. PA01], [Pr. PE01], and the controller control command, a control method can be selected as described in the following table.

[Pr. PA01.4 Fully closed loop operation mode selection]	[Pr. PE01.0 Fully closed loop function selection]	Semi closed loop control/fully closed loop control switching signal	Command unit	Control method	Absolute position detection system
"0" Semi closed loop system	—	—	Servo motor encoder unit	Semi closed loop control	○
"1" Fully closed loop system	"0"	—	Load-side encoder unit	Dual feedback control (Fully closed loop control)	○ *1
	"1"	OFF		Semi closed loop control	×
		ON		Dual feedback control (Fully closed loop control)	×

\*1 Can be supported when the load-side encoder is an absolute position encoder.

### ■Selecting an operation mode

Select an operation mode.

- [Pr. PA01.4 Fully closed loop operation mode selection]

Setting value	Operation mode	Control unit
0	Semi closed loop system	Servo motor-side resolution unit
1	Fully closed loop system	Load-side resolution unit

### ■Selecting semi closed/fully closed loop control

Select semi closed/fully closed loop control.

- [Pr. PE01.0 Fully closed loop function selection]

If this servo parameter is set to "1" while [Pr. PA03.0 Absolute position detection system selection] has been set to "1" (enabled (absolute position detection system)), [AL. 037 Parameter error] will occur.

0: Always enabled

1: Switching by "fully closed loop selection" from the controller (C\_CLD) and by the input device "fully closed loop selection" (CLD)

Fully closed loop selection		Control method
Command from controller (C_CLD)	CLD (fully closed loop selection) *1	
OFF	OFF	Semi closed loop control
ON	OFF	Fully closed loop control
OFF	ON	
ON	ON	

\*1 This is always off if the CLD (fully closed loop selection) is not assigned to an input device.

This setting is enabled when "1" (enabled (fully closed loop control mode)) is selected in [Pr. PA01.4 Fully closed loop operation selection].

Depending on the device configuration, if [Pr. PE01.4 Fully closed loop control - Droop pulse clear selection] is set to "0" (enabled) and switching between semi closed loop control and fully closed loop control is performed to clear droop pulses, an error may occur in the stop position compared to when [Pr. PE01.4] is set to "1" (disabled). If [Pr. PE01.4] is set to "0" (enabled) and switching between semi closed loop control and fully closed loop control is performed, perform homing again.

## Setting the polarity of the load-side encoder

10

### Precautions

- Do not set the incorrect direction in [Pr. PC27.0 Encoder pulse count polarity selection].

If the correct direction is not set, the encoder will not operate correctly, possibly causing a collision that results in an accident or damage to other devices.

- [Pr. PC27.0 Encoder pulse count polarity selection] is not related to [Pr. PA14 Travel direction selection].

Set this parameter according to the relationship between the servo motor and the linear encoder /rotary encoder.

- Do not set the incorrect direction in [Pr. PC27.0 Encoder pulse count polarity selection].

During the positioning operation, [AL. 042 Fully closed loop control error] may occur.

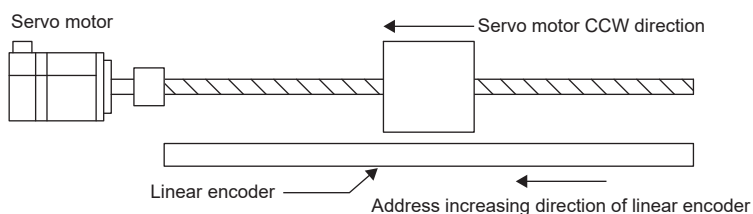
### ■ Servo parameter

Set the polarity of the load-side encoder that is connected to the CN2L connector so that the CCW direction of the servo motor matches the increasing direction of the load-side encoder feedback.

- [Pr. PC27.0 Encoder pulse count polarity selection]

0: Load-side encoder pulse increasing direction in the servo motor CCW

1: Load-side encoder pulse decreasing direction in the servo motor CCW



### ■ Checking the feedback direction of the load-side encoder

Refer to the following for checking the feedback direction of the load-side encoder.

📖 Page 237 Checking position data of the load-side encoder

## Setting the feedback pulse electronic gear

### Precautions

If an incorrect value is set for the feedback pulse electronic gear ([Pr. PE04 Fully closed loop control - Feedback pulse electronic gear 1 - Numerator] or [Pr. PE05 Fully closed loop control - Feedback pulse electronic gear 1 - Denominator]), [AL. 037 Parameter error] may occur and prevent normal operation.

In addition, [AL. 042.8 Fully closed loop control error based on position deviation] may occur during the positioning operation. For servo motor-side encoder pulses, set the numerator [Pr. PE04] and denominator [Pr. PE05] of the electronic gear. Set the electronic gear so that the number of servo motor encoder pulses per servo motor revolution is converted into the number of load-side encoder pulses. The relation is as follows.

$$\frac{[\text{Pr. PE04}]}{[\text{Pr. PE05}]} = \frac{\text{The number of load-side encoder pulses per servo motor revolution}}{\text{The number of servo motor encoder pulses per servo motor revolution}}$$

Select a load-side encoder of which the number of load-side encoder pulses per servo motor revolution is within the following range.

$$4096 (2^{12}) \leq \text{Number of load-side encoder pulses per servo motor revolution} \leq 67108864 (2^{26})$$

### ■ Example settings of a ball screw (direct connection) with a linear encoder resolution of 0.05 $\mu\text{m}$

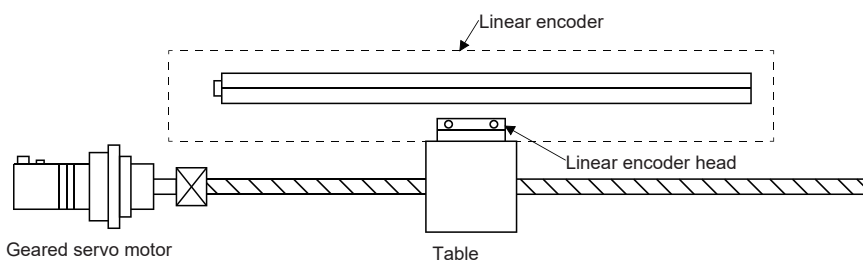
- Conditions

Servo motor resolution: 16777216 pulses/rev

Servo motor reduction ratio: 1/11

Ball screw lead: 20 mm

Linear encoder resolution: 0.05  $\mu\text{m}$



Calculate the number of linear encoder pulses per ball screw revolution.

