MITSUBISHI ELECTRIC

General-Purpose AC Servo
EZMOTION MR-E Super
General-Purpose Interface

MODEL

MR-E-□A-QW003
MR-E-□AG-QW003

INSTRUCTION MANUAL

HF-KN/HF-SN servo motor is available for the servo amplifier with software version A9 or later.

For HF-KN/HF-SN servo motor, refer to HF-KN/HF-SN Servo Motor Instruction Manual (SH030123).

B

● Safety Instructions ●

(Always read these instructions before using the equipment.)

Do not attempt to install, operate, maintain or inspect the servo amplifier and servo motor until you have read through this Instruction Manual, Installation guide, Servo motor Instruction Manual and appended documents carefully and can use the equipment correctly. Do not use the servo amplifier and servo motor until you have a full knowledge of the equipment, safety information and instructions.
In this Instruction Manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

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

Note that the CAUTION level may lead to a serious consequence according to conditions. Please follow the instructions of both levels because they are important to personnel safety.
What must not be done and what must be done are indicated by the following diagrammatic symbols.

🚫: Indicates what must not be done. For example, "No Fire" is indicated by ⊗ .

⬤: Indicates what must be done. For example, grounding is indicated by ⏚ .

In this Instruction Manual, instructions at a lower level than the above, instructions for other functions, and so on are classified into "POINT".
After reading this installation guide, always keep it accessible to the operator.

1. To prevent electric shock, note the following

```
┌─────────────────────────────────────────────────────────────────────────┐
│                          ⚠ WARNING                                        │
├─────────────────────────────────────────────────────────────────────────┤
```

・Before wiring or inspection, turn off the power and wait for 15 minutes or more until the charge lamp turns off. Otherwise, an electric shock may occur. In addition, always confirm from the front of the servo amplifier, whether the charge lamp is off or not.

・Connect the servo amplifier and servo motor to ground.

・Any person who is involved in wiring and inspection should be fully competent to do the work.

・Do not attempt to wire the servo amplifier and servo motor until they have been installed. Otherwise, you may get an electric shock.

・Operate the switches with dry hand to prevent an electric shock.

・The cables should not be damaged, stressed, loaded, or pinched. Otherwise, you may get an electric shock.

・To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

・When using a residual current device (RCD), select the type B.

・Insulate the connections of the power supply terminals to prevent an electric shock.

2. To prevent fire, note the following

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┌─────────────────────────────────────────────────────────────────────────┐
│                          ⚠ CAUTION                                        │
├─────────────────────────────────────────────────────────────────────────┤
```

・Install the servo amplifier, servo motor and regenerative resistor on incombustible material. Installing them directly or close to combustibles will lead to a fire.

・Always connect a magnetic contactor between the main circuit power supply and L_1, L_2, and L_3 of the servo amplifier, and configure the wiring to be able to shut down the power supply on the side of the servo amplifier's power supply. If a magnetic contactor is not connected, continuous flow of a large current may cause a fire when the servo amplifier malfunctions.

・When a regenerative resistor is used, use an alarm signal to switch main power off. Otherwise, a regenerative transistor fault or the like may overheat the regenerative resistor, causing a fire.

・Provide adequate protection to prevent screws and other conductive matter, oil and other combustible matter from entering the servo amplifier, and servo motor.

・Always connect a molded-case circuit breaker to the power supply of the servo amplifier.

3. To prevent injury, note the follow

```
┌─────────────────────────────────────────────────────────────────────────┐
│                          ⚠ CAUTION                                        │
├─────────────────────────────────────────────────────────────────────────┤
```

・Only the voltage specified in the Instruction Manual should be applied to each terminal, Otherwise, a burst, damage, etc. may occur.

・Connect the terminals correctly to prevent a burst, damage, etc.

・Ensure that polarity (＋, －) is correct. Otherwise, a burst, damage, etc. may occur.

・Take safety measures, e.g. provide covers, to prevent accidental contact of hands and parts (cables, etc.) with the servo amplifier heat sink, regenerative resistor, servo motor, etc. since they may be hot while power is on or for some time after power-off. Their temperatures may be high and you may get burnt or a parts may damaged.

・During operation, never touch the rotating parts of the servo motor. Doing so can cause injury.

4. Additional instructions

The following instructions should also be fully noted. Incorrect handling may cause a fault, injury, electric shock, etc.

(1) Transportation and installation

⚠ CAUTION
・Transport the products correctly according to their mass.
・Stacking in excess of the specified number of products is not allowed.
・Do not carry the servo motor by the cables, shaft or encoder.
・Install the servo amplifier in a load-bearing place in accordance with the Instruction Manual.
・Do not get on or put heavy load on the equipment.
・The servo amplifier and servo motor must be installed in the specified direction.
・Leave specified clearances between the servo amplifier and control enclosure walls or other equipment.
・Do not install or operate the servo amplifier and servo motor which has been damaged or has any parts missing.
・Do not block intake and exhaust areas of the servo amplifier. Doing so may cause malfunction to the equipment.
・Do not drop or strike servo amplifier or servo motor. Isolate from all impact loads.
・When you keep or use it, please fulfill the following environmental conditions.

Environment			Conditions
			Servo amplifier
Ambient temperature	In operation	[℃]	0 to 55 (non-freezing)
		[°F]	32 to 131 (non-freezing)
	In storage	[℃]	−20 to 65 (non-freezing)
		[°F]	−4 to 149 (non-freezing)
Ambient humidity	In operation		90%RH or less (non-condensing)
	In storage		90%RH or less (non-condensing)
Ambience			Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt
Altitude			Max. 1000m above sea level
(Note) Vibration resistance			5.9m/s^2 at 10Hz to 55Hz (directions of X,Y, and Z axes)

・Securely attach the servo motor to the machine. If attach insecurely, the servo motor may come off during operation.

・Be sure to measure the motor vibration level with the servo motor mounted to the machine when checking the vibration level. A great vibration may cause the early damage of a bearing, encoder, brake, and reduction gear. The great vibration may also cause the poor connector connection or bolt looseness.

・For the gain adjustment at the equipment startup, check the torque waveform and the speed waveform by using a measurement device, and then check that no vibration occurs. If the vibration occurs due to high gain, the vibration may cause the early damage of the servo motor.

・Take safety measures, e.g. provide covers, to prevent accidental access to the rotating parts of the servo motor during operation.

・Never hit the servo motor or shaft, especially when coupling the servo motor to the machine. The encoder may become faulty.

・Do not subject the servo motor shaft to more than the permissible load. Otherwise, the shaft may break.

(2) Wiring

⚠ CAUTION

· Wire the equipment correctly and securely. Otherwise, the servo motor may operate unexpectedly.

· Do not install a power capacitor, surge absorber or radio noise filter (FR-BIF option) between the servo motor and servo amplifier.

· Connect the wires to the correct phase terminals (U, V, W) of the servo amplifier and servo motor. Otherwise, the servo motor does not operate properly.

· Connect the servo motor power terminal (U, V, W) to the servo motor power input terminal (U, V, W) directly. Do not let a magnetic contactor, etc. intervene.
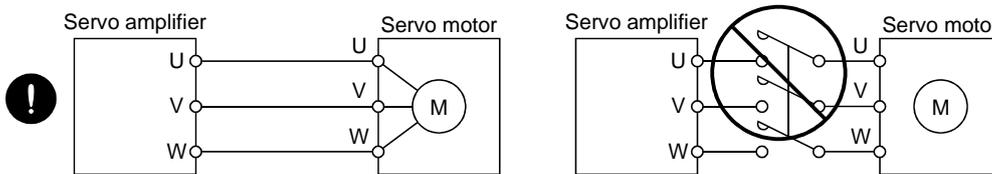
· Do not connect AC power directly to the servo motor. Otherwise, a fault may occur.

· The surge absorbing diode installed on the DC output signal relay of the servo amplifier must be wired in the specified direction. Otherwise, the emergency stop and other protective circuits may not operate.
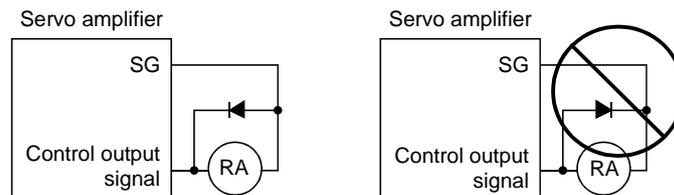
· When the cable is not tightened enough to the terminal block (connector), the cable or terminal block (connector) may generate heat because of the poor contact. Be sure to tighten the cable with specified torque.

(3) Test run adjustment

⚠ CAUTION

· Before operation, check the parameter settings. Improper settings may cause some machines to perform unexpected operation.

· The parameter settings must not be changed excessively. Operation will be insatiable.

(4) Usage

⚠ CAUTION

・Provide an external emergency stop circuit to ensure that operation can be stopped and power switched off immediately.

・Any person who is involved in disassembly and repair should be fully competent to do the work.

・Before resetting an alarm, make sure that the run signal of the servo amplifier is off to prevent an accident. A sudden restart is made if an alarm is reset with the run signal on.

・Do not modify the equipment.

・Use a noise filter, etc. to minimize the influence of electromagnetic interference, which may be caused by electronic equipment used near the servo amplifier.

・Burning or breaking a servo amplifier may cause a toxic gas. Do not burn or break a servo amplifier.

・Use the servo amplifier with the specified servo motor.

・The electromagnetic brake on the servo motor is designed to hold the servo motor shaft and should not be used for ordinary braking.

・For such reasons as service life and mechanical structure (e.g. where a ball screw and the servo motor are coupled via a timing belt), the electromagnetic brake may not hold the servo motor shaft. To ensure safety, install a stopper on the machine side.

(5) Corrective actions

⚠ CAUTION

・When it is assumed that a hazardous condition may take place at the occur due to a power failure or a product fault, use a servo motor with electromagnetic brake or an external brake mechanism for the purpose of prevention.

・Configure an electromagnetic brake circuit so that it is activated also by an external EMG stop switch.

Contacts must be open when an trouble (ALM) and when an electromagnetic brake interlock (MBR) turns off.

Contacts must be open with the EMG stop switch.

Servo motor

RA

24VDC

Electromagnetic brake
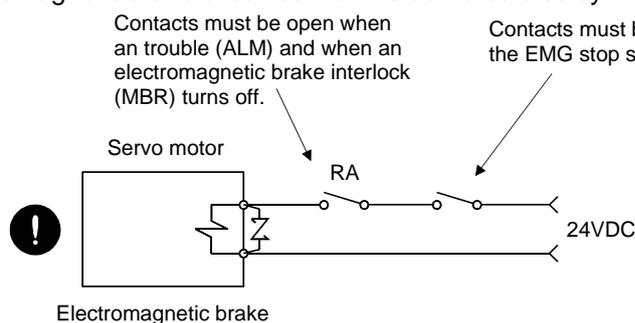
・When any alarm has occurred, eliminate its cause, ensure safety, and deactivate the alarm before restarting operation.

・Provide an adequate protection to prevent unexpected restart after an instantaneous power failure.

(6) Storage for servo motor

⚠ CAUTION

Note the following points when storing the servo motor for an extended period of time (guideline: three or more months).

・Always store the servo motor indoors in a clean and dry place.

・If it is stored in a dusty or damp place, make adequate provision, e.g. cover the whole product.

・If the insulation resistance of the winding decreases, reexamine the storage method.

・Though the servo motor is rust-proofed before shipment using paint or rust prevention oil, rust may be produced depending on the storage conditions or storage period.
If the servo motor is to be stored for longer than six months, apply rust prevention oil again especially to the machined surfaces of the shaft, etc.

・Before using the product after storage for an extended period of time, hand-turn the motor output shaft to confirm that nothing is wrong with the servo motor. (When the servo motor is equipped with a brake, make the above check after releasing the brake with the brake power supply.)

・When the equipment has been stored for an extended period of time, please contact your local sales office.

(7) Maintenance, inspection and parts replacement

⚠ CAUTION

・With age, the electrolytic capacitor of the servo amplifier will deteriorate. To prevent a secondary accident due to a fault, it is recommended to replace the electrolytic capacitor every 10 years when used in general environment.
For replacement, please contact your local sales office.

(8) General instruction

・To illustrate details, the equipment in the diagrams of this Instruction Manual may have been drawn without covers and safety guards. When the equipment is operated, the covers and safety guards must be installed as specified. Operation must be performed in accordance with this Instruction Manual.

● DISPOSAL OF WASTE ●

Please dispose a servo amplifier and other options according to your local laws and regulations.

⚠ EEP-ROM life

The number of write times to the EEP-ROM, which stores parameter settings, etc., is limited to 100,000. If the total number of the following operations exceeds 100,000, the servo amplifier may fail when the EEP-ROM reaches the end of its useful life.
・Write to the EEP-ROM due to parameter setting changes
・Write to the EEP-ROM due to device changes

Precautions for Choosing the Products

Mitsubishi will not be held liable for damage caused by factors found not to be the cause of Mitsubishi; machine damage or lost profits caused by faults in the Mitsubishi products; damage, secondary damage, accident compensation caused by special factors unpredictable by Mitsubishi; damages to products other than Mitsubishi products; and to other duties.

COMPLIANCE WITH CE MARKING

Refer to Appendix 1 for the compliance with CE marking.

COMPLIANCE WITH UL/cUL STANDARD

Refer to Appendix 2 for the compliance with UL/cUL standard.

<<About the manuals>>

Relevant manuals

Manual name	Manual No.
HF-KN/HF-SN Servo Motor Instruction Manual	SH(NA)030123
MR-E Series Instructions and Cautions for Safe Use of AC Servos	IB(NA)0300057
EMC Installation Guidelines	IB(NA)67310

<<Wiring>>

Wires mentioned in this instruction manual are selected based on the ambient temperature of 40 $^{\circ}$C (104 $^{\circ}$F).

CONTENTS

8. SPECIAL ADJUSTMENT FUNCTIONS

9. INSPECTION

10. TROUBLESHOOTING

11. OUTLINE DIMENSION DRAWINGS

12. CHARACTERISTICS

13. OPTIONS AND AUXILIARY EQUIPMENT

14. MR-E- □AG-QW003 SERVO AMPLIFIER COMPATIBLE WITH ANALOG INPUT   14- 1 to 14- 64

APPENDIX   App.- 1 to App.- 6

1. FUNCTIONS AND CONFIGURATION

1.1 Introduction

The Mitsubishi general-purpose AC servo MR-E Super has position control and internal speed control modes. It can perform operation with the control modes changed, e.g. position/internal speed control. Hence, it is applicable to wide range of fields such as precision positioning and smooth speed control of machine tools and general industrial machines.

As this new series has the RS-232C or RS-422 serial communication function, a MR Configurator (servo configuration software)-installed personal computer or the like can be used to perform parameter setting, test operation, status display monitoring, gain adjustment, etc.

With real-time auto tuning, you can automatically adjust the servo gains according to the machine.

The MR-E Super servo motor is equipped with an incremental position encoder that has the resolution of 131072 pulses/rev to ensure high precision positioning.

(1) Position control mode

An up to 1Mpps high-speed pulse train is used to control the speed and direction of a motor and execute precision positioning of 131072 pulses/rev resolution.

The position smoothing function provides a choice of two different modes appropriate for a machine, so a smoother start/stop can be made in response to a sudden position command.

A torque limit is imposed on the servo amplifier by the clamp circuit to protect the power transistor in the main circuit from overcurrent due to sudden acceleration/deceleration or overload. This torque limit value can be changed to any value with the parameter.

(2) Internal speed control mode

The parameter-driven internal speed command (max. 7 speeds) is used to control the speed and direction of a servo motor smoothly.

There are also the acceleration/deceleration time constant setting in response to speed command, the servo lock function at a stop time.

1.2 Function block diagram

The function block diagram of this servo is shown below.
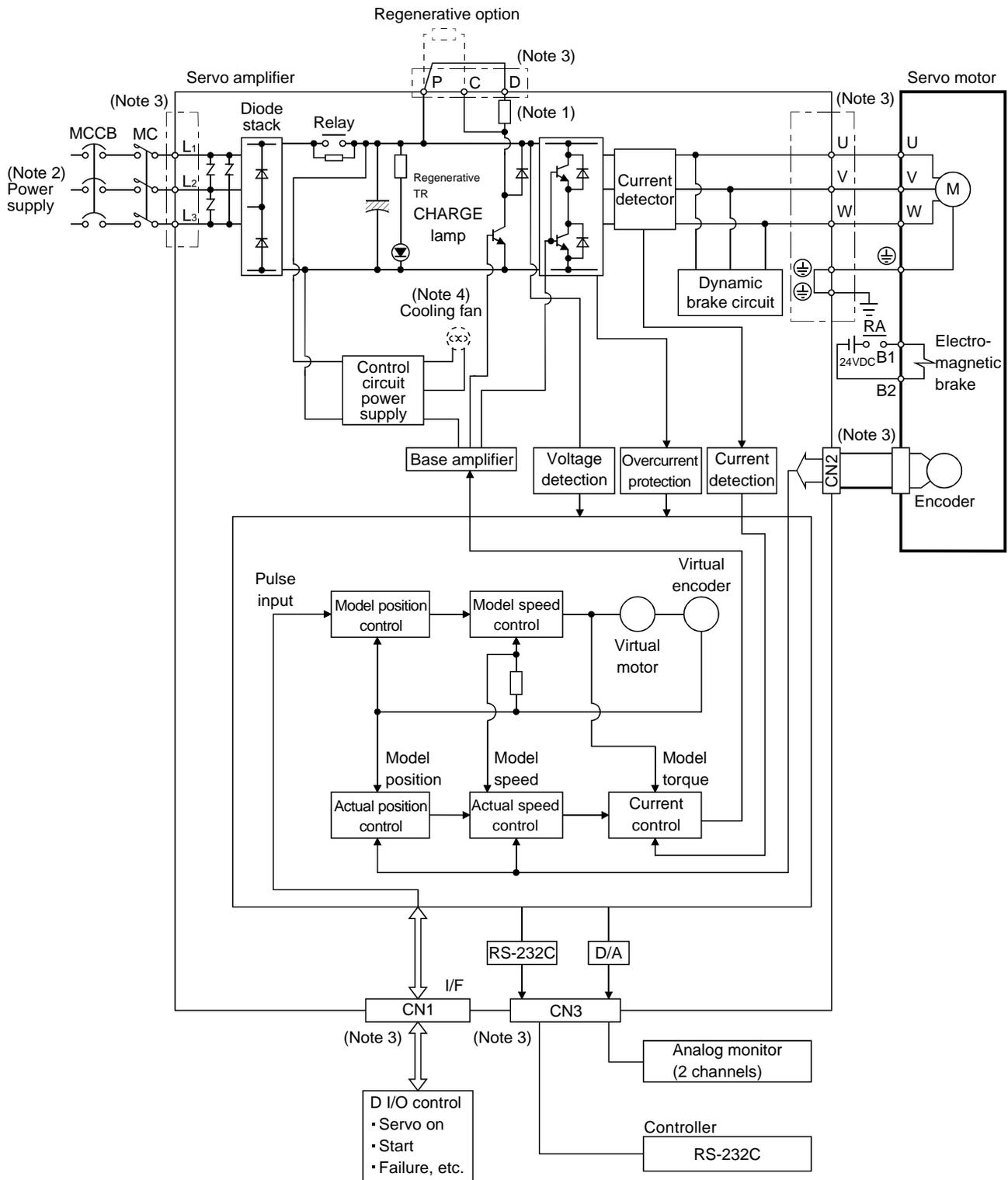
Note 1. The built-in regenerative resistor is not provided for the MR-E-10A-QW003/MR-E-20A-QW003.
   2. The single-phase 230VAC can be used for MR-E-70A-QW003 or smaller servo amplifier.
      Connect the power supply cables to L_1 and L_2 while leaving L_3 open. Refer to section 1.3 for the power supply specification.
   3. The control circuit connectors (CN1, CN2 and CN3) are safely isolated from main circuit terminals
      (L_1, L_2, L_3, U, V, W, P, C and D).
   4. Servo amplifiers MR-E-200A-QW003 have a cooling fan.

1.3 Servo amplifier standard specifications

<table>
<tr><td colspan="4" rowspan="2">Item</td><td align="right">Servo amplifier
MR-E-□-QW003</td><td>10A</td><td>20A</td><td>40A</td><td>70A</td><td>100A</td><td>200A</td></tr>
<tr><td colspan="6"> </td></tr>
<tr><td colspan="3" rowspan="2">Output</td><td colspan="2">Rated voltage</td><td colspan="6">3-phase 170VAC</td></tr>
<tr><td colspan="2">Rated current   [A]</td><td>0.7</td><td>1.1</td><td>2.3</td><td>5.8</td><td>6.0</td><td>11.0</td></tr>
<tr><td rowspan="6">Power supply</td><td colspan="3">Voltage/frequency</td><td colspan="4">3-phase 200 to 230VAC, 50/60Hz or 1-phase 230VAC, 50/60Hz</td><td colspan="2">3-phase 200 to 230VAC, 50/60Hz</td></tr>
<tr><td colspan="3">Rated current   [A]</td><td>0.9</td><td>1.5</td><td>2.6</td><td>3.8</td><td>5.0</td><td>10.5</td></tr>
<tr><td colspan="3">Permissible voltage fluctuation</td><td colspan="4">3-phase 200 to 230VAC: 170 to 253VAC
1-phase 230VAC: 207 to 253VAC</td><td colspan="2">3-phase 170 to 253VAC</td></tr>
<tr><td colspan="3">Permissible frequency fluctuation</td><td colspan="6">Within ±5%</td></tr>
<tr><td colspan="3">Power supply capacity</td><td colspan="6">Refer to section 12.2</td></tr>
<tr><td colspan="4">Inrush current   [A]</td><td colspan="6">Refer to section 12.5</td></tr>
<tr><td colspan="4">Control system</td><td colspan="6">Sine-wave PWM control, current control system</td></tr>
<tr><td colspan="4">Dynamic brake</td><td colspan="6">Built-in</td></tr>
<tr><td colspan="4">Protective functions</td><td colspan="6">Overcurrent shut-off, regenerative overvoltage shut-off, overload shut-off (electronic thermal relay), encoder error protection, regenerative error protection, undervoltage, instantaneous power failure protection, overspeed protection, excessive error protection</td></tr>
<tr><td rowspan="5">Position control mode</td><td colspan="3">Max. input pulse frequency</td><td colspan="6">1Mpps (for differential receiver), 200kpps (for open collector)</td></tr>
<tr><td colspan="3">Command pulse multiplying factor</td><td colspan="6">Electronic gear A: 1 to 65535 B: 1 to 65535, 1/50 < A/B < 50</td></tr>
<tr><td colspan="3">In-position range setting</td><td colspan="6">0 to ±10000 pulse (command pulse unit)</td></tr>
<tr><td colspan="3">Error excessive</td><td colspan="6">±2.5 revolutions</td></tr>
<tr><td colspan="3">Torque limit</td><td colspan="6">Set by parameter setting</td></tr>
<tr><td rowspan="3">Internal speed control mode</td><td colspan="3">Speed control range</td><td colspan="6">Internal speed command 1: 5000</td></tr>
<tr><td colspan="3">Speed fluctuation ratio</td><td colspan="6">±0.01% or less (load fluctuation 0 to 100%)
0% (power fluctuation ±10%)</td></tr>
<tr><td colspan="3">Torque limit</td><td colspan="6">Set by parameter setting</td></tr>
<tr><td colspan="4">Structure</td><td colspan="5">Self-cooled, open (IP00)</td><td>Force-cooling, open (IP00)</td></tr>
<tr><td rowspan="9">Environment</td><td rowspan="4">Ambient temperature</td><td rowspan="2">Operation</td><td>[℃]</td><td colspan="6">0 to 55 (non-freezing)</td></tr>
<tr><td>[℉]</td><td colspan="6">32 to 131 (non-freezing)</td></tr>
<tr><td rowspan="2">Storage</td><td>[℃]</td><td colspan="6">－20 to 65 (non-freezing)</td></tr>
<tr><td>[℉]</td><td colspan="6">－4 to 149 (non-freezing)</td></tr>
<tr><td rowspan="2">Ambient humidity</td><td colspan="2">Operation</td><td colspan="6" rowspan="2">90%RH or less (non-condensing)</td></tr>
<tr><td colspan="2">Storage</td></tr>
<tr><td colspan="3">Ambient</td><td colspan="6">Indoors (no direct sunlight)
Free from corrosive gas, flammable gas, oil mist, dust and dirt</td></tr>
<tr><td colspan="3">Altitude</td><td colspan="6">Max. 1000m above sea level</td></tr>
<tr><td colspan="3">Vibration resistance</td><td colspan="6">5.9m/s² at 10Hz to 55Hz (directions of X,Y, and Z axes)</td></tr>
<tr><td colspan="4">Mass   [kg]</td><td>0.7</td><td>0.7</td><td>1.1</td><td>1.7</td><td>1.7</td><td>2.0</td></tr>
</table>

1.4 Function list

The following table lists the functions of this servo. For details of the functions, refer to the reference field.

Function	Description	(Note) Control mode	Reference
Position control mode	This servo is used as position control servo.	P	Section 3.1.1 Section 3.4.1 Section 4.2.2
Internal speed control mode	This servo is used as internal speed control servo.	S	Section 3.1.2 Section 3.4.2 Section 4.2.3
Position/internal speed control change mode	Using external input signal, control can be switched between position control and internal speed control.	P/S	Section 3.4.4
High-resolution encoder	High-resolution encoder of 131072 pulses/rev is used as a servo motor encoder.	P, S	
Gain changing function	You can switch between gains during rotation and gains during stop or use an external input signal to change gains during operation.	P, S	Section 8.5
Adaptive vibration suppression control	Servo amplifier detects mechanical resonance and sets filter characteristics automatically to suppress mechanical vibration.	P, S	Section 8.3
Low-pass filter	Suppresses high-frequency resonance which occurs as servo system response is increased.	P, S	Section 8.4
Machine analyzer function	Analyzes the frequency characteristic of the mechanical system by simply connecting a MR Configurator (servo configuration software)-installed personal computer and servo amplifier.	P	
Machine simulation	Can simulate machine motions on a personal computer screen on the basis of the machine analyzer results.	P	
Gain search function	MR Configurator (servo configuration software) installed in a personal computer changes gains automatically and searches for overshoot-free gains in a short time.	P	
Slight vibration suppression control	Suppresses vibration of ±1 pulse produced at a servo motor stop.	P	Parameter No.20
Electronic gear	Input pulses can be multiplied by 1/50 to 50.	P	Parameters No.3, 4, 69 to 71
Auto tuning	Automatically adjusts the gain to optimum value if load applied to the servo motor shaft varies.	P, S	Chapter 7
Position smoothing	Speed can be increased smoothly in response to input pulse.	P	Parameter No.7
S-pattern acceleration/ deceleration time constant	Speed can be increased and decreased smoothly.	S	Parameter No.13
Regenerative option	Used when the built-in regenerative resistor of the servo amplifier does not have sufficient regenerative capability for the regenerative power generated.	P, S	Section 13.1.1

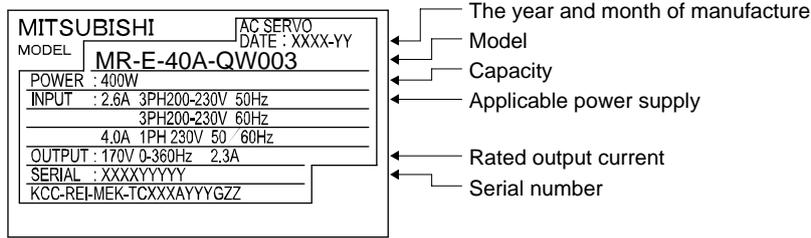| Function	Description	(Note) Control mode	Reference
Alarm history clear	Alarm history is cleared.	P, S	Parameter No.16
Restart after instantaneous power failure	If the input power supply voltage had reduced to cause an alarm but has returned to normal, the servo motor can be restarted by merely switching on the start signal.	S	Parameter No.20
Command pulse selection	Command pulse train form can be selected from among four different types.	P	Parameter No.21
Input signal selection	Forward rotation start, reverse rotation start, servo-on and other input signals can be assigned to any pins.	P, S	Parameters No.43 to 48
Torque limit	Servo motor torque can be limited to any value.	P, S	Section 3.4.1 (5) Parameter No.28
Status display	Servo status is shown on the 5-digit, 7-segment LED display	P, S	Section 6.2
External I/O signal display	ON/OFF statuses of external I/O signals are shown on the display.	P, S	Section 6.6
Output signal (DO) forced output	Output signal can be forced on/off independently of the servo status. Use this function for output signal wiring check, etc.	P, S	Section 6.7
Test operation mode	Servo motor can be run from the operation section of the servo amplifier without the start signal entered.	P, S	Section 6.8
Analog monitor output	Servo status is output in terms of voltage in real time.	P, S	Parameter No.17
MR Configurator (servo configuration software)	Using a personal computer, parameter setting, test operation, status display, etc. can be performed.	P, S	Section 13.1.4
Alarm code output	If an alarm has occurred, the corresponding alarm number is output in 3-bit code.	P, S	Section 10.2.1

Note. P: Position control mode, S: Internal speed control mode
      P/S: Position/internal speed control change mode
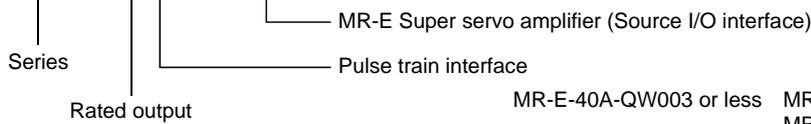
1.5 Model code definition

(1) Rating plate

```
MITSUBISHI        AC SERVO
                  DATE : XXXX-YY
MODEL    MR-E-40A-QW003
POWER  : 400W
INPUT  : 2.6A  3PH200-230V  50Hz
                3PH200-230V  60Hz
         4.0A  1PH 230V  50 / 60Hz
OUTPUT : 170V 0-360Hz   2.3A
SERIAL : XXXXYYYYY
KCC-REI-MEK-TCXXXAYYYGZZ
```

— The year and month of manufacture
— Model
— Capacity
— Applicable power supply

— Rated output current
— Serial number

(2) Model