Number of linear encoder pulses per ball screw revolution

= Ball screw lead/Linear encoder resolution

= 20 mm/0.05  $\mu\text{m}$  = 400000 pulses

$$\frac{[\text{Pr. PE04}]}{[\text{Pr. PE05}]} = \frac{400000}{16777216} \times \frac{1}{11} = \frac{3125}{131072} \times \frac{1}{11} = \frac{3125}{1441792}$$



## ■ Example settings when using a rotary encoder as the load-side encoder of a roll feeder

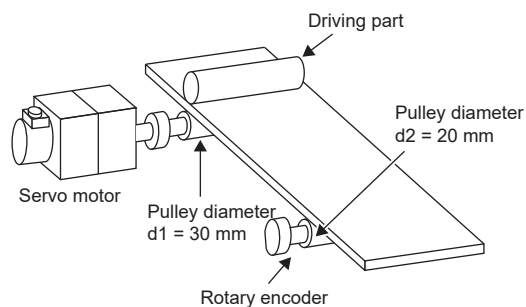
- Conditions

Servo motor resolution: 16777216 pulses/rev

Servo motor-side pulley diameter: 30 mm

Rotary encoder side pulley diameter: 20 mm

Rotary encoder resolution: 16777216 pulses/rev



If the pulley ratio or reduction ratio is not one-to-one, calculate the electronic gear by taking that into consideration.

$$\frac{[\text{Pr. PE04}]}{[\text{Pr. PE05}]} = \frac{16777216 \times 30}{16777216 \times 20} = \frac{1}{1} \times \frac{3}{2} = \frac{3}{2}$$

## Setting the fully closed loop dual feedback filter

Use auto tuning or a similar mode to adjust the gain in the same way as when using semi closed loop control while [Pr. PE08 Fully closed loop dual feedback filter] is being set to the initial value (setting value = 10).

Adjust the dual feedback filter while observing the servo operation waveforms with the graph function or a similar function of MR Configurator2.

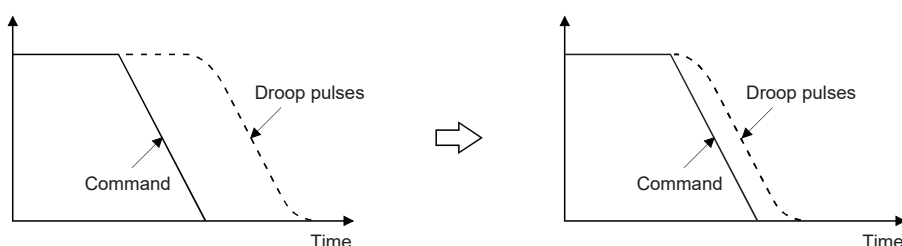
The operation status of the dual feedback filter varies depending on the setting value as shown below.

Setting value of [Pr. PE08]	Control mode	Vibration	Settling time
1 to 4499	Dual feedback	Hardly occurs to Easily occurs	Longer to shorter
4500	Fully closed	—	—

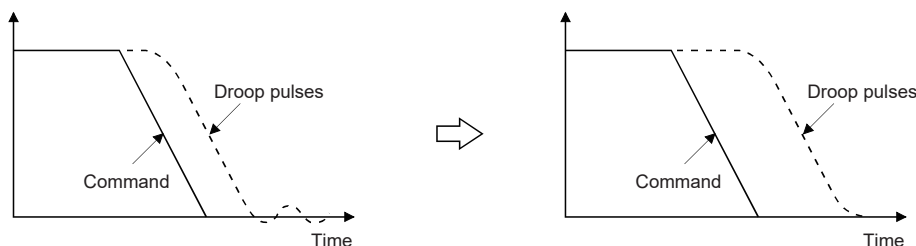
When the setting value for the dual feedback filter is increased, the settling time becomes shorter. However the vibration of the servo motor will be larger because the servo motor becomes susceptible to the vibrations of the load-side encoder.

For the dual feedback filter, set a value that is equal to or smaller than a half of the setting value for PG2.

- To shorten the settling time: Increase the value for the dual feedback filter.



- To suppress vibration: Decrease the value for the dual feedback filter.



## Load-side encoder resolution setting

When using an A/B/Z-phase differential output rotary encoder, set the resolution in [Pr. PE51 Load-side encoder resolution setting].

When using an A/B/Z-phase differential output linear encoder, set [Pr. PE51] to "0".

- [Pr. PE51 Load-side encoder resolution setting]

Set the resolution of the A/B/Z-phase differential output rotary encoder used on the load-side.

When an A/B/Z-phase differential output type encoder is connected, the value set to this servo parameter is used to determine whether it is a rotary encoder or a linear encoder.

0: Linear encoder

Other than 0: Rotary encoder

# Checking position data of the load-side encoder

## Precautions

Depending on the check items, MR Configurator2 may be used. Refer to "Help" of MR Configurator2 for the data displayed on the MR Configurator2.

Check the load-side encoder mounting and parameter settings for any problems.

No.	Check item	Confirmation method and description
1	Reading the position data of the load-side encoder	<p>When a load-side encoder that is installed and connected correctly is operated, the value for load side encoder cumulative feedback pulses is counted correctly.</p> <p>If the value is not counted correctly, the following are likely causes.</p> <p>(1) An alarm occurred.</p> <p>(2) The load-side encoder is not installed correctly.</p> <p>(3) The encoder cable is not wired correctly.</p>
2	Reading the home position of the load-side encoder (reference mark, Z-phase)	<p>If the home position (reference mark, or Z-phase) of the load-side encoder is in a normal condition (mounting, connection, etc.), the value of load-side encoder information 1 is cleared to 0 when the load-side encoder is moved to pass through the home position (reference mark, or Z-phase).</p> <p>If the value is not cleared, the following are likely causes.</p> <p>(1) The load-side encoder is not installed correctly.</p> <p>(2) The encoder cable is not wired correctly.</p>
3	Checking the load-side encoder feedback direction (setting the polarity of the load-side encoder)	<p>Move the device (load-side encoder) manually in servo-off status to confirm that the directions of the cumulative feedback pulses of the servo motor encoder (after taking the gear into consideration) and the load-side cumulative feedback pulses are matched.</p> <p>If the directions are mismatched, reverse the polarity.</p>
4	Setting the electronic gear for the load-side encoder	<p>When the servo motor and the load-side encoder move synchronously, the servo motor-side cumulative feedback pulses (after taking the gear into consideration) and load side encoder cumulative feedback pulses increase by the same amount.</p> <p>If the cumulative feedback pulses are mismatched, use the following procedure to review the settings of the fully closed loop control feedback electronic gear ([Pr. PE04 Fully closed loop control - Feedback pulse electronic gear 1 - Numerator] and [Pr. PE05 Fully closed loop control - Feedback pulse electronic gear 1 - Denominator]).</p> <p>(1) Check the servo motor-side cumulative feedback pulses (before taking the gear into consideration).</p> <p>(2) Check the load-side cumulative feedback pulses.</p> <p>(3) Check that the ratio of (1) to (2) mentioned above is the same as the feedback electronic gear ratio.</p>

# 10.5 Basic functions

## Homing

Homing is performed based on the load-side encoder feedback data regardless of the load-side encoder type.