```
M R — E — □ A — Q W 0 0 3
```

— MR-E Super servo amplifier (Source I/O interface)

Series

— Pulse train interface

Rated output

Symbol	Rated output [W]	Symbol	Rated output [W]
10	100	70	750
20	200	100	1000
40	400	200	2000

MR-E-40A-QW003 or less   MR-E-70A-QW003, MR-E-100A-QW003   MR-E-200A-QW003

Rating plate   Rating plate   Rating plate
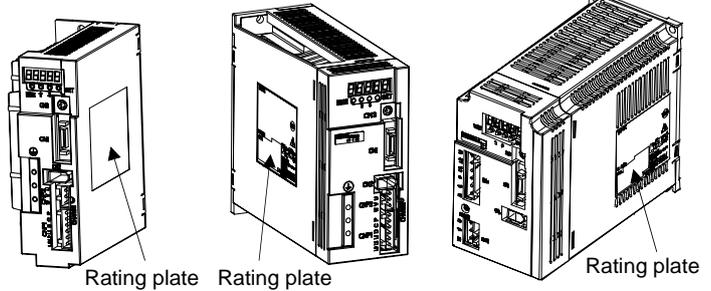
1.6 Combination with servo motor

The following table lists combinations of servo amplifiers and servo motors. The same combinations apply to the servo motor models with electromagnetic brakes. HF-KN/HF-SN servo motor is available for the servo amplifier with software version A9 or later.

Servo amplifier	Servo motors	
	HF-KN□(J)	HF-SN□J
MR-E-10A-QW003	13	
MR-E-20A-QW003	23	
MR-E-40A-QW003	43	
MR-E-70A-QW003	73	52
MR-E-100A-QW003		102
MR-E-200A-QW003		152・202

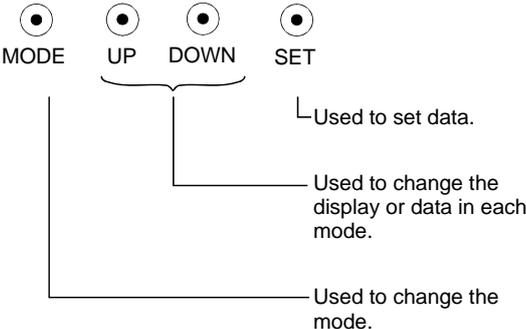## 1.7 Parts identification

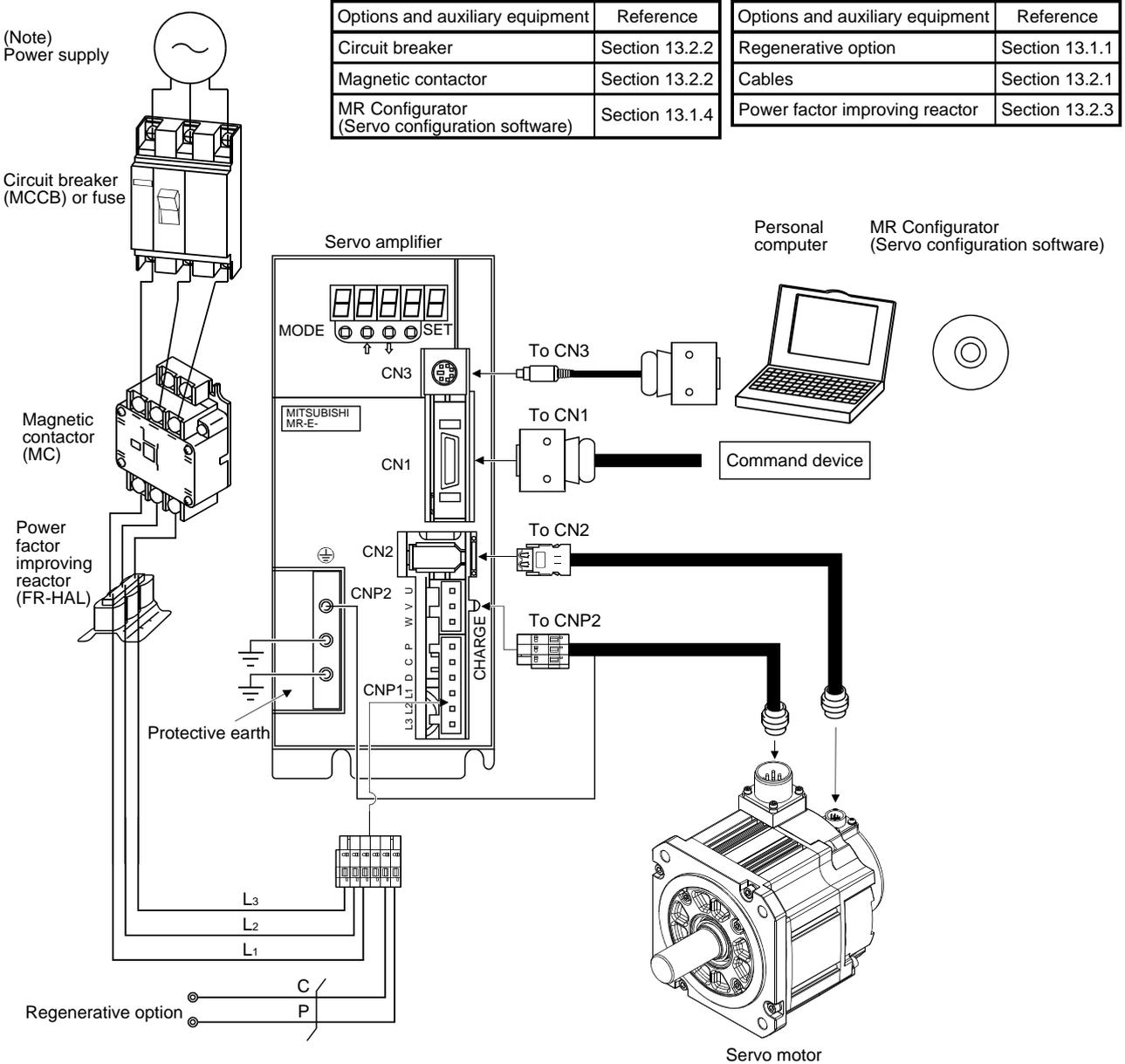### (1) MR-E-100A-QW003 or less

Name/application	Reference
Display The 5-digit, seven-segment LED shows the servo status and alarm number.	Chapter 6
Operation section Used to perform status display, diagnostic, alarm and parameter setting operations. MODE UP DOWN SET Used to set data. Used to change the display or data in each mode. Used to change the mode.	Chapter 6
Communication connector (CN3) Used to connect a command device (RS-232C) and output analog monitor data.	Section 3.3 Section 13.1.2
I/O signal connector (CN1) Used to connect digital I/O signals.	Section 3.3
Encoder connector (CN2) Use to connect the servo motor encoder.	Section 3.3 Section1 3.1.2
Charge lamp Lit to indicate that the main circuit is charged. While this lamp is lit, do not reconnect the cables.	
Servo motor power connector (CNP2) Used to connect the servo motor.	Section 3.7 Section 11.1
Power supply/regenerative connector (CNP1) Used to connect the input power supply and regenerative option.	Section 3.7 Section 11.1 Section 13.1.1
Protective earth (PE) terminal (⊕) Ground terminal.	Section 3.9 Section 11.1

Fixed part
(MR-E-10A-QW003 to MR-E-40A-QW003: 2 places
MR-E-70A-QW003 ·MR-E-100A-QW003: 3 places)

(2) MR-E-200A-QW003

Name/application	Reference
Display The 5-digit, seven-segment LED shows the servo status and alarm number.	Chapter 6
Operation section Used to perform status display, diagnostic, alarm and parameter setting operations. ● MODE ● UP ● DOWN ● SET └ Used to set data. Used to change the display or data in each mode. Used to change the mode.	Chapter 6
Communication connector (CN3) Used to connect a command device (RS-232C) and output analog monitor data.	Section 3.3 Section 13.1.2
I/O signal connector (CN1) Used to connect digital I/O signals.	Section 3.3
Rating plate	Section 1.5
Encoder connector (CN2) Used to connect the servo motor encoder.	Section 3.3 Section 13.1.2
Power supply/regenerative connector (CNP1) Used to connect the input power supply and regenerative option.	Section 3.7 Section 11.1 Section 13.1.1
Charge lamp Lit to indicate that the main circuit is charged. While this lamp is lit, do not reconnect the cables.	
Protective earth (PE) terminal (⏚) Ground terminal.	Section 3.9 Section 11.1
Servo motor power connector (CNP2) Used to connect the servo motor.	Section 3.7 Section 11.1

Cooling fan

Fixed part
(3 places)

1.8 Servo system with auxiliary equipment

⚠ WARNING	To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

(1) MR-E-100A-QW003 or less

Options and auxiliary equipment	Reference		Options and auxiliary equipment	Reference
Circuit breaker	Section 13.2.2		Regenerative option	Section 13.1.1
Magnetic contactor	Section 13.2.2		Cables	Section 13.2.1
MR Configurator (Servo configuration software)	Section 13.1.4		Power factor improving reactor	Section 13.2.3

Note. A 1-phase 230VAC power supply may be used with the servo amplifier of MR-E-70A-QW003 or less. Connect the power supply to L_1 and L_2 terminals and leave L_3 open. Refer to section 1.3 for the power supply specification.

(2) MR-E-200A-QW003

Options and auxiliary equipment	Reference	Options and auxiliary equipment	Reference
Circuit breaker	Section 13.2.2	Regenerative option	Section 13.1.1
Magnetic contactor	Section 13.2.2	Cables	Section 13.2.1
MR Configurator (Servo configuration software)	Section 13.1.4	Power factor improving reactor	Section 13.2.3
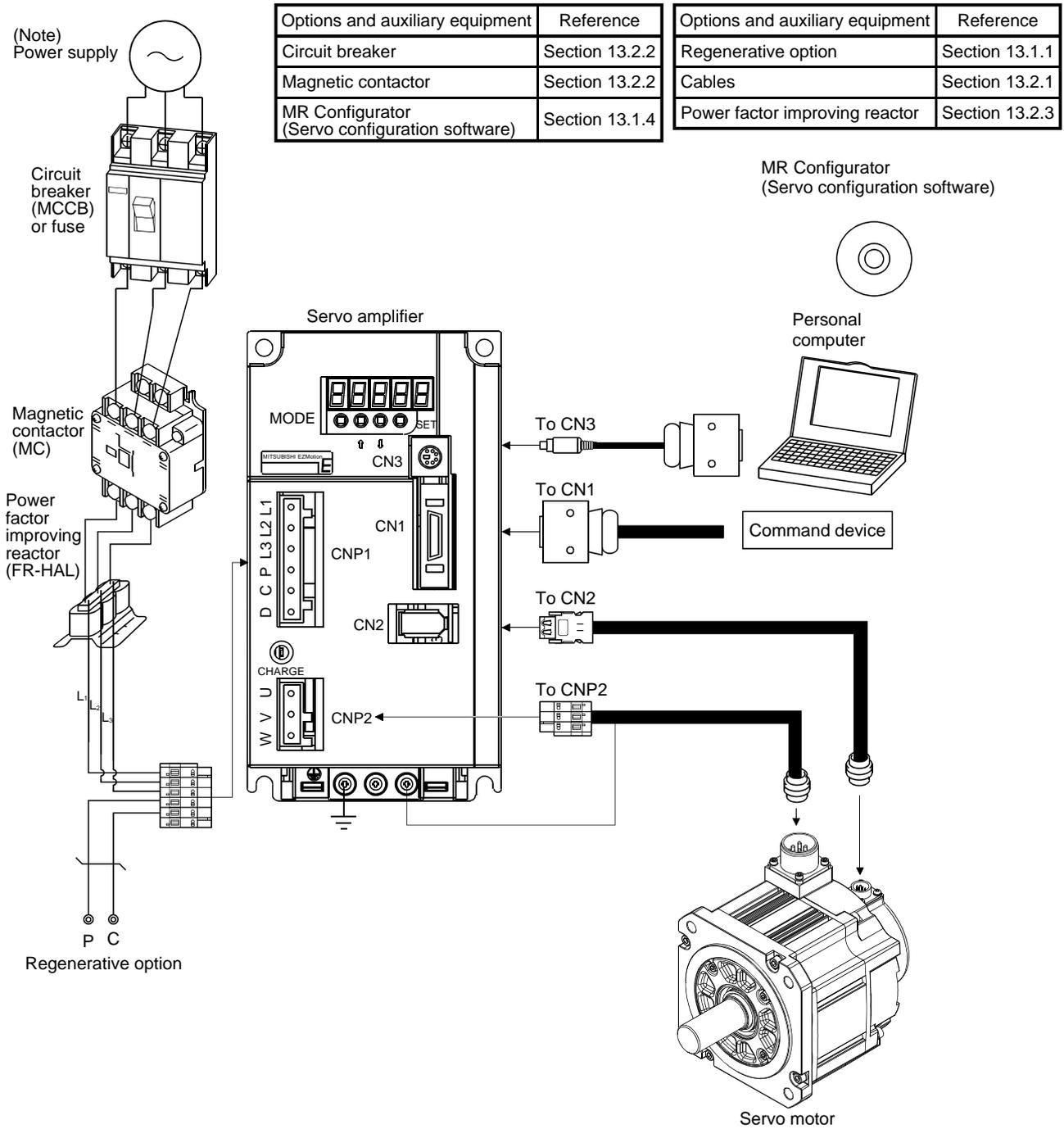
Note. Refer to section 1.3 for the power supply specification.

2. INSTALLATION

⚠ WARNING	・To prevent electric shock, ground each equipment securely.

⚠ CAUTION	・Stacking in excess of the limited number of products is not allowed. ・Install the equipment on incombustible material. Installing them directly or close to combustibles will lead to a fire. ・Install the equipment in a load-bearing place in accordance with this Instruction Manual. ・Do not get on or put heavy load on the equipment to prevent injury. ・Use the equipment within the specified environmental condition range. (For details of the environmental condition, refer to section 2.1.) ・Provide an adequate protection to prevent screws, metallic detritus and other conductive matter or oil and other combustible matter from entering the servo amplifier. ・Do not block the intake/exhaust ports of the servo amplifier. Otherwise, a fault may occur. ・Do not subject the servo amplifier to drop impact or shock loads as they are precision equipment. ・Do not install or operate a faulty servo amplifier. ・When the product has been stored for an extended period of time, please contact your local sales office. ・When treating the servo amplifier, be careful about the edged parts such as the corners of the servo amplifier. ・The servo amplifier must be installed in the metal cabinet (control box).

2.1 Environmental conditions

Environment			Conditions
Ambient temperature	In operation	[℃]	0 to 55 (non-freezing)
		[℉]	32 to 131 (non-freezing)
	In storage	[℃]	－20 to 65 (non-freezing)
		[℉]	－4 to 149 (non-freezing)
Ambient humidity	In operation		90%RH or less (non-condensing)
	In storage		
Ambience			Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt
Altitude			Max. 1000m above sea level
Vibration resistance			5.9m/s^2 at 10Hz to 55Hz (directions of X,Y, and Z axes)

2.2 Installation direction and clearances

⚠ CAUTION	・The equipment must be installed in the specified direction. Otherwise, a fault may occur. ・Leave specified clearances between the servo amplifier and control box inside walls or other equipment.

(1) Installation of one servo amplifier
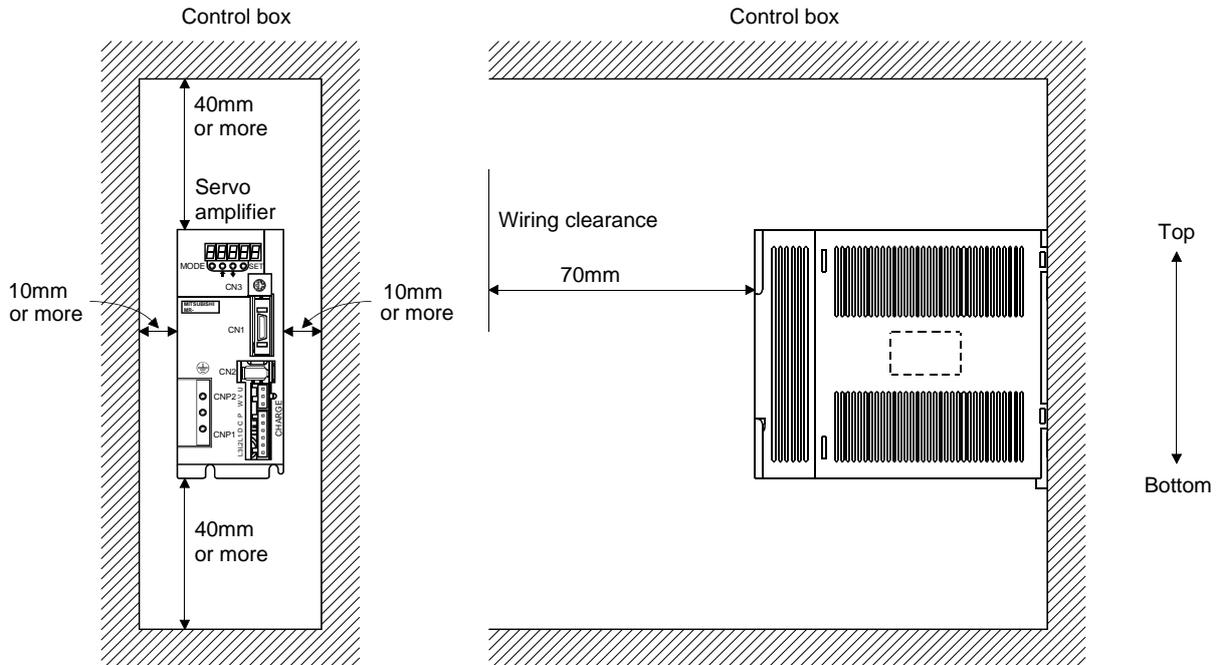
(2) Installation of two or more servo amplifiers

Leave a large clearance between the top of the servo amplifier and the internal surface of the control box, and install a cooling fan to prevent the internal temperature of the control box from exceeding the environmental conditions.
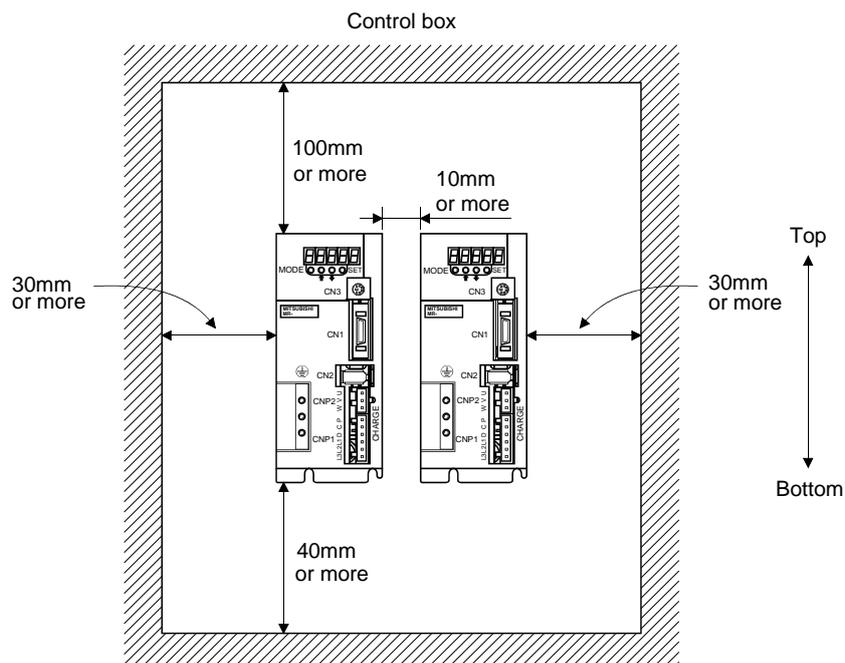
(3) Others

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

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

2.3 Keep out foreign materials

(1) When installing the unit in a control box, prevent drill chips and wire fragments from entering the servo amplifier.
(2) Prevent oil, water, metallic dust, etc. from entering the servo amplifier through openings in the control box or a cooling fan installed on the ceiling.
(3) When installing the control box in a place where there are much toxic gas, dirt and dust, conduct an air purge (force clean air into the control box from outside to make the internal pressure higher than the external pressure) to prevent such materials from entering the control box.

2.4 Cable stress

(1) The way of clamping the cable must be fully examined so that flexing stress and cable's own weight stress are not applied to the cable connection.
(2) For use in any application where the servo motor moves, fix the cables (encoder, power supply, and brake) with having some slack from the connector connection part of the servo motor to avoid putting stress on the connector connection part. Use the optional encoder cable within the flexing life range. Use the power supply and brake wiring cables within the flexing life of the cables.
(3) Avoid any probability that the cable insulator might be cut by sharp chips, rubbed by a machine corner or stamped by workers or vehicles.
(4) For installation on a machine where the servo motor will move, the flexing radius should be made as large as possible. Refer to section 12.4 for the flexing life.

MEMO

3. SIGNALS AND WIRING

⚠ WARNING	・Any person who is involved in wiring should be fully competent to do the work. ・Before wiring, turn off the power and wait for 15 minutes or more until the charge lamp turns off. Otherwise, an electric shock may occur. In addition, always confirm from the front of the servo amplifier whether the charge lamp is off or not. ・Ground the servo amplifier and the servo motor securely. ・Do not attempt to wire the servo amplifier and servo motor until they have been installed. Otherwise, you may get an electric shock. ・The cables should not be damaged, stressed excessively, loaded heavily, or pinched. Otherwise, you may get an electric shock. ・Insulate the connections of the power supply terminals to prevent an electric shock.

⚠ CAUTION	・Wire the equipment correctly and securely. Otherwise, the servo motor may operate unexpectedly, resulting in injury. ・Connect cables to correct terminals to prevent a burst, fault, etc. ・Ensure that polarity (＋, －) is correct. Otherwise, a burst, damage, etc. may occur. ・The surge absorbing diode installed to the DC relay designed for control output should be fitted in the specified direction. Otherwise, the signal is not output due to a fault, disabling the emergency stop and other protective circuits. Servo amplifier ... SG ... Control output signal ... RA Servo amplifier ... SG ... Control output signal ... RA (crossed out) ・Use a noise filter, etc. to minimize the influence of electromagnetic interference, which may be given to electronic equipment used near the servo amplifier. ・Do not install a power capacitor, surge suppressor or radio noise filter (FR-BIF option) with the power line of the servo motor. ・When using the regenerative resistor, switch power off with the alarm signal. Otherwise, a transistor fault or the like may overheat the regenerative resistor, causing a fire. ・Do not modify the equipment. ・During power-on, do not open or close the motor power line. Otherwise, a malfunction or faulty may occur.
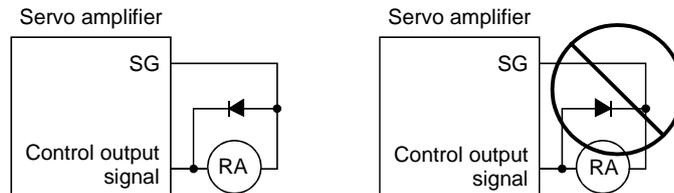
3.1 Standard connection example

> POINT
>
> ・Refer to section 3.7.1 for the connection of the power supply system and to HF-
> KN/HF-SN Servo Motor Instruction Manual for connection with the servo motor.

3.1.1 Position control mode

(1) FX-10GM
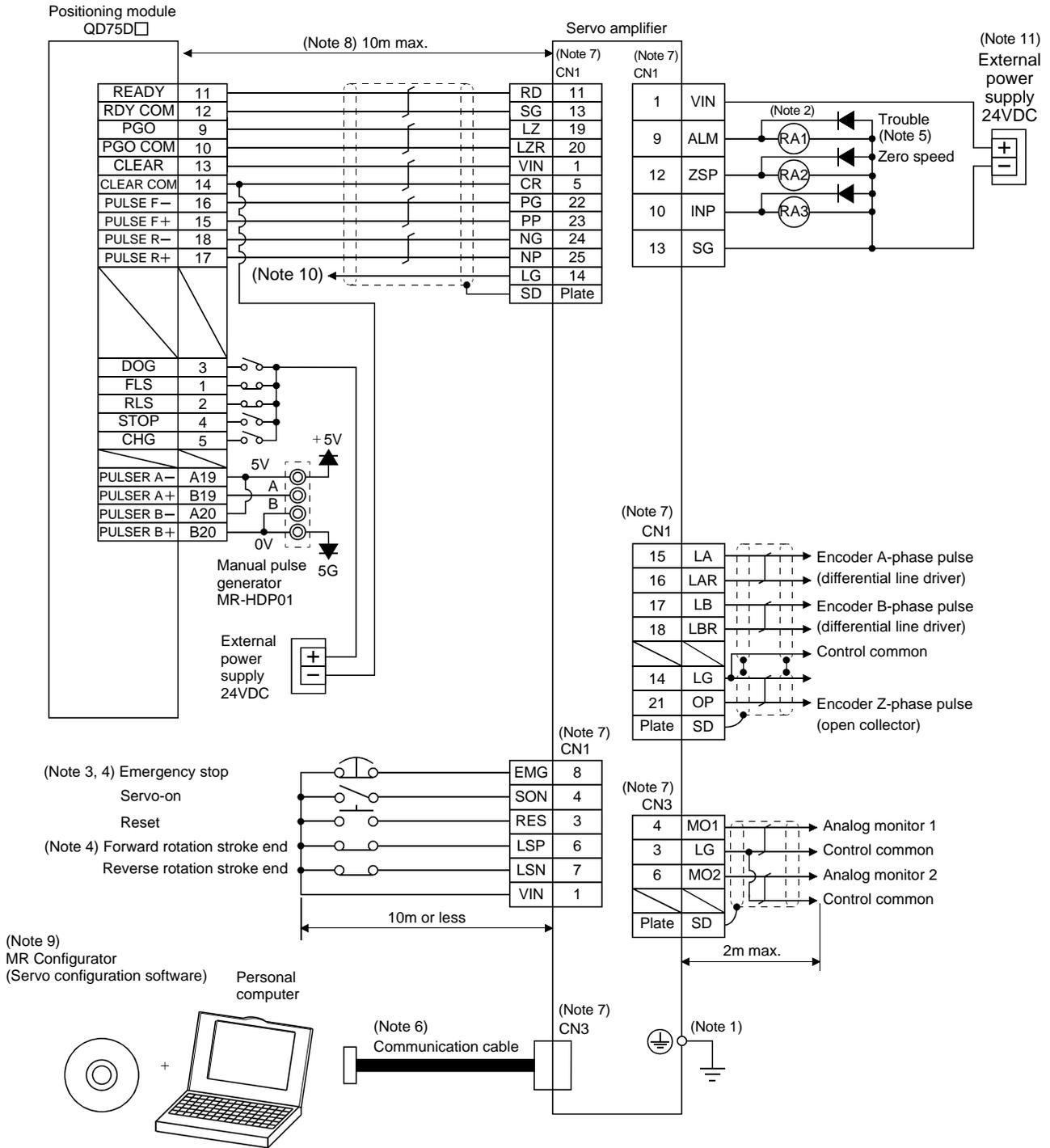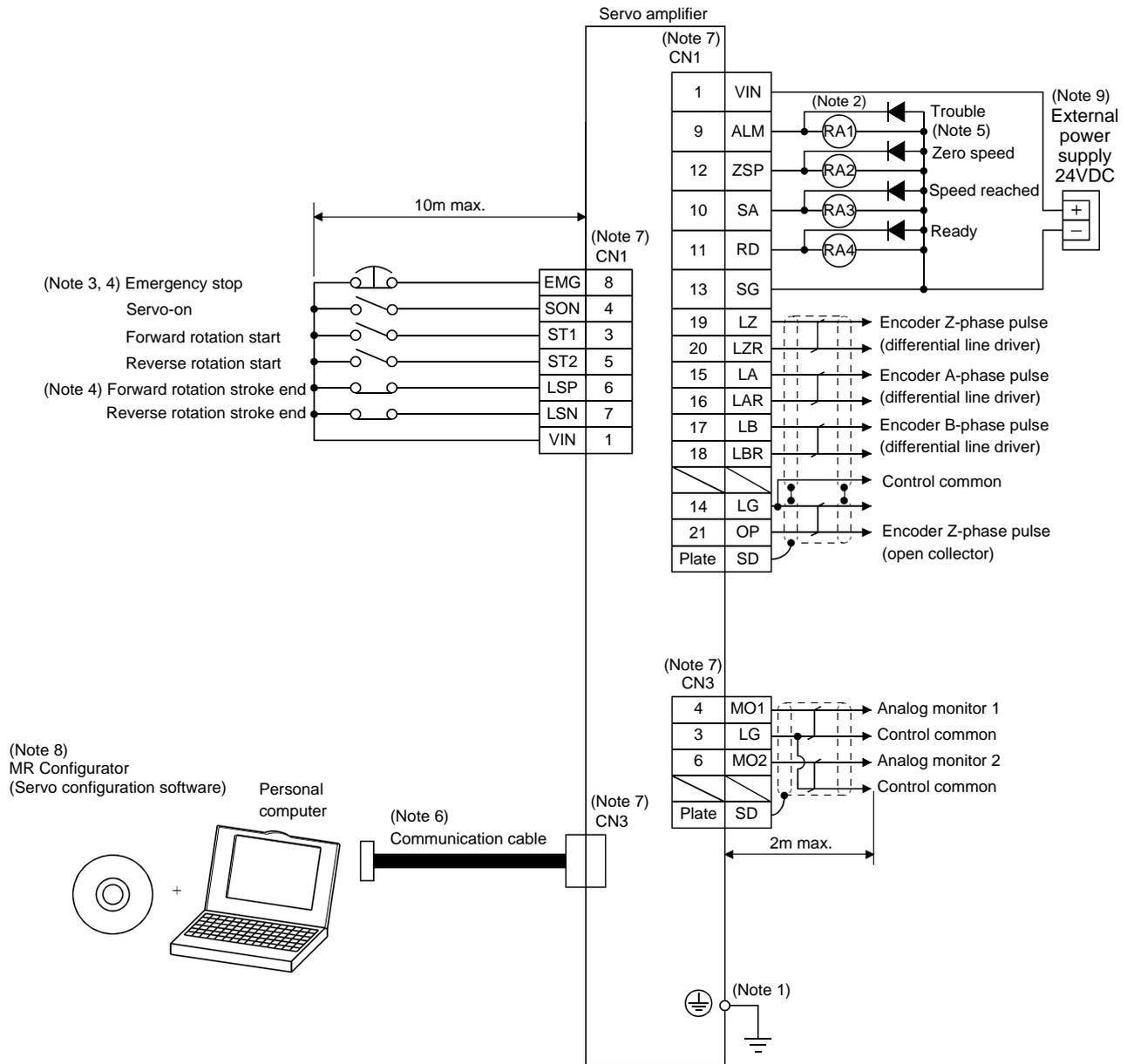
Note 1. To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

2. Connect the diode in the correct direction. If it is connected reversely, the servo amplifier will be faulty and will not output signals, disabling the emergency stop and other protective circuits.

3. The emergency stop switch (normally closed contact) must be installed.

4. When starting operation, always connect the emergency stop (EMG) and forward rotation stroke end (LSN), reverse rotation stroke end (LSP) with VIN. (Normally closed contacts)

5. Trouble (ALM) is connected with VIN in normal alarm-free condition (normally closed contact). When this signal is switched off (at occurrence of an alarm), the output of the controller should be stopped by the sequence program.

6. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to section 13.1.3)

7. The pins with the same signal name are connected in the servo amplifier.

8. This length applies to the command pulse train input in the open collector system. It is 10m or less in the differential line driver system.

9. Use MRZJW3-SETUP154E or 154C.

10. Externally supply 24VDC ±10%, 200mA power for the interface. 200mA is a value applicable when all I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to the current necessary for the interface described in section 3.6.2. Connect the external 24VDC power supply if the output signals are not used.

(2) AD75P□ (A1SD75P□)

Positioning module
AD75P□
(A1SD75P□)

Servo amplifier

(Note 8) 10m max.

(Note 11)
External power supply
24VDC

READY	7		RD	11
COM	26		SG	13
INPS	8		INP	10
PGO(24V)	6			
PGO(5V)	24		LZ	19
PGO COM	25		LZR	20
CLEAR	5		VIN	1
CLEAR COM	23		CR	5
PULSE F−	21		PG	22
PULSE F+	3		PP	23
PULSE R−	22		NG	24
PULSE R+	4		NP	25
			LG	14
			SD	Plate
PULSE F	1			
PULSE COM	19	(Note 10)		
PULSE R	2			
PULSE COM	20			
DOG	11			
FLS	12			
RLS	13			
STOP	14			
CHG	15			
START	16			
COM	35			
COM	36			

24VDC

(Note 7) CN1 / (Note 7) CN1

1	VIN
9	ALM
12	ZSP
13	SG

(Note 2) RA1 — Trouble (Note 5)
RA2 — Zero speed

(Note 7) CN1

15	LA	Encoder A-phase pulse (differential line driver)
16	LAR	
17	LB	Encoder B-phase pulse (differential line driver)
18	LBR	
		Control common
14	LG	
21	OP	Encoder Z-phase pulse (open collector)
Plate	SD	

(Note 3, 4) Emergency stop
Servo-on
Reset
(Note 4) Forward rotation stroke end
Reverse rotation stroke end

(Note 7) CN1

EMG	8
SON	4
RES	3
LSP	6
LSN	7
VIN	1

(Note 7) CN3

4	MO1	Analog monitor 1
3	LG	Control common
6	MO2	Analog monitor 2
		Control common
Plate	SD	

2m max.

(Note 9)
MR Configurator
(Servo configuration software)

Personal computer

(Note 6) Communication cable

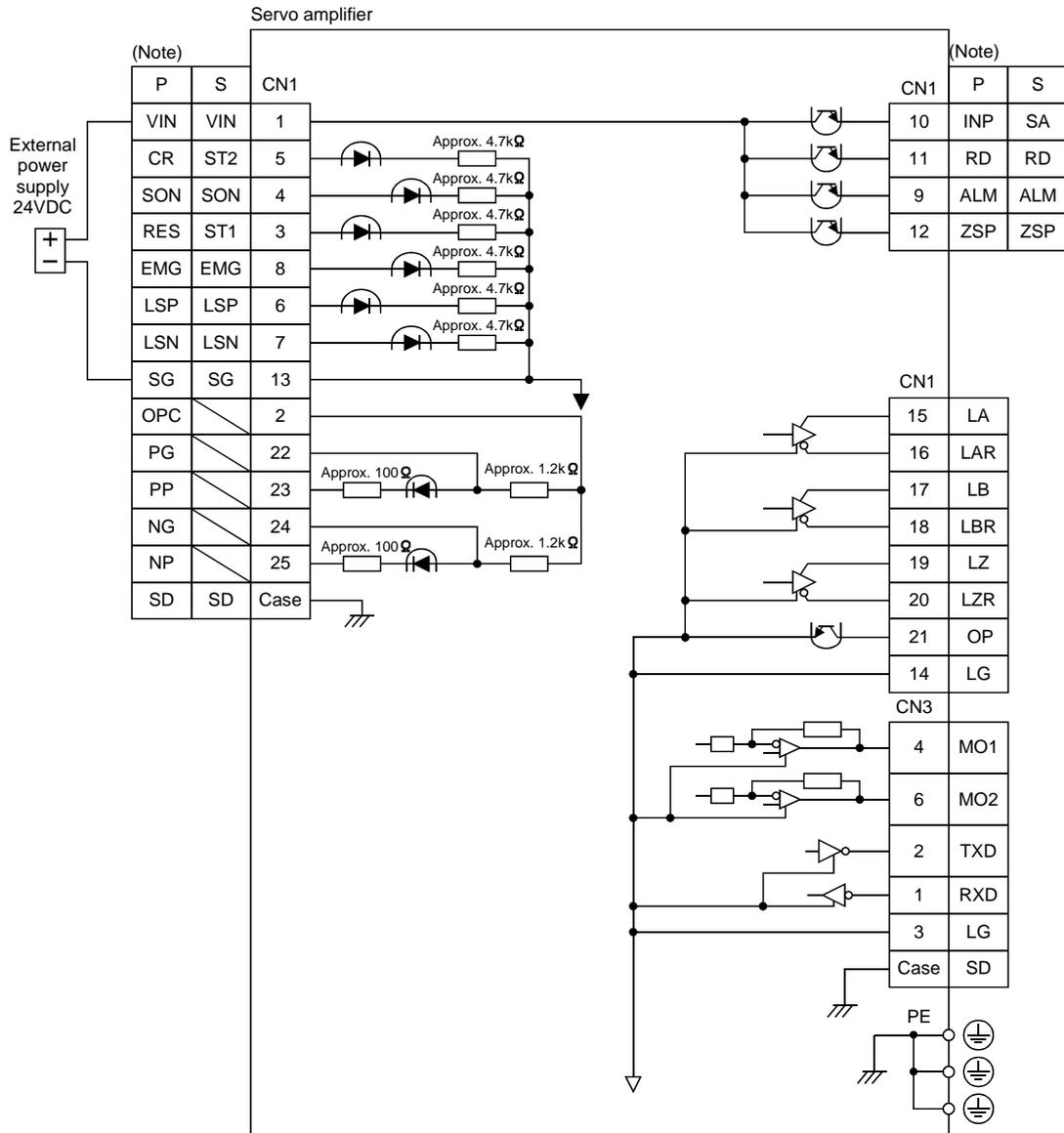(Note 7) CN3

(Note 1)

3 - 4

Note 1. To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⊕) of the servo amplifier to the protective earth (PE) of the control box.

  2. Connect the diode in the correct direction. If it is connected reversely, the servo amplifier will be faulty and will not output signals, disabling the emergency stop and other protective circuits.

  3. The emergency stop switch (normally closed contact) must be installed.

  4. When starting operation, always connect the emergency stop (EMG) and forward rotation stroke end (LSN), reverse rotation stroke end (LSP) with VIN. (Normally closed contacts)

  5. Trouble (ALM) is connected with VIN in normal alarm-free condition (normally closed contact). When this signal is switched off (at occurrence of an alarm), the output of the controller should be stopped by the sequence program.

  6. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to section 13.1.3)

  7. The pins with the same signal name are connected in the servo amplifier.

  8. This length applies to the command pulse train input in the differential line driver system.
     It is 2m or less in the open collector system.

  9. Use MRZJW3-SETUP154E or 154C.

  10. To enhance noise immunity, connect LG and pulse output COM.

  11. Externally supply 24VDC ±10%, 200mA power for the interface. 200mA is a value applicable when all I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to the current necessary for the interface described in section 3.6.2. Connect the external 24VDC power supply if the output signals are not used.

(3) QD75D☐ (differential driver)

Note 1. To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

    2. Connect the diode in the correct direction. If it is connected reversely, the servo amplifier will be faulty and will not output signals, disabling the emergency stop and other protective circuits.

    3. The emergency stop switch (normally closed contact) must be installed.

    4. When starting operation, always connect the emergency stop (EMG) and forward rotation stroke end (LSN), reverse rotation stroke end (LSP) with VIN. (Normally closed contacts)

    5. Trouble (ALM) is connected with VIN in normal alarm-free condition (normally closed contact). When this signal is switched off (at occurrence of an alarm), the output of the controller should be stopped by the sequence program.

    6. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to section 13.1.3)

    7. The pins with the same signal name are connected in the servo amplifier.

    8. This length applies to the command pulse train input in the differential line driver system.
       It is 2m or less in the open collector system.

    9. Use MRZJW3-SETUP154E or 154C.

    10. This connection is not required for the QD75D. Depending on the used positioning module, however, it is recommended to connect the LG and control common terminals of the servo amplifier to enhance noise immunity.

    11. Externally supply 24VDC ±10%, 200mA power for the interface. 200mA is a value applicable when all I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to the current necessary for the interface described in section 3.6.2. Connect the external 24VDC power supply if the output signals are not used.

3.1.2 Internal speed control mode

Note 1. To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

    2. Connect the diode in the correct direction. If it is connected reversely, the servo amplifier will be faulty and will not output signals, disabling the emergency stop and other protective circuits.

    3. The emergency stop switch (normally closed contact) must be installed.

    4. When starting operation, always connect the emergency stop (EMG) and forward rotation stroke end (LSN), reverse rotation stroke end (LSP) with VIN (Normally closed contacts).

    5. Trouble (ALM) is connected with VIN in normal alarm-free condition (normally closed contact).

    6. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to section 13.1.3)

    7. The pins with the same signal name are connected in the servo amplifier.

    8. Use MRZJW3-SETUP154E or 154C.

    9. Externally supply 24VDC ±10%, 200mA power for the interface. 200mA is a value applicable when all I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to the current necessary for the interface described in section 3.6.2. Connect the external 24VDC power supply if the output signals are not used.

3.2 Internal connection diagram of servo amplifier

The following is the internal connection diagram where the signal assignment has been made in the initial status in each control mode.

Note. P: Position control mode, S: Internal speed control mode

3.3 I/O signals

3.3.1 Connectors and signal arrangements

```
┌─────────────────────────────────────────────────────────────┐
│  POINT                                                        │
│  ・The pin configurations of the connectors are as viewed     │
│    from the cable connector wiring section.                   │
│  ・Refer to the next page for CN1 signal assignment.          │
└─────────────────────────────────────────────────────────────┘
```

(1) Signal arrangement

The connector frames are connected with the PE (earth) terminal inside the servo amplifier.

3 - 10

(2) CN1 signal assignment

The signal assignment of connector changes with the control mode as indicated below;

For the pins which are given parameter No.s in the related parameter column, their signals can be changed using those parameters.

Connector	Pin No.	(Note 1) I/O	(Note 2) I/O Signals in control modes			Related parameter
			P	P/S	S	
CN1	1		VIN	VIN	VIN	
	2		OPC	OPC		
	3	I	RES	RES/ST1	ST1	No.43 to 48
	4	I	SON	SON	SON	No.43 to 48
	5	I	CR	LOP	ST2	No.43 to 48
	6	I	LSP	LSP	LSP	No.43・48
	7	I	LSN	LSN	LSN	No.43・48
	8	I	EMG	EMG	EMG	
	9	O	ALM	ALM	ALM	No.49
	10	O	INP	INP/SA	SA	No.49
	11	O	RD	RD	RD	No.49
	12	O	ZSP	ZSP	ZSP	No.1, 49
	13		SG	SG	SG	
	14		LG	LG	LG	
	15	O	LA	LA	LA	
	16	O	LAR	LAR	LAR	
	17	O	LB	LB	LB	
	18	O	LBR	LBR	LBR	
	19	O	LZ	LZ	LZ	
	20	O	LZR	LZR	LZR	
	21	O	OP	OP	OP	
	22	I	PG	PG/—		
	23	I	PP	PP/—		
	24	I	NG	NG/—		
	25	I	NP	NP/—		
	26					

Note 1. I: Input signal, O: Output signal

2. P: Position control mode, S: Internal speed control mode, P/S: Position/internal speed control change mode

(3) Symbols and signal names

Symbol	Signal name	Symbol	Signal name
SON	Servo-on	ZSP	Zero speed detection
LSP	Forward rotation stroke end	INP	In position
LSN	Reverse rotation stroke end	SA	Speed reached
CR	Clear	ALM	Trouble
SP1	Speed selection 1	WNG	Warning
SP2	Speed selection 2	OP	Encoder Z-phase pulse (open collector)
PC	Proportion control	MBR	Electromagnetic brake interlock
ST1	Forward rotation start	LZ	Encoder Z-phase pulse
ST2	Reverse rotation start	LZR	(differential line driver)
TL1	Internal Torque limit selection	LA	Encoder A-phase pulse
RES	Reset	LAR	(differential line driver)
EMG	Emergency stop	LB	Encoder B-phase pulse
LOP	Control change	LBR	(differential line driver)
PP	Forward/reverse rotation pulse train	VIN	Digital I/F power supply input
NP		OPC	Open collector power input
PG		SG	Digital I/F common
NG		LG	Control common
RD	Ready	SD	Shield

3.3.2 Signal explanations

For the I/O interfaces (symbols in I/O column in the table), refer to section 3.6.2.

In the control mode field of the table

P : Position control mode, S: Internal speed control mode

○ : Denotes that the signal may be used in the initial setting status.

△ : Denotes that the signal may be used by setting the corresponding parameter among parameters No.43 to 49.

The pin No.s in the connector pin No. column are those in the initial status.

(1) Input signals

```
┌─────────────────────────────────────────────────────────────────┐
│  POINT                                                            │
│ ・The acceptance delay time of each input signal is less than 10ms.│
└─────────────────────────────────────────────────────────────────┘
```

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode P	Control mode S
Servo-on	SON	CN1-4	Connect SON-VIN to switch on the base circuit and make the servo amplifier ready to operate (servo-on). Disconnect SON-VIN to shut off the base circuit and coast the servo motor (servo off) . Set "□□1" in parameter No.41 to switch this signal on (keep terminals connected) automatically in the servo amplifier.	DI-1	○	○
Reset	RES	CN1-3	Disconnect RES-VIN for more than 50ms to reset the alarm. Some alarms cannot be deactivated by the reset (RES). (Refer to section 10.2.1.) Shorting RES-VIN in an alarm-free status shuts off the base circuit. The base circuit is not shut off when "□1□" is set in parameter No.51. This device is not designed to make a stop. Do not turn it ON during operation.	DI-1	○	△
Forward rotation stroke end	LSP	CN1-6	To start operation, short LSP-VIN and/or LSN-VIN. Open them to bring the motor to a sudden stop and make it servo-locked. Set "□□1" in parameter No.22 to make a slow stop. (Refer to section 5.2.3.)	DI-1	○	○
Reverse rotation stroke end	LSN	CN1-7				

(Note) Input signals		Operation	
LSP	LSN	CCW direction	CW direction
1	1	○	○
0	1		○
1	0	○	
0	0		

Note. 0: LSP/LSN-VIN off (open)
     1: LSP/LSN-VIN on (short)

Set parameter No.41 as indicated below to switch on the signals (keep terminals connected) automatically in the servo amplifier.

Parameter No.41	Automatic ON
□□1□	LSP
□1□□	LSN

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode P	Control mode S
Internal torque limit selection	TL1		When using this signal, make it usable by making the setting of parameter No.43 to 48. (Refer to section 3.4.1 (5).)	DI-1	△	△
Forward rotation start	ST1	CN1-3	Used to start the servo motor in any of the following directions. **(Note) Input signals / Servo motor starting direction** ST2 / ST1 / Servo motor starting direction 0 / 0 / Stop (servo lock) 0 / 1 / CCW 1 / 0 / CW 1 / 1 / Stop (servo lock) Note. 0: ST1/ST2-VIN off (open) 1: ST1/ST2-VIN on (short) If both ST1 and ST2 are switched on or off during operation, the servo motor will be decelerated to a stop according to the parameter No.12 setting and servo-locked.	DI-1		○
Reverse rotation start	ST2	CN1-5				
Speed selection 1	SP1		<Internal speed control mode> Used to select the command speed for operation. When using SP1 to SP3, make it usable by making the setting of parameter No.43 to 48.	DI-1		△
Speed selection 2	SP2		**(Note) Input signals / Servo motor starting direction** SP3 / SP2 / SP1 / Servo motor starting direction 0 / 0 / 0 / Internal speed command 1 (parameter No.8) 0 / 0 / 1 / Internal speed command 1 (parameter No.8) 0 / 1 / 0 / Internal speed command 2 (parameter No.9) 0 / 1 / 1 / Internal speed command 3 (parameter No.10) 1 / 0 / 0 / Internal speed command 4 (parameter No.72) 1 / 0 / 1 / Internal speed command 5 (parameter No.73) 1 / 1 / 0 / Internal speed command 6 (parameter No.74) 1 / 1 / 1 / Internal speed command 7 (parameter No.75)	DI-1		△
Speed selection 3	SP3		Note. 0: SP1/SP2/SP3-VIN off (open) 1: SP1/SP2/SP3-VIN on (short)	DI-1		△
Proportion control	PC		Connect PC-VIN to switch the speed amplifier from the proportional integral type to the proportional type. If the servo motor at a stop is rotated even one pulse due to any external factor, it generates torque to compensate for a position shift. When the servo motor shaft is to be locked mechanically after positioning completion (stop), switching on the proportion control signal (PC) upon positioning completion will suppress the unnecessary torque generated to compensate for a position shift. When the shaft is to be locked for a long time, set the internal torque limit 1 and 2 (parameter No.28 and 76) to make the torque less than the rated torque at the same time of turning ON the proportion control signal.	DI-1	△	△

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode P	Control mode S
Emergency stop	EMG	CN1-8	Disconnect EMG-VIN to bring the servo motor to emergency stop state, in which the servo is switched off and the dynamic brake is operated. Connect EMG-VIN in the emergency stop state to reset that state.	DI-1	○	○
Clear	CR	CN1-5	Connect CR-VIN to clear the position control counter droop pulses on its leading edge. The pulse width should be 10ms or more. When the parameter No.42 setting is "□□1□", the pulses are always cleared while CR-VIN are connected.	DI-1	○	
Electronic gear selection 1	CM1		When using CM1 and CM2, make them usable by the setting of parameters No.43 to 48. The combination of CM1-VIN and CM2-VIN gives you a choice of four different electronic gear numerators set in the parameters.	DI-1	△	
Electronic gear selection 2	CM2		<table><tr><th colspan="2">(Note) Input signals</th><th rowspan="2">Electronic gear numerator</th></tr><tr><th>CM2</th><th>CM1</th></tr><tr><td>0</td><td>0</td><td>Parameter No.3</td></tr><tr><td>0</td><td>1</td><td>Parameter No.69</td></tr><tr><td>1</td><td>0</td><td>Parameter No.70</td></tr><tr><td>1</td><td>1</td><td>Parameter No.71</td></tr></table> Note. 0: CM1/CM2-VIN off (open) 1: CM1/CM2-VIN on (short)	DI-1	△	
Gain changing	CDP		When using this signal, make it usable by the setting of parameter No.43 to 48. Connect CDP-VIN to change the load inertia moment ratio into the parameter No.61 setting and the gain values into the values multiplied by the parameter No.62 to 64 settings.	DI-1	△	△
Control change	LOP		<Position/internal speed control change mode> Used to select the control mode in the position/internal speed control change mode. <table><tr><th>(Note) LOP</th><th>Control mode</th></tr><tr><td>0</td><td>Position</td></tr><tr><td>1</td><td>Internal speed</td></tr></table> Note. 0: LOP-VIN off (open) 1: LOP-VIN on (short)	DI-1	Refer to Functions /appli- cations	
Forward rotation pulse train Reverse rotation pulse train	PP NP PG NG	CN1-23 CN1-25 CN1-22 CN1-24	Used to enter a command pulse train. ・In the open collector system (max. input frequency 200kpps). Forward rotation pulse train across PP-SG Reverse rotation pulse train across NP-SG ・In the differential receiver system (max. input frequency 500kpps). Forward rotation pulse train across PG-PP Reverse rotation pulse train across NG-NP The command pulse train form can be changed using parameter No.21.	DI-2	○	

(2) Output signals

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode	
					P	S
Trouble	ALM	CN1-9	ALM-VIN are disconnected when power is switched off or the protective circuit is activated to shut off the base circuit. Without alarm, ALM-VIN are connected within about 1s after power on.	DO-1	○	○
Ready	RD	CN1-11	RD-VIN are connected when the servo is switched on and the servo amplifier is ready to operate.	DO-1	○	○
In position	INP	CN1-10	INP-VIN are connected when the number of droop pulses is in the preset in-position range. The in-position range can be changed using parameter No.5. When the in-position range is increased, INP-VIN may be kept connected during low-speed rotation.	DO-1	○	
Speed reached	SA		SA turns off when servo on (SON) turns off or the servo motor speed has not reached the preset speed with both forward rotation start (ST1) and reverse rotation start (ST2) turned off. SA turns on when the servo motor speed has nearly reached the preset speed. When the preset speed is 20r/min or less, SA always turns on.	DO-1		○
Zero speed detection	ZSP	CN1-12	ZSP-VIN are connected when the servo motor speed is zero speed (50r/min) or less. Zero speed can be changed using parameter No.24.	DO-1	○	○
Electromagnetic brake interlock	MBR	(CN1-12)	Set "□□1□" in parameter No.1 to use this parameter. Note that ZSP will be unusable. In the servo-off or alarm status, MBR-VIN are disconnected. When an alarm occurs, they are disconnected independently of the base circuit status.	DO-1	△	△
Warning	WNG		To use this signal, assign the connector pin for output using parameter No.49. The old signal before assignment will be unusable. When warning has occurred, WNG-VIN are connected. When there is no warning, WNG-VIN are disconnected within about 1s after power-on.	DO-1	△	△

Signal	Symbol	Connector pin No.	Functions/applications					I/O division	Control mode	
									P	S
Alarm code	ACD 0 ACD 1 ACD 2		To use this signal, set "□□□1" in parameter No.49. This signal is output when an alarm occurs. When there is no alarm, respective ordinary signals (RD, INP, SA, ZSP) are output. Alarm codes and alarm names are listed below.					DO-1	△	△

Table within Functions/applications column:

(Note) Alarm code			Alarm display	Name
CN1 12 Pin	CN1 11 Pin	CN1 10 Pin		
0	0	0	88888	Watchdog
			AL.12	Memory error 1
			AL.13	Clock error
			AL.15	Memory error 2
			AL.17	Board error
			AL.19	Memory error 3
			AL.37	Parameter error
			AL.8A	Serial communication timeout
			AL.8E	Serial communication error
0	1	0	AL.30	Regenerative error
			AL.33	Overvoltage
0	0	1	AL.10	Undervoltage
0	1	1	AL.45	Main circuit device
			AL.46	Servo motor overheat
			AL.50	Overload 1
			AL.51	Overload 2
1	0	0	AL.24	Main circuit error
			AL.32	Overcurrent
1	1	0	AL.31	Overspeed
			AL.35	Command pulse frequency alarm
			AL.52	Error excessive
1	0	1	AL.16	Encoder error 1
			AL.1A	Monitor combination error
			AL.20	Encoder error 2

Note. 0: Pin-VIN off (open)
   1: Pin-VIN on (short)

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode P	Control mode S
Encoder Z-phase pulse (Open collector)	OP	CN1-21	Outputs the zero-point signal of the encoder. One pulse is output per servo motor revolution. OP and LG are connected when the zero-point position is reached. (Negative logic) The minimum pulse width is about 400μs. For home position return using this pulse, set the creep speed to 100r/min. or less.	DO-2	○	○
Encoder A-phase pulse (Differential line driver)	LA LAR	CN1-15 CN1-16	Outputs pulses per servo motor revolution set in parameter No.27 in the differential line driver system. In CCW rotation of the servo motor, the encoder B-phase pulse lags the encoder A-phase pulse by a phase angle of $\pi/2$.	DO-2	○	○
Encoder B-phase pulse (Differential line driver)	LB LBR	CN1-17 CN1-18	The relationships between rotation direction and phase difference of the A- and B-phase pulses can be changed using parameter No.54.			
Encoder Z-phase pulse (Differential line driver)	LZ LZR	CN1-19 CN1-20	The same signal as OP is output in the differential line driver system.	DO-2	○	○
Analog monitor 1	MO1	CN3-4	Used to output the data set in parameter No.17 to across MO1-LG in terms of voltage. Resolution 10 bits	Analog output	○	○
Analog monitor 2	MO2	CN3-6	Used to output the data set in parameter No.17 to across MO2-LG in terms of voltage. Resolution 10 bits	Analog output	○	○

(3) Communication

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode P	Control mode S
RS-232C I/F	RXD TXD	CN3-1 CN3-2	RS-232C communication interface.		○	○

(4) Power supply

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode P	Control mode S
Digital I/F power supply input	VIN	CN1-1	Used to input 24VDC for input interface. Connect the positive terminal of the 24VDC external power supply. 24VDC ±10%		○	○
Open collector power input	OPC	CN1-2	When inputting a pulse train in the open collector system, supply this terminal with the positive (＋) power of 24VDC.		○	○
Digital I/F common	SG	CN1-13	Common terminal for output signals such as ALM and INP. Separated from LG.		○	○
Control common	LG	CN1-14	Common terminal for OP, MO1, and MO2. Pins are connected internally.		○	○
Shield	SD	Plate	Connect the external conductor of the shield cable.		○	○

3.4 Detailed description of the signals

3.4.1 Position control mode

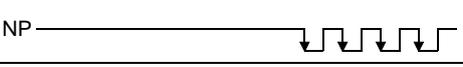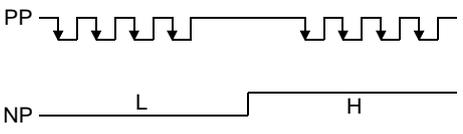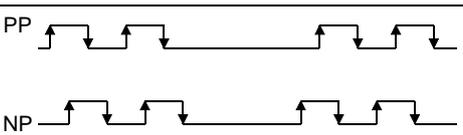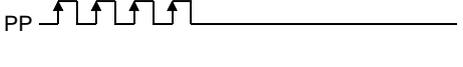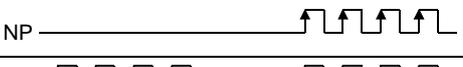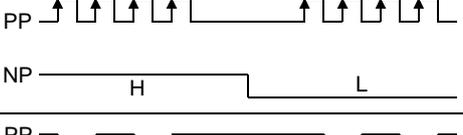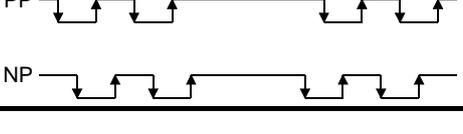(1) Pulse train input
    (a) Input pulse waveform selection
        Encoder pulses may be input in any of three different forms, for which positive or negative logic can be chosen. Set the command pulse train form in parameter No.21.
   Arrow ⌐ or ⌐ in the table indicates the timing of importing a pulse train.
        A- and B-phase pulse trains are imported after they have been multiplied by 4.

|	Pulse train form	Forward rotation command	Reverse rotation command	Parameter No.21 (Command pulse train)
Negative logic	Forward rotation pulse train / Reverse rotation pulse train	PP / NP		0010
	Pulse train + sign	PP / NP (L ... H)		0011
	A-phase pulse train / B-phase pulse train	PP / NP		0012
Positive logic	Forward rotation pulse train / Reverse rotation pulse train	PP / NP		0000
	Pulse train + sign	PP / NP (H ... L)		0001
	A-phase pulse train / B-phase pulse train	PP / NP		0002

(b) Connections and waveforms
1) Open collector system
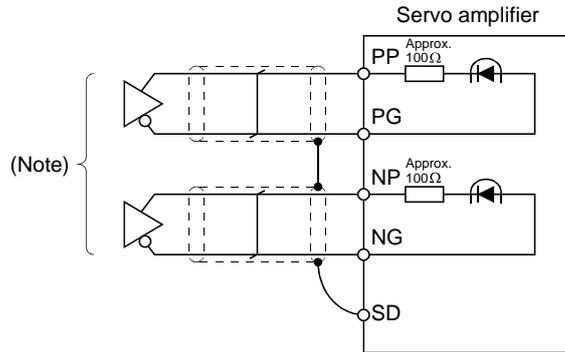Connect as shown below.
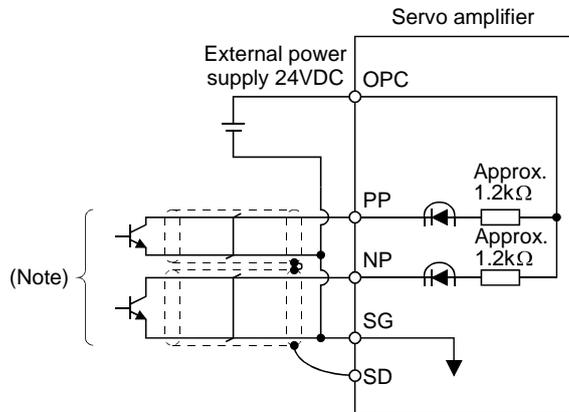
Note. Pulse train input interface is comprised of a photo coupler.
Therefore, it may be any malfunctions since the current is reduced when connect a resistance to a pulse train signal line.

The explanation assumes that the input waveform has been set to the negative logic and forward and reverse rotation pulse trains (parameter No.21 has been set to 0010). The waveforms in the table in (1) (a) of this section are voltage waveforms of PP and NP based on SG. Their relationships with transistor ON/OFF are as follows.
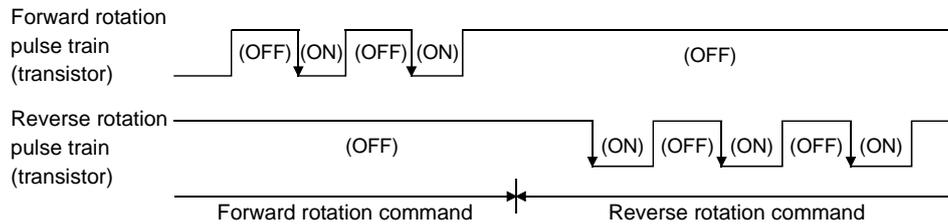
2) Differential line driver system
   Connect as shown below.

Note. Pulse train input interface is comprised of a photo coupler.
     Therefore, it may be any malfunctions since the current is reduced when connect a resistance
     to a pulse train signal line.

The explanation assumes that the input waveform has been set to the negative logic and forward and reverse rotation pulse trains (parameter No.21 has been set to 0010).
For the differential line driver, the waveforms in the table in (1) (a) of this section are as follows.
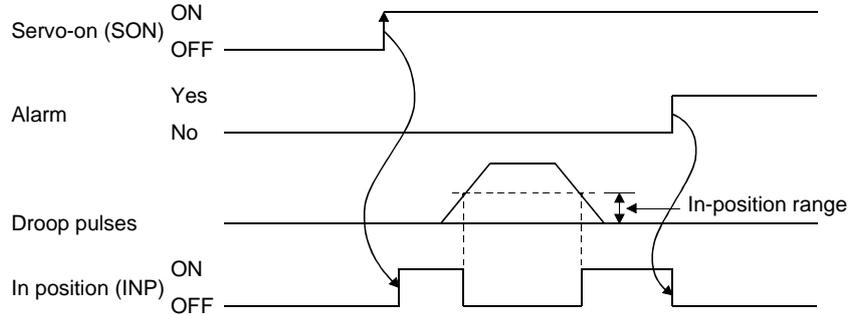The waveforms of PP, PG, NP and NG are based on that of the ground of the differential line driver.
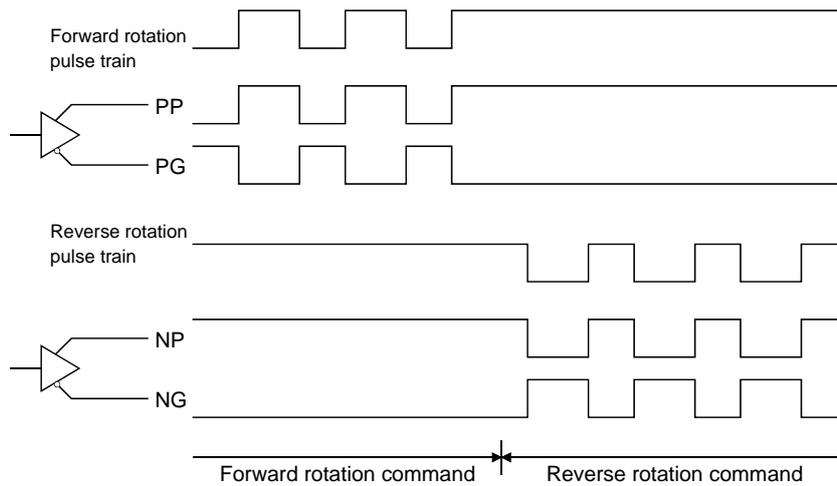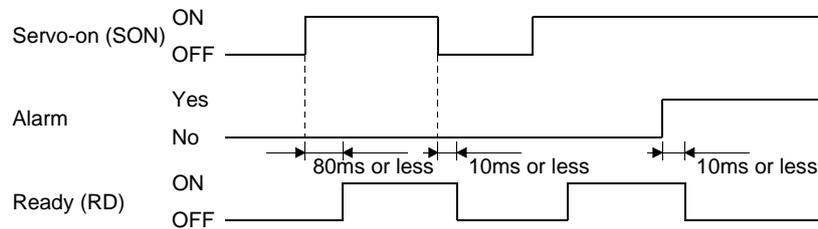
(2) In-position (INP)

PF-VIN are connected when the number of droop pulses in the deviation counter falls within the preset in-position range (parameter No.5). INP-VIN may remain connected when low-speed operation is performed with a large value set as the in-position range.

(3) Ready (RD)

(4) Electronic gear switching

The combination of CM1-VIN and CM2-VIN gives you a choice of four different electronic gear numerators set in the parameters.

As soon as CM1/CM2 is turned ON or OFF, the numerator of the electronic gear changes. Therefore, if any shock occurs at this change, use position smoothing (parameter No.7) to relieve shock.

(Note) External input signal		Electronic gear numerator
CM2	CM1	
0	0	Parameter No.3
0	1	Parameter No.69
1	0	Parameter No.70
1	1	Parameter No.71

Note. 0: CM1/CM2-VIN off(open)
   1: CM1/CM2-VIN on(short)

(5) Torque limit

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> ⚠ CAUTION
> · Releasing the torque limit during servo lock may cause the servo motor to suddenly rotate according to the position deviation from the instructed position.

(a) Torque limit and torque

By setting parameter No.28 (internal torque limit 1), torque is always limited to the maximum value during operation. A relationship between the limit value and servo motor torque is shown below.
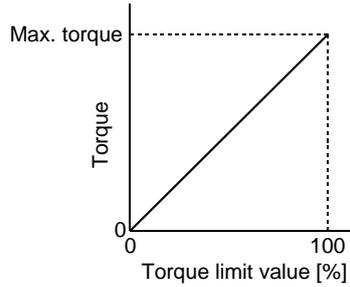
(b) Torque limit value selection

When internal torque limit selection (TL1) is made usable by parameter No.43 to 48, internal torque limit 2 (parameter No.76) can be selected. However, if the parameter No.28 value is less than the limit value selected by parameter No.76, the parameter No.28 value is made valid.

(Note) External input signals	Torque limit value made valid
TL1	
0	Internal torque limit value 1 (parameter No.28)
1	Parameter No.76 > Parameter No.28: Parameter No.28 Parameter No.76 < Parameter No.28: Parameter No.76

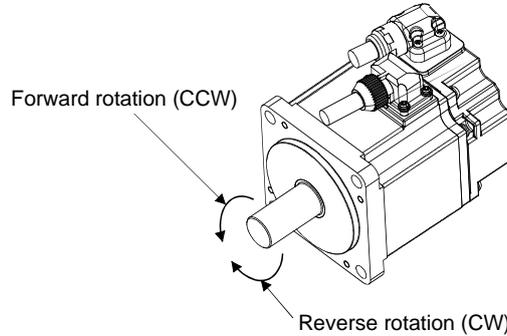Note. 0: TL/TL1-VIN off (open)
     1: TL/TL1-VIN on (short)

3.4.2 Internal speed control mode

(1) Speed setting
   (a) Speed command and speed
      The servo motor is run at the speeds set in the parameters.

Forward rotation (CCW)

Reverse rotation (CW)

The following table indicates the rotation direction according to forward rotation start (ST1) and reverse rotation start (ST2) combination.

| (Note 1) External input signals		(Note 2) Rotation direction
ST2	ST1	Internal speed commands
0	0	Stop (Servo lock)
0	1	CCW
1	0	CW
1	1	Stop (Servo lock)

Note 1. 0: ST1/ST2-VIN off (open)
            1: ST1/ST2-VIN on (short)
       2. Releasing the torque limit during servo lock may cause the servo motor to suddenly rotate according to the position deviation from the instructed position.

The forward rotation start (ST1) and reverse rotation start (ST2) can be assigned to any pins of the connector CN1 using parameters No.43 to 48.
Generally, make connection as shown below.

Servo amplifier

ST1
ST2
VIN
SD
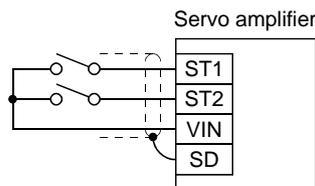