It is irrelevant to the Z-phase position of the servo motor encoder.

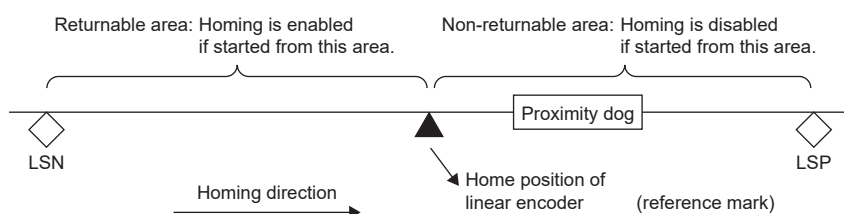
The types and methods of homing are basically the same as in semi closed loop control.

### Restriction

- In the case of homing with a dog signal, the home position (reference mark) must be passed through when an incremental type linear encoder is used, or the Z-phase must be passed through when a rotary encoder is used, during a period from a home position return start until the dog signal turns off.
- For the linear encoder, a home position (reference mark) of the linear encoder is necessary in the homing direction. In addition, place the proximity dog position one half of the rotation or more before the reference mark.

## Precautions

To execute homing securely in the following example, start homing after moving the servo motor to LSN with the JOG operation.

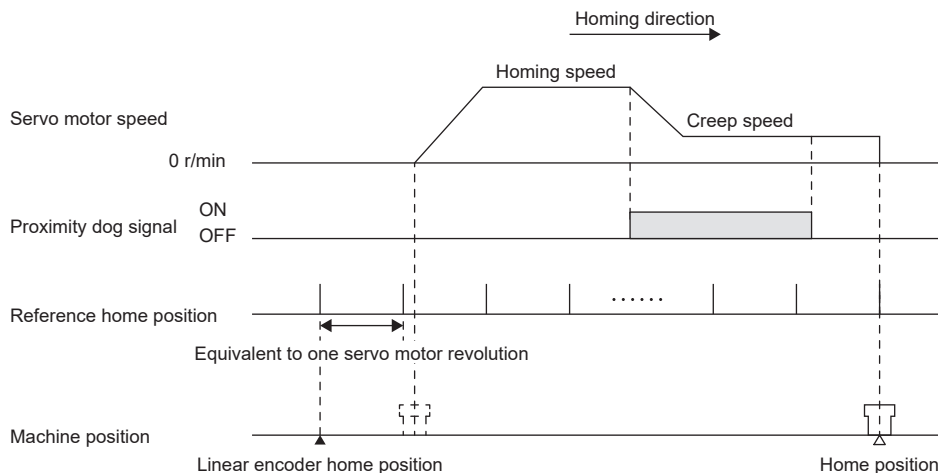


## Reference home position

### ■Absolute position linear encoder

The reference home position for an absolute position linear encoder is every position per servo motor revolution starting from the linear encoder home position (absolute position data = 0).

In the case of Method -1 (dog type homing), the nearest position after the proximity dog signal turned off is the home position. The linear encoder home position can be set in any position.



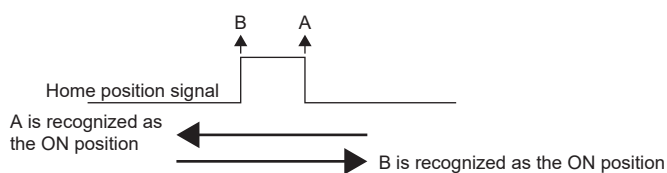
### ■Incremental linear encoder

#### Precautions

- To execute homing securely, start homing after moving the servo motor to the opposite stroke end with the JOG operation from the controller or other methods.
- If the linear encoder home position (reference mark) does not exist on the incremental linear encoder, only the homing methods that do not use the Z-phase can be executed.
- Do not set multiple homing positions (reference marks).
- 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.)

Example: When the Z-phase is recognized at startup



The position where the signal turns on depends on the direction in which the home position is passed through. In a case where homing is always required to be completed at the same position (such as dog type homing), start homing with the same direction.

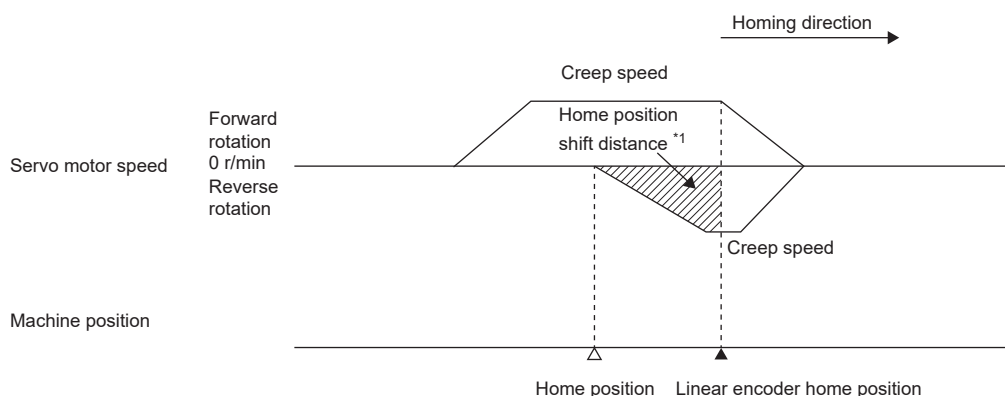
The reference home position for an incremental linear encoder is every position per servo motor revolution starting from the first linear encoder home position which has been passed through after the power-on. (reference mark).

In the case of Method -1 (dog type homing), the nearest reference home position after the proximity dog signal rear end is detected is the home position.

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

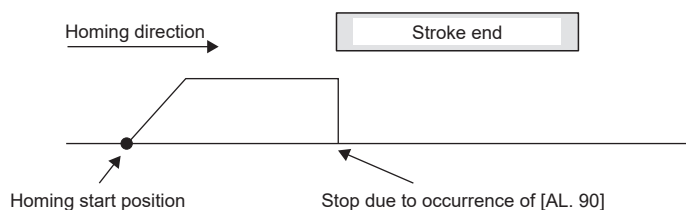
The position obtained by moving the home position shift distance from the linear encoder home position (reference mark) is set as the home position.