(b) Speed selection 1 (SP1), speed selection 2 (SP2), speed selection 3 (SP3) and speed command value
   By making speed selection 1 (SP1), speed selection 2 (SP2) and speed selection 3 (SP3) usable by setting of parameter No.43 to 47, you can choose the speed command values of internal speed commands 1 to 7.

(Note) External input signals			Speed command value
SP3	SP2	SP1	
0	0	0	Internal speed command 1 (parameter No.8)
0	0	1	Internal speed command 1 (parameter No.8)
0	1	0	Internal speed command 2 (parameter No.9)
0	1	1	Internal speed command 3 (parameter No.10)
1	0	0	Internal speed command 4 (parameter No.72)
1	0	1	Internal speed command 5 (parameter No.73)
1	1	0	Internal speed command 6 (parameter No.74)
1	1	1	Internal speed command 7 (parameter No.75)

Note. 0: SP1/SP2/SP3-VIN off (open)
     1: SP1/SP2/SP3-VIN on (short)

The speed may be changed during rotation. In this case, the values set in parameters No.11 and 12 are used for acceleration/deceleration.
When the speed has been specified under any internal speed command, it does not vary due to the ambient temperature.

(2) Speed reached (SA)
   SA-VIN are connected when the servo motor speed nearly reaches the speed set to the internal speed command.
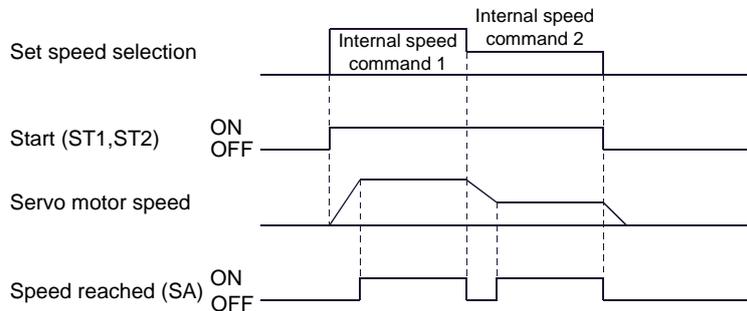
(3) Torque limit
   As in section 3.4.1 (5).

3.4.3 Position/internal speed control change mode

Set "0001" in parameter No.0 to switch to the position/internal speed control change mode.
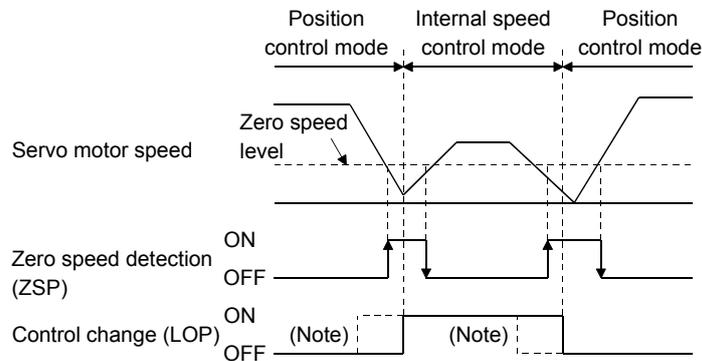
(1) Control change (LOP)

Use control change (LOP) to switch between the position control mode and the internal speed control mode from an external contact. Relationships between LOP-VIN status and control modes are indicated below.

(Note) LOP	Servo control mode
0	Position control mode
1	Speed control mode

Note. 0: LOP-VIN off (open)
      1: LOP-VIN on (short)

The control mode may be changed in the zero-speed status. To ensure safety, change control after the servo motor has stopped. When position control mode is changed to speed control mode, droop pulses are reset.
If the LOP has been switched on-off at the speed higher than the zero speed and the speed is then reduced to the zero speed or less, the control mode cannot be changed. A change timing chart is shown below.

Note. When Zero speed detection (ZSP) is not on, control cannot be
      changed if Control change (LOP) is switched on-off.
      If Zero speed detection (ZSP) switches on after that, control cannot
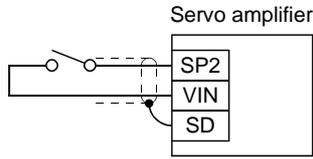   be changed.

(2) Torque limit in position control mode

As in section 3.4.1 (5).

(3) Internal speed setting in speed control mode

    (a) Speed command and speed

        The servo motor is run at the speed set in parameter No.8 (internal speed command 1) the forward rotation start (ST1) and reverse rotation start (ST2) are as in section 3.4.2 (1) (a).

        Generally, make connection as shown below.

    (b) Speed selection 2 (SP2) and speed command value

        Use speed selection 2 (SP2) to select between the speed set by the internal speed command 1 and the speed set by the Internal speed command 2 as indicated in the following table.

(Note) External input signals	Speed command value
SP1	
0	Internal speed command 1 (parameter No.8)
1	Internal speed command 2 (parameter No.9)

    Note. 0: SP1-VIN off (open)
          1: SP1-VIN on (short)

        The speed may also be changed during rotation. In this case, it is increased or decreased according to the value set in parameter No.11 or 12.

        When the internal speed command 1 is used to command the speed, the speed does not vary with the ambient temperature.

   (c) Speed reached (SA)

        As in section 3.4.2 (2).

3.5 Alarm occurrence timing chart

⚠ CAUTION	・When an alarm has occurred, remove its cause, make sure that the operation signal is not being input, ensure safety, and reset the alarm before restarting operation. ・As soon as an alarm occurs, turn off Servo-on (SON) and power off the power supply.

When an alarm occurs in the servo amplifier, the base circuit is shut off and the servo motor is coated to a stop. Switch off the power supply in the external sequence. To reset the alarm, switch the power supply from off to on, press the "SET" button on the current alarm screen, or turn the reset (RES) from off to on. However, the alarm cannot be reset unless its cause is removed.
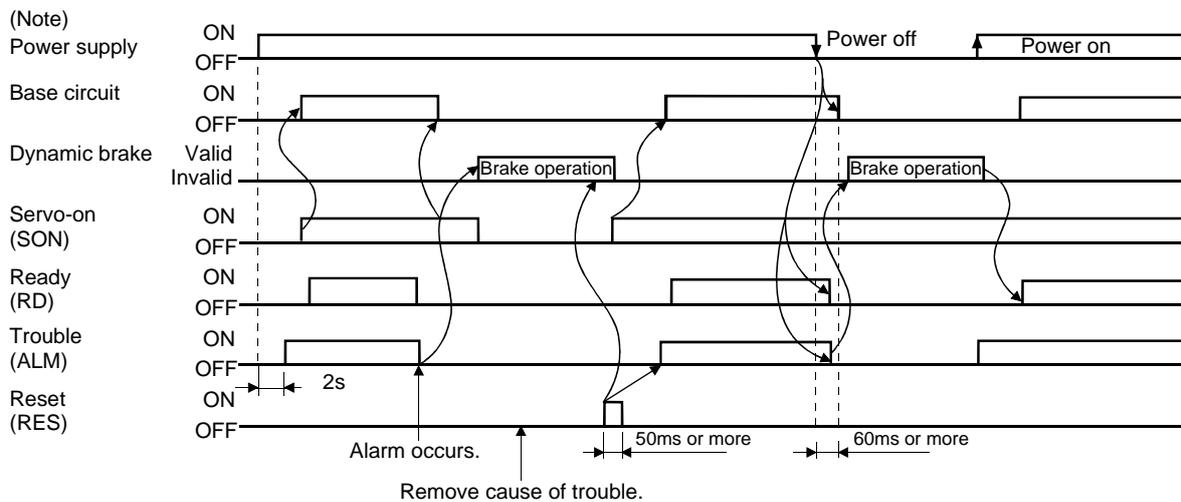
Note. Shut off the power as soon as an alarm occurs.

(1) Overcurrent, overload 1 or overload 2

If operation is repeated by switching power off, then on to reset the overcurrent (AL.32), overload 1 (AL.50) or overload 2 (AL.51) alarm after its occurrence, without removing its cause, the servo amplifier and servo motor may become faulty due to temperature rise. Securely remove the cause of the alarm and also allow about 30 minutes for cooling before resuming operation.

(2) Regenerative error

If operation is repeated by switching power off, then on to reset the regenerative (AL.30) alarm after its occurrence, the external regenerative resistor will generate heat, resulting in an accident.

(3) Instantaneous power failure

・Undervoltage (AL.10) occurs when the input power is in either of the following statuses.
A power failure of the control circuit power supply continues for 60ms or longer, then the power restores.

・During the servo-on status, the bus voltage dropped to 200VDC.

(4) In position control mode
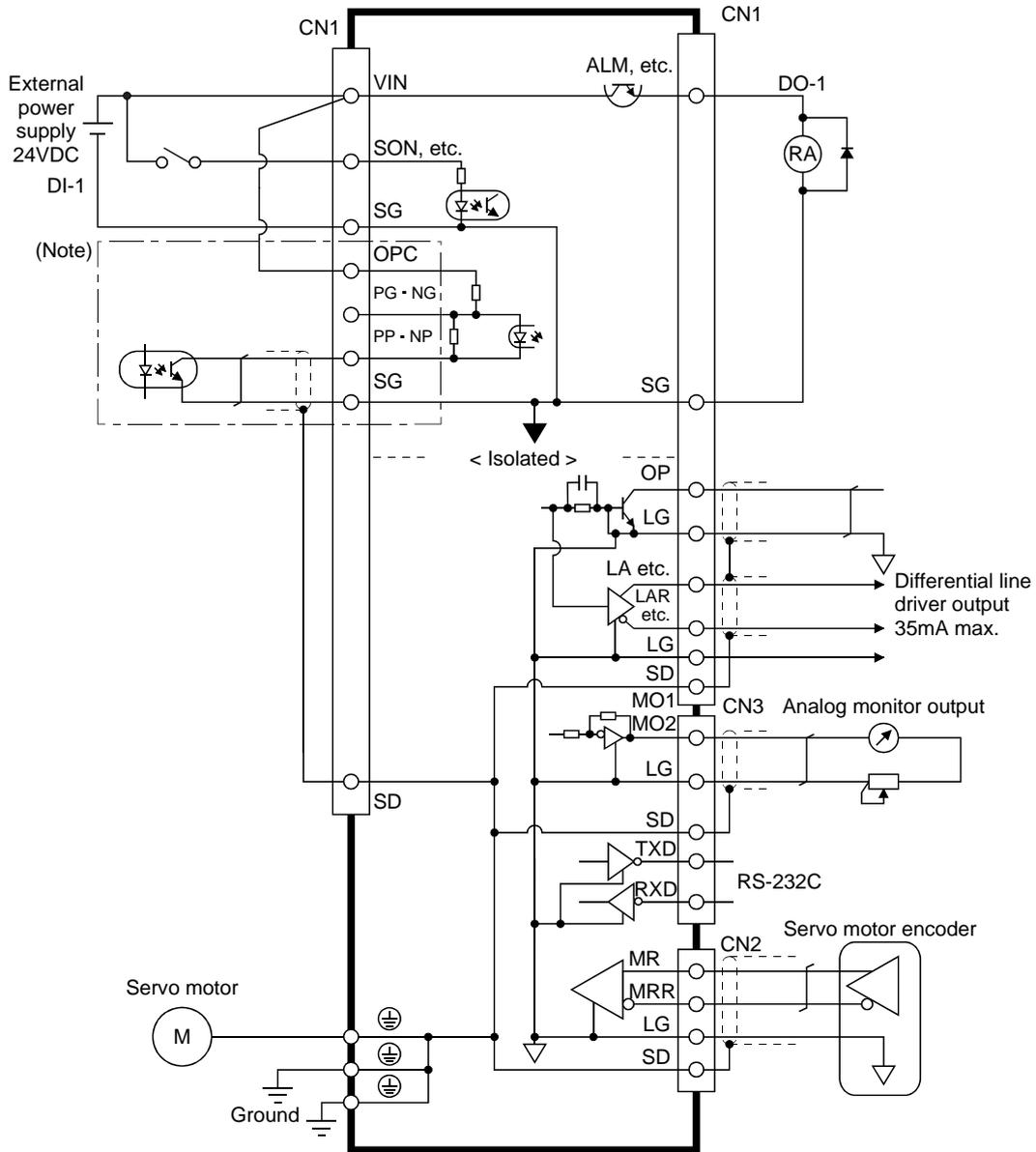
When an alarm occurs, the home position is lost. When resuming operation after deactivating the alarm, make a home position return.
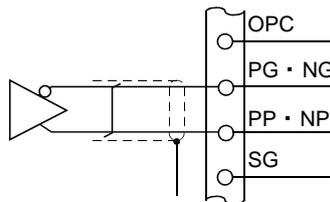
3.6 Interfaces

3.6.1 Common line

The following diagram shows the power supply and its common line.

Note. For the open collection pulse train input. Make the following connection for the different line driver pulse train input.
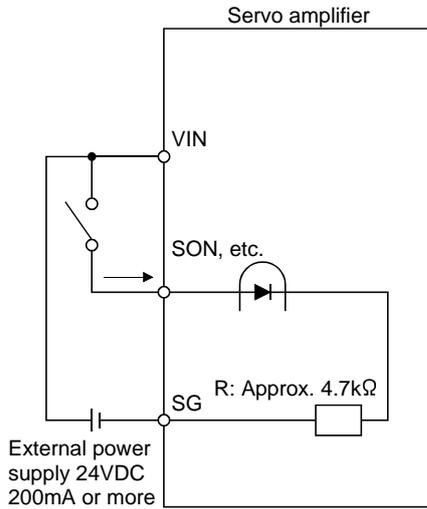
3.6.2 Detailed description of the interfaces

This section gives the details of the I/O signal interfaces (refer to I/O Division in the table) indicated in section 3.3.2.

Refer to this section and connect the interfaces with the external equipment.
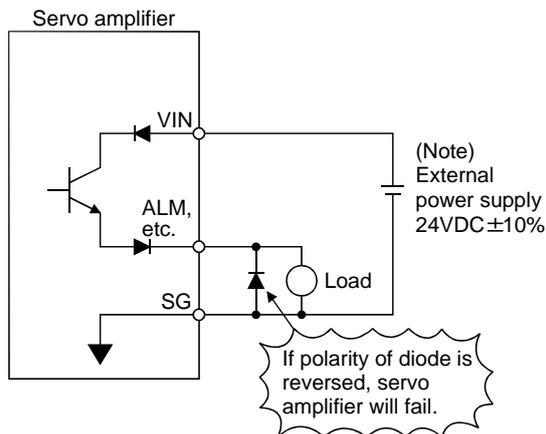
(1) Digital input interface DI-1

Give a signal with a relay or open collector transistor.

(2) Digital output interface DO-1

A lamp, relay or photocoupler can be driven. Provide a diode (D) for an inductive load, or an inrush current suppressing resistor (R) for a lamp load. (Rated current: 40mA or less, maximum current: 50mA or less, inrush current: 100mA or less)
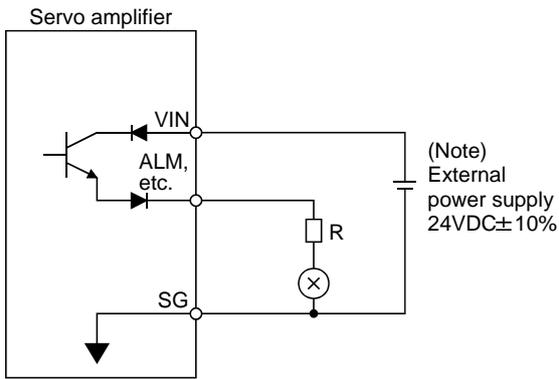
(a) Inductive load

Note. If the voltage drop (maximum of 2.6V) interferes with the relay operation, apply high voltage (up to 26.4V) from external source.
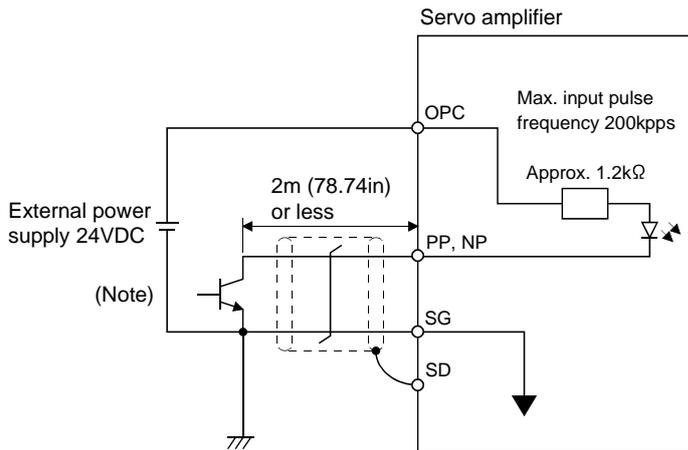
(b) Lamp load

Note. If the voltage drop (maximum of 2.6V) interferes with the relay operation, apply high voltage (up to 26.4V) from external source.

(3) Pulse train input interface DI-2

Provide a pulse train signal in the open collector or differential line driver system.
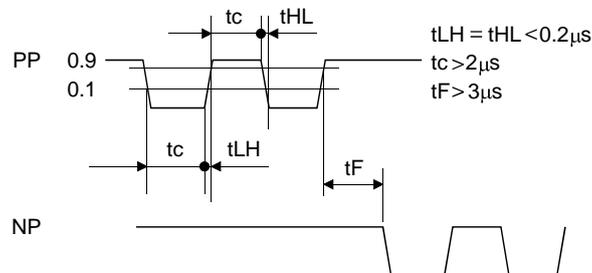
(a) Open collector system

1) Interface

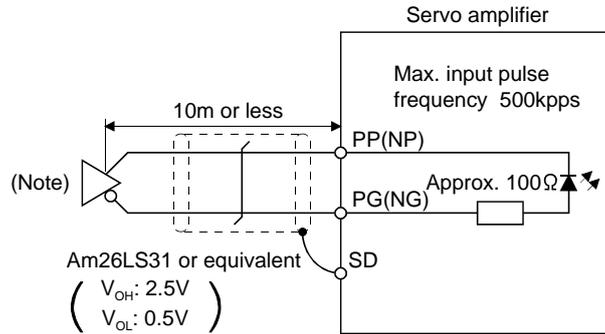Note. Pulse train input interface is comprised of a photo coupler.

Therefore, it may be any malfunctions since the current is reduced when connect a resistance to a pulse train signal line.

2) Conditions of the input pulse

$tLH = tHL < 0.2\mu s$
$tc > 2\mu s$
$tF > 3\mu s$

(b) Differential line driver system

   1) Interface

Note. Pulse train input interface is comprised of a photo coupler.

  Therefore, it may be any malfunctions since the current is reduced when connect a resistance to a pulse train signal line.
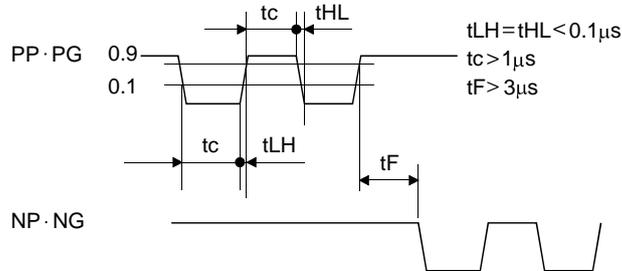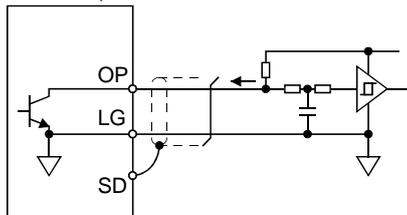
   2) Conditions of the input pulse

$tLH = tHL < 0.1 \mu s$
$tc > 1 \mu s$
$tF > 3 \mu s$

(4) Encoder pulse output

   (a) Open collector system

      Interface

      Max. output current : 35mA
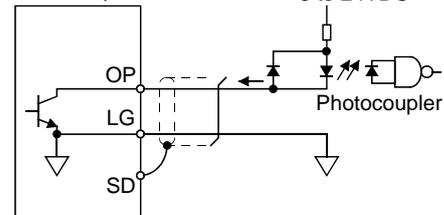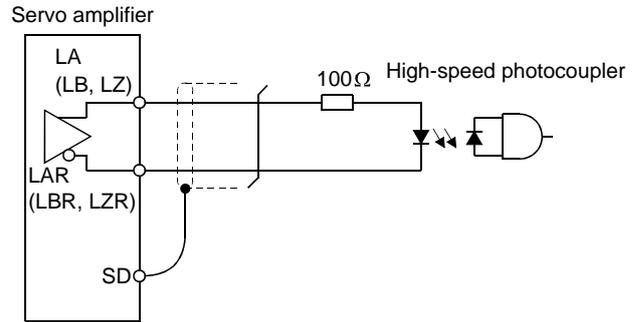
(b) Differential line driver system
1) Interface
Max. output current: 35mA

2) Output pulse

Servo motor CCW rotation

Time cycle (T) is determined by the settings of parameter No.27 and 54.
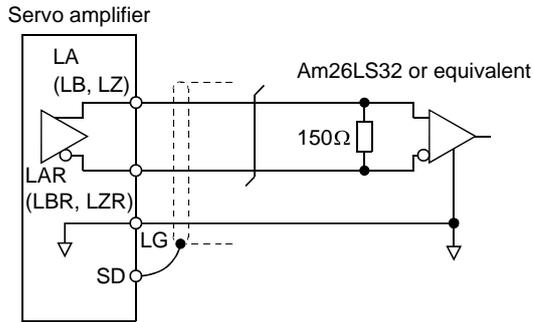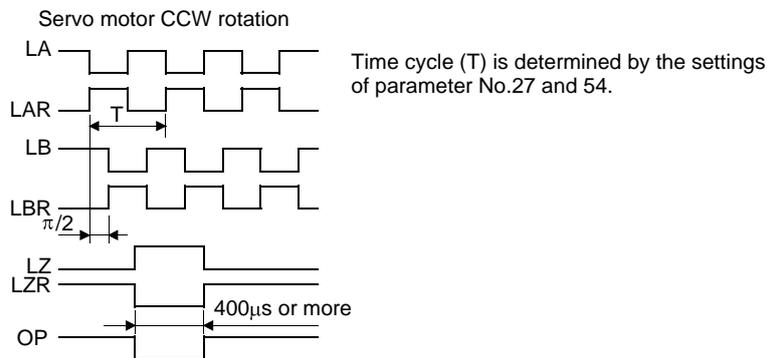
(5) Analog output
Output voltage ±10V
Max. 1mA
Max. output current
Resolution: 10bit

Output voltage: ±10V
Max. Output current: 1mA
Resolution: 10 bits or equivalent
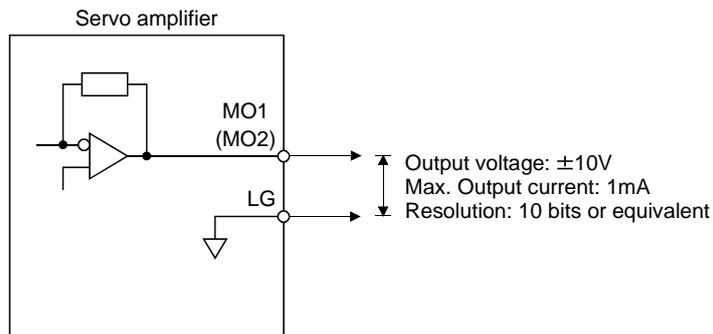
3.7 Input power supply circuit

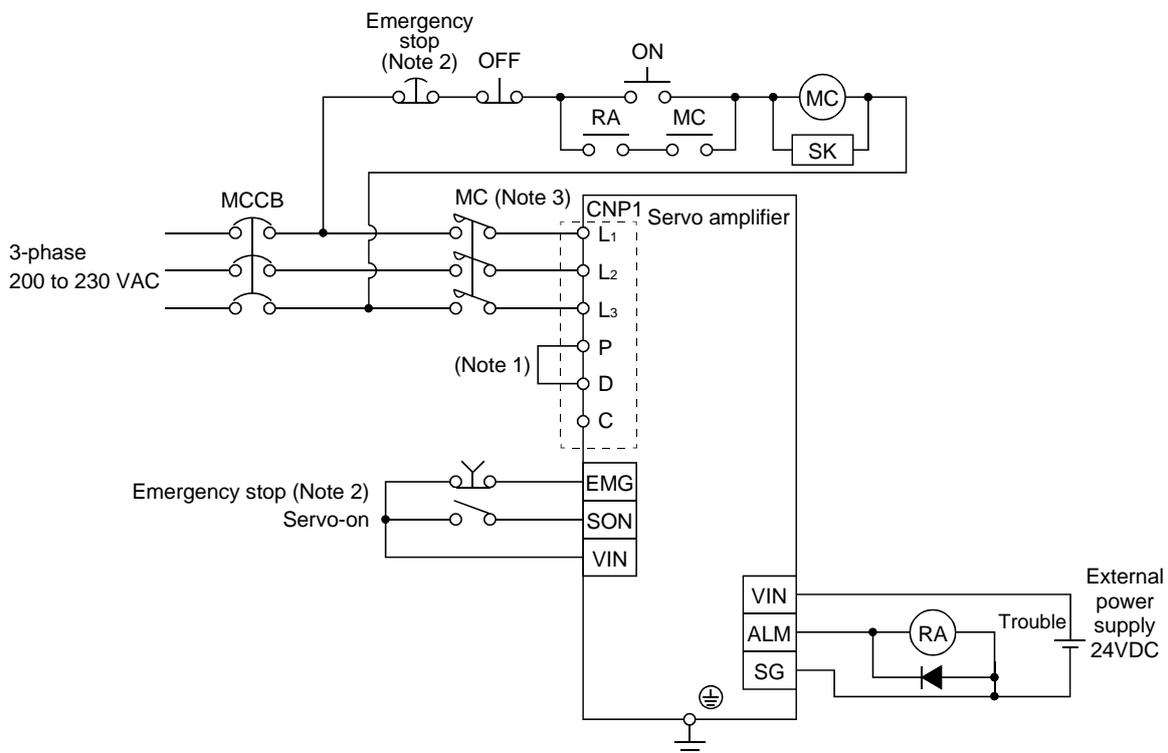|	
⚠ CAUTION	・Always connect a magnetic contactor between the main circuit power supply and L_1, L_2, and L_3 of the servo amplifier, and configure the wiring to be able to shut down the power supply on the side of the servo amplifier's power supply. If a magnetic contactor is not connected, continuous flow of a large current may cause a fire when the servo amplifier malfunctions. ・Use the trouble (ALM) to switch power off. Otherwise, a regenerative transistor fault or the like may overheat the regenerative resistor, causing a fire. ・For main circuit power supply of servo amplifier, check the model of servo amplifier and input the correct voltage. If a voltage exceeding the upper limit shown in the servo amplifier input voltage specification is input, the servo amplifier malfunctions.

POINT

・The power supply connector (CNP1) is optional. Purchase it without fail.

3.7.1 Connection example

Wire the power supply and main circuit as shown below so that the servo-on (SON) turns off as soon as alarm occurrence is detected and power is shut off.
A circuit breaker (MCCB) must be used with the input cables of the power supply.

(1) For 3-phase 200 to 230VAC power supply

Note 1. To use the built-in regenerative resistor, be sure to connect across P and D of the power supply connector (CNP1).
   2. Configure the circuit to shut off the main circuit power supply by an external sequence simultaneously with the emergency stop turning OFF.
   3. Be sure to use a magnetic contactor with an operation delay time of 80ms or less. The operation delay time is the time interval between current being applied to the coil until closure of contacts.
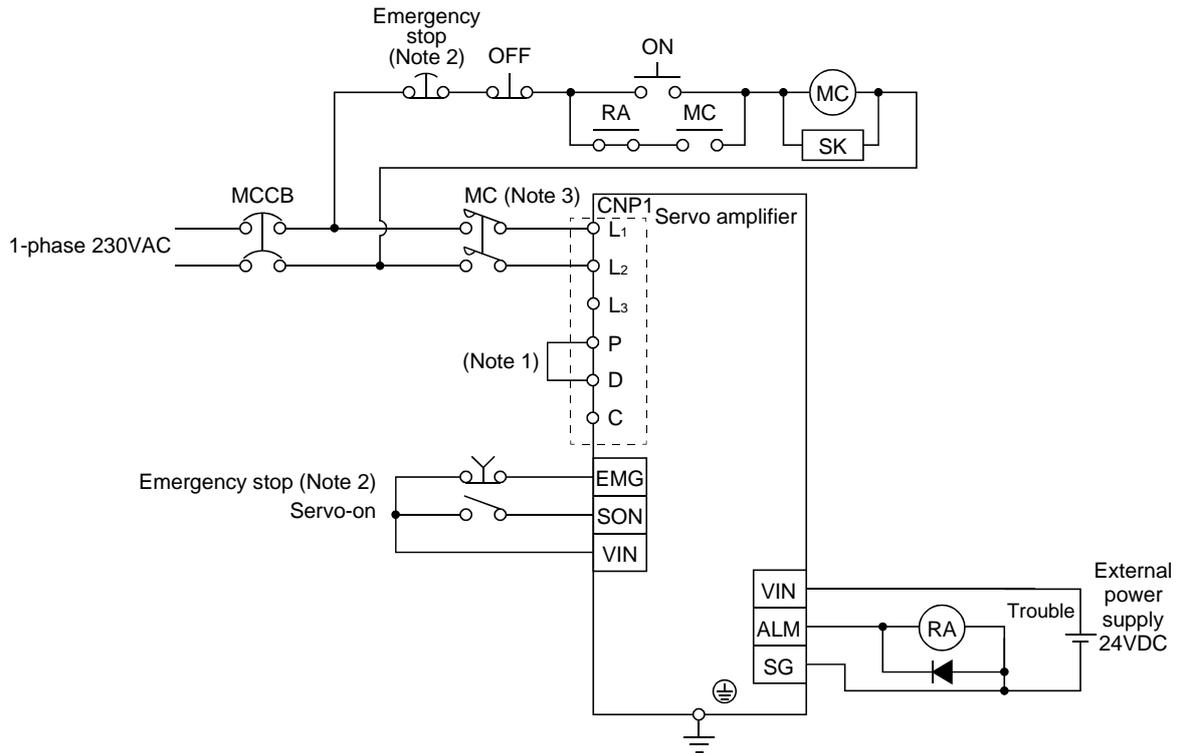
(2) For 1-phase 230VAC power supply

Note 1. To use the built-in regenerative resistor, be sure to connect across P and D of the power supply connector (CNP1).

2. Configure the circuit to shut off the main circuit power supply by an external sequence simultaneously with the emergency stop turning OFF.

3. Be sure to use a magnetic contactor with an operation delay time of 80ms or less. The operation delay time is the time interval between current being applied to the coil until closure of contacts.

3.7.2 Terminals

Refer to section 11.1 (4) for the signal arrangement.

Connected terminal (Application)	Symbol	Description
Power supply	L_1	Supply L_1, L_2 and L_3 with the following power. For 1-phase 230VAC, connect the power supply to L_1, L_2 and L_3 open. _(see table below)_
	L_2	
	L_3	
Servo motor	U	Connect to the servo motor power terminals (U, V, W). During power-on, do not open or close the motor power line. Otherwise, a malfunction or faulty may occur.
	V	
	W	
Regenerative option	P	To use the built-in regenerative resistor of the servo amplifier, connect the wiring across P-D of the power supply connector (CNP1). When using the regenerative option, always remove the wiring from across P-D and connect the regenerative option across P-C. Refer to section 13.1.1 for details.
	C	
	D	
Protective earth (PE)	⏚	Connect this terminal to the protective earth (PE) terminals of the servo motor and control box for grounding.

| Power supply \ Servo amplifier	MR-E-10A-QW003 to MR-E-70A-QW003	MR-E-100A-QW003/ MR-E-200A-QW003
3-phase 200 to 230VAC, 50/60Hz	$L_1 \cdot L_2 \cdot L_3$	
1-phase 230VAC, 50/60Hz	$L_1 \cdot L_2$	

3.7.3 Power-on sequence

(1) Power-on procedure

1) Always wire the power supply as shown in above section 3.7.1 using the magnetic contactor with the power supply (three-phase 200V: L_1, L_2, L_3, single-phase 230V: L_1, L_2). Configure up an external sequence to switch off the magnetic contactor as soon as an alarm occurs.

2) The servo amplifier can accept the servo-on (SON) 2s or more after the power supply is switched on. Therefore, when SON is switched on simultaneously with the power supply, the base circuit will switch on in about 1 to 2s, and the ready (RD) will switch on in further about 20ms, making the servo amplifier ready to operate. (Refer to paragraph (2) in this section.)

3) When the reset (RES) is switched on, the base circuit is shut off and the servo motor shaft coasts.

(2) Timing chart
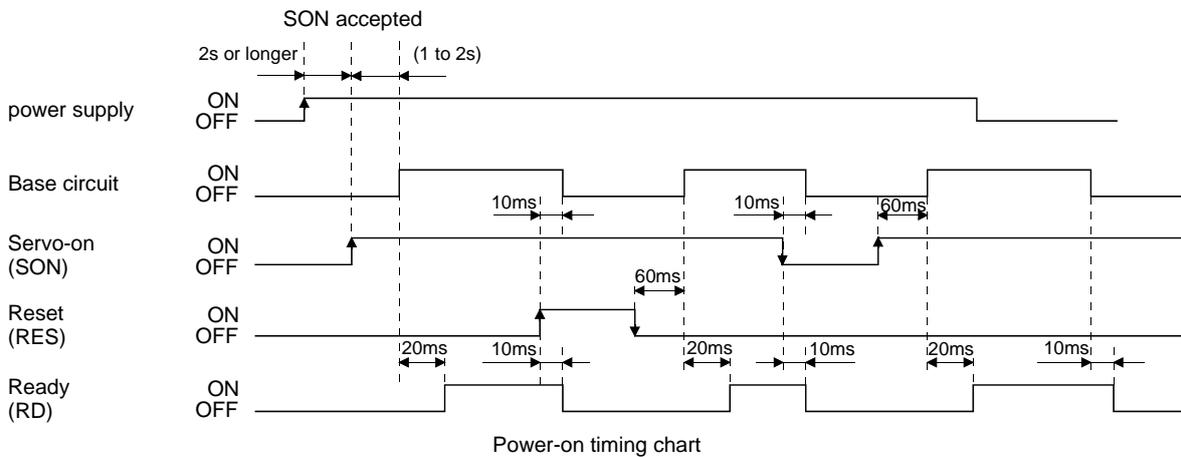
Power-on timing chart

(3) Emergency stop

⚠ CAUTION · Provide an external emergency stop circuit to ensure that operation can be stopped and power switched off immediately.

Make up a circuit which shuts off power as soon as EMG-VIN are opened at an emergency stop. To ensure safety, always install an external emergency stop switch across EMG-VIN. By disconnecting EMG-VIN, the dynamic brake is operated to bring the servo motor to a sudden stop. At this time, the display shows the servo emergency stop warning (AL.E6).
During ordinary operation, do not use the external emergency stop signal to alternate stop and run.
The servo amplifier life may be shortened.
Also, if the start signal is on or a pulse train is input during an emergency stop, the servo motor will rotate as soon as the warning is reset. During an emergency stop, always shut off the run command.
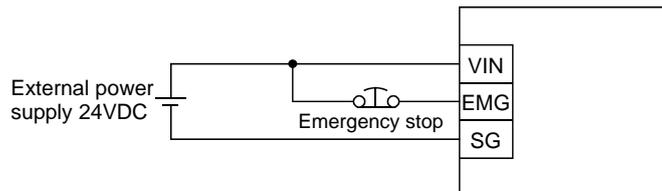
3.8 Servo motor with electromagnetic brake

3.8.1 Precautions

> ⚠ **CAUTION**
>
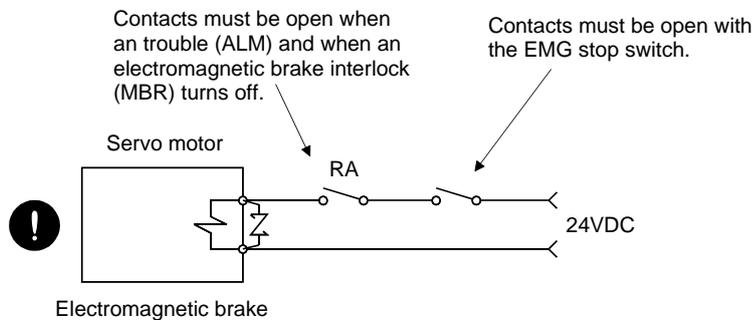> · Configure an electromagnetic brake circuit so that it is activated also by an external EMG stop switch.
>
> Contacts must be open when an trouble (ALM) and when an electromagnetic brake interlock (MBR) turns off.
>
> Contacts must be open with the EMG stop switch.
>
> Servo motor
>
> RA
>
> 24VDC
>
> Electromagnetic brake
>
> · The electromagnetic brake is provided for holding purpose and must not be used for ordinary braking.
>
> · Before performing the operation, be sure to confirm that the electromagnetic brake operates properly.
>
> · Do not use the 24VDC interface power supply for the electromagnetic brake. Always use the power supply designed exclusively for the electromagnetic brake. Otherwise, a fault may occur.

> **POINT**
>
> · Refer to HF-KN/HF-SN Servo Motor Instruction Manual for specifications such as the power supply capacity and operation delay time of the electromagnetic brake.
> · Refer to HF-KN/HF-SN Servo Motor Instruction Manual for wiring diagrams.

Note the following when the servo motor equipped with electromagnetic brake is used.

1) Set "□□1□" in parameter No.1 to make the electromagnetic brake interlock (MBR) valid. Note that this will make the zero speed signal (ZSP) unavailable.
2) Do not share the 24VDC interface power supply between the interface and electromagnetic brake. Always use the power supply designed exclusively for the electromagnetic brake.
3) The brake will operate when the power (24VDC) switches off.
4) While the reset (RES) is on, the base circuit is shut off. When using the servo motor with a vertical shaft, use the electromagnetic brake interlock (MBR).
5) Switch off the servo-on signal after the servo motor has stopped.

3.8.2 Setting

1) Set "□□1□" in parameter No.1 to make the electromagnetic brake interlock (MBR) valid.
2) Using parameter No.33 (electromagnetic brake sequence output), set a delay time (Tb) at servo-off from electromagnetic brake operation to base circuit shut-off as in the timing chart shown in section 3.9.3.

3.8.3 Timing charts

(1) Servo-on signal command (from controller) ON/OFF

Tb [ms] after the servo-on (SON) signal is switched off, the servo lock is released and the servo motor coasts. If the electromagnetic brake is made valid in the servo lock status, the brake life may be shorter. Therefore, when using the electromagnetic brake in a vertical lift application or the like, set Delay time (Tb) to about the same as the electromagnetic brake operation delay time to prevent a drop.
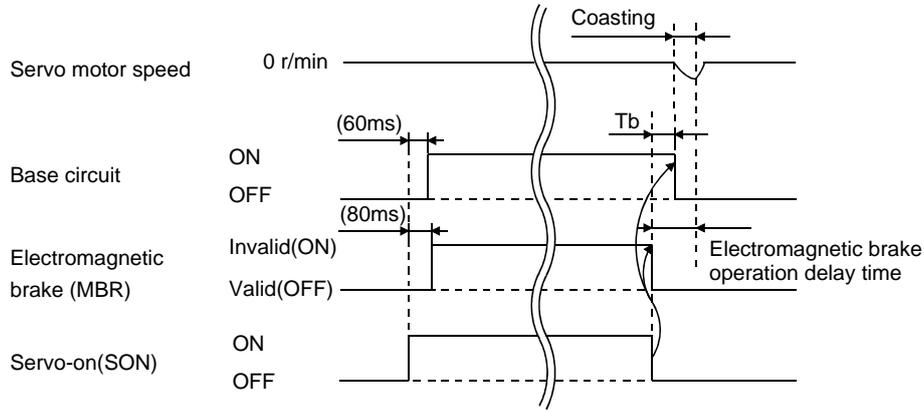
(2) Emergency stop (EMG) ON/OFF
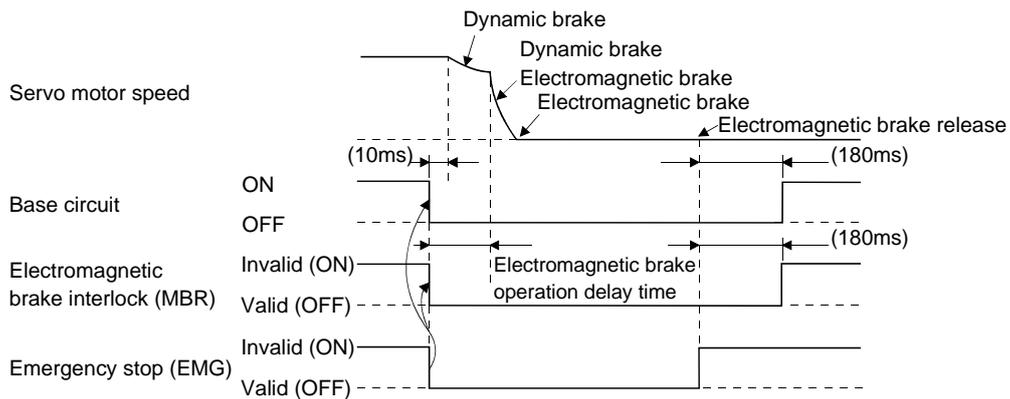
(3) Alarm occurrence

(4) Power off
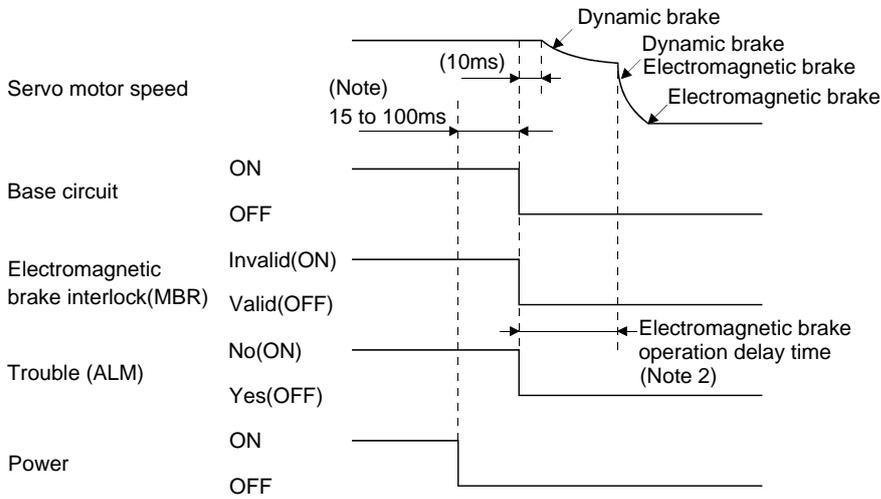
Note. Changes with the operating status.

3.9 Grounding

> ⚠ **WARNING**
> · Ground the servo amplifier and servo motor securely.
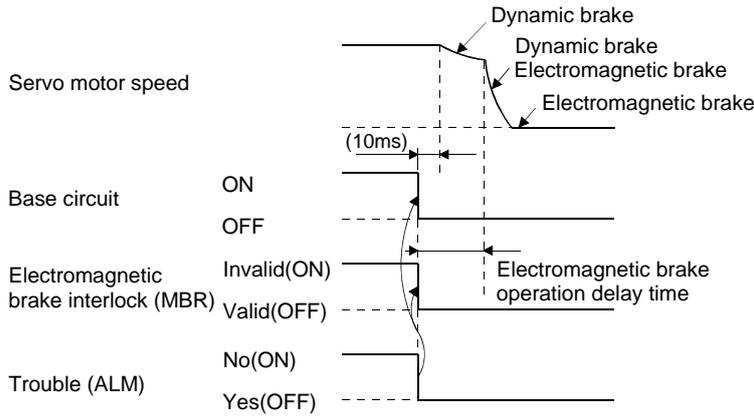> · To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier with the protective earth (PE) of the control box.

The servo amplifier switches the power transistor on-off to supply power to the servo motor. Depending on the wiring and ground cable 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 always ground.
To conform to the EMC Directive, refer to the EMC Installation Guidelines (IB(NA)67310).
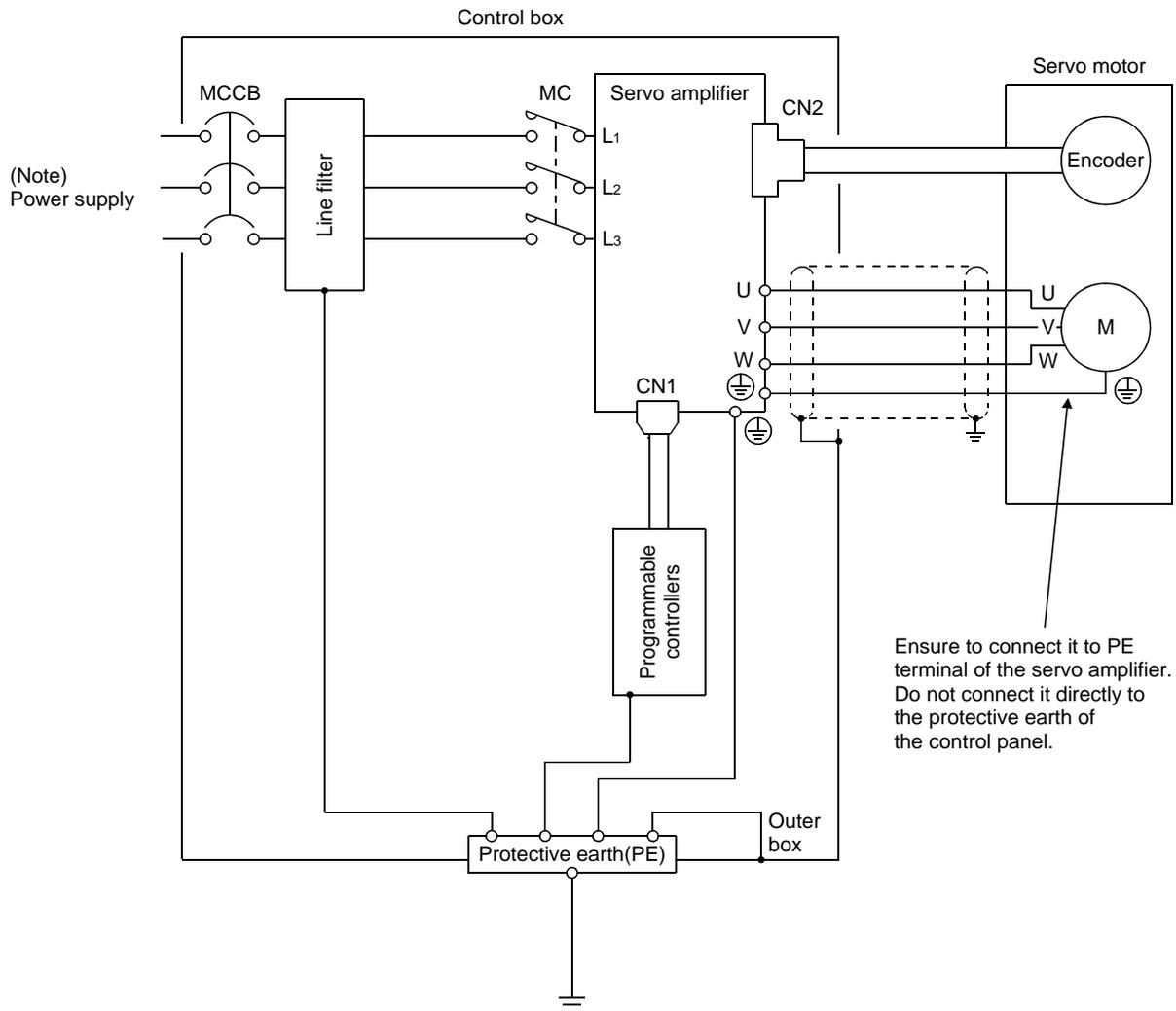
Note. For 1-phase 230VAC, connect the power supply to L_1, L_2 and leave L_3 open. Refer to section 1.3 for the power supply specification.

3.10 Servo amplifier connectors (CNP1, CNP2) wiring method (When MR-ECPN1-B and MR-ECPN2-B of an option are used.)

```
POINT
・For the wire sizes used for wiring, refer to Table 13.1 1), 2) and 3) of section
 13.2.1.
```

(1) Termination of the cables

Solid wire: After the insulator has been stripped, the cable can be used as it is.

8 to 9 mm
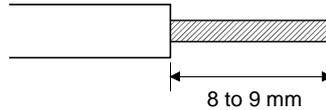
Twisted wire: Use the cable after stripping the insulator and twisting the core. At this time, take care to avoid a short caused by the loose wires of the core and the adjacent pole. Do not solder the core as it may cause a contact fault.

(2) Inserting the cable into the connector

    (a) Applicable flat-blade screwdriver dimensions

        Always use the screwdriver shown here to do the work.

[Unit: mm]

    (b) When using the flat-blade screwdriver - part 1

1) Insert the screwdriver into the square hole.
   Insert it along the top of the square hole to insert it smoothly.

2) If inserted properly, the screwdriver is held.

3) With the screwdriver held, insert the cable in the direction of arrow. (Insert the cable as far as it will go.)

4) Releasing the screwdriver connects the cable.
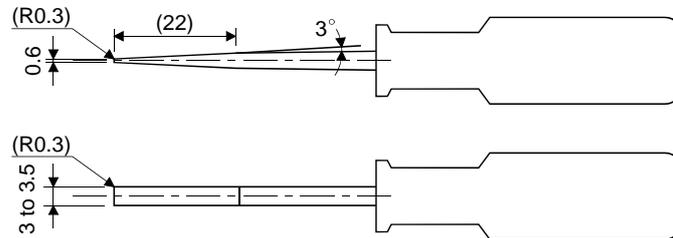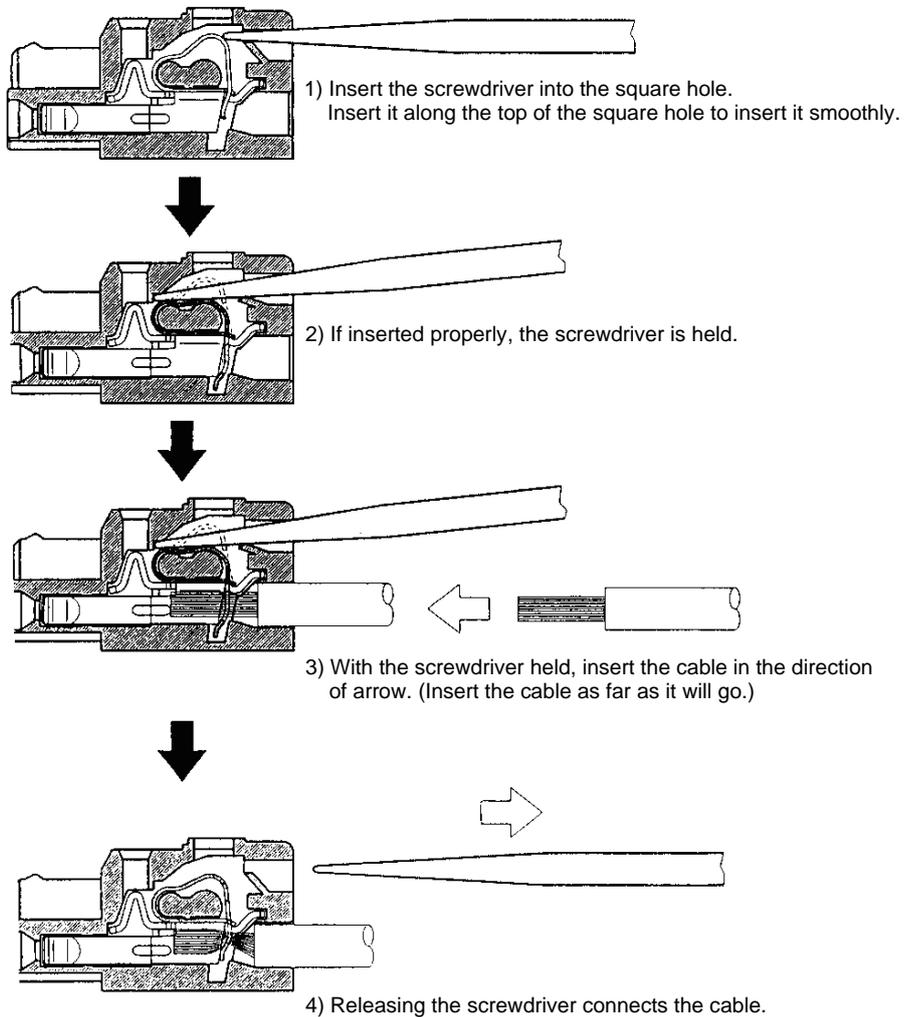
(c) When using the flat-blade screwdriver - part 2
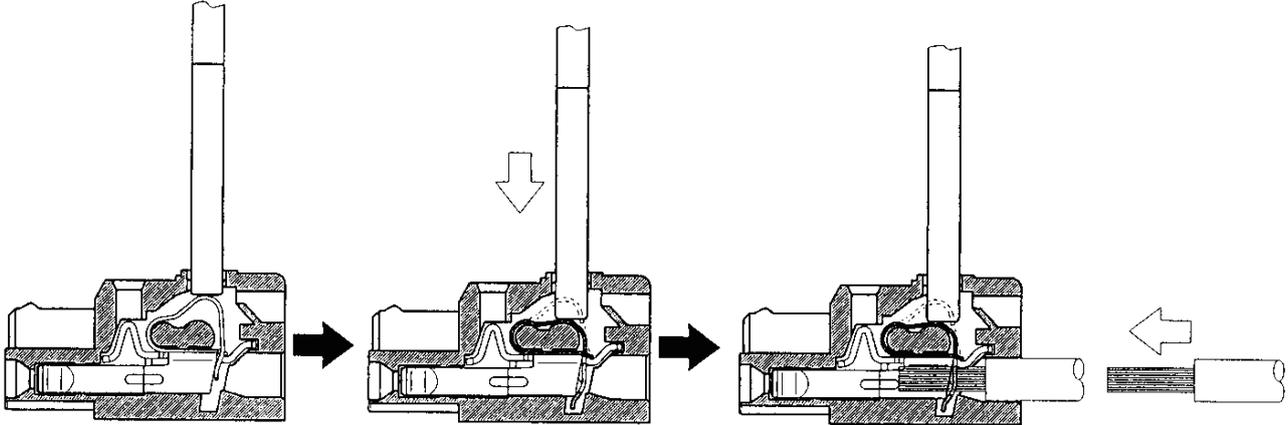
1) Insert the screwdriver into the square window at top of the connector.

2) Push the screwdriver in the direction of arrow.

3) With the screwdriver pushed, insert the cable in the direction of arrow. (Insert the cable as far as it will go.)
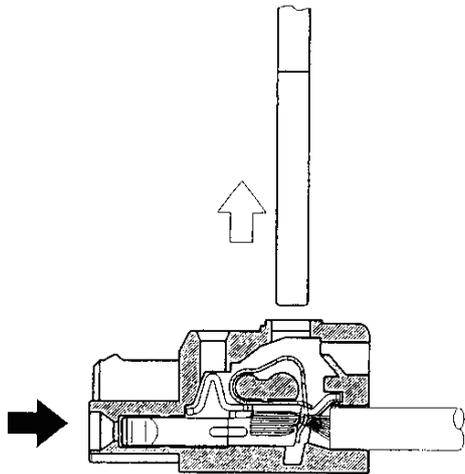
4) Releasing the screwdriver connects the cable.

3.11 Instructions for the 3M connector

When fabricating an encoder cable or the like, securely connect the shielded external conductor of the cable to the ground plate as shown in this section and fix it to the connector shell.

External conductor   Insulator

Strip the insulator

Core   External conductor   Insulator

Pull back the external conductor to cover the insulator

Screw

Cable

Screw

Ground plate
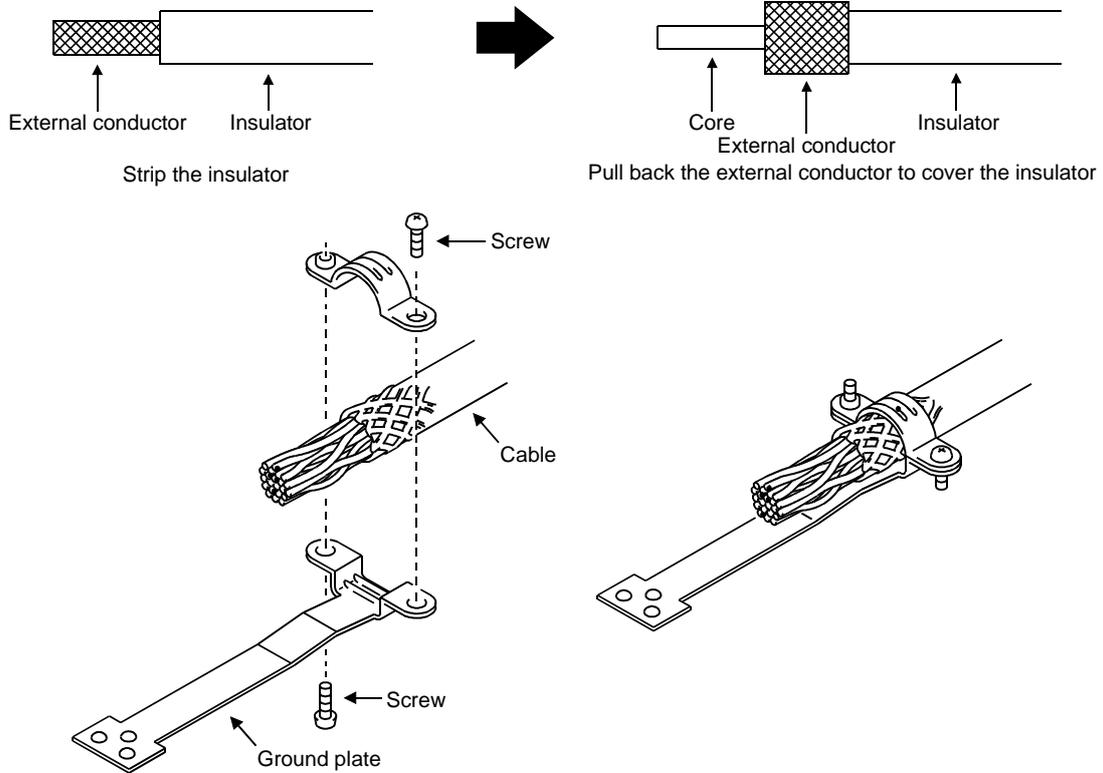
4. OPERATION

4.1 When switching power on for the first time

Before starting operation, check the following.

(1) Wiring
   (a) A correct power supply is connected to the power input terminals (L_1, L_2, L_3) of the servo amplifier.

   (b) The servo motor power supply terminals (U, V, W) of the servo amplifier match in phase with the power input terminals (U, V, W) of the servo motor.

   (c) The servo motor power supply terminals (U, V, W) of the servo amplifier are not shorted to the power input terminals (L_1, L_2, L_3) of the servo motor.

   (d) The earth terminal of the servo motor is connected to the PE terminal of the servo amplifier.

   (e) When using the regenerative option, the lead has been removed from across D-P of the servo amplifier built-in regenerative resistor, and twisted cables are used for its wiring.

   (f) When stroke end limit switches are used, the signals across LSP-VIN and LSN-VIN are on during operation.

   (g) 24VDC or higher voltages are not applied to the pins of connectors CN1.

   (h) SD and SG of connectors CN1 are not shorted.

   (i) The wiring cables are free from excessive force.

(2) Environment
   Signal cables and power cables are not shorted by wire offcuts, metallic dust or the like.

(3) Machine
   (a) The screws in the servo motor installation part and shaft-to-machine connection are tight.

   (b) The servo motor and the machine connected with the servo motor can be operated.

4.2 Startup

| ⚠ WARNING | ・Do not operate the switches with wet hands. You may get an electric shock. |

| ⚠ CAUTION | ・Before starting operation, check the parameters. Some machines may perform unexpected operation.
・Take safety measures, e.g. provide covers, to prevent accidental contact of hands and parts (cables, etc.) with the servo amplifier heat sink, regenerative resistor, servo motor, etc. since they may be hot while power is on or for some time after power-off. Their temperatures may be high and you may get burnt or a parts may damaged.
・During operation, never touch the rotating parts of the servo motor. Doing so can cause injury. |

Connect the servo motor with a machine after confirming that the servo motor operates properly alone.

4.2.1 Selection of control mode

Use parameter No.0 to choose the control mode used. After setting, this parameter is made valid by switching power off, then on.

4.2.2 Position control mode

(1) Power on
   1) Switch off the servo-on (SON).
   2) When power is switched on, the display shows "C (Cumulative feedback pulses)", and in two second later, shows data.

(2) Test operation 1
   Confirm servo motor operation by operating JOG of test operation mode at lowest speed possible. (Refer to section 6.8.2)

(3) Parameter setting
   Set the parameters according to the structure and specifications of the machine. Refer to chapter 5 for the parameter definitions and to section 6.5 for the setting method.

Parameter No.	Name	Setting	Description
0	Control mode, regenerative option selection	□3□0	Position control mode MR-RB12 regenerative option is used.
1	Function selection 1	□□02	Input filter 3.555ms (initial value) Electromagnetic brake interlock (MBR) is not used.
2	Auto tuning	□1□5	Middle response (initial value) is selected. Auto tuning mode 1 is selected.
3	Electronic gear numerator (CMX)	1	Electronic gear numerator
4	Electronic gear denominator (CDV)	1	Electronic gear denominator

Turn the power off after setting parameters No.0 and 1. Then switch power on again to make the set parameter values valid.

(4) Servo-on

Switch the servo-on in the following procedure.

1) Switch on power supply.

2) Switch on the servo-on (SON).

When placed in the servo-on status, the servo amplifier is ready to operate and the servo motor is locked.

(5) Command pulse input

Entry of a pulse train from the positioning device rotates the servo motor. At first, run it at lowest speed possible and check the rotation direction, etc. If it does not run in the intended direction, check the input signal.

On the status display, check the speed, command pulse frequency, load factor, etc. of the servo motor.

When machine operation check is over, check automatic operation with the program of the positioning device.

This servo amplifier has a real-time auto tuning function under model adaptive control. Performing operation automatically adjusts gains. The optimum tuning results are provided by setting the response level appropriate for the machine in parameter No.2. (Refer to chapter 7)

(6) Home position return

Make home position return as required.

(7) Stop

In any of the following statuses, the servo amplifier interrupts and stops the operation of the servo motor. Refer to section 3.8 for the servo motor equipped with electromagnetic brake. Note that the stop pattern of forward rotation stroke end (LSP), reverse rotation stroke end (LSN) OFF is as described below.

(a) Servo-on (SON) OFF

The base circuit is shut off and the servo motor coasts.

(b) Alarm occurrence

When an alarm occurs, the base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop.

(c) Emergency stop (EMG) OFF

The base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop. Alarm AL.E6 (servo emergency stop warning) occurs.

(d) Forward rotation stroke end (LSP), reverse rotation stroke end (LSN) OFF

The droop pulse value is erased and the servo motor is stopped and servo-locked. It can be run in the opposite direction.

4.2.3 Internal speed control mode

(1) Power on
  1) Switch off the servo-on (SON).

  2) When circuit power is switched on, the display shows "r (servo motor speed)", and in two second later, shows data.

(2) Test operation
  Using jog operation in the test operation mode, make sure that the servo motor operates. (Refer to section 6.8.2.)

(3) Parameter setting
  Set the parameters according to the structure and specifications of the machine. Refer to chapter 5 for the parameter definitions and to section 6.5 for the setting method.

Parameter No.	Name	Setting	Description
0	Control mode, regenerative option selection	□0□2	Internal speed control mode — Regenerative option is not used.
1	Function selection 1	□□12	Input filter 3.555ms (initial value) — Electromagnetic brake interlock (MBR) is used.
2	Auto tuning	□1□5	Middle response (initial value) is selected. — Auto tuning mode 1 is selected.
8	Internal speed command 1	1000	Set 1000r/min.
9	Internal speed command 1	1500	Set 1500r/min.
10	Internal speed command 1	2000	Set 2000r/min.
11	Acceleration time constant	1000	Set 1000ms.
12	Deceleration time constant	500	Set 500ms.
13	S-pattern acceleration/deceleration time constant	0	Not used

  Turn the power off after setting parameters No.0 and 1. Then switch power on again to make the set parameter values valid.

(4) Servo-on
  Switch the servo-on in the following procedure.

  1) Switch on circuit power supply.

  2) Switch on the servo-on (SON) signal. (Short between SON and VIN.)
    When placed in the servo-on status, the servo amplifier is ready to operate and the servo motor is locked.

(5) Start

Using speed selection 1 (SP1) and speed selection 2 (SP2), choose the servo motor speed. Turn on forward rotation start (ST1) to run the motor in the forward rotation (CCW) direction or reverse rotation start (ST2) to run it in the reverse rotation (CW) direction. At first, set a low speed and check the rotation direction, etc. If it does not run in the intended direction, check the input signal.

On the status display, check the speed, load factor, etc. of the servo motor.

When machine operation check is over, check automatic operation with the host controller or the like.

This servo amplifier has a real-time auto tuning function under model adaptive control. Performing operation automatically adjusts gains. The optimum tuning results are provided by setting the response level appropriate for the machine in parameter No.2. (Refer to chapter 7)

(6) Stop

In any of the following statuses, the servo amplifier interrupts and stops the operation of the servo motor.

Refer to section 3.8 for the servo motor equipped with electromagnetic brake. Note that simultaneous ON or simultaneous OFF of forward rotation stroke end (LSP), reverse rotation stroke end (LSN) OFF and forward rotation start (ST1) or reverse rotation start (ST2) signal has the same stop pattern as described below.

(a) Servo-on (SON) OFF

The base circuit is shut off and the servo motor coasts.

(b) Alarm occurrence

When an alarm occurs, the base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop.

(c) Emergency stop (EMG) OFF

The base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop. Alarm AL.E6 (servo emergency stop warning) occurs.

(d) Forward rotation stroke end (LSP), reverse rotation stroke end (LSN) OFF

The servo motor is brought to a sudden stop and servo-locked. The motor may be run in the opposite direction.

(e) Simultaneous ON or simultaneous OFF of forward rotation start (ST1) and reverse rotation start (ST2) signals

The servo motor is decelerated to a stop.

POINT
・A sudden stop indicates deceleration to a stop at the deceleration time constant of zero.

MEMO

5. PARAMETERS

⚠ CAUTION	・Never adjust or change the parameter values extremely as it will make operation instable. ・If fixed values are written in the digits of a parameter, do not change these values. ・Do not change parameters for manufacturer setting.

5.1 Parameter list

5.1.1 Parameter write inhibit

POINT
・After setting the parameter No.19 value, switch power off, then on to make that setting valid.

This servo amplifier, its parameters are classified into the basic parameters (No.0 to 19), expansion parameters 1 (No.20 to 49) and expansion parameters 2 (No.50 to 84) according to their safety aspects and frequencies of use. In the factory setting condition, the customer can change the basic parameter values but cannot change the expansion parameter values. When fine adjustment, e.g. gain adjustment, is required, change the parameter No.19 setting to make the expansion parameters write-enabled.
The following table indicates the parameters which are enabled for reference and write by the setting of parameter No.19. Operation can be performed for the parameters marked ○.

Parameter No.19 setting	Operation	Basic parameters No.0 to 19	Expansion parameters 1 No.20 to 49	Expansion parameters 2 No.50 to 84
0000 (initial value)	Reference	○		
	Write	○		
000A	Reference	No.19 only		
	Write	No.19 only		
000B	Reference	○	○	
	Write	○		
000C	Reference	○	○	
	Write	○	○	
000E	Reference	○	○	○
	Write	○	○	○
100B	Reference	○		
	Write	No.19 only		
100C	Reference	○	○	
	Write	No.19 only		
100E	Reference	○	○	○
	Write	No.19 only		

5.1.2 Lists

> POINT
> ・For any parameter whose symbol is preceded by *, set the parameter value and switch power off once, then switch it on again to make that parameter setting valid.

The symbols in the control mode column of the table indicate the following modes.
P: Position control mode
S: Internal speed control mode

(1) Item list

	No.	Symbol	Name	Control mode	Initial value	Unit	Customer setting
Basic parameters	0	*STY	Control mode, regenerative option selection	P・S	(Note 1)		
	1	*OP1	Function selection 1	P・S	0002		
	2	ATU	Auto tuning	P・S	0105		
	3	CMX	Electronic gear numerator	P	1		
	4	CDV	Electronic gear denominator	P	1		
	5	INP	In-position range	P	100	pulse	
	6	PG1	Position loop gain 1	P	35	rad/s	
	7	PST	Position command acceleration/deceleration time constant (Position smoothing)	P	3	ms	
	8	SC1	Internal speed command 1	S	100	r/min	
	9	SC2	Internal speed command 2	S	500	r/min	
	10	SC3	Internal speed command 3	S	1000	r/min	
	11	STA	Acceleration time constant	S	0	ms	
	12	STB	Deceleration time constant	S	0	ms	
	13	STC	S-pattern acceleration/deceleration time constant	S	0	ms	
	14		For manufacturer setting		0		
	15	*SNO	Station number setting	P・S	0	station	
	16	*BPS	Serial communication function selection, alarm history clear	P・S	0000		
	17	MOD	Analog monitor output	P・S	0100		
	18	*DMD	Status display selection	P・S	0000		
	19	*BLK	Parameter write inhibit	P・S	0000		

	No.	Symbol	Name	Control mode	Initial value	Unit	Customer setting
Expansion parameters 1	20	*OP2	Function selection 2	P・S	0000		
	21	*OP3	Function selection 3 (Command pulse selection)	P	0000		
	22	*OP4	Function selection 4	P・S	0000		
	23	FFC	Feed forward gain	P	0	%	
	24	ZSP	Zero speed detection	P・S	50	r/min	
	25		For manufacturer setting		0		
	26		For manufacturer setting		100		
	27	*ENR	Encoder output pulses	P・S	4000	pulse /rev	
	28	TL1	Internal torque limit 1	P・S	100	%	
	29		For manufacturer setting		0		
	30		For manufacturer setting		0		
	31	MO1	Analog monitor 1 offset	P・S	0	mV	
	32	MO2	Analog monitor 2 offset	P・S	0	mV	
	33	MBR	Electromagnetic brake sequence output	P・S	100	ms	
	34	GD2	Ratio of load inertia moment to servo motor inertia moment	P・S	70	Multiplier $(\times 10^{-1})$	
	35	PG2	Position loop gain 2	P	35	rad/s	
	36	VG1	Speed loop gain 1	P・S	177	rad/s	
	37	VG2	Speed loop gain 2	P・S	817	rad/s	
	38	VIC	Speed integral compensation	P・S	48	ms	
	39	VDC	Speed differential compensation	P・S	980		
	40		For manufacturer setting		0		
	41	*DIA	Input signal automatic ON selection	P・S	0000		
	42	*DI1	Input signal selection 1	P・S	0002		
	43	*DI2	Input signal selection 2 (CN1-4)	P・S	0111		
	44	*DI3	Input signal selection 3 (CN1-3)	P・S	0882		
	45	*DI4	Input signal selection 4 (CN1-5)	P・S	0995		
	46	*DI5	Input signal selection 5 (CN1-6)	P・S	0000		
	47	*DI6	Input signal selection 6 (CN1-7)	P・S	0000		
	48	*LSPN	LSP/LSN input terminals selection	P・S	0403		
	49	*DO1	Output signal selection 1	P・S	0000		

5. PARAMETERS

	No.	Symbol	Name	Control mode	Initial value	Unit	Customer setting
Expansion parameters 2	50		For manufacturer setting		0000		
	51	*OP6	Function selection 6	P・S	0000		
	52		For manufacturer setting		0000		
	53	*OP8	Function selection 8	P・S	0000		
	54	*OP9	Function selection 9	P・S	0000		
	55	*OPA	Function selection A	P	0000		
	56	SIC	Serial communication time-out selection	P・S	0	s	
	57		For manufacturer setting		10		
	58	NH1	Machine resonance suppression filter 1	P・S	0000		
	59	NH2	Machine resonance suppression filter 2	P・S	0000		
	60	LPF	Low-pass filter/adaptive vibration suppression control	P・S	0000		
	61	GD2B	Ratio of load inertia moment to Servo motor inertia moment 2	P・S	70	Multiplier ($\times 10^{-1}$)	
	62	PG2B	Position control gain 2 changing ratio	P	100	%	
	63	VG2B	Speed control gain 2 changing ratio	P・S	100	%	
	64	VICB	Speed integral compensation changing ratio	P・S	100	%	
	65	*CDP	Gain changing selection	P・S	0000		
	66	CDS	Gain changing condition	P・S	10	(Note 2)	
	67	CDT	Gain changing time constant	P・S	1	ms	
	68		For manufacturer setting		0		
	69	CMX2	Command pulse multiplying factor numerator 2	P	1		
	70	CMX3	Command pulse multiplying factor numerator 3	P	1		
	71	CMX4	Command pulse multiplying factor numerator 4	P	1		
	72	SC4	Internal speed command 4	S	200	r/min	
	73	SC5	Internal speed command 5	S	300	r/min	
	74	SC6	Internal speed command 6	S	500	r/min	
	75	SC7	Internal speed command 7	S	800	r/min	
	76	TL2	Internal torque limit 2	P・S	100	%	
	77		For manufacturer setting		100		
	78				10000		
	79				10		
	80				10		
	81				100		
	82				100		
	83				100		
	84				0000		

Note 1. Depends on the capacity of the servo amplifier.
　　 2. Depends on the parameter No.65 setting.

(2) Details list

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	0	*STY	Control mode, regenerative option selection Used to select the control mode and regenerative option. Select the control mode. 0: Position 1: Position and internal speed 2: Internal speed Motor series selection 0: HF-KN□(J) 1: HF-SN□J Selection of regenerative option 0: Regenerative option is not used ・For the servo amplifier of 200W or lower, regenerative resistor is not used. ・For the servo amplifier of 400W or higher, built-in regenerative resistor is used. 2: MR-RB032 3: MR-RB12 4: MR-RB32 5: MR-RB30 6: MR-RB50 (Cooling fan is required) Motor capacity selection 0: 100W 1: 200W 2: 400W 3: 500W 4: 750W 5: 1kW 6: 1.5kW 7: 2kW POINT ・Wrong setting may cause the regenerative option to burn. ・If the regenerative option selected is not for use with the servo amplifier, parameter error (AL.37) occurs.	100W : 0000 200W : 1000 400W : 2000 750W : 4000 1kW : 5010 2kW : 6010		Refer to name and function column.	P・S
	1	*OP1	Function selection 1 Used to select the input signal filter, the function of pin CN1-12. 0 0 Input signal filter If external input signal causes chattering due to noise, etc., input filter is used to suppress it. 0: None 1: 1.777[ms] 2: 3.555[ms] 3: 5.333[ms] CN1-12 function selection 0: Zero Speed detection signal 1: Electromagnetic brake interlock (MBR)	0002		Refer to name and function column.	P・S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	2	ATU	Auto tuning Used to selection the response level, etc. for execution of auto tuning. Refer to chapter 7. `0 _ 0 _` Auto tuning response level setting 	Set value	Response level	Machine resonance frequency guideline
---	---	---
1	Low response	15Hz
2		20Hz
3		25Hz
4		30Hz
5		35Hz
6		45Hz
7		55Hz
8	Middle response	70Hz
9		85Hz
A		105Hz
B		130Hz
C		160Hz
D		200Hz
E	High response	240Hz
F		300Hz	 • If the machine hunts or generates large gear sound, decrease the set value. • To improve performance, e.g. shorten the settling time, increase the set value. Gain adjustment mode selection (For more information, refer to section 7.1.1.) 	Set value	Gain adjustment mode	Description
---	---	---
0	Interpolation mode	Fixes position control gain 1 (parameter No.6).
1	Auto tuning mode 1	Ordinary auto tuning.
2	Auto tuning mode 2	Fixes the load inertia moment ratio set in parameter No.34. Response level setting can be changed.
3	Manual mode 1	Simple manual adjustment.
4	Manual mode 2	Manual adjustment of all gains.		0105		Refer to name and function column.	P・S
	3	CMX	Electronic gear numerator Used to set the electronic gear numerator value. For the setting, refer to section 5.2.1. Setting "0" automatically sets the resolution of the servo motor connected.	1		0 1 to 65535	P
	4	CDV	Electronic gear denominator Used to set the electronic gear denominator value. For the setting, refer to section 5.2.1.	1		1 to 65535	P

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	5	INP	In-position range Used to set the in-position signal (INP) output range in the command pulse increments prior to electronic gear calculation.	100	pulse	0 to 10000	P
	6	PG1	Position loop gain 1 Used to set the gain of position loop. Increase the gain to improve track ability in response to the position command. When auto turning mode 1,2 is selected, the result of auto turning is automatically used.	35	red/s	4 to 2000	P
	7	PST	Position command acceleration/deceleration time constant (position smoothing) Used to set the time constant of a low-pass filter in response to the position command. You can use parameter No.55 to choose the primary delay or linear acceleration/deceleration control system. When you choose linear acceleration/deceleration, the setting range is 0 to 10ms. Setting of longer than 10ms is recognized as 10ms. POINT ・When you have chosen linear acceleration/deceleration, do not select control selection (parameter No.0) and restart after instantaneous power failure (parameter No.20). Doing so will cause the servo motor to make a sudden stop at the time of position control switching or restart. Example: When a command is given from a synchronizing detector, synchronous operation can be started smoothly if started during line operation.	3	ms	0 to 20000	P
	8	SC1	Internal speed command 1 Used to set speed 1 of internal speed commands.	100	r/min	0 to instantaneous permissible speed	S
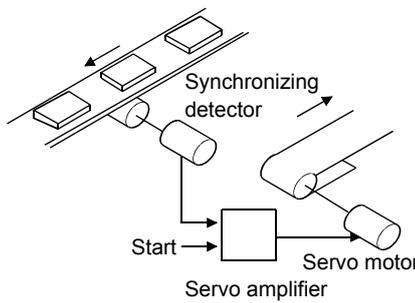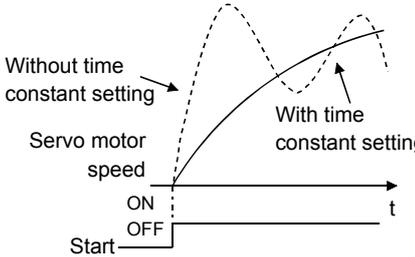
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	9	SC2	Internal speed command 2 Used to set speed 2 of internal speed commands.	500	r/min	0 to instantaneous permissible speed	S
	10	SC3	Internal speed command 3 Used to set speed 3 of internal speed commands.	1000	r/min	0 to instantaneous permissible speed	S
	11	STA	Acceleration time constant Used to set the acceleration time required to reach the rated speed from 0r/min in response to the internal speed commands 1 to 7. If the preset speed command is lower than the rated speed, acceleration/deceleration time will be shorter. Speed Rated speed Zero speed Time Parameter No.11 setting Parameter No.12 setting For example for the servo motor of 3000r/min rated speed, set 3000 (3s) to increase speed from 0r/min to 1000r/min in 1 second.	0	ms	0 to 20000	S
	12	STB	Deceleration time constant Used to set the deceleration time required to reach 0r/min from the rated speed in response to the internal speed commands 1 to 7.	0			
	13	STC	S-pattern acceleration/deceleration time constant Used to smooth start/stop of the servo motor. Set the time of the arc part for S-pattern acceleration/deceleration. Speed command Speed Servo motor 0r/min Time STC STA STC STC STB STC STA: Acceleration time constant (parameter No.11) STB: Deceleration time constant (parameter No.12) STC: S-pattern acceleration/deceleration time constant (parameter No.13) Long setting of STA (acceleration time constant) or STB (deceleration time constant) may produce an error in the time of the arc part for the setting of the S-pattern acceleration/deceleration time constant. The upper limit value of the actual arc part time is limited by $\frac{2000000}{STA}$ for acceleration or by $\frac{2000000}{STB}$ for deceleration. (Example) At the setting of STA=20000, STB=5000 and STC=200, the actual arc part times are as follows. During acceleration: 100[ms] Limited to 100[ms] since $\frac{2000000}{20000} = 100[ms] < 200[ms]$. During deceleration: 200[ms] 200[ms] as set since $\frac{2000000}{5000} = 400[ms] > 200[ms]$.	0	ms	0 to 1000	S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	14		For manufacturer setting Do not change this value by any means.	0			
	15	*SNO	Station number setting Used to specify the station number for serial communication. Always set one station to one axis of servo amplifier. If one station number is set to two or more stations, normal communication cannot be made.	0	station	0 to 31	P・S
	16	*BPS	Serial communication function selection, alarm history clear Used to select the serial communication baud rate, select various communication conditions, and clear the alarm history. Serial baud rate selection 0: 9600 [bps] 1: 19200[bps] 2: 38400[bps] 3: 57600[bps] Alarm history clear 0: Invalid (not cleared) 1: Valid (cleared) When alarm history clear is made valid, the alarm history is cleared at next power-on. After the alarm history is cleared, the setting is automatically made invalid (reset to 0). Serial communication response delay time 0: Invalid 1: Valid, reply sent after delay time of 800μs or more	0000		Refer to name and function column.	P・S
	17	MOD	Analog monitor output Used to selection the signal provided to the analog monitor (MO1)・analog monitor (MO2) output. (Refer to section 5.2.2.)	0100		Refer to name and function column.	P・S

Setting	Analog monitor 2 (MO2)	Analog monitor 1 (MO1)
0	Servo motor speed (±8V/max. speed)	
1	Torque (±8V/max. torque)	
2	Servo motor speed (+8V/max. speed)	
3	Torque (+8V/max. torque)	
4	Current command (±8V/max. current command)	
5	Command pulse frequency (±10V/500kpulse/s)	
6	Droop pulses (±10V/128 pulses)	
7	Droop pulses (±10V/2048 pulses)	
8	Droop pulses (±10V/8192 pulses)	
9	Droop pulses (±10V/32768 pulses)	
A	Droop pulses (±10V/131072 pulses)	
B	Bus voltage (+8V/400V)	

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	18	*DMD	Status display selection Used to select the status display shown at power-on. 0 0 □ □ Selection of status display at power-on 0: Cumulative feedback pulses 1: Servo motor speed 2: Droop pulses 3: Cumulative command pulses 4: Command pulse frequency 7: Regenerative load ratio 8: Effective load ratio 9: Peak load ratio A: Instantaneous torque B: Within one-revolution position low C: Within one-revolution position high D: Load inertia moment ratio E: Bus voltage Status display at power-on in corresponding control mode 0: Depends on the control mode. <table><tr><td>Control mode</td><td>Status display at power-on</td></tr><tr><td>Position</td><td>Cumulative feedback pulses</td></tr><tr><td>Position/ internal speed</td><td>Cumulative feedback pulses/ servo motor speed</td></tr><tr><td>Internal speed</td><td>Servo motor speed</td></tr></table> 1: Depends on the first digit setting of this parameter.	0000		Refer to name and function column.	P・S
	19	*BLK	Parameter write inhibit Used to select the reference and write ranges of the parameters. Operation can be performed for the parameters marked ○. (table below)	0000		Refer to name and function column.	P・S

Table for parameter No.19 (*BLK):

Set value	Operation	Basic parameters No.0 to 19	Expansion parameters 1 No.20 to 49	Expansion parameters 2 No.50 to 84
0000 (Initial value)	Reference	○		
	Write	○		
000A	Reference	No.19 only		
	Write	No.19 only		
000B	Reference	○	○	
	Write	○		
000C	Reference	○	○	
	Write	○	○	
000E	Reference	○	○	○
	Write	○	○	○
100B	Reference	○		
	Write	No.19 only		
100C	Reference	○	○	
	Write	No.19 only		
100E	Reference	○	○	○
	Write	No.19 only		

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	20	*OP2	Function selection 2 Used to select restart after instantaneous power failure, servo lock at a stop in internal speed control mode, and slight vibration suppression control. ⬚⬚⬚⬚ Restart after instantaneous power failure If the power supply voltage has returned to normal after an undervoltage status caused by the reduction of the input power supply voltage in the speed control mode, the servo motor can be restarted by merely turning on the start signal without resetting the alarm. 0: Invalid (Undervoltage alarm (AL.10) occurs.) 1: Valid Stop-time servo lock selection The shaft can be servo-locked to remain still at a stop in the internal speed control mode. 0: Valid 1: Invalid Slight vibration suppression control Made valid when auto tuning selection is set to "0400" in parameter No.2. Used to suppress vibration at a stop. 0: Invalid 1: Valid Encoder cable communication system selection 0: Two-wire type 1: Four-wire type Incorrect setting will result in an encoder alarm 1 (AL.16) or encoder alarm 2 (AL.20).	0000		Refer to name and function column.	S P・S P・S
	21	*OP3	Function selection 3 (Command pulse selection) Used to select the input form of the pulse train input signal. (Refer to section 3.4.1.) 0 0 ⬚ ⬚ Command pulse train input form 0: Forward/reverse rotation pulse train 1: Signed pulse train 2: A・B-phase pulse train Pulse train logic selection 0: Positive logic 1: Negative logic	0000		Refer to name and function column.	P

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	22	*OP4	Function selection 4 Used to select stop processing at forward rotation stroke end (LSP)・reverse rotation stroke end (LSN) off and choose TLC/VLC output. $\boxed{0}\ \boxed{0}\ \boxed{0}\ \boxed{}$ How to make a stop when forward rotation stroke end (LSP)・reverse rotation stroke end (LSN) is OFF. (Refer to section 5.2.3.) 0: Sudden stop 1: Slow stop	0000		Refer to name and function column.	P・S
	23	FFC	Feed forward gain Set the feed forward gain. When the setting is 100%, the droop pulses during operation at constant speed are nearly zero. However, sudden acceleration/deceleration will increase the overshoot. As a guideline, when the feed forward gain setting is 100%, set 1s or more as the acceleration time constant up to the rated speed.	0	%	0 to 100	P
	24	ZSP	Zero speed Used to set the output range of the zero speed detection (ZSP).	50	r/min	0 to 10000	P・S
	25		For manufacturer setting	0			
	26		Do not change this value by any means.	100			
	27	*ENR	Encoder output pulses Used to set the encoder pulses (A-phase or B-phase) output by the servo amplifier. Set the value 4 times greater than the A-phase or B-phase pulses. You can use parameter No.54 to choose the output pulse designation or output division ratio setting. The number of A・B-phase pulses actually output is 1/4 times greater than the preset number of pulses. The maximum output frequency is 1.3Mpps (after multiplication by 4). Use this parameter within this range. ・For output pulse designation Set "0□□□" (initial value) in parameter No.54. Set the number of pulses per servo motor revolution. Output pulse = set value [pulses/rev] At the setting of 5600, for example, the actually A・B-phase pulses output are as indicated below. A・B-phase output pulses $= \dfrac{5600}{4} = 1400$[pulse] ・For output division ratio setting Set "1□□□" in parameter No.54. The number of pulses per servo motor revolution is divided by the set value. Output pulse $= \dfrac{\text{Resolution per servo motor revolution}}{\text{Set value}}$ [pulses/rev] At the setting of 8, for example, the actually A・B-phase pulses output are as indicated below. A・B-phase output pulses $= \dfrac{10000}{8} \cdot \dfrac{1}{4} \fallingdotseq 313$[pulse]	4000	pulse/rev	1 to 65535	P・S

5. PARAMETERS

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	28	TL1	Internal torque limit 1 Set this parameter to limit servo motor torque on the assumption that the maximum torque is 100[%]. When 0 is set, torque is not produced. <table><tr><td>(Note) External input signals TL1</td><td>Torque limit value made valid</td></tr><tr><td>0</td><td>Internal torque limit value 1 (parameter No.28)</td></tr><tr><td>1</td><td>Parameter No.76 > Parameter No.28: Parameter No.28 Parameter No.76 < Parameter No.28: Parameter No.76</td></tr></table> Note. 0: TL1-VIN off (open) 　　　1: TL1-VIN on (short) When torque is output in analog monitor output, this set value is the maximum output voltage (＋8V). (Refer to section 3.4.1 (5))	100	%	0 to 100	P・S
	29		For manufacturer setting	0			
	30		Do not change this value by any means.				
	31	MO1	Analog monitor 1 offset Used to set the offset voltage of the analog monitor 1 (MO1).	0	mV	−999 to 999	P・S
	32	MO2	Analog monitor 2 offset Used to set the offset voltage of the analog monitor 2 (MO2).	0	mV	−999 to 999	P・S
	33	MBR	Electromagnetic brake sequence output Used to set the delay time (Tb) between electronic brake interlock (MBR) and the base drive circuit is shut-off.	100	ms	0 to 1000	P・S
	34	GD2	Ratio of load inertia moment to servo motor inertia moment Used to set the ratio of the load inertia moment to the servo motor shaft inertia moment. When auto tuning mode 1 and interpolation mode is selected, the result of auto tuning is automatically used. (Refer to section 7.1.1) In this case, it varies between 0 and 1000.	70	Multi-plier ($\times 10^{-1}$)	0 to 3000	P・S
	35	PG2	Position loop gain 2 Used to set the gain of the position loop. Set this parameter to increase the position response to level load disturbance. Higher setting increases the response level but is liable to generate vibration and/or noise. When auto tuning mode 1・2 and interpolation mode is selected, the result of auto tuning is automatically used.	35	rad/s	1 to 1000	P
	36	VG1	Speed loop gain 1 Normally this parameter setting need not be changed. Higher setting increases the response level but is liable to generate vibration and/or noise. When auto tuning mode 1・2, manual mode and interpolation mode is selected, the result of auto tuning is automatically used.	177	rad/s	20 to 8000	P・S
	37	VG2	Speed loop gain 2 Set this parameter when vibration occurs on machines of low rigidity or large backlash. Higher setting increases the response level but is liable to generate vibration and/or noise. When auto tuning mode 1・2 and interpolation mode is selected, the result of auto tuning is automatically used.	817	rad/s	20 to 20000	P・S
	38	VIC	Speed integral compensation Used to set the integral time constant of the speed loop. Higher setting increases the response level but is liable to generate vibration and/or noise. When auto tuning mode 1・2 and interpolation mode is selected, the result of auto tuning is automatically used.	48	ms	1 to 1000	P・S
	39	VDC	Speed differential compensation Used to set the differential compensation. Made valid when the proportion control (PC) is switched on.	980		0 to 1000	P・S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	40		For manufacturer setting Do not change this value by any means.	0			

	41	*DIA	Input signal automatic ON selection
			Used to set automatic servo-on (SON)・forward rotation stroke end (LSP)・reverse rotation stroke end (LSN).
			
			0 ☐ ☐ ☐
			
			Servo-on (SON) input selection
			  0: Switched on/off by external input.
			  1: Switched on automatically in servo amplifier.
			  (No need of external wiring)
			
			Forward rotation stroke end (LSP) input selection
			  0: Switched on/off by external input.
			  1: Switched on automatically in servo amplifier.
			  (No need of external wiring)
			
			Reverse rotation stroke end (LSN) input selection
			  0: Switched on/off by external input.
			  1: Switched on automatically in servo amplifier.
			  (No need of external wiring)
				0000		Refer to name and function column.	P・S
							
							P・S

	42	*DI1	Input signal selection 1
			Used to assign the control mode changing signal input pins and to set the clear (CR).
			
			0 0 ☐ ☐
			
			Control change (LOP) input pin assignment
			Used to set the control mode change signal input connector pins. Note that this parameter is made valid when parameter No.0 is set to select the position/internal speed change mode.
			
			<table><tr><th>Set value</th><th>Connector pin No.</th></tr><tr><td>0</td><td>CN1-4</td></tr><tr><td>1</td><td>CN1-3</td></tr><tr><td>2</td><td>CN1-5</td></tr><tr><td>3</td><td>CN1-6</td></tr><tr><td>4</td><td>CN1-7</td></tr></table>
			If forward rotation stroke end (LSP) or reverse rotation stroke end (LSN) is assigned to any pin with parameter No.48, this setting is invalid.
			
			Clear (CR) selection
			  0: Droop pulses are cleared on the leading edge.
			  1: While turning on, droop pulses are always cleared.
				0002		Refer to name and function column.	P/S
							
							P

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	43	*DI2	Input signal selection 2 (CN1-4) Allows any input signal to be assigned to CN1-pin 4. Note that the setting digit and assigned signal differ according to the control mode. `0 1 ▢ ▢` Position control mode ⎫ Internal speed control mode ⎬ Input signals of CN1-pin 4 selected. Signals that may be assigned in each control mode are indicated below by their symbols. Setting of any other signal will be invalid. 	Set value	(Note) Control mode	
	P	S
0		
1	SON	SON
2	RES	RES
3	PC	PC
4		
5	CR	CR
6		SP1
7		SP2
8		ST1
9		ST2
A		SP3
B	CM1	
C	CM2	
D	TL1	TL1
E	CDP	CDP
F			 Note. P: Position control mode S: Internal speed control mode This parameter is unavailable when parameter No.42 is set to assign the control change (LOP) to CN1-pin 4. This parameter is unavailable when parameter No.48 is set to assign the Forward rotation stroke end (LSP) and Reverse rotation stroke end (LSN) to be assigned to CN1-pin 4.	0111		Refer to name and function column.	P・S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	44	*DI3	Input signal selection 3 (CN1-3) Allows any input signal to be assigned to CN1-pin 3. The assignable signals and setting method are the same as in input signal selection 2 (parameter No.43). `0  0  [ ]  [ ]` Position control mode Internal speed control mode ⎫ Input signals of CN1-pin 3 selected. This parameter is unavailable when parameter No.42 is set to assign the control change (LOP) to CN1-pin 3. This parameter is unavailable when parameter No.48 is set to assign the Forward rotation stroke end (LSP) and Reverse rotation stroke end (LSN) to be assigned to CN1-pin 3.	0882		Refer to name and function column.	P・S
	45	*DI4	Input signal selection 4 (CN1-5) Allows any input signal to be assigned to CN1-pin 5. The assignable signals and setting method are the same as in input signal selection 2 (parameter No.43). `0  9  [ ]  [ ]` Position control mode Internal speed control mode ⎫ Input signals of CN1-pin 5 selected. This parameter is unavailable when parameter No.42 is set to assign the control change (LOP) to CN1-pin 5. This parameter is unavailable when parameter No.48 is set to assign the Forward rotation stroke end (LSP) and Reverse rotation stroke end (LSN) to be assigned to CN1-pin 5	0995		Refer to name and function column.	P・S
	46	*DI5	Input signal selection 5 (CN1-6) Allows any input signal to be assigned to CN1-pin 6. The assignable signals and setting method are the same as in input signal selection 2 (parameter No.43). `0  0  [ ]  [ ]` Position control mode Internal speed control mode ⎫ Input signals of CN1-pin 6 selected. This parameter is unavailable when parameter No.42 is set to assign the control change (LOP) to CN1-pin 6. This parameter is unavailable when parameter No.48 is set to assign the Reverse rotation stroke end (LSN) to be assigned to CN1-pin 6.	0000		Refer to name and function column.	P・S

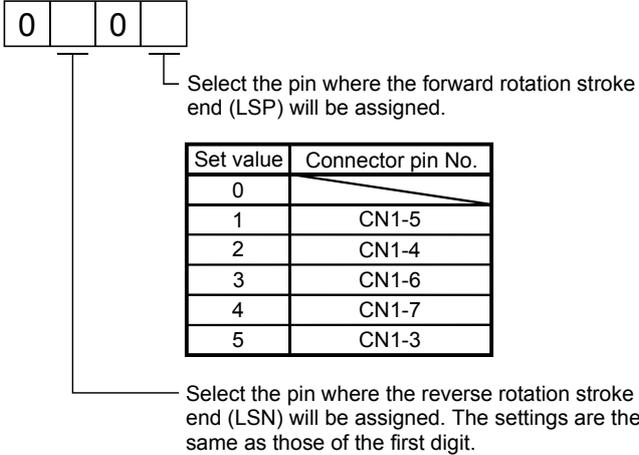| Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	47	*DI6	Input signal selection 6 (CN1-7) Allows any input signal to be assigned to CN1-pin 7. The assignable signals and setting method are the same as in input signal selection 2 (parameter No.43). 0 0 ☐ ☐ └─ Position control mode ┐ Input signals of └─ Internal speed control mode ┘ CN1-pin 7 selected. This parameter is unavailable when parameter No.42 is set to assign the control change signal (LOP) to CN1-pin 7. This parameter is unavailable when parameter No.48 is set to assign the Forward rotation stroke end (LSP) to be assigned to CN1-pin 7.	0000		Refer to name and function column.	P · S
	48	*LSPN	LSP/LSN input terminal selection Select the pins where the forward rotation stroke end (LSP) and reverse rotation stroke end (LSN) will be assigned. If the signals have already been assigned using parameter No.42 to 47, this parameter setting has preference. However, if the forward rotation stroke end (LSP) is assigned at pin 6 of CN1 (default setting), the setting of parameter No.46 takes priority. Similarly, if the reverse rotation stroke end (LSN) is assigned at pin 7 of CN1 (default setting), the setting of parameter No.47 takes priority. If the forward rotation stroke end (LSP) and reverse rotation stroke end (LSN) are assigned at the same pin, the forward rotation stroke end (LSP) takes priority while the reverse rotation stroke end (LSN) is disabled. 0 ☐ 0 ☐ └─ Select the pin where the forward rotation stroke end (LSP) will be assigned. <table><tr><td>Set value</td><td>Connector pin No.</td></tr><tr><td>0</td><td></td></tr><tr><td>1</td><td>CN1-5</td></tr><tr><td>2</td><td>CN1-4</td></tr><tr><td>3</td><td>CN1-6</td></tr><tr><td>4</td><td>CN1-7</td></tr><tr><td>5</td><td>CN1-3</td></tr></table> └─ Select the pin where the reverse rotation stroke end (LSN) will be assigned. The settings are the same as those of the first digit.	0403		Refer to name and function column.	P · S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	49	*DO1	Output signal selection 1 Used to select the connector pins to output the alarm code and warning (WNG). ┌─┬─┬─┬─┐ │ 0 │ 0 │ │ │ └─┴─┴─┴─┘ Setting of alarm code output	0000		Refer to name and function column.	P · S

Setting of alarm code output

Set value	Connector pins		
	CN1-10	CN1-11	CN1-12
0	INP or SA	RD	ZSP
1	Alarm code is output at alarm occurrence.		

(Note) Alarm code			Alarm display	Name
CN1 pin 10	CN1 pin 11	CN1 pin 12		
0	0	0	88888	Watchdog
			AL.12	Memory error 1
			AL.13	Clock error
			AL.15	Memory error 2
			AL.17	Board error 2
			AL.19	Memory error 3
			AL.37	Parameter error
			AL.8A	Serial communication time-out error
			AL.8E	Serial communication error
0	1	0	AL.30	Regenerative error
			AL.33	Overvoltage
1	0	0	AL.10	Undervoltage
1	1	0	AL.45	Main circuit device overheat
			AL.46	Servo motor overheat
			AL.50	Overload 1
			AL.51	Overload 2
0	0	1	AL.24	Main circuit
			AL.32	Overcurrent
0	1	1	AL.31	Overspeed
			AL.35	Command pulse frequency error
			AL.52	Error excessive
1	0	1	AL.16	Encoder error 1
			AL.1A	Motor combination error
			AL.20	Encoder error 2

Note. 0: Pin-VIN off (open)
1: Pin-VIN on (short)

Setting of warning (WNG) output
Select the connector pin to output warning. The old signal before selection will be unavailable.

Set value	Connector pin No.
0	Not output.
1	CN1-11
2	CN1-9
3	CN1-10
4	CN1-12

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	50		For manufacturer setting Do not change this value by any means.	0000			
	51	*OP6	Function selection 6 Used to select the operation to be performed when the reset (RES) switches on. 0 ⬚ 0 0 Operation to be performed when the reset (RES) switches on 0: Base circuit shut off 1: Base circuit not shut off	0000		Refer to name and function column.	P・S
	52		For manufacturer setting Do not change this value by any means.	0000			
	53	*OP8	Function selection 8 Used to select the protocol of serial communication. 0 ⬚ ⬚ 0 Protocol checksum selection 0: Yes (checksum added) 1: No (checksum not added) Protocol checksum selection 0: With station numbers 1: No station numbers	0000		Refer to name and function column.	P・S
	54	*OP9	Function selection 9 Use to select the command pulse rotation direction, encoder output pulse direction and encoder pulse output setting. ⬚ ⬚ 0 ⬚ Servo motor rotation direction changing Changes the servo motor rotation direction for the input pulse train. Encoder pulse output phase changing Changes the phases of A・B-phase encoder pulses output. Encoder output pulse setting selection (refer to parameter No.27) 0: Output pulse setting 1: Division ratio setting	0000		Refer to name and function column.	P・S

For parameter No. 54, Servo motor rotation direction changing:

Set value	Servo motor rotation direction	
	At forward rotation pulse input	At reverse rotation pulse input
0	CCW	CW
1	CW	CCW

Encoder pulse output phase changing:

Set value	Servo motor rotation direction	
	CCW	CW
0	A-phase / B-phase	A-phase / B-phase
1	A-phase / B-phase	A-phase / B-phase

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	55	*OPA	Function selection A Used to select the position command acceleration/deceleration time constant (parameter No.7) control system. 0 0 0 Position command acceleration/deceleration time constant control 0: Primary delay 1: Linear acceleration/deceleration	0000		Refer to name and function column.	P
	56	SIC	Serial communication time-out selection Used to set the communication protocol time-out period in [s]. When you set "0", time-out check is not made.	0	 s	0 1 to 60	P・S
	57		For manufacturer setting Do not change this value by any means.	10			
	58	NH1	Machine resonance suppression filter 1 Used to selection the machine resonance suppression filter. (Refer to section 8.2.) 0 Notch frequency selection Set "00" when you have set adaptive vibration suppression control to be "valid" or "held" (parameter No.60: □1□□ or □2□□).	0000		Refer to name and function column.	P・S
	59	NH2	Machine resonance suppression filter 2 Used to set the machine resonance suppression filter. 0 Notch frequency Same setting as in parameter No.58 However, you need not set "00" if you have set adaptive vibration suppression control to be "valid" or "held". Notch depth Same setting as in parameter No.58	0000		Refer to name and function column.	P・S

Notch frequency selection table (parameter No.58):

Setting value	Frequency	Setting value	Frequency	Setting value	Frequency	Setting value	Frequency
00	Invalid	08	562.5	10	281.3	18	187.5
01	4500	09	500	11	264.7	19	180
02	2250	0A	450	12	250	1A	173.1
03	1500	0B	409.1	13	236.8	1B	166.7
04	1125	0C	375	14	225	1C	160.1
05	900	0D	346.2	15	214.3	1D	155.2
06	750	0E	321.4	16	204.5	1E	150
07	642.9	0F	300	17	195.7	1F	145.2

Notch depth selection:

Setting value	Depth	Gain
0	Deep	−40dB
1	to	−14dB
2		−8dB
3	Shallow	−4dB

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	60	LPF	Low-pass filter/adaptive vibration suppression control Used to selection the low-pass filter and adaptive vibration suppression control. (Refer to chapter 8.) ☐ ☐ ☐ 0 Low-pass filter selection 0: Valid (Automatic adjustment) 1: Invalid When you choose "valid", $\dfrac{VG2\ setting \times 10}{2\pi(1+GD2\ setting \times 0.1)}$ [Hz] bandwidth filter is set automatically. Adaptive vibration suppression control selection Choosing "valid" or "held" in adaptive vibration suppression control selection makes the machine resonance suppression filter 1 (parameter No.58) invalid. 0: Invalid 1: Valid Machine resonance frequency is always detected and the filter is generated in response to resonance to suppress machine vibration. 2: Held The characteristics of the filter generated so far are held, and detection of machine resonance is stopped. Adaptive vibration suppression control sensitivity selection Used to set the sensitivity of machine resonance detection. 0: Normal 1: Large sensitivity	0000		Refer to name and function column.	P・S
	61	GD2B	Ratio of load inertia moment to servo motor inertia moment 2 Used to set the ratio of load inertia moment to servo motor inertia moment when gain changing is valid.	70	Multi-plier ($\times 10^{-1}$)	0 to 3000	P・S
	62	PG2B	Position control gain 2 changing ratio Used to set the ratio of changing the position control gain 2 when gain changing is valid. Made valid when auto tuning is invalid.	100	%	10 to 200	P
	63	VG2B	Speed control gain 2 changing ratio Used to set the ratio of changing the speed control gain 2 when gain changing is valid. Made valid when auto tuning is invalid.	100	%	10 to 200	P・S
	64	VICB	Speed integral compensation changing ratio Used to set the ratio of changing the speed integral compensation when gain changing is valid. Made valid when auto tuning is invalid.	100	%	50 to 1000	P・S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	65	*CDP	Gain changing selection Used to select the gain changing condition. (Refer to section 8.5.) 0 0 0 ☐ Gain changing selection Gains are changed in accordance with the settings of parameters No.61 to 64 under any of the following conditions: 0: Invalid 1: Gain changing (CDP) is ON 2: Command frequency is equal to higher than parameter No.66 setting 3: Droop pulse value is equal to higher than parameter No.66 setting 4: Servo motor speed is equal to higher than parameter No.66 setting	0000		Refer to name and function column.	P・S
	66	CDS	Gain changing condition Used to set the value of gain changing condition (command frequency, droop pulses, servo motor speed) selected in parameter No.65.The set value unit changes with the changing condition item. (Refer to section 8.5.)	10	kpps pulse r/min	10 to 9999	P・S
	67	CDT	Gain changing time constant Used to set the time constant at which the gains will change in response to the conditions set in parameters No.65 and 66. (Refer to section 8.5.)	1	ms	0 to 100	P・S
	68		For manufacturer setting Do not change this value by any means.	0			
	69	CMX2	Command pulse multiplying factor numerator 2 Used to set the multiplier for the command pulse. Setting "0" automatically sets the connected motor resolution.	1		0・1 to 65535	P
	70	CMX3	Command pulse multiplying factor numerator 3 Used to set the multiplier for the command pulse. Setting "0" automatically sets the connected motor resolution.	1		0・1 to 65535	P
	71	CMX4	Command pulse multiplying factor numerator 4 Used to set the multiplier for the command pulse. Setting "0" automatically sets the connected motor resolution.	1		0・1 to 65535	P
	72	SC4	Internal speed command 4 Used to set speed 4 of internal speed commands.	200	r/min	0 to instantaneous permissible speed	S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	73	SC5	Internal speed command 5 Used to set speed 5 of internal speed commands.	300	r/min	0 to instan- taneous permis- sible speed	S
	74	SC6	Internal speed command 6 Used to set speed 6 of internal speed commands.	500	r/min	0 to instant- aneous permis- sible speed	S
	75	SC7	Internal speed command 7 Used to set speed 7 of internal speed commands.	800	r/min	0 to instant- aneous permis- sible speed	S
	76	TL2	Internal torque limit 2 Set this parameter to limit servo motor torque on the assumption that the maximum torque is 100[%]. When 0 is set, torque is not produced. When torque is output in analog monitor output, this set value is the maximum output voltage (＋8V).	100	%	0 to 100	P・S
	77		For manufacturer setting Do not change this value by any means.	100			
	78			10000			
	79			10			
	80			10			
	81			100			
	82			100			
	83			100			
	84			0000			

5.2 Detailed description

5.2.1 Electronic gear

⚠ CAUTION · Wrong setting can lead to unexpected fast rotation, causing injury.