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

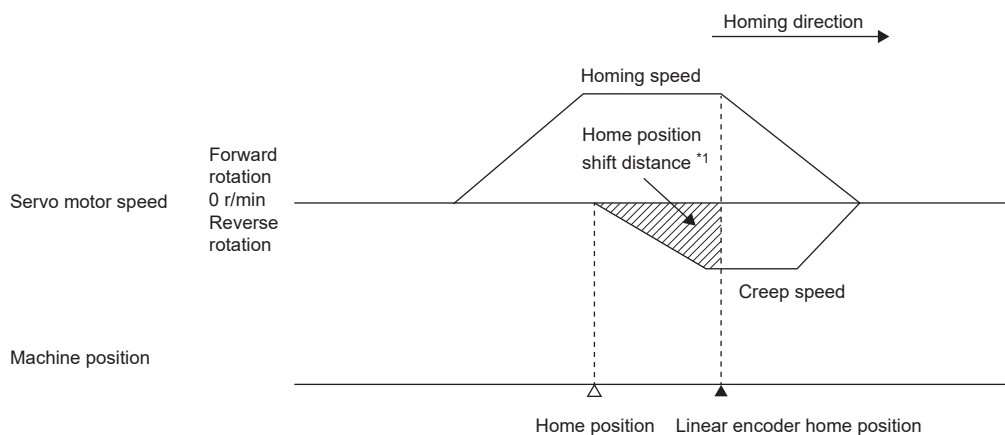


\*1 Home position shift distance can be changed with [Pr. PT07 Home position shift distance].

When the stroke end is detected

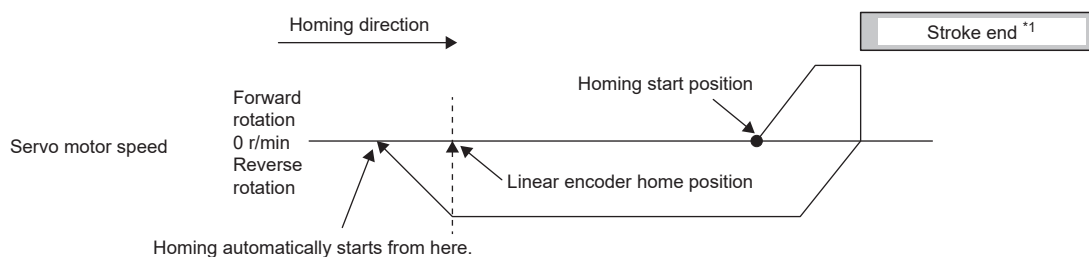


The following figure shows the operation of Homing method -11. The homing direction of Homing method -43 is opposite to that of Homing method -11.



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

When the servo motor returns at the stroke end

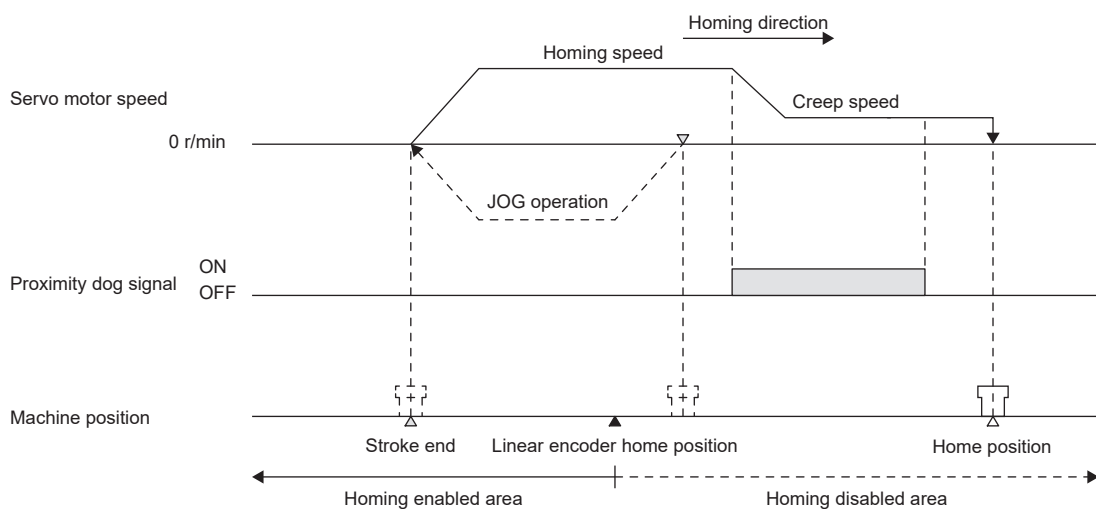


\*1 This cannot be used with the software limit.

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

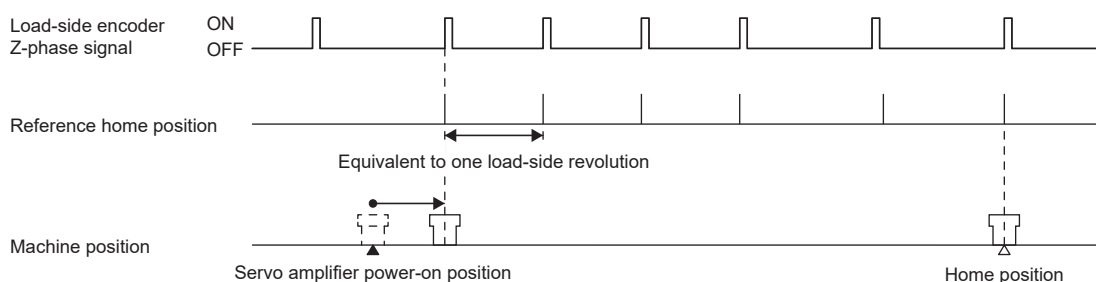
If homing is performed from a position where the linear encoder home position does not exist in the homing direction, an error may occur depending on the homing method.

If an error occurs, change the homing method or temporarily move the servo motor to the stroke end opposite of homing with the JOG operation or other methods from the controller, then perform homing.



### ■ Rotary encoder of a serial communication servo motor

If using the rotary encoder of a serial communication servo motor as the load-side encoder, the home position is at the load side Z-phase position.



## Operation from controller

The positioning operation from the controller is basically the same as in semi closed loop control.