```
POINT
```
· The guideline of the electronic gear setting range is $\frac{1}{50} < \frac{CMX}{CDV} < 50$.
  If the set value is outside this range, noise may be generated during acceleration/ deceleration or operation may not be performed at the preset speed and/or acceleration/deceleration time constants.
· Always set the electronic gear with servo off state to prevent unexpected operation due to improper setting.

The machine can be moved at any multiplication factor to input pulses.

$$\frac{CMX}{CDV} = \frac{\text{Parameter No.3}}{\text{Parameter No.4}}$$
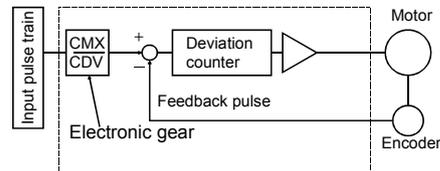
The following setting examples are used to explain how to calculate the electronic gear.

```
POINT
```
· The following specification symbols are required to calculate the electronic gear
  Pb : Ball screw lead [mm]
  1/n : Reduction ratio
  Pt : Servo motor resolution [pulses/rev]
  $\Delta \ell_0$: Travel per command pulse [mm/pulse]
  ΔS : Travel per servo motor revolution [mm/rev]
  $\Delta\theta°$: Angle per pulse [° /pulse]
  $\Delta\theta$: Angle per revolution [° /rev]

(1) For motion in increments of 10μm per pulse

Machine specifications

Ball screw lead Pb = 10 [mm]
Reduction ratio: 1/n = 1/2
Z_1: Number of gear cogs on servo motor side
Z_2: Number of gear cogs on load side
Servo motor resolution: Pt = 131072 [pulses/rev]
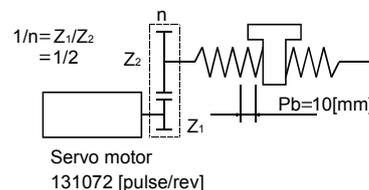
$$\frac{CMX}{CDV} = \Delta\ell_0 \cdot \frac{Pt}{\Delta S} = \Delta\ell_0 \cdot \frac{Pt}{1/n \cdot Pb} = 10 \times 10^{-3} \cdot \frac{131072}{1/2 \cdot 10} = \frac{262144}{1000} = \frac{32768}{125}$$

Hence, set 32768 to CMX and 125 to CDV.

(2) Conveyor setting example

For rotation in increments of 0.01° per pulse

Machine specifications

Servo motor
131072 [pulse/rev]

Table

Timing belt : 4/64

Table : 360° /rev
Reduction ratio: 1/n = 1/18
Servo motor resolution: Pt = 131072 [pulses/rev]
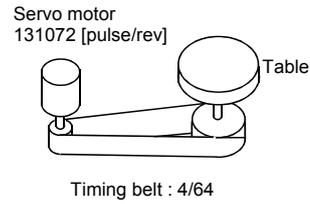
$$\frac{CMX}{CDV} = \Delta\theta° \cdot \frac{Pt}{\Delta\theta} = 0.01 \cdot \frac{131072}{4/64 \cdot 360} = \frac{65536}{1125} \dots\dots\dots\dots\dots\dots (5.1)$$

Since CMX is not within the setting range in this status, it must be reduced to the lowest term.
When CMX has been reduced to a value within the setting range, round off the value to the nearest unit.

$$\frac{CMX}{CDV} = \frac{65536}{1125} = \frac{26214.4}{450} \cong \frac{26214}{450}$$

Hence, set 26214 to CMX and 450 to CDV.

POINT

· When "0" is set to parameter No.3 (CMX), CMX is automatically set to the servo motor resolution. Therefore, in the case of Expression (5.2), setting 0 to CMX and 2250 to CDX concludes in the following expression: CMX/CDV=131072/2250, and electric gear can be set without the necessity to reduce the fraction to the lowest term.

· For unlimited one-way rotation, e.g. an index table, indexing positions will be missed due to cumulative error produced by rounding off.

· For example, entering a command of 36000 pulses in the above example causes the table to rotate only the following:

$$36000 \cdot \frac{26214}{450} \cdot \frac{1}{131072} \cdot \frac{4}{64} \cdot 360° = 359.995°$$

· Therefore, indexing cannot be done in the same position on the table.

---

(3) Instructions for reduction

The calculated value before reduction must be as near as possible to the calculated value after reduction. In the case of (2) in this section, an error will be smaller if reduction is made to provide no fraction for CDV. The fraction of Expression (5.1) before reduction is calculated as follows.

$$\frac{CMX}{CDV} = \frac{65536}{1125} = 58.25422 \quad\text{(5.2)}$$

The result of reduction to provide no fraction for CMX is as follows.

$$\frac{CMX}{CDV} = \frac{65536}{1125} = \frac{32768}{562.5} \cong \frac{32768}{563} = 58.20249 \quad\text{(5.3)}$$

The result of reduction to provide no fraction for CDV is as follows.

$$\frac{CMX}{CDV} = \frac{65536}{1125} = \frac{26214.4}{450} \cong \frac{26214}{450} = 58.25333 \quad\text{(5.4)}$$

As a result, it is understood that the value nearer to the calculation result of Expression (5.2) is the result of Expression (5.4). Accordingly, the set values of (2) in this section are CMX 26214, CDV 450.

5.2.2 Analog monitor

The servo status can be output to two channels in terms of voltage.

(1) Setting

Change the following digits of parameter No.17.

Parameter No.17

| 0 | | 0 | |

Analog monitor 1 (MO1) output selection
(Signal output to across MO1-LG)

Analog monitor 2 (MO2) output selection
(Signal output to across MO2-LG)
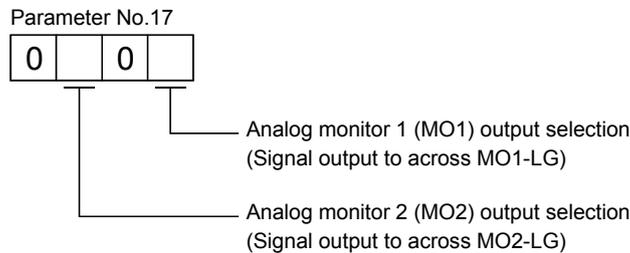
Parameters No.31 and 32 can be used to set the offset voltages to the analog output voltages. The setting range is between −999 and 999mV.

Parameter No.	Description	Setting range [mV]
31	Used to set the offset voltage for the analog monitor 1 (MO1) output.	−999 to 999
32	Used to set the offset voltage for the analog monitor 2 (MO2) output.	

(2) Set content

The servo amplifier is factory-set to output the servo motor speed to Analog monitor 1 (MO1) and the torque to Analog monitor 2 (MO2). The setting can be changed as listed below by changing the parameter No.17 value.

Refer to (3) for the measurement point.

Setting	Output item	Description	Setting	Output item	Description
0	Servo motor speed	8[V] CCW direction; Max. speed — 0 — Max. speed; −8[V] CW direction	6	Droop pulses (Note 1) (±10V/128pulse)	10[V] CCW direction; 128[pulse] — 0 — 128[pulse]; −10[V] CW direction
1	Torque (Note 2)	8[V] Driving in CCW direction; Max. torque — 0 — Max. torque; −8[V] Driving in CW direction	7	Droop pulses (Note 1) (±10V/2048pulse)	10[V] CCW direction; 2048[pulse] — 0 — 2048[pulse]; −10[V] CW direction
2	Servo motor speed	CW direction 8[V] CCW direction; Max. speed — 0 — Max. speed	8	Droop pulses (Note 1) (±10V/8192pulse)	10[V] CCW direction; 8192[pulse] — 0 — 8192[pulse]; −10[V] CW direction
3	Torque (Note 2)	Driving in CW direction 8[V] Driving in CCW direction; Max. torque — 0 — Max. torque	9	Droop pulses (Note 1) (±10V/32768pulse)	10[V] CCW direction; 32768[pulse] — 0 — 32768[pulse]; −10[V] CW direction
4	Current command	8[V] CCW direction; Max. command current — 0 — Max. command current; −8[V] CW direction	A	Droop pulses (Note 1) (±10V/131072pulse)	10[V] CCW direction; 131072[pulse] — 0 — 131072[pulse]; −10[V] CW direction
5	Command pulse frequency	10[V] CCW direction; −500kpps — 0 — 500kpps; −10[V] CW direction	B	Bus voltage	8[V]; 0 — 400[V]

Note 1. Encoder pulse unit.
   2. 8V is outputted at the maximum torque.
      However, when parameter No.28 ⁑ 76 are set to limit torque, 8V is outputted at the torque highly limited.

(3) Analog monitor block diagram
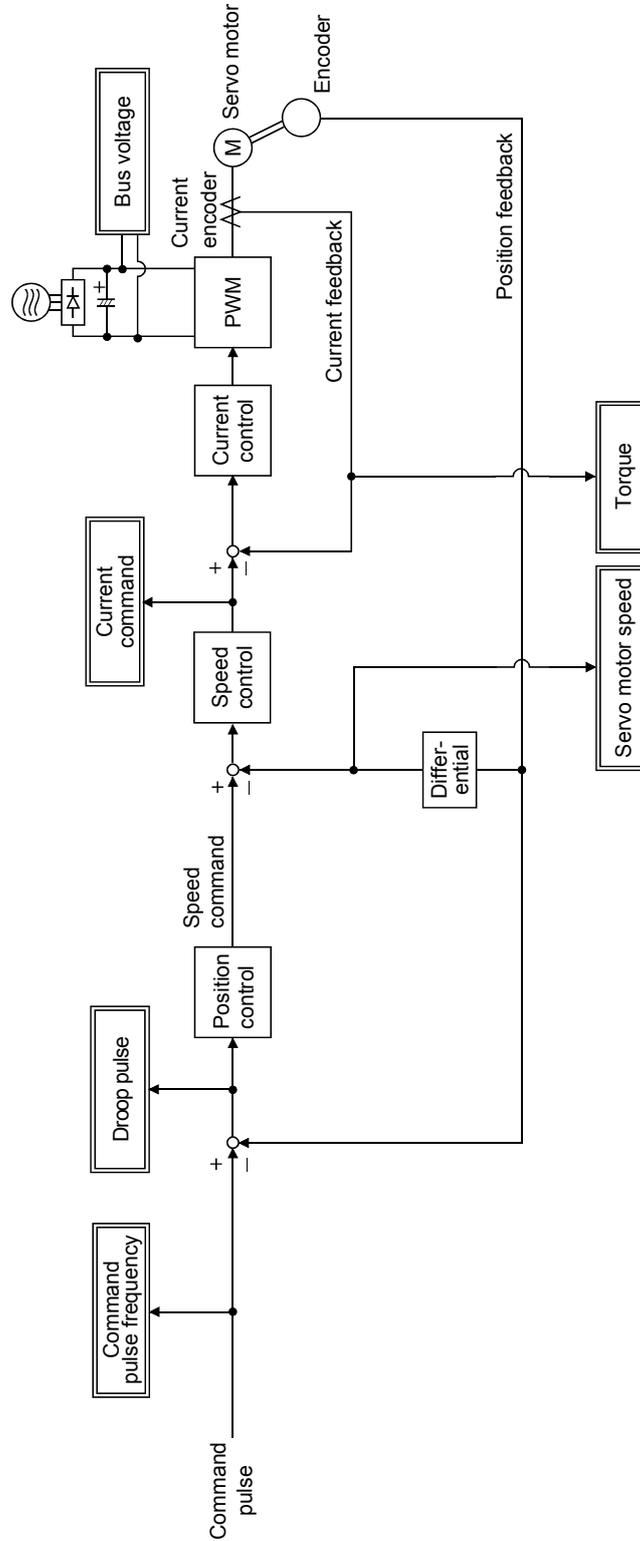
5.2.3 Using forward/reverse rotation stroke end to change the stopping pattern

The stopping pattern is factory-set to make a sudden stop when the forward/reverse rotation stroke end is OFF. A slow stop can be made by changing the parameter No.22 value.

Parameter No.22 setting	Stopping method	
□□□0 (initial value)	Sudden stop	
	Position control mode	: Motor stops with droop pulses cleared.
	Internal speed control mode	: Motor stops at deceleration time constant of zero.
□□□1	Slow stop	
	Position control mode	: The motor is decelerated to a stop in accordance with the parameter No.7 value.
	Internal speed control mode	: The motor is decelerated to a stop in accordance with the parameter No.12 value.

5.2.4 Alarm history clear

The servo amplifier stores one current alarm and five past alarms from when its power is switched on first. To control alarms which will occur during operation, clear the alarm history using parameter No.16 before starting operation.
Clearing the alarm history automatically returns to "□□0□".
After setting, this parameter is made valid by switch power from OFF to ON.

Parameter No.16

```
┌───┬───┬───┬───┐
│   │   │   │   │
└───┴───┴───┴───┘
          └─────── Alarm history clear
                   0: Invalid (not cleared)
                   1: Valid (cleared)
```
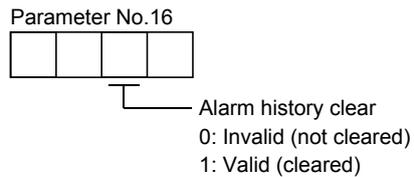
5.2.5 Position smoothing

By setting the position command acceleration/deceleration time constant (parameter No.7), you can run the servo motor smoothly in response to a sudden position command.
The following diagrams show the operation patterns of the servo motor in response to a position command when you have set the position command acceleration/deceleration time constant.
Choose the primary delay or linear acceleration/deceleration in parameter No.55 according to the machine used.

(1) For step input

——————— : Input position command

— — — : Position command after filtering for primary delay

— - — - — : Position command after filtering for linear acceleration/deceleration

t : Position command acceleration/deceleration time constant (parameter No.7)

(2) For trapezoidal input

——————— : Input position command

— — — : Position command after filtering for linear acceleration/deceleration

— - — - — : Position command after filtering for primary delay

t : Position command acceleration/deceleration time constant (parameter No.7)

6. DISPLAY AND OPERATION

6.1 Display flowchart

Use the display (5-digit, 7-segment LED) on the front panel of the servo amplifier for status display, parameter setting, etc. Set the parameters before operation, diagnose an alarm, confirm external sequences, and/or confirm the operation status. Press the "MODE" "UP" or "DOWN" button once to move to the next screen.
To refer to or set the expansion parameters, make them valid with parameter No.19 (parameter write disable).

⦿ button
MODE

Status display	Diagnosis	Alarm	Basic parameters	Expansion parameters 1	Expansion parameters 2
C (Note) Cumulative feedback pulses [pulse]	rd-oF Sequence	AL -- Current alarm	P 00 Parameter No.0	P 20 Parameter No.20	P 50 Parameter No.50
r Servo motor speed [r/min]	- - - - - External I/O signal display	A0 -- Last alarm	P 01 Parameter No.1	P 21 Parameter No.21	P 51 Parameter No.51
E Droop pulses [pulse]	do-on Output (DO) signal forced output	A1 -- Second alarm in past			
P Cumulative command pulses [pulse]	rESr1 Test operation mode Jog feed	A2 -- Third alarm in past			
n Command pulse frequency [kpps]	rESr2 Test operation mode Positioning operation	A3 -- Fourth alarm in past	P 18 Parameter No.18	P 48 Parameter No.48	P 83 Parameter No.83
F	rESr3 Test operation mode Motor-less operation	A4 -- Fifth alarm in past	P 19 Parameter No.19	P 49 Parameter No.49	P 84 Parameter No.84
U	rESr4 Test operation mode Machine analyzer operation	A5 -- Sixth alarm in past			
L Regenerative load ratio [%]	-A0 Software version low	E -- Parameter error No.			UP
J Effective load ratio [%]	_000 Software version high				DOWN
b Peak load ratio [%]	H1 0 Manufacturer setting screen				
r Instantaneous torque [%]	H2 0 Motor series ID				
CY1 Within one-revolution position low [pulse]	H3 0 Motor type ID				
CY2 Within one-revolution position, high [100 pulses]	H4 0 Encoder ID				
dC Load inertia moment ratio [Multiplier (×1)]					
Pn Bus voltage [V]					

Note. The initial status display at power-on depends on the control mode.
Position control mode: Cumulative feedback pulses(C), Internal speed control mode: Servo motor speed(r)
Also, parameter No.18 can be used to change the initial indication of the status display at power-on.

6.2 Status display

The servo status during operation is shown on the 5-digit, 7-segment LED display. Press the "UP" or "DOWN" button to change display data as desired. When the required data is selected, the corresponding symbol appears. Press the "SET" button to display its data. At only power-on, however, data appears after the symbol of the status display selected in parameter No.18 has been shown for 2.
The servo amplifier display shows the lower five digits of 16 data items such as the servo motor speed.

6.2.1 Display examples

The following table lists display examples.

Item	Status	Displayed data
		Servo amplifier display
Servo motor speed	Forward rotation at 3000r/min	**2500**
	Reverse rotation at 3000r/min	**-3000** Reverse rotation is indicated by " − ".
Load inertia moment	15.5 times	**15.5**
Multi-revolution counter	11252pulse	**11252**
	−12566pulse	**1.2.5.6.6.** Lit Negative value is indicated by the lit decimal points in the upper four digits.

6.2.2 Status display list

The following table lists the servo statuses that may be shown.

Name	Symbol	Unit	Description	Display range
Cumulative feedback pulses	C	pulse	Feedback pulses from the servo motor encoder are counted and displayed. The value in excess of ±99999 is counted, bus since the servo amplifier display is five digits, it shows the lower five digits of the actual value. Press the "SET" button to reset the display value to zero. Reverse rotation is indicated by the lit decimal points in the upper four digits.	−99999 to 99999
Servo motor speed	r	r/min	The servo motor speed is displayed. The value rounded off is displayed in × 0.1r/min.	−5400 to 5400
Droop pulses	E	pulse	The number of droop pulses in the deviation counter is displayed. When the servo motor is rotating in the reverse direction, the decimal points in the upper four digits are lit. Since the servo amplifier display is five digits, it shows the lower five digits of the actual value. The number of pulses displayed is not yet multiplied by the electronic gear.	−99999 to 99999
Cumulative command pulses	P	pulse	The position command input pulses are counted and displayed. As the value displayed is not yet multiplied by the electronic gear (CMX/CDV), it may not match the indication of the cumulative feedback pulses. The value in excess of ±99999 is counted, but since the servo amplifier display is five digits, it shows the lower five digits of the actual value. Press the "SET" button to reset the display value to zero. When the servo motor is rotating in the reverse direction, the decimal points in the upper four digits are lit.	−99999 to 99999
Command pulse frequency	n	kpps	The frequency of the position command input pulses is displayed. The value displayed is not multiplied by the electronic gear (CMX/CDV).	−800 to 800
Regenerative load ratio	L	%	The ratio of regenerative power to permissible regenerative power is displayed in %.	0 to 100
Effective load ratio	J	%	The continuous effective load torque is displayed. The effective value in the past 15 seconds is displayed relative to the rated torque of 100%.	0 to 300
Peak load ratio	b	%	The maximum torque generated during acceleration/deceleration, etc. The highest value in the past 15 seconds is displayed relative to the rated torque of 100%.	0 to 400
Instantaneous torque	T	%	Torque that occurred instantaneously is displayed. The value of the torque that occurred is displayed in real time relative to the rate torque of 100%.	0 to 400
Within one-revolution position low	Cy1	pulse	Position within one revolution is displayed in encoder pulses. The value returns to "0" when it exceeds the maximum number of pulses. The value is incremented in the CCW direction of rotation.	0 to 99999

Name	Symbol	Unit	Description	Display range
Within one-revolution position high	Cy2	100 pulse	The within one-revolution position is displayed in 100 pulse increments of the encoder. The value returns to 0 when it exceeds the maximum number of pulses. The value is incremented in the CCW direction of rotation.	0 to 1310
Load inertia moment ratio	dC	Multiplier (×1)	The estimated ratio of the load inertia moment to the servo motor shaft inertia moment is displayed.	0.0 to 300.0
Bus voltage	Pn	V	The voltage (across P-N) of the main circuit converter is displayed.	0 to 450

6.2.3 Changing the status display screen

The status display item of the servo amplifier display shown at power-on can be changed by changing the parameter No.18 settings.
The item displayed in the initial status changes with the control mode as follows.

Control mode	Status display at power-on
Position	Cumulative feedback pulses
Position/ internal speed	Cumulative feedback pulses/servo motor speed
Internal speed	Servo motor speed

6.3 Diagnostic mode

Name		Display	Description
Sequence		⌐d-oF	Not ready. Indicates that the servo amplifier is being initialized or an alarm has occurred.
		⌐d-on	Ready. Indicates that the servo was switched on after completion of initialization and the servo amplifier is ready to operate.
External I/O signal display		Refer to section 6.6.	Indicates the ON-OFF states of the external I/O signals. The upper segments correspond to the input signals and the lower segments to the output signals. Lit: ON Extinguished: OFF The I/O signals can be changed using parameters No.43 to 49.
Output (DO) signal forced output		do-on	The digital output signal can be forced on/off. For more information, refer to section 6.7.
Test operation mode	Jog feed	⌐ES⌐ 1	Jog operation can be performed when there is no command from the external command device. For details, refer to section 6.8.2.
	Positioning operation	⌐ES⌐ 2	The MR Configurator (servo configuration software) is required for positioning operation. This operation cannot be performed from the operation section of the servo amplifier. Positioning operation can be performed once when there is no command from the external command device.
	Motor-less operation	⌐ES⌐ 3	Without connection of the servo motor, the servo amplifier provides output signals and displays the status as if the servo motor is running actually in response to the external input signal. For details, refer to section 6.8.4.
	Machine analyzer operation	⌐ES⌐ 4	Merely connecting the servo amplifier allows the resonance point of the mechanical system to be measured. The MR Configurator (servo configuration software) is required for machine analyzer operation.
Software version low		-A0	Indicates the version of the software.
Software version high		⁻000	Indicates the system number of the software.
Manufacturer setting screen		H1 0	Screen for manufacturer setting. When this screen is being displayed, do not press any other buttons than "UP" and "DOWN" button.
Motor series ID		H2 0	Press the "SET" button to show the motor series ID of the servo motor currently connected.
Motor type ID		H3 0	Press the "SET" button to show the motor type ID of the servo motor currently connected.
Encoder ID		H4 0	Press the "SET" button to show the encoder ID of the servo motor currently connected.
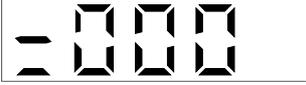
6.4 Alarm mode

The current alarm, past alarm history and parameter error are displayed. The lower 2 digits on the display indicate the alarm number that has occurred or the parameter number in error. Display examples are shown below.

Name	Display	Description
Current alarm	AL --	Indicates no occurrence of an alarm.
	AL 33	Indicates the occurrence of overvoltage (AL.33). Flickers at occurrence of the alarm.
Alarm history	A0 50	Indicates that the last alarm is overload 1 (AL.50).
	A1 33	Indicates that the second alarm in the past is overvoltage (AL.33).
	A2 10	Indicates that the third alarm in the past is undervoltage (AL.10).
	A3 31	Indicates that the fourth alarm in the past is overspeed (AL.31).
	A4 --	Indicates that there is no fifth alarm in the past.
	A5 --	Indicates that there is no sixth alarm in the past.
Parameter error No.	E.--	Indicates no occurrence of parameter error (AL.37).
	E.01	Indicates that the data of parameter No.1 is faulty.

Functions at occurrence of an alarm
(1) Any mode screen displays the current alarm.
(2) Even during alarm occurrence, the other screen can be viewed by pressing the button in the operation area. At this time, the decimal point in the fourth digit remains flickering.
(3) For any alarm, remove its cause and clear it in any of the following methods (for clearable alarms, refer to section 10.2.1).
    (a) Switch power OFF, then ON.
    (b) Press the "SET" button on the current alarm screen.
    (c) Turn on the reset (RES).
(4) Use parameter No.16 to clear the alarm history.
(5) Pressing "SET" button on the alarm history display screen for 2s or longer shows the following detailed information display screen. Note that this is provided for maintenance by the manufacturer.

A0C02

(6) Press the "UP" or "DOWN" button to display the next alarm in the history.

6.5 Parameter mode

The parameters whose abbreviations are marked* are made valid by changing the setting and then switching power off once and switching it on again. Refer to section 5.1.2.

(1) Operation example
   The following example shows the operation procedure performed after power-on to change the control mode (parameter No.0) to the Internal speed control mode.
   Using the "MODE" button, show the basic parameter screen.

P   00   ········ The parameter number is displayed.
            Press UP or DOWN to change the number.
            Press SET twice.

0000   ········ The set value of the specified parameter number flickers.

            Press UP once.

0002   ········ During flickering, the set value can be changed.
            Use UP or DOWN .
            (□□□2: Internal speed control mode)
            Press SET to enter.
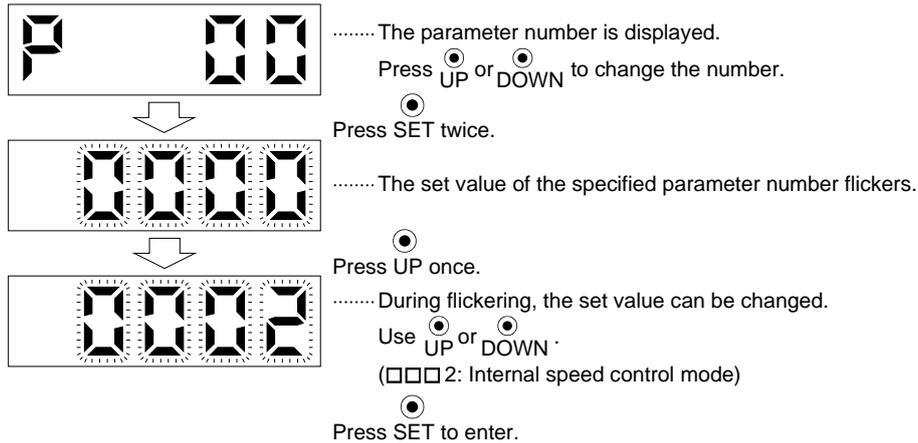
   To shift to the next parameter, press the UP / DOWN button.
   When changing the parameter No.0 setting, change its set value, then switch power off once and switch it on again to make the new value valid.

(2) Expansion parameters
   To use the expansion parameters, change the setting of parameter No.19 (parameter write disable).
   Refer to section 5.1.1.

6.6 External I/O signal display

The ON/OFF states of the digital I/O signals connected to the servo amplifier can be confirmed.

(1) Operation
   Call the display screen shown after power-on.
   Using the "MODE" button, show the diagnostic screen.

........External I/O signal display screen

Press UP once.

(2) Display definition

Lit: ON
Extinguished: OFF
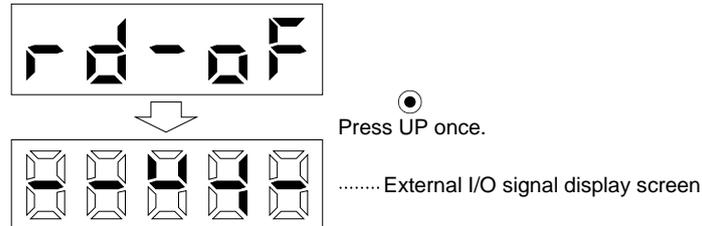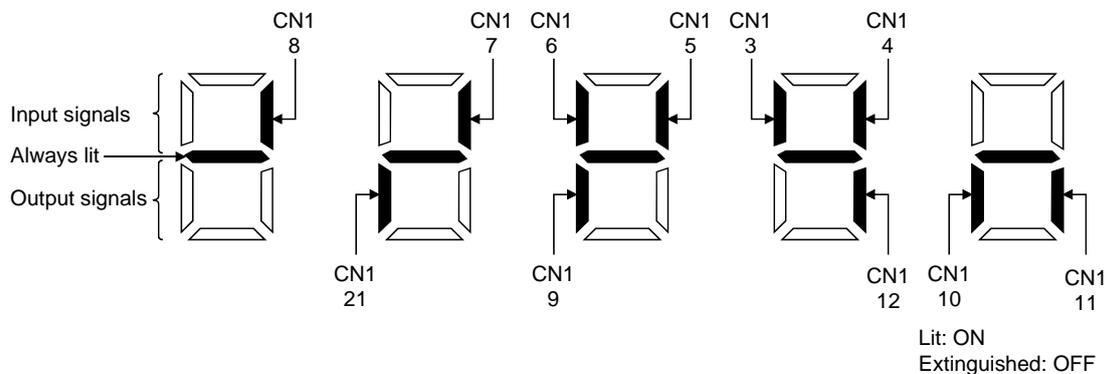
The 7-segment LED shown above indicates ON/OFF.
Each segment at top indicates the input signal and each segment at bottom indicates the output signal. The signals corresponding to the pins in the respective control modes are indicated below.

CN1 Pin No.	Input/Output (Note 1) I/O	(Note 2) Signal abbreviation		Related parameter No.
		P	S	
3	I	RES	ST1	43 to 47
4	I	SON	SON	43 to 47
5	I	CR	ST2	43 to 47
6	I	LSP	LSP	43 to 48
7	I	LSN	LSN	43 to 48
8	I	EMG	EMG	
9	O	ALM	ALM	49
10	O	INP	SA	49
11	O	RD	RD	49
12	O	ZSP	ZSP	49
21	O	OP	OP	

Note 1. I: Input signal, O: Output signal
   2. P: Position control mode, S: Internal speed control mode
   3. CN1B-4 and CN1A-18 output signals are the same.

(3) Default signal indications

(a) Position control mode

EMG (CN 1-8) Emergency stop
LSN (CN 1-7) Reverse rotation stroke end
LSP (CN 1-6) Forward rotation stroke end
CR (CN 1-5) Clear
RES (CN 1-3) Reset
SON (CN 1-4) Servo-on

Input signals
Output signals

Lit: ON
Extinguished: OFF

RD (CN 1-11) Ready
INP (CN 1-10) In position
ZSP (CN 1-12) Zero speed detection

ALM (CN 1-9) Trouble
OP (CN 1-21) Encoder Z-phase pulse

(b) Internal speed control mode

EMG (CN 1-8) Emergency stop
LSN (CN 1-7) Reverse rotation stroke end
LSP (CN 1-6) Forward rotation stroke end
ST2 (CN 1-5) Reverse rotation start
ST1 (CN 1-3) Forward rotation start
SON (CN 1-4) Servo-on

Input signals
Output signals

Lit: ON
Extinguished: OFF

RD (CN 1-11) Ready
SA (CN 1-10) Limiting speed
ZSP (CN 1-12) Zero speed detection

ALM (CN 1-9) Trouble
OP (CN 1-21) Encoder Z-phase pulse

6.7 Output signal (DO) forced output

```
┌─────────────────┐
│ POINT           │
└─────────────────┘
```
· When the servo system is used in a vertical lift application, turning on the
  electromagnetic brake interlock (MBR) after assigning it to pin CN1-12 will
  release the electromagnetic brake, causing a drop. Take drop preventive
  measures on the machine side.

The output signal can be forced on/off independently of the servo status. This function is used for output signal
wiring check, etc. This operation must be performed in the servo off state.

Operation
Call the display screen shown after power-on.
Using the "MODE" button, show the diagnostic screen.

Press UP twice.

Press SET for more than 2 seconds.

······ Switch on/off the signal below the lit segment.
—— Always lit
······ Indicates the ON/OFF of the output signal. The correspondences
       between segments and signals are as in the output signals of the
       external I/O signal display.
       (Lit: ON, extinguished: OFF)

CN1   CN1   CN1 CN1 CN1
12   9   12   10   11

Press MODE once.

······ The segment above CN1-pin 10 is lit.

Press UP once.

······ CN1-pin 10 is switched on.
       (CN1-pin 10-VIN conduct.)

Press DOWN once.

······ CN1-pin 10 is switched off.

Press SET for more than seconds.
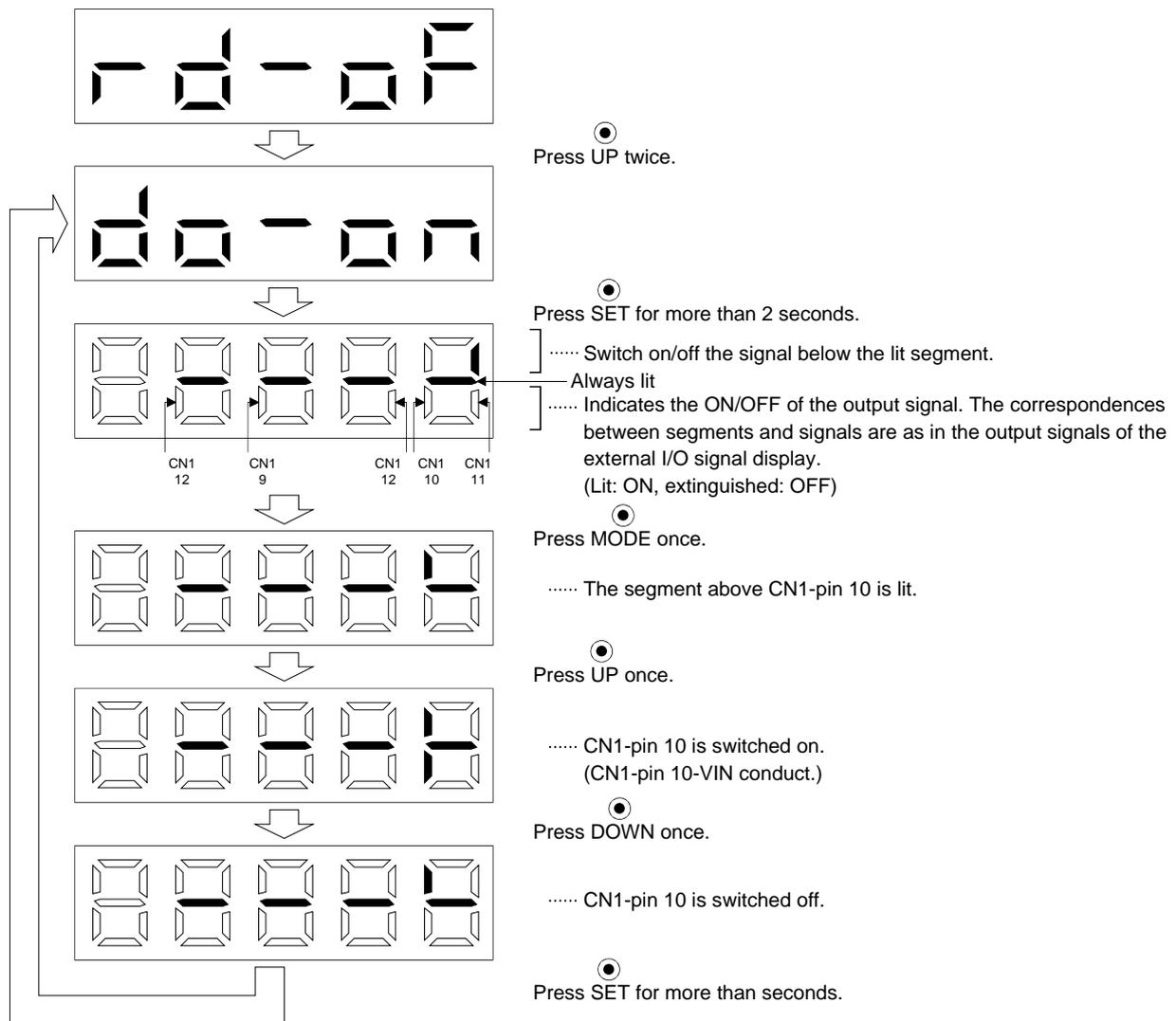
6.8 Test operation mode

⚠ CAUTION	・The test operation mode is designed to confirm servo operation and not to confirm machine operation. In this mode, do not use the servo motor with the machine. Always use the servo motor alone. ・If any operational fault has occurred, stop operation using the emergency stop (EMG) signal.

POINT
・The MR Configurator (servo configuration software) is required to perform positioning operation.
・Test operation cannot be performed if the servo-on (SON) is not turned OFF.

6.8.1 Mode change

After power-on, change the display to the diagnostic screen using the "MODE" button. Choose jog operation/motor-less operation in the following procedure.
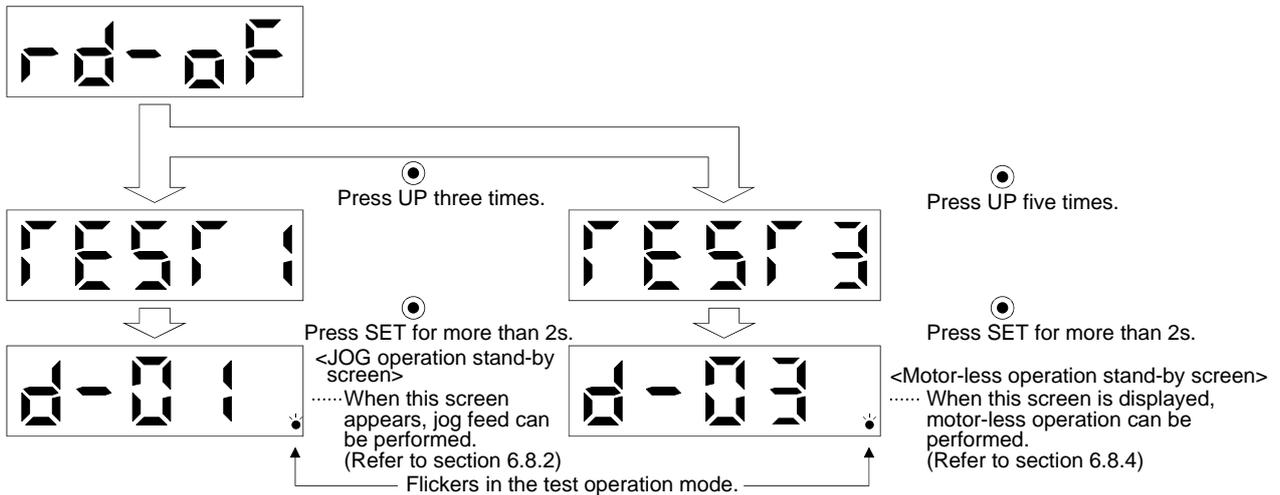
6.8.2 Jog operation

Jog operation can be performed when there is no command from the external command device.

(1) Operation

Connect EMG-VIN to start jog operation to use the internal power supply.

Hold down the "UP" or "DOWN" button to run the servo motor. Release it to stop. When using the MR Configurator (servo configuration software), you can change the operation conditions. The initial conditions and setting ranges for operation are listed below.

Item	Initial setting	Setting range
Speed [r/min]	200	0 to instantaneous permissible speed
Acceleration/deceleration time constant [ms]	1000	0 to 50000

How to use the buttons is explained below.

Button	Description
"UP"	Press to start CCW rotation. Release to stop.
"DOWN"	Press to start CW rotation. Release to stop.

If the communication cable is disconnected during jog operation performed by using the MR Configurator (servo configuration software), the servo motor will be decelerated to a stop.

(2) Status display

You can confirm the servo status during jog operation.

Pressing the "MODE" button in the jog operation-ready status calls the status display screen. With this screen being shown, perform jog operation with the "UP" or "DOWN" button. Every time you press the "MODE" button, the next status display screen appears, and on completion of a screen cycle, pressing that button returns to the jog operation-ready status screen. For full information of the status display, refer to section 6.2. In the test operation mode, you cannot use the "UP" and "DOWN" buttons to change the status display screen from one to another.

(3) Termination of jog operation

To end the jog operation, switch power off once or press the "MODE" button to switch to the next screen and then hold down the "SET" button for 2 or more seconds.
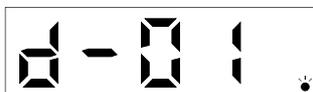
6.8.3 Positioning operation

> POINT
> ・The MR Configurator (servo configuration software) is required to perform positioning operation.

Positioning operation can be performed once when there is no command from the external command device.

(1) Operation

Connect EMG-VIN to start positioning operation to use the internal power supply.

Click the "Forward" or "Reverse" button on the MR Configurator (servo configuration software) starts the servo motor, which will then stop after moving the preset travel distance. You can change the operation conditions on the MR Configurator (servo configuration software). The initial conditions and setting ranges for operation are listed below.

Item	Initial setting	Setting range
Travel distance [pulse]	10000	0 to 9999999
Speed [r/min]	200	0 to instantaneous permissible speed
Acceleration/deceleration time constant [ms]	1000	0 to 50000

How to use the buttons is explained below.

Button	Description
"Forward"	Click to start positioning operation CCW.
"Reverse"	Click to start positioning operation CW.
"Pause"	Click during operation to make a temporary stop. Pressing the "Pause" button again erases the remaining distance. To resume operation, click the button that was clicked to start the operation.

If the communication cable is disconnected during positioning operation, the servo motor will come to a sudden stop.

(2) Status display

You can monitor the status display even during positioning operation.

6.8.4 Motor-less operation

Without connecting the servo motor, you can provide output signals or monitor the status display as if the servo motor is running in response to external input signals. This operation can be used to check the sequence of a host programmable controller or the like.

(1) Operation

    After turning off the signal across SON-VIN, choose motor-less operation. After that, perform external operation as in ordinary operation.

(2) Status display

    You can confirm the servo status during motor-less operation.

    Change the display to the status display screen by pressing the "MODE" button. (Refer to section 6.1.)

    The status display screen can be changed by pressing the "UP" or the "DOWN" button. (Refer to section 6.2.)

(3) Termination of motor-less operation

    To terminate the motor-less operation, switch power off.

7. GENERAL GAIN ADJUSTMENT

```
┌─────────────┐
│ POINT       │
└─────────────┘
```
・For the gain adjustment, check that the machine operates below the maximum torque of the servo motor. If the machine operates beyond the maximum torque of the servo motor, the machine may perform unexpected operation such as the machine vibration. Make the gain adjustment with a safety margin considering characteristic differences of each machine. Generated torque during operation must be the 90% maximum torque or less of the servo motor.

7.1 Different adjustment methods

7.1.1 Adjustment on a single servo amplifier

The gain adjustment in this section can be made on a single servo amplifier. For gain adjustment, first execute auto tuning mode 1. If you are not satisfied with the results, execute auto tuning mode 2, manual mode 1 and manual mode 2 in this order.

(1) Gain adjustment mode explanation

Gain adjustment mode	Parameter No.2 setting	Estimation of load inertia moment ratio	Automatically set parameters	Manually set parameters
Auto tuning mode 1 (initial value)	010☐	Always estimated	PG1 (parameter No.6) GD2 (parameter No.34) PG2 (parameter No.35) VG1 (parameter No.36) VG2 (parameter No.37) VIC (parameter No.38)	Response level setting of parameter No.2
Auto tuning mode 2	020☐	Fixed to parameter No.34 value	PG1 (parameter No.6) PG2 (parameter No.35) VG1 (parameter No.36) VG2 (parameter No.37) VIC (parameter No.38)	GD2 (parameter No.34) Response level setting of parameter No.2
Manual mode 1	030☐		PG2 (parameter No.35) VG1 (parameter No.36)	PG1 (parameter No.6) GD2 (parameter No.34) VG2 (parameter No.37) VIC (parameter No.38)
Manual mode 2	040☐			PG1 (parameter No.6) GD2 (parameter No.34) PG2 (parameter No.35) VG1 (parameter No.36) VG2 (parameter No.37) VIC (parameter No.38)
Interpolation mode	000☐	Always estimated	GD2 (parameter No.34) PG2 (parameter No.35) VG2 (parameter No.37) VIC (parameter No.38)	PG1 (parameter No.6) VG1 (parameter No.36)

(2) Adjustment sequence and mode usage
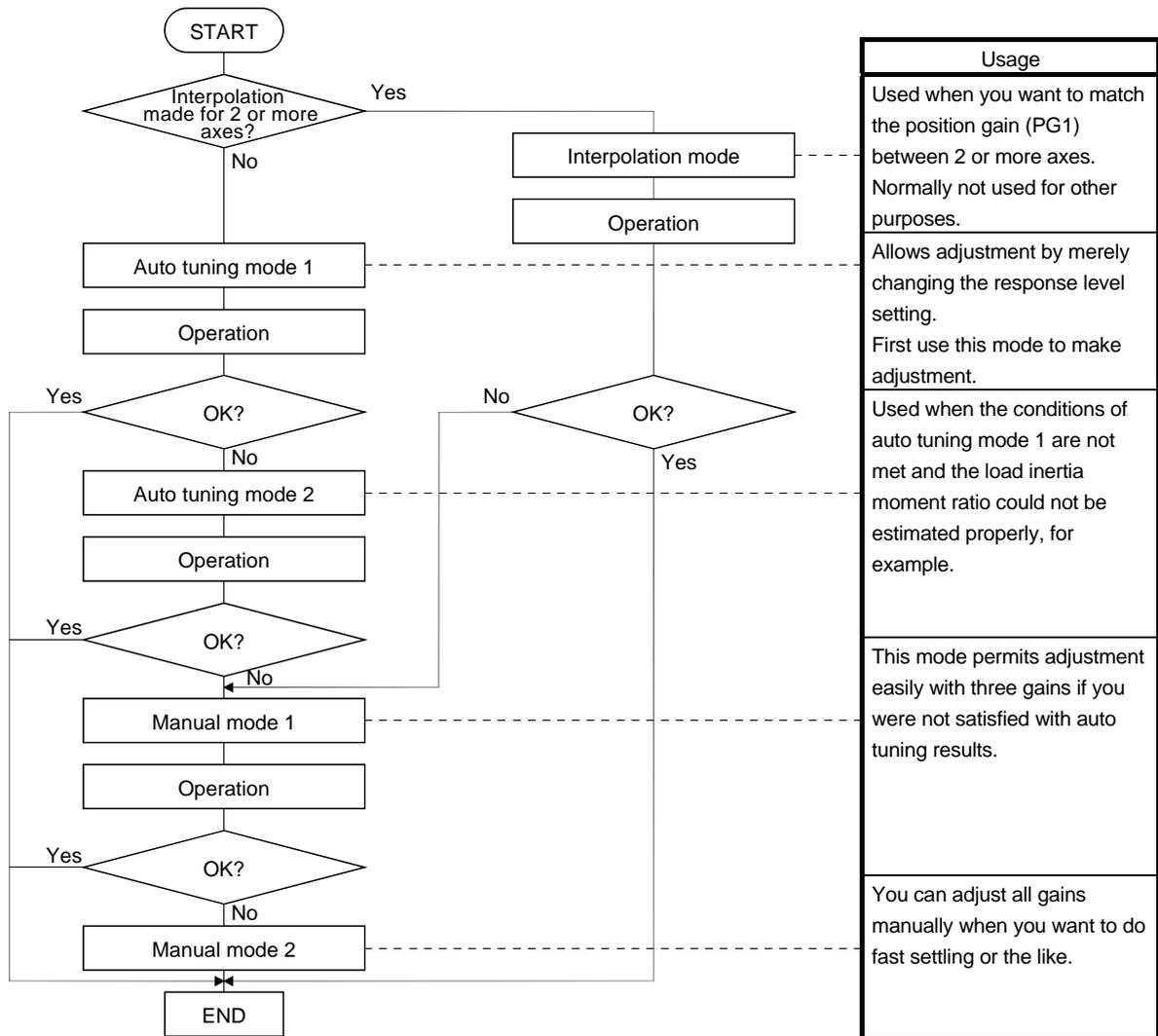
7.1.2 Adjustment using MR Configurator (servo configuration software)

This section gives the functions and adjustment that may be performed by using the servo amplifier with the MR Configurator (servo configuration software) which operates on a personal computer.

Function	Description	Adjustment
Machine analyzer	With the machine and servo motor coupled, the characteristic of the mechanical system can be measured by giving a random vibration command from the personal computer to the servo and measuring the machine response.	• You can grasp the machine resonance frequency and determine the notch frequency of the machine resonance suppression filter. • You can automatically set the optimum gains in response to the machine characteristic. This simple adjustment is suitable for a machine which has large machine resonance and does not require much settling time.
Gain search	Executing gain search under to-and-fro positioning command measures settling characteristic while simultaneously changing gains, and automatically searches for gains which make settling time shortest.	• You can automatically set gains which make positioning settling time shortest.
Machine simulation	Response at positioning settling of a machine can be simulated from machine analyzer results on personal computer.	• You can optimize gain adjustment and command pattern on personal computer.

7.2 Auto tuning

7.2.1 Auto tuning mode

The servo amplifier has a real-time auto tuning function which estimates the machine characteristic (load inertia moment ratio) in real time and automatically sets the optimum gains according to that value. This function permits ease of gain adjustment of the servo amplifier.

(1) Auto tuning mode 1

　　The servo amplifier is factory-set to the auto tuning mode 1.

　　In this mode, the load inertia moment ratio of a machine is always estimated to set the optimum gains automatically.

　　The following parameters are automatically adjusted in the auto tuning mode 1.

Parameter No.	Abbreviation	Name
6	PG1	Position control gain 1
34	GD2	Ratio of load inertia moment to servo motor inertia moment
35	PG2	Position control gain 2
36	VG1	Speed control gain 1
37	VG2	Speed control gain 2
38	VIC	Speed integral compensation

```
POINT

・ The auto tuning mode 1 may not be performed properly if the following
  conditions are not satisfied.
  ・Time to reach 2000r/min is the acceleration/deceleration time constant of 5s or
    less.
  ・Speed is 150r/min or higher.
  ・The load to motor inertia moment ratio is 100 times or less.
  ・The acceleration/deceleration torque is 10% or more of the rated torque.
・Under operating conditions which will impose sudden disturbance torque during
  acceleration/deceleration or on a machine which is extremely loose, auto tuning
  may not function properly, either. In such cases, use the auto tuning mode 2 or
  manual mode 1,2 to make gain adjustment.
```

(2) Auto tuning mode 2

　　Use the auto tuning mode 2 when proper gain adjustment cannot be made by auto tuning mode 1. Since the load inertia moment ratio is not estimated in this mode, set the value of a correct load inertia moment ratio (parameter No.34).

　　The following parameters are automatically adjusted in the auto tuning mode 2.

Parameter No.	Abbreviation	Name
6	PG1	Position control gain 1
35	PG2	Position control gain 2
36	VG1	Speed control gain 1
37	VG2	Speed control gain 2
38	VIC	Speed integral compensation

7.2.2 Auto tuning mode basis

The block diagram of real-time auto tuning is shown below.
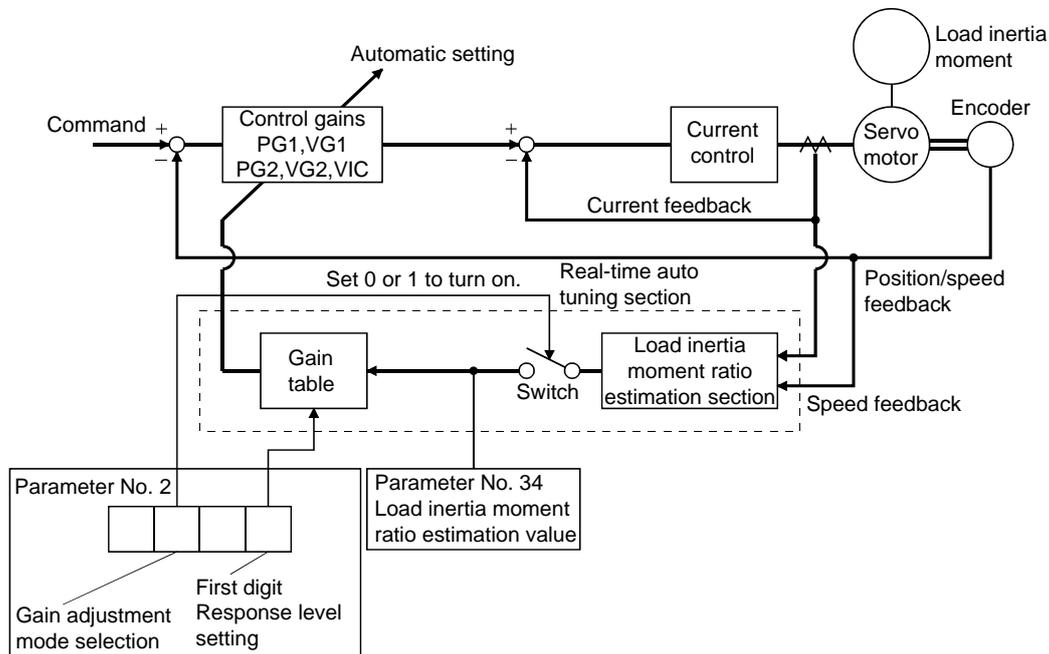
When a servo motor is accelerated/decelerated, the load inertia moment ratio estimation section always estimates the load inertia moment ratio from the current and speed of the servo motor. The results of estimation are written to parameter No.34 (the ratio of load inertia moment to servo motor). These results can be confirmed on the status display screen of the MR Configurator (servo configuration software) section.
If the value of the load inertia moment ratio is already known or if estimation cannot be made properly, chose the "auto tuning mode 2" (parameter No.2: ☐2☐☐) to stop the estimation of the load inertia moment ratio (Switch in above diagram turned off), and set the load inertia moment ratio (parameter No.34) manually.
From the preset load inertia moment ratio (parameter No.34) value and response level (The first digit of parameter No.2), the optimum control gains are automatically set on the basis of the internal gain tale.
The auto tuning results are saved in the EEP-ROM of the servo amplifier every 60 minutes since power-on. At power-on, auto tuning is performed with the value of each control gain saved in the EEP-ROM being used as an initial value.

POINT

・If sudden disturbance torque is imposed during operation, the estimation of the inertia moment ratio may malfunction temporarily. In such a case, choose the "auto tuning mode 2" (parameter No.2: ☐2☐☐) and set the correct load inertia moment ratio in parameter No.34.

・When any of the auto tuning mode 1, auto tuning mode 2 and manual mode 1 settings is changed to the manual mode 2 setting, the current control gains and load inertia moment ratio estimation value are saved in the EEP-ROM.

7.2.3 Adjustment procedure by auto tuning

Since auto tuning is made valid before shipment from the factory, simply running the servo motor automatically sets the optimum gains that match the machine. Merely changing the response level setting value as required completes the adjustment. The adjustment procedure is as follows.

```
            ┌─────────────────────────────┐
            │   Auto tuning adjustment     │
            └─────────────────────────────┘
                          │
            ┌─────────────────────────────┐
            │ Acceleration/deceleration    │
            │ repeated                     │
            └─────────────────────────────┘
                          │
Yes                  ◇ Load inertia moment ratio
 ◄───────────────────  estimation value stable? ◇
                          │ No
                  ◇ Auto tuning                      No
                  conditions not satisfied. ◇ ──────────┐
                  (Estimation of load inertia          │
                  moment ratio is difficult)           │
                          │ Yes                         │
            ┌─────────────────────────────┐            │
            │ Choose the auto tuning mode 2│            │
            │ (parameter No.2: 020□) and set│           │
            │ the load inertia moment ratio │           │
            │ (parameter No.34) manually.   │           │
            └─────────────────────────────┘            │
                          │                            │
            ┌─────────────────────────────┐            │
            │ Adjust response level setting│ ◄──────────┘
            │ so that desired response is  │
            │ achieved on vibration-free level.│
            └─────────────────────────────┘
                          │
            ┌─────────────────────────────┐
            │ Acceleration/deceleration    │
            │ repeated                     │
            └─────────────────────────────┘
                          │
                  ◇ Requested              No
                  performance satisfied? ◇ ──────────┐
                          │ Yes                       │
                    ┌──────────┐              ┌──────────────┐
                    │   END    │              │ To manual mode│
                    └──────────┘              └──────────────┘
```

7.2.4 Response level setting in auto tuning mode

Set the response (The first digit of parameter No.2) of the whole servo system. As the response level setting is increased, the track ability and settling time for a command decreases, but a too high response level will generate vibration. Hence, make setting until desired response is obtained within the vibration-free range.

If the response level setting cannot be increased up to the desired response because of machine resonance beyond 100Hz, adaptive vibration suppression control (parameter No.60) or machine resonance suppression filter (parameter No.58・59) may be used to suppress machine resonance. Suppressing machine resonance may allow the response level setting to increase. Refer to section 8.2, 8.3 for adaptive vibration suppression control and machine resonance suppression filter.