## Fully closed loop control error detection function

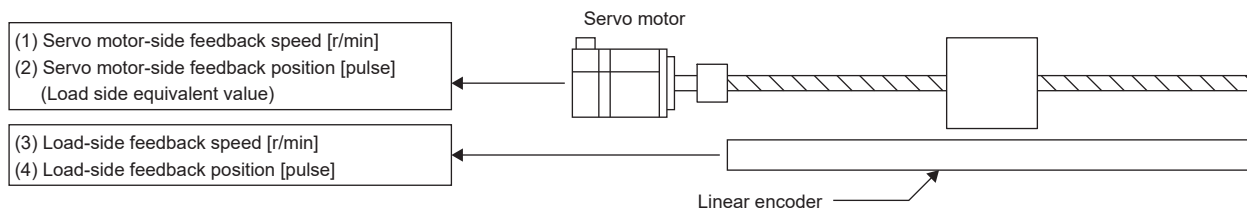
If fully closed loop control becomes unstable for some reason, the servo motor-side speed may increase abnormally. To detect this state and to stop operation, the fully closed loop control error detection function is used as a protective function. The fully closed loop control error detection function has two types of detection methods: speed deviation and position deviation. Errors are detected only when each method is enabled with [Pr. PE03.0 Fully closed loop control error - Detection function selection].

In addition, the detection level settings can be changed with [Pr. PE06 Fully closed loop control - Speed deviation error detection level] and [Pr. PE07 Fully closed loop control - Position deviation error detection level].

### Fully closed loop control error - Detection function selection

Select the fully closed loop control error detection function.

Servo parameter	Description
PE03.0	Fully closed loop control error - Detection function selection 0: Disabled 1: Speed deviation error detection 2: Position deviation error detection 3: Speed deviation error, position deviation error detection (initial value)



### ■Speed deviation error detection

Set [Pr. PE03.0 Fully closed loop control error - Detection function selection] to "1" (speed deviation error detection) to enable the speed deviation error detection.

Servo parameter	Description
PE03.0	Fully closed loop control error - Detection function selection 1: Speed deviation error detection

When the difference between the servo motor-side feedback speed (1) and the load-side feedback speed (3) is equal to or more than the value of [Pr. PE06 Fully closed loop control - Speed deviation error detection level] (1 r/min to permissible speed), [AL. 042.9 Servo control error based on speed deviation] occurs, and the servo motor stops.

The initial value for [Pr. PE06] is 400 r/min. Change the setting value as necessary.



## ■Position deviation error detection

Set [Pr. PE03.0 Fully closed loop control error - Detection function selection] to "2" (position deviation error detection) to enable the position deviation error detection.

Servo parameter	Description
PE03.0	Fully closed loop control error - Detection function selection 2: Position deviation error detection
PE03.1	Position deviation error - Detection method selection 0: Continuous detection 1: Detection only at stop (An error is detected if the command is "0".) 2: Detection only at stop 2 (An error is detected during servo-off or if the command is "0" while in servo-on state.)
Servo parameter	Description
PE10.1	Fully closed loop control - Position deviation error detection level - Unit selection 0: 1 [kpulse] unit 1: 1 [pulse] unit

When the difference between the servo motor-side feedback position (2) and the load-side feedback position (4) is equal to or more than the value of [Pr. PE07 Fully closed loop control - Position deviation error detection level] (1 kpulse to 20000 kpulses), [AL. 042.8 Servo control error based on position deviation] occurs, and the servo motor stops.

If the difference is equal to or more than the value of [Pr. PE07] at the command stop, [AL. 042.A Fully closed loop control error based on position deviation during command stop] occurs.

When [Pr. PE03.1 Position deviation error - Detection method selection] is set to "1" (Detection only at stop), only [AL. 042.A] is detected.

The initial value for [Pr. PE07] is 100 kpulses.

The setting unit for [Pr. PE07] can be changed with [Pr. PE10.1 Fully closed loop control - Position deviation error detection level - Unit selection].

Change the setting value as necessary.

## ■Detecting multiple deviation errors

Multiple deviation errors can be detected when [Pr. PE03.0 Fully closed loop control error - Detection function selection] is set to "3" (speed deviation error detection and position deviation error detection).

Refer to the following for the error detection method.

☞ Page 242 Speed deviation error detection

☞ Page 243 Position deviation error detection

## Fully closed loop control error - Reset selection

Select the reset condition of fully closed loop control errors.

### ■[Pr. PE03.3 Fully closed loop control error - Reset selection]

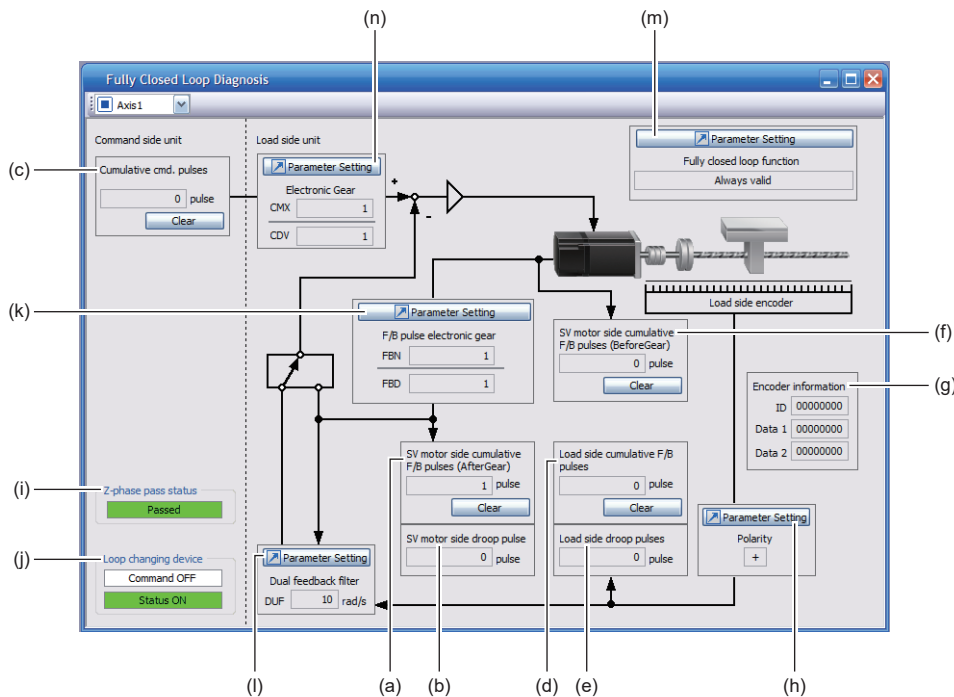
0: Reset disabled (reset by cycling the power or software reset)

1: Reset enabled


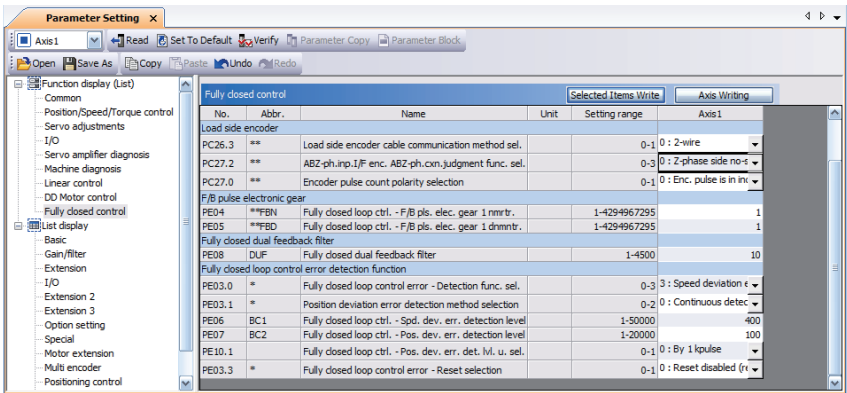
# About MR Configurator2

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 Fully Closed Loop Diagnosis screen.



Symbol	Name	Explanation	Unit
(a)	Servo motor-side cumulative feedback pulses (after gear)	The feedback pulses from the servo motor encoder are counted and displayed. (load-side encoder unit) When the setting value exceeds 999999999, it starts from 0. Click "Clear" to reset the value to "0". In reverse rotation, the value is negative.	pulse
(b)	Servo motor-side droop pulses	Droop pulses of the deviation counter between a servo motor-side position and a command are displayed. In reverse rotation, the value is negative.	pulse
(c)	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
(d)	Load-side encoder cumulative feedback pulses	The feedback pulses from the load-side encoder are counted and displayed. When the setting value exceeds 999999999, it starts from 0. Click "Clear" to reset the value to "0". In reverse rotation, the value is negative.	pulse
(e)	Load-side encoder droop pulses	Droop pulses of the deviation counter between a load-side position and a command are displayed. In reverse rotation, the value is negative.	pulse
(f)	Servo motor-side cumulative feedback pulses (before gear)	The feedback pulses from the servo motor encoder are counted and displayed. (Servo motor encoder unit) When the setting value exceeds 999999999, it starts from 0. Click "Clear" to reset the value to "0". In reverse rotation, the value is negative.	pulse
(g)	Encoder information	The load-side encoder information is displayed. The display contents differ depending on the load-side encoder type. <ul style="list-style-type: none"> <li>• ID: The ID No. of the load-side encoder is displayed.</li> <li>• 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.</li> <li>• 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.</li> </ul>	—
(h)	Parameter Setting (Polarity)	"+" is displayed for the address increasing direction in the servo motor CCW direction, and "-" is displayed for the address decreasing direction in the servo motor CCW direction.	—

Symbol	Name	Explanation	Unit
(i)	Z-phase pass status	When the fully closed loop system is disabled, the Z-phase pass status of the servo motor encoder is displayed. When the fully closed loop system is enabled or when switching between semi closed loop control and fully closed loop control is enabled, Z-phase pass status of the load-side encoder is displayed.	—
(j)	Fully closed loop changing device	This item is displayed only when switching between semi closed loop control and fully closed loop control is enabled. The state of the semi closed loop control/fully closed loop control switching signal and the internal state when switching between semi closed loop control and fully closed loop control is enabled.	—
(k)	Parameter Setting (F/B pulse electronic gear)	With this servo parameter, the feedback pulse electronic gears ([Pr. PE04 Fully closed loop control - Feedback pulse electronic gear 1 - Numerator] and [Pr. PE05 Fully closed loop control - Feedback pulse electronic gear 1 - Denominator]) for servo motor encoder pulses can be displayed and set.  Page 234 Setting the feedback pulse electronic gear	—
(l)	Parameter Setting (Dual F/B filter)	With this servo parameter, the band for [Pr. PE08 Fully closed loop dual feedback filter] can be displayed and set.	—
(m)	Parameter Setting (Fully closed loop function)	The servo parameters for the fully closed loop control can be displayed and set. Click "Parameter Setting" to display the "Parameter Setting (Function display (List))" window.	—
			—
(n)	Parameter Setting (Electronic gear)	Set the servo parameters for the electronic gears. [Pr. PA06 Electronic gear numerator], [Pr. PA07 Electronic gear denominator]	—

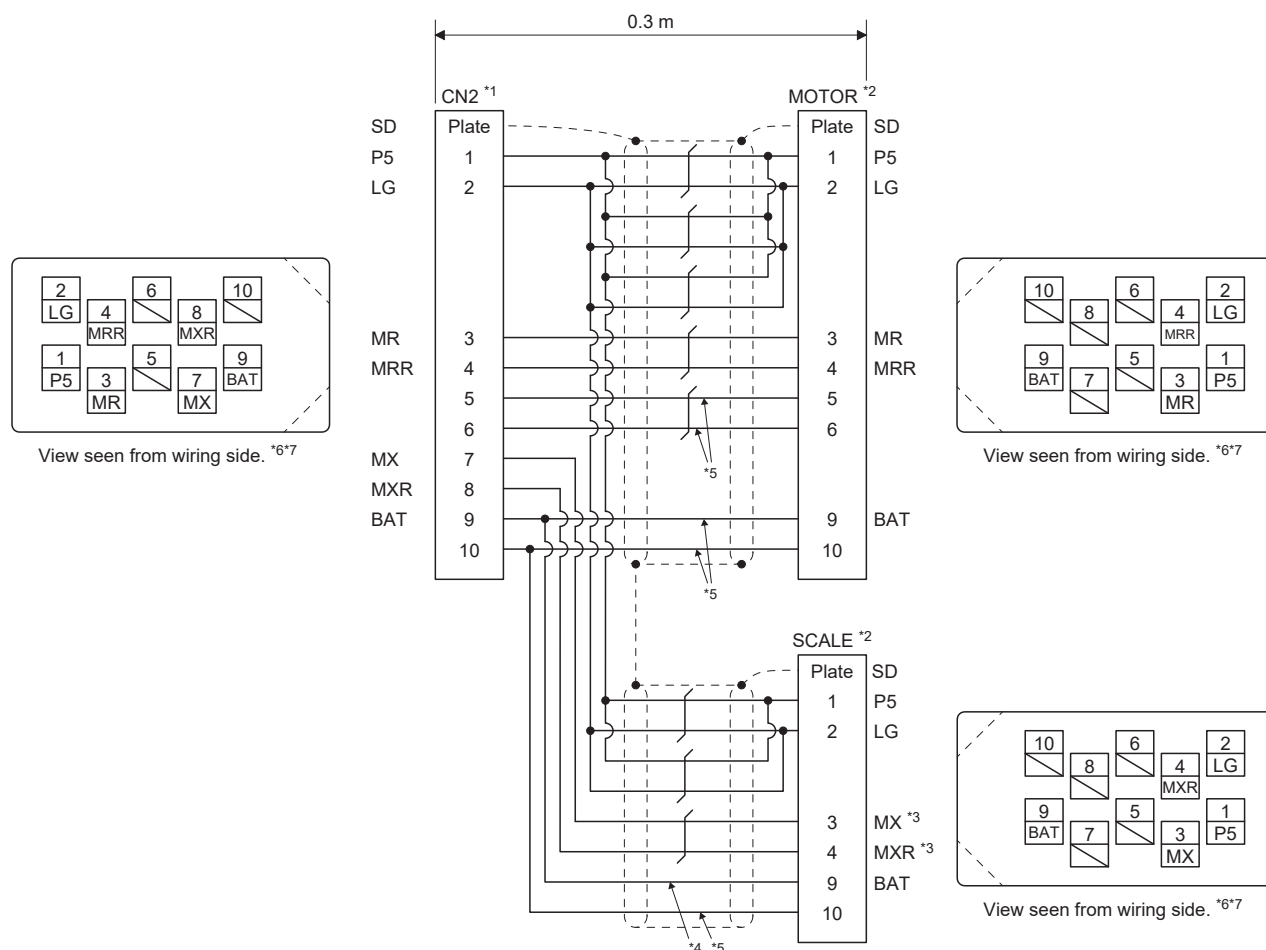
# 10.6 Options and peripheral equipment

## MR-J4FCCBL03M branch cable

This branch cable is for connecting the encoder of a rotary servo motor and the load-side rotary encoder to the CN2 connector.

When fabricating the branch cable using the MR-J3THMCN2 connector set, fabricate one as shown in the connection diagram below. The branch cable length should be 0.3 m or less. For the MR-J3THMCN2 connector set, refer to "Fabricating a branch cable for a fully closed loop system" in the following manual.

📖MR-JET Partner's Encoder User's Manual



\*1 Receptacle: 36210-0100PL, Shell kit: 36310-3200-008 (3M)

\*2 Plug: 36110-3000FD, Shell kit: 36310-F200-008 (3M)

\*3 MX of the SCALE connector is connected to MR of the load-side linear encoder, and MXR of the SCALE connector is connected to MRR of the load-side linear encoder.

\*4 This part should be connected when configuring an absolute position detection system by using a battery backup type absolute position encoder on the load side. Wiring is not necessary for use in an incremental system.

\*5 Wiring is not necessary for when a branch cable is fabricated.

\*6 Do not connect anything to the pins that are marked with a diagonal line.


\*7 Refer to "Shielding CN2 side connectors" in the following manual and securely connect the external conductor of the shielded cable to the ground plate and fix it to the connector shell.

📖MR-JET Partner's Encoder User's Manual

## 10.7 Absolute position detection system

### Structure

For whether the battery is required when configuring an absolute position detection system in the fully closed loop control, refer to the following.

 Page 125 Battery

An absolute position linear encoder is required to configure an absolute position detection system under fully closed loop control using a linear encoder.

In this case, an encoder battery need not be installed to the servo amplifier.

When a battery backup type rotary encoder is used, an absolute position detection system can be configured by using the battery "MR-BAT6V1SET-B" and battery branch cable "MR-BT6V4CBL03M".

### Restriction

- Use an absolute position type encoder for the load-side encoder.

Using an incremental type encoder triggers [AL. 037 Parameter error].

- Switching between semi closed loop control and fully closed loop control cannot be performed. Set [Pr. PE01.0 Fully closed loop function selection] to "0" (Always enabled). If [Pr. PE01.0] is set to "1", [AL. 037] occurs.
- Use the encoder within the range of 32-bit absolute position data. When the degree unit is used, the infinite feed function is enabled. For details, refer to "Infinite feed function" in the following manual.

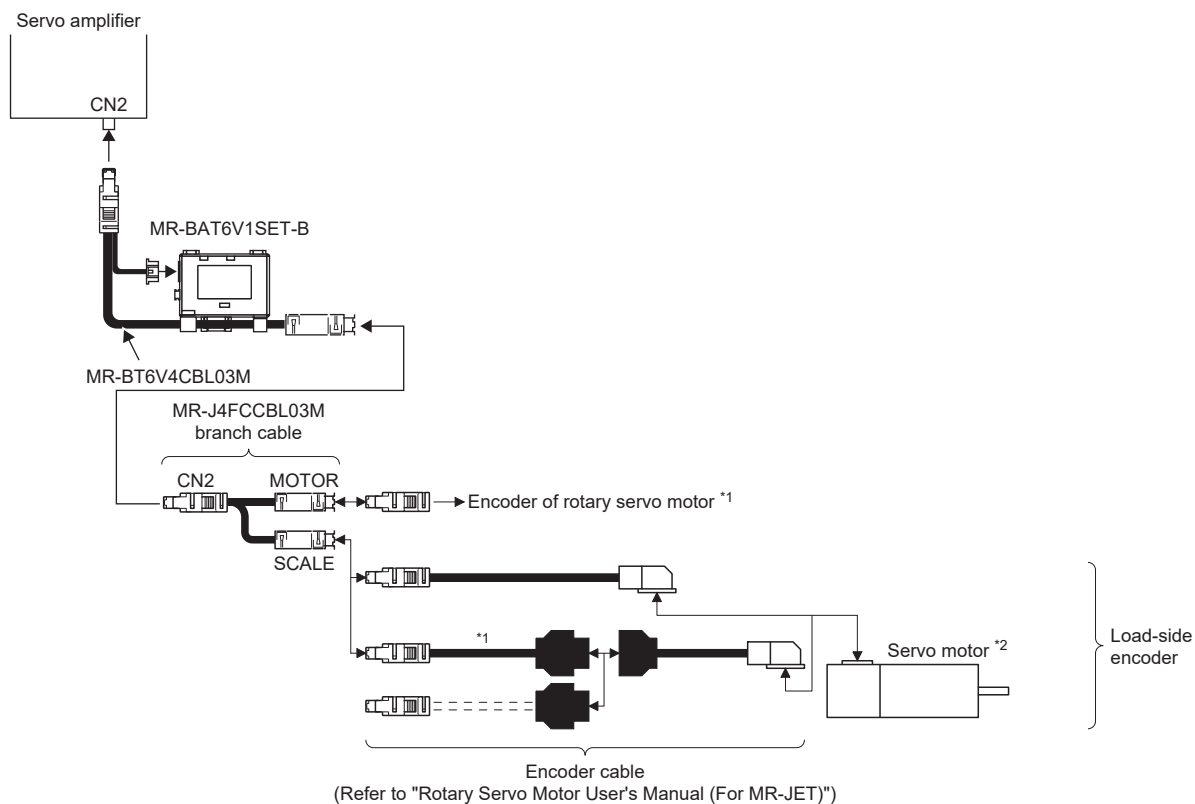
 MR-JET User's Manual (Function)

- When a linear encoder is used for the load-side encoder, absolute position-related alarms ([AL. 025 Absolute position erased]) and warnings ([AL. 092 Battery cable disconnection warning] and [AL. 09F Battery warning]) are not detected.

### Precautions

When the absolute position detection system is configured with a rotary encoder, the battery life will be shorten because the current consumption is increased as the power from the battery is supplied to both the servo motor-side and the load-side encoder.

## Encoder cable configuration diagram (When using an HG-KNS servo motor)



\*1 Use a two-wire type encoder cable. A four-wire type encoder cable cannot be used.

\*2 Use the servo motor in the range not exceeding the maximum servo motor speed described in "Standard specifications list" in the "Rotary Servo Motor User's Manual (For MR-JET)".

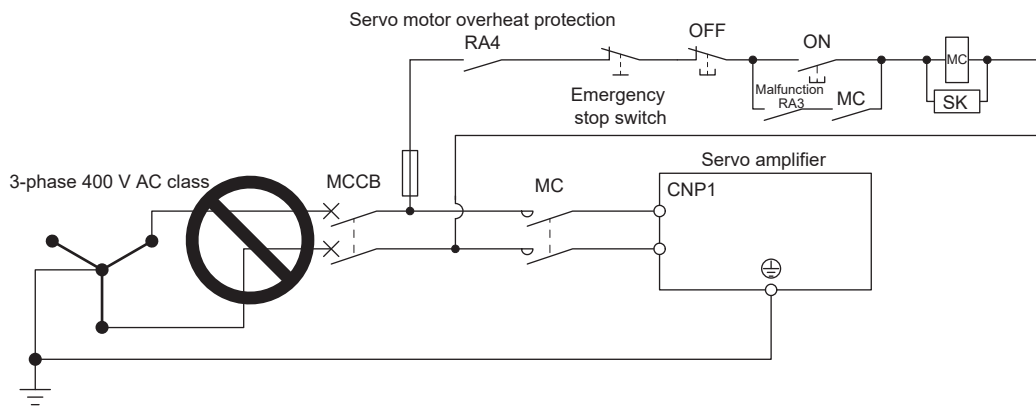
### 11.1 1-phase 200 V AC power supply input using a neutral point of 3-phase 400 V AC power supply

11

\*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 power supply to a 200 V 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	<p>■Information on the following function is added: Linear servo motor control mode</p> <p>■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.</p>
November 2020	IB(NA)-0300453ENG-C	<p>■Information on the following functions is added: Output devices, EMC filter</p> <p>■Added/edited: Section 3.5, Section 6.12</p>
July 2021	IB(NA)-0300453ENG-D	<p>■Information on the following function is added: CC-Link IE Field Network Basic</p> <p>■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</p>
January 2023	IB(NA)-0300453ENG-E	<p>■Information on the following functions is added: Fully closed loop system, touch probe</p> <p>■Combinations of servo amplifiers with the following linear servo motor are added: LM-AU</p> <p>■Added/edited: Section 1.2, Section 3.2, Section 3.3, Section 3.4, Section 3.5, Section 3.6, Section 5.1, Section 6.1, Section 6.2, Section 6.5, Section 6.6, Section 6.7, Section 6.10, Section 6.12, Chapter 7, Section 8.1, Section 8.2, Section 8.5, Chapter 9</p>
January 2024	IB(NA)-0300453ENG-F	<p>■Correction of error on overload protection characteristics of linear servo motors.</p> <p>■Added/edited: Section 8.5</p>
November 2024	IB(NA)-0300453ENG-G	<p>■Information on the following functions is added: Functional safety</p> <p>■The following model is added: MR-JET- G4-HS(N1)</p> <p>■Combinations with servo amplifiers and motors are added: HK-KN, HK-FN, HK-SN</p> <p>■Added/edited: Chapter 1, Chapter 2, Section 2.1, Section 2.4, Chapter 3, Chapter 4, Section 5.1, Section 5.2, Section 5.3, Section 5.5, Section 6.1, Section 6.2, Section 6.4, Section 6.5, Section 6.6, Section 6.7, Section 6.8, Section 6.10, Section 6.11, Section 6.12, Section 6.13, Section 6.14, Chapter 7, Chapter 8, Section 10.2, Section 10.3, Section 10.4, Section 10.7, Chapter 11</p>

This manual confers no industrial property rights or any rights of any other kind, nor does it confer any patent licenses. Mitsubishi Electric Corporation cannot be held responsible for any problems involving industrial property rights which may occur as a result of using the contents noted in this manual.

© 2019 MITSUBISHI ELECTRIC CORPORATION

# 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.
- (3) Mitsubishi Electric shall have no responsibility or liability for any problems involving programmable controller trouble and system trouble caused by DoS attacks, unauthorized access, computer viruses, and other cyberattacks.

# TRADEMARKS

---

MELSERVO is a trademark or registered trademark of Mitsubishi Electric Corporation in Japan and/or other countries.  
All other product names and company names are trademarks or registered trademarks of their respective companies.



IB(NA)-0300453ENG-G(2411)MEE

MODEL:

MODEL CODE:

## **mitsubishi electric corporation**

HEAD OFFICE: TOKYO BLDG., 2-7-3, MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN  
NAGOYA WORKS: 1-14, YADA-MINAMI 5-CHOME, HIGASHI-KU, NAGOYA 461-8670, JAPAN

When exported from Japan, this manual does not require application to the  
Ministry of Economy, Trade and Industry for service transaction permission.

Specifications are subject to change without notice.

Compliance with the indicated global standards and regulations is current as of the release date of this manual.