```
              Parameter No.2
          ┌────┬────┬────┬────┐
          │    │    │    │    │
          └────┴────┴────┴────┘
                      │    └──────Response level setting
                      └───────────Gain adjustment mode selection
```
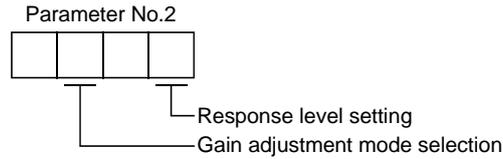
Response level setting	Machine characteristic		
	Machine rigidity	Machine resonance frequency guideline	Guideline of corresponding machine
1	Low	15Hz	
2		20Hz	
3		25Hz	
4	↑	30Hz	Large conveyor
5		35Hz	
6		45Hz	Arm robot
7		55Hz	General machine tool conveyor
8	Middle	70Hz	
9		85Hz	Precision working machine
A		105Hz	
B		130Hz	
C	↓	160Hz	Inserter Mounter Bonder
D		200Hz	
E		240Hz	
F	High	300Hz	

7.3 Manual mode 1 (simple manual adjustment)

If you are not satisfied with the adjustment of auto tuning, you can make simple manual adjustment with three parameters.

7.3.1 Manual Mode 1 basis

In this mode, setting the three gains of position control gain 1 (PG1), speed control gain 2 (VG2) and speed integral compensation (VIC) automatically sets the other gains to the optimum values according to these gains.

```
                    ┌──────────┐
                    │   GD2    │
                    └──────────┘
 User setting             │
 ┌──────────┐             ↓              ┌──────────┐
 │   PG1    │                            │   PG2    │
 │   VG2    │ ─────────────────────────→ │   VG1    │
 │   VIC    │     Automatic setting      │          │
 └──────────┘                            └──────────┘
```
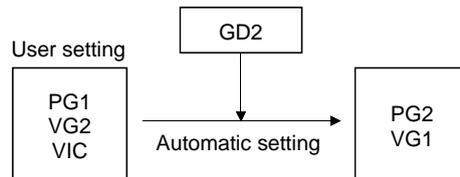
Therefore, you can adjust the model adaptive control system in the same image as the general PI control system (position gain, speed gain, speed integral time constant). Here, the position gain corresponds to PG1, the speed gain to VG2 and the speed integral time constant to VIC. When making gain adjustment in this mode, set the load inertia moment ratio (parameter No.34) correctly.

7.3.2 Adjustment by manual mode 1

> POINT
> ・If machine resonance occurs, adaptive vibration suppression control (parameter No.60) or machine resonance suppression filter (parameter No.58・59) may be used to suppress machine resonance. (Refer to section 8.2, 8.3.)

(1) For speed control
    (a) Parameters
       The following parameters are used for gain adjustment.

Parameter No.	Abbreviation	Name
34	GD2	Ratio of load inertia moment to servo motor inertia moment
37	VG2	Speed control gain 2
38	VIC	Speed integral compensation

    (b) Adjustment procedure

Step	Operation	Description
1	Set an estimated value to the ratio of load inertia moment to servo motor inertia moment (parameter No.34).	
2	Increase the speed control gain 2 (parameter No.37) within the vibration- and unusual noise-free range, and return slightly if vibration takes place.	Increase the speed control gain.
3	Decrease the speed integral compensation (parameter No.38) within the vibration-free range, and return slightly if vibration takes place.	Decrease the time constant of the speed integral compensation.
4	If the gains cannot be increased due to mechanical system resonance or the like and the desired response cannot be achieved, response may be increased by suppressing resonance with adaptive vibration suppression control or machine resonance suppression filter and then executing steps 2 and 3.	Suppression of machine resonance. Refer to section 8.2, 8.3.

(c)Adjustment description

　1) Speed control gain 2 (parameter No.37)

　　This parameter determines the response level of the speed control loop. Increasing this value enhances response but a too high value will make the mechanical system liable to vibrate. The actual response frequency of the speed loop is as indicated in the following expression.

$$\text{Speed loop response frequency(Hz)} = \frac{\text{Speed control gain 2 setting}}{(1 + \text{ratio of load inertia moment to servo motor inertia moment}) \times 2\pi}$$

　2) Speed integral compensation (VIC: parameter No.38)

　　To eliminate stationary deviation against a command, the speed control loop is under proportional integral control. For the speed integral compensation, set the time constant of this integral control. Increasing the setting lowers the response level. However, if the load inertia moment ratio is large or the mechanical system has any vibratory element, the mechanical system is liable to vibrate unless the setting is increased to some degree. The guideline is as indicated in the following expression.

$$\text{Speed integral compensation setting(ms)} \geq \frac{2000 \text{ to } 3000}{\text{Speed control gain 2 setting}/(1 + \text{ratio of load inertia moment to servo motor inertia moment setting} \times 0.1)}$$

(2) For position control

　(a) Parameters

　　The following parameters are used for gain adjustment.

Parameter No.	Abbreviation	Name
6	PG1	Position control gain 1
34	GD2	Ratio of load inertia moment to servo motor inertia moment
37	VG2	Speed control gain 2
38	VIC	Speed integral compensation

　(b) Adjustment procedure

Step	Operation	Description
1	Set an estimated value to the ratio of load inertia moment to servo motor inertia moment (parameter No.34).	
2	Set a slightly smaller value to the position control gain 1 (parameter No.6).	
3	Increase the speed control gain 2 (parameter No.37) within the vibration- and unusual noise-free range, and return slightly if vibration takes place.	Increase the speed control gain.
4	Decrease the speed integral compensation (parameter No.38) within the vibration-free range, and return slightly if vibration takes place.	Decrease the time constant of the speed integral compensation.
5	Increase the position control gain 1 (parameter No.6).	Increase the position control gain.
6	If the gains cannot be increased due to mechanical system resonance or the like and the desired response cannot be achieved, response may be increased by suppressing resonance with adaptive vibration suppression control or machine resonance suppression filter and then executing steps 3 to 5.	Suppression of machine resonance. Refer to section 8.2, 8.3.
7	While checking the settling characteristic and rotational status, fine-adjust each gain.	Fine adjustment

(c) Adjustment description

1) Position control gain 1 (parameter No.6)

This parameter determines the response level of the position control loop. Increasing position control gain 1 improves track ability to a position command but a too high value will make overshooting liable to occur at the time of settling.

$$\text{Position control gain 1 guideline} \leq \frac{\text{Speed control gain 2 setting}}{(1+\text{ratio of load inertia moment to servo motor inertia moment})} \times \left(\frac{1}{3} \text{ to } \frac{1}{5}\right)$$

2) Speed control gain 2 (VG2: parameter No.37)

This parameter determines the response level of the speed control loop. Increasing this value enhances response but a too high value will make the mechanical system liable to vibrate. The actual response frequency of the speed loop is as indicated in the following expression.

$$\text{Speed loop response frequency(Hz)} = \frac{\text{Speed control gain 2 setting}}{(1+\text{ratio of load inertia moment to servo motor inertia moment}) \times 2\pi}$$

3) Speed integral compensation (parameter No.38)

To eliminate stationary deviation against a command, the speed control loop is under proportional integral control. For the speed integral compensation, set the time constant of this integral control. Increasing the setting lowers the response level. However, if the load inertia moment ratio is large or the mechanical system has any vibratory element, the mechanical system is liable to vibrate unless the setting is increased to some degree. The guideline is as indicated in the following expression.

$$\text{Speed integral compensation setting(ms)} \geq \frac{2000 \text{ to } 3000}{\text{Speed control gain 2 setting/(1+ratio of load inertia moment to servo motor inertia moment 2 setting} \times 0.1)}$$

7.4 Interpolation mode

The interpolation mode is used to match the position control gains of the axes when performing the interpolation operation of servo motors of two or more axes for an X-Y table or the like. In this mode, the position control gain 2 and speed control gain 2 which determine command track ability are set manually and the other parameter for gain adjustment are set automatically.

(1) Parameter
    (a) Automatically adjusted parameters
        The following parameters are automatically adjusted by auto tuning.

Parameter No.	Abbreviation	Name
34	GD2	Ratio of load inertia moment to servo motor inertia moment
35	PG2	Position control gain 2
37	VG2	Speed control gain 2
38	VIC	Speed integral compensation

    (b) Manually adjusted parameters
        The following parameters are adjustable manually.

Parameter No.	Abbreviation	Name
6	PG1	Position control gain 1
36	VG1	Speed control gain 1

(2) Adjustment procedure

Step	Operation	Description
1	Set 15Hz (parameter No.2: 010☐) as the machine resonance frequency of response in the auto tuning mode 1.	Select the auto tuning mode 1.
2	During operation, increase the response level setting (parameter No.2), and return the setting if vibration occurs.	Adjustment in auto tuning mode 1.
3	Check the values of position control gain 1 (parameter No.6) and speed control gain 1 (parameter No.36).	Check the upper setting limits.
4	Set the interpolation mode (parameter No.2: 000☐).	Select the interpolation mode.
5	Using the position control gain 1 value checked in step 3 as the guideline of the upper limit, set in PG1 the value identical to the position loop gain of the axis to be interpolated.	Set position control gain 1.
6	Using the speed control gain 1 value checked in step 3 as the guideline of the upper limit, look at the rotation status and set in speed control gain 1 the value three or more times greater than the position control gain 1 setting.	Set speed control gain 1.
7	Looking at the interpolation characteristic and rotation status, fine-adjust the gains and response level setting.	Fine adjustment.

(3) Adjustment description
    (a) Position control gain 1 (parameter No.6)
        This parameter determines the response level of the position control loop. Increasing position control gain 1 improves track ability to a position command but a too high value will make overshooting liable to occur at the time of settling. The droop pulse value is determined by the following expression.

$$\text{Droop pulse value (pulse)} = \frac{\dfrac{\text{Rotation speed (r/min)}}{60} \times 131{,}072(\text{pulse})}{\text{Position control gain 1 setting}}$$

    (b) Speed control gain 1 (parameter No.36)
        Set the response level of the speed loop of the model. Make setting using the following expression as a guideline.
        Speed control gain 1 setting $\geq$ Position control gain 1 setting $\times$ 3

8. SPECIAL ADJUSTMENT FUNCTIONS

```
┌─────────────────────────────────────────────────────────────────┐
│ ┌──────────┐                                                      │
│ │  POINT   │                                                      │
│ └──────────┘                                                      │
│ ･The functions given in this chapter need not be used generally.  │
│   Use them if you are not satisfied with the machine status       │
│   after making adjustment in the methods in chapter 7.            │
└─────────────────────────────────────────────────────────────────┘
```

If a mechanical system has a natural resonance level point, increasing the servo system response may cause the mechanical system to produce resonance (vibration or unusual noise) at that resonance frequency.
Using the machine resonance suppression filter and adaptive vibration suppression control functions can suppress the resonance of the mechanical system.

8.1 Function block diagram
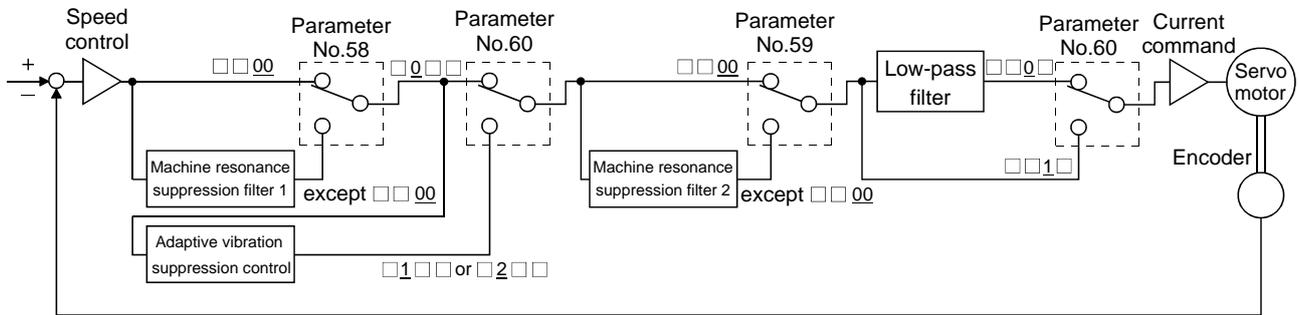
8.2 Machine resonance suppression filter

(1) Function

The machine resonance suppression filter is a filter function (notch filter) which decreases the gain of the specific frequency to suppress the resonance of the mechanical system. You can set the gain decreasing frequency (notch frequency) and gain decreasing depth.

You can use the machine resonance suppression filter 1 (parameter No.58) and machine resonance suppression filter 2 (parameter No.59) to suppress the vibration of two resonance frequencies. Note that if adaptive vibration suppression control is made valid, the machine resonance suppression filter 1 (parameter No.58) is made invalid.

Machine resonance point

Mechanical system response level

Frequency

Notch depth

Frequency

Parameter No. 58   Parameter No. 59

POINT

· The machine resonance suppression filter is a delay factor for the servo system. Hence, vibration may increase if you set a wrong resonance frequency or a too deep notch.

(2) Parameters

  (a) Machine resonance suppression filter 1 (parameter No.58)

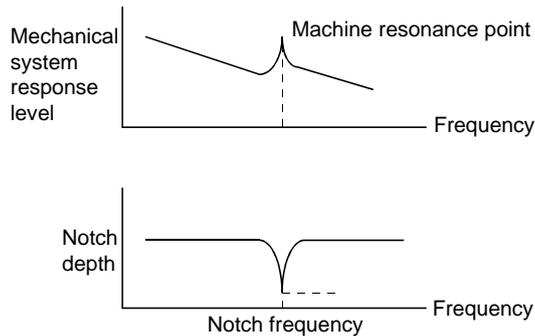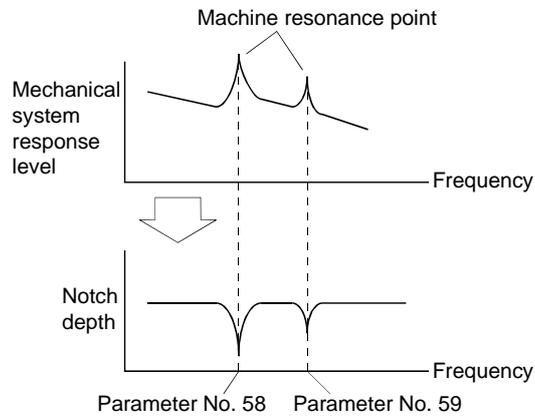   Set the notch frequency and notch depth of the machine resonance suppression filter 1 (parameter No.58)

   When you have made adaptive vibration suppression control selection (parameter No.60) "valid" or "held", make the machine resonance suppression filter 1 invalid (parameter No.58: 0000).

Parameter No.58

Notch frequency

Setting value	Frequency	Setting value	Frequency	Setting value	Frequency	Setting value	Frequency
00	Invalid	08	562.5	10	281.3	18	187.5
01	4500	09	500	11	264.7	19	180
02	2250	0A	450	12	250	1A	173.1
03	1500	0B	409.1	13	236.8	1B	166.7
04	1125	0C	375	14	225	1C	160.1
05	900	0D	346.2	15	214.3	1D	155.2
06	750	0E	321.4	16	204.5	1E	150
07	642.9	0F	300	17	195.7	1F	145.2

Notch depth

Setting value	Depth (Gain)
00	Deep (−40dB)
00	↑ (−14dB)
00	↓ (−8dB)
00	Shallow(−4dB)

```
┌─────────────────────────────────────────────────────────────────┐
│ ┌──────────┐                                                      │
│ │  POINT   │                                                      │
│ └──────────┘                                                      │
│ ・If the frequency of machine resonance is unknown, decrease the notch │
│   frequency from higher to lower ones in order. The optimum notch frequency is │
│   set at the point where vibration is minimal.                     │
│ ・A deeper notch has a higher effect on machine resonance suppression but │
│   increases a phase delay and may increase vibration.              │
│ ・The machine characteristic can be grasped beforehand by the machine │
│   analyzer on the MR Configurator (servo configuration software). This allows the │
│   required notch frequency and depth to be determined.             │
│ ・Resonance may occur if parameter No.58・59 is used to select a close notch │
│   frequency and set a deep notch.                                  │
└─────────────────────────────────────────────────────────────────┘
```
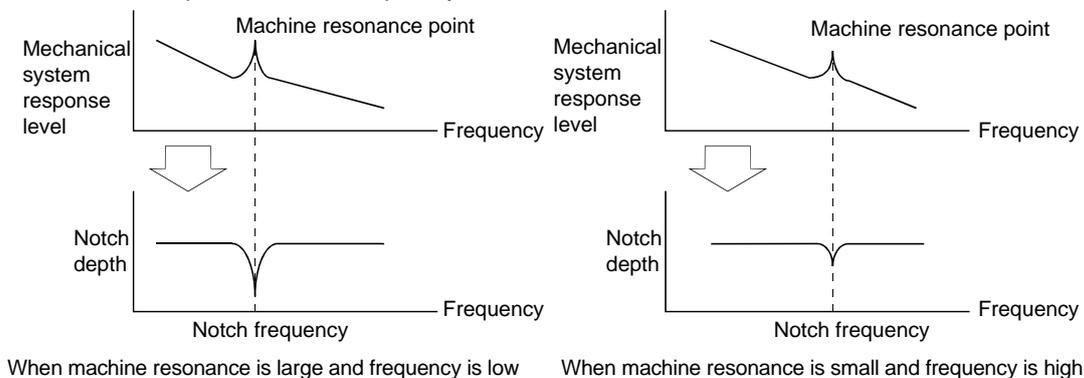
(b) Machine resonance suppression filter 2 (parameter No.59)

The setting method of machine resonance suppression filter 2 (parameter No.59) is the same as that of machine resonance suppression filter 1 (parameter No.58). However, the machine resonance suppression filter 2 can be set independently of whether adaptive vibration suppression control is valid or invalid.

8.3 Adaptive vibration suppression control

(1) Function

Adaptive vibration suppression control is a function in which the servo amplifier detects machine resonance and sets the filter characteristics automatically to suppress mechanical system vibration. Since the filter characteristics (frequency, depth) are set automatically, you need not be conscious of the resonance frequency of a mechanical system. Also, while adaptive vibration suppression control is valid, the servo amplifier always detects machine resonance, and if the resonance frequency changes, it changes the filter characteristics in response to that frequency.

When machine resonance is large and frequency is low   When machine resonance is small and frequency is high

```
┌─────────────────────────────────────────────────────────────────┐
│ ┌──────────┐                                                      │
│ │  POINT   │                                                      │
│ └──────────┘                                                      │
│ ・The machine resonance frequency which adaptive vibration suppression │
│   control can respond to is about 150 to 500Hz. Adaptive vibration suppression │
│   control has no effect on the resonance frequency outside this range. Use the │
│   machine resonance suppression filter for the machine resonance of such │
│   frequency.                                                       │
│ ・Adaptive vibration suppression control may provide no effect on a mechanical │
│   system which has complex resonance characteristics or which has too large │
│   resonance.                                                       │
│ ・Under operating conditions in which sudden disturbance torque is imposed │
│   during operation, the detection of the resonance frequency may malfunction │
│   temporarily, causing machine vibration. In such a case, set adaptive vibration │
│   suppression control to be "held" (parameter No.60: □2□□) to fix the │
│   characteristics of the adaptive vibration suppression control filter. │
└─────────────────────────────────────────────────────────────────┘
```

(2) Parameters

Set the adaptive vibration suppression control (parameter No.60).

Parameter No.60

Adaptive vibration suppression control selection
Choosing "valid" or "held" in adaptive vibration suppression
control selection makes the machine resonance suppression
filter 1 (parameter No.58) invalid.
0: Invalid
1: Valid
  Machine resonance frequency is always detected to
  generate the filter in response to resonance, suppressing
  machine vibration.
2: Held
  Filter characteristics generated so far is held, and detection of
  machine resonance is stopped.

Adaptive vibration suppression control sensitivity selection
Set the sensitivity of detecting machine resonance.
0: Normal
1: Large sensitivity

```
POINT
・Adaptive vibration suppression control is factory-set to be invalid (parameter
 No.60: 0000).
・Setting the adaptive vibration suppression control sensitivity can change the
 sensitivity of detecting machine resonance. Setting of "large sensitivity" detects
 smaller machine resonance and generates a filter to suppress machine
 vibration. However, since a phase delay will also increase, the response of the
 servo system may not increase.
```

8.4 Low-pass filter

(1) Function

When a ball screw or the like is used, resonance of high frequency may occur as the response level of the servo system is increased. To prevent this, the low-pass filter is factory-set to be valid for a torque command. The filter frequency of this low-pass filter is automatically adjusted to the value in the following expression.

$$\text{Filter frequency(Hz)} = \frac{\text{Speed control gain 2 setting} \times 10}{2\pi \times (1 + \text{Ratio of load inertia moment to servo motor inertia moment setting} \times 0.1)}$$

(2) Parameter

Set the low-pass filter (parameter No.60.)

Parameter No.60

Low-pass filter selection
0: Valid (automatic adjustment) ← initial value
1: Invalid

```
POINT
・In a mechanical system where rigidity is extremely high and resonance level is
 difficult to occur, setting the low-pass filter to be "invalid" may increase the
 servo system response level to shorten the settling time.
```

8.5 Gain changing function

This function can change the gains. You can change between gains during rotation and gains during stop or can use an external input signal to change gains during operation.

8.5.1 Applications

This function is used when.
(1) You want to increase the gains during servo lock but decrease the gains to reduce noise during rotation.
(2) You want to increase the gains during settling to shorten the stop settling time.
(3) You want to change the gains using an external input signal to ensure stability of the servo system since the load inertia moment ratio varies greatly during a stop (e.g. a large load is mounted on a carrier).

8.5.2 Function block diagram

The valid control gains PG2, VG2, VIC and GD2 of the actual loop are changed according to the conditions selected by gain changing selection CDP (parameter No.65) and gain changing condition CDS (parameter No.66).
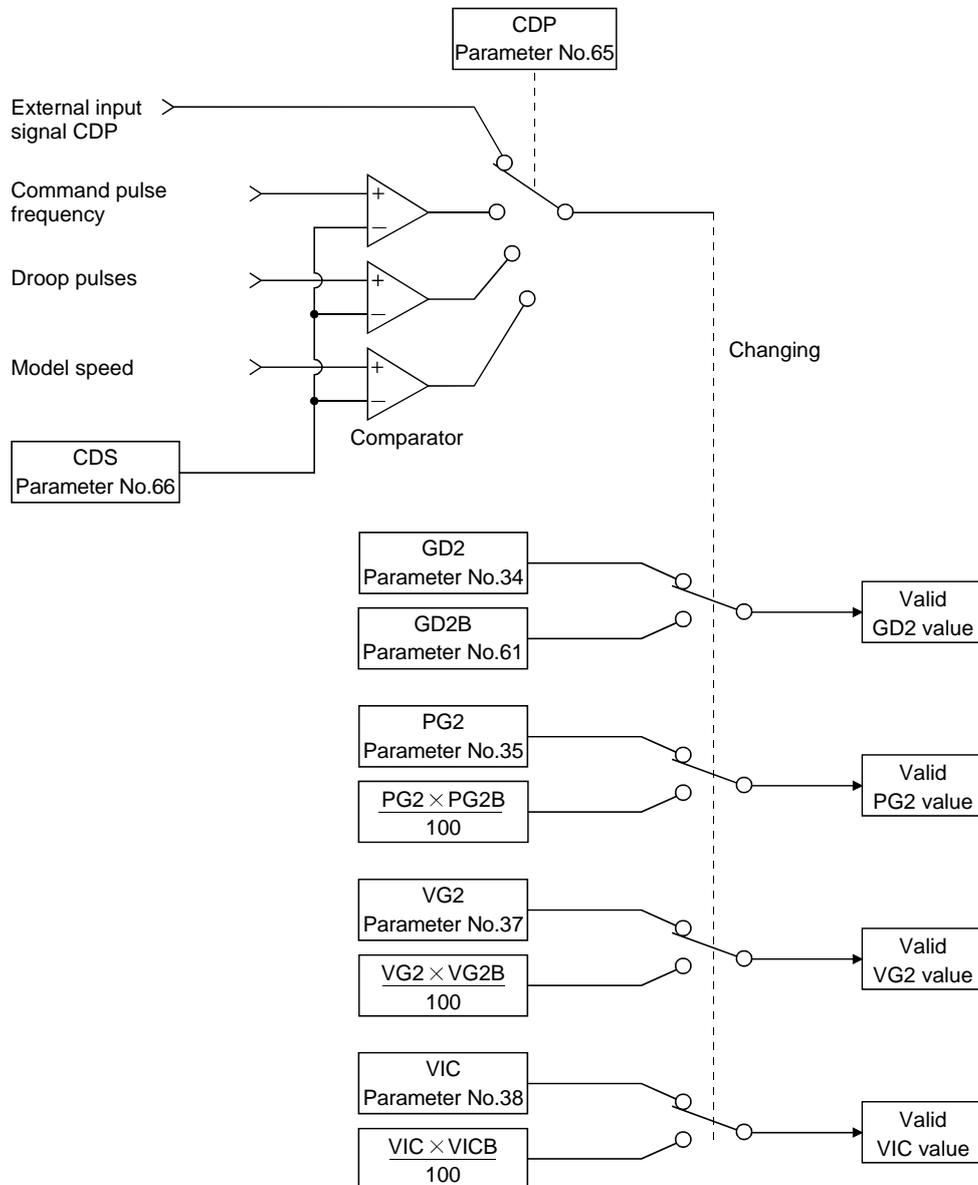
8.5.3 Parameters

When using the gain changing function, always set "□□4□" in parameter No.2 (auto tuning) to choose the manual mode of the gain adjustment modes. The gain changing function cannot be used in the auto tuning mode.

Parameter No.	Abbreviation	Name	Unit	Description
6	PG1	Position control gain 1	rad/s	Position and speed gains of a model used to set the response level to a command. Always valid.
36	VG1	Speed control gain 1	rad/s	
34	GD2	Ratio of load inertia moment to servo motor inertia moment	Multiplier ($\times 10^{-1}$)	Control parameters before changing.
35	PG2	Position control gain 2	rad/s	
37	VG2	Speed control gain 2	rad/s	
38	VIC	Speed integral compensation	ms	
61	GD2B	Ratio of load inertia moment to servo motor inertia moment 2	Multiplier ($\times 10^{-1}$)	Used to set the ratio of load inertia moment to servo motor inertia moment after changing.
62	PG2B	Position control gain 2 changing ratio	%	Used to set the ratio (%) of the after-changing position control gain 2 to position control gain 2.
63	VG2B	Speed control gain 2 changing ratio	%	Used to set the ratio (%) of the after-changing speed control gain 2 to speed control gain 2.
64	VICB	Speed integral compensation changing ratio	%	Used to set the ratio (%) of the after-changing speed integral compensation to speed integral compensation.
65	CDP	Gain changing selection		Used to select the changing condition.
66	CDS	Gain changing condition	kpps pulse r/min	Used to set the changing condition values.
67	CDT	Gain changing time constant	ms	You can set the filter time constant for a gain change at changing.

(1) Parameters No.6, 34 to 38

These parameters are the same as in ordinary manual adjustment. Gain changing allows the values of ratio of load inertia moment to servo motor inertia moment, position control gain 2, speed control gain 2 and speed integral compensation to be changed.

(2) Ratio of load inertia moment to servo motor inertia moment 2 (GD2B: parameter No.61)

Set the ratio of load inertia moment to servo motor inertia moment after changing. If the load inertia moment ratio does not change, set it to the same value as ratio of load inertia moment to servo motor inertia moment (parameter No.34).

(3) Position control gain 2 changing ratio (parameter No.62), speed control gain 2 changing ratio (parameter No.63), speed integral compensation changing ratio (parameter No.64)

Set the values of after-changing position control gain 2, speed control gain 2 and speed integral compensation in ratio (%). 100% setting means no gain change.

For example, at the setting of position control gain 2 = 100, speed control gain 2 = 2000, speed integral compensation = 20 and position control gain 2 changing ratio = 180%, speed control gain 2 changing ratio = 150% and speed integral compensation changing ratio = 80%, the after-changing values are as follows.

Position control gain 2 = Position control gain 2 × Position control gain 2 changing ratio /100=180rad/s

Speed control gain 2 = Speed control gain 2 × Speed control gain 2 changing ratio /100 = 3000rad/s

Speed integral compensation = Speed integral compensation × Speed integral compensation changing ratio /100 = 16ms

(4) Gain changing selection (parameter No.65)

Used to set the gain changing condition. Choose the changing condition in the first digit. If you set "1" here, you can use the gain changing (CDP) external input signal for gain changing. The gain changing (CDP) can be assigned to the pins using parameters No.43 to 48.
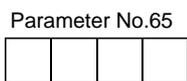
```
        Parameter No.65

        ┌──┬──┬──┬──┐
        │  │  │  │  │
        └──┴──┴──┴──┘
                   └─ Gain changing selection
                      Gains are changed in accordance with the settings of
                      parameters No.61 to 64 under any of the following conditions:
                      0: Invalid
                      1: Gain changing (CDP) input is ON
                      2: Command frequency is equal to higher than parameter No.66 setting
                      3: Droop pulse value is equal to higher than parameter No.66 setting
                      4: Servo motor speed is equal to higher than parameter No.66 setting
```

(5) Gain changing condition (parameter No.66)

When you selected "command frequency", "droop pulses" or "servo motor speed" in gain changing selection (parameter No.65), set the gain changing level.

The setting unit is as follows.

Gain changing condition	Unit
Command frequency	kpps
Droop pulses	pulse
Servo motor speed	r/min

(6) Gain changing time constant (parameter No.67)

You can set the primary delay filter to each gain at gain changing. This parameter is used to suppress shock given to the machine if the gain difference is large at gain changing, for example.

8.5.4 Gain changing procedure

This operation will be described by way of setting examples.

(1) When you choose changing by external input
   (a) Setting

Parameter No.	Abbreviation	Name	Setting	Unit
6	PG1	Position control gain 1	100	rad/s
36	VG1	Speed control gain 1	1000	rad/s
34	GD2	Ratio of load inertia moment to servo motor inertia moment	4	Multiplier ($\times 10^{-1}$)
35	PG2	Position control gain 2	120	rad/s
37	VG2	Speed control gain 2	3000	rad/s
38	VIC	Speed integral compensation	20	ms
61	GD2B	Ratio of load inertia moment to servo motor inertia moment 2	100	Multiplier ($\times 10^{-1}$)
62	PG2B	Position control gain 2 changing ratio	70	%
63	VG2B	Speed control gain 2 changing ratio	133	%
64	VICB	Speed integral compensation changing ratio	250	%
65	CDP	Gain changing selection	0001 (Changed by ON/OFF of pin CN1-10)	
67	CDT	Gain changing time constant	100	ms
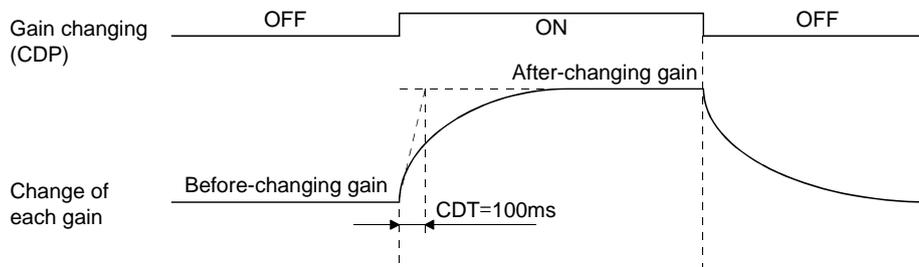
   (b) Changing timing chart

Position control gain 1	100				
Speed control gain 1	1000				
Ratio of load inertia moment to servo motor inertia moment	4.0	$\rightarrow$	10.0	$\rightarrow$	4.0
Position control gain 2	120	$\rightarrow$	84	$\rightarrow$	120
Speed control gain 2	3000	$\rightarrow$	4000	$\rightarrow$	3000
Speed integral compensation	20	$\rightarrow$	50	$\rightarrow$	20

(2) When you choose changing by droop pulses

(a) Setting

Parameter No.	Abbreviation	Name	Setting	Unit
6	PG1	Position control gain 1	100	rad/s
36	VG1	Speed control gain 1	1000	rad/s
34	GD2	Ratio of load inertia moment to servo motor inertia moment	40	Multiplier ($\times 10^{-1}$)
35	PG2	Position control gain 2	120	rad/s
37	VG2	Speed control gain 2	3000	rad/s
38	VIC	Speed integral compensation	20	ms
61	GD2B	Ratio of load inertia moment to servo motor inertia moment 2	100	Multiplier ($\times 10^{-1}$)
62	PG2B	Position control gain 2 changing ratio	70	%
63	VG2B	Speed control gain 2 changing ratio	133	%
64	VICB	Speed integral compensation changing ratio	250	%
65	CDP	Gain changing selection	0003 (Changed by droop pulses)	
66	CDS	Gain changing condition	50	pulse
67	CDT	Gain changing time constant	100	ms
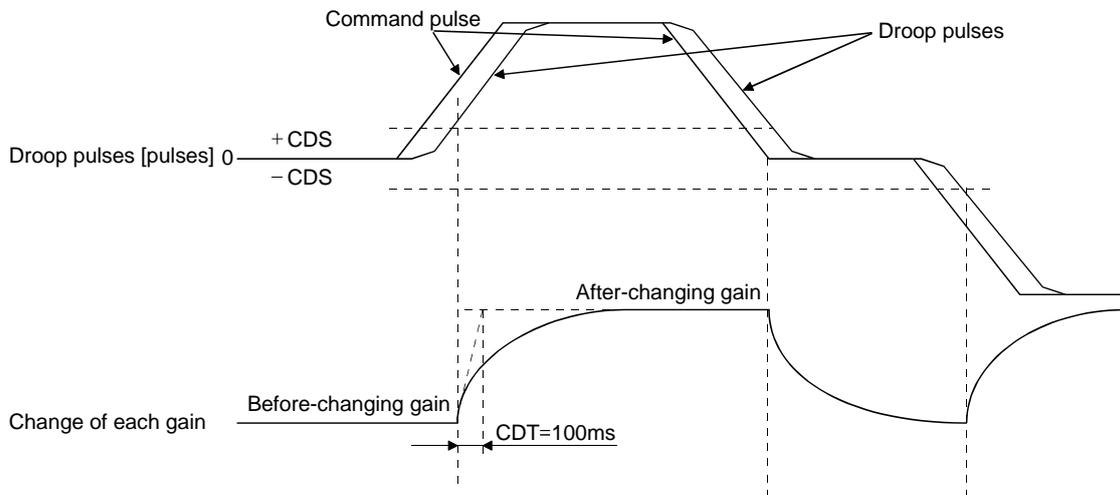
(b) Changing timing chart

Position control gain 1	100						
Speed control gain 1	1000						
Ratio of load inertia moment to servo motor inertia moment	4.0	→	10.0	→	4.0	→	10.0
Position control gain 2	120	→	84	→	120	→	84
Speed control gain 2	3000	→	4000	→	3000	→	4000
Speed integral compensation	20	→	50	→	20	→	50

MEMO

9. INSPECTION

9. INSPECTION

⚠WARNING	・Before starting maintenance and/or inspection, turn off the power and wait for 15 minutes or more until the charge lamp turns off. Otherwise, an electric shock may occur. In addition, always confirm from the front of the servo amplifier whether the charge lamp is off or not. ・Due to risk of electric shock, only qualified personnel should attempt inspection. For repair and parts replacement, please contact your local sales office.

⚠CAUTION	・Do not perform insulation resistance test on the servo amplifier as damage may result. ・Do not disassemble and/or repair the equipment on customer side.

(1) Inspection

It is recommended to make the following checks periodically.

(a) Check for loose terminal block screws. Retighten any loose screws.

(b) Check the cables and the like for scratches and cracks. Perform periodic inspection according to operating conditions.

(c) Check the servo motor bearings, brake section, etc. for unusual noise.

(d) Check the cables and the like for scratches and cracks. Perform periodic inspection according to operating conditions.

(e) Check the servo motor shaft and coupling for misalignment.

(2) Life

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

Part name	Life guideline
Smoothing capacitor	10 years
Cooling fan	10,000 to 30,000 hours (2 to 3 years)
Relay	Number of power-on and number of emergency stop times: 100,000 times
Bearings	20,000 to 30,000 hours
Encoder	20,000 to 30,000 hours
Oil seal	5,000 hours

(a) Smoothing capacitor

Affected by ripple currents, etc. and deteriorates in characteristic. The life of the capacitor greatly depends on ambient temperature and operating conditions. The capacitor will reach the end of its life in 10 years of continuous operation in normal air-conditioned environment.

(b) Relays

Their contacts will wear due to switching currents and contact faults occur. Relays reach the end of their life when the cumulative number of power-on and emergency stop times is 100,000, which depends on the power supply capacity.

(c) Servo amplifier cooling fan

The cooling fan bearings reach the end of their life in 10,000 to 30,000 hours. Normally, therefore, the cooling fan must be changed in a few years of continuous operation as a guideline.

It must also be changed if unusual noise or vibration is found during inspection.

(d) Bearings

When the servo motor is run at rated speed under rated load, change the bearings in 20,000 to 30,000 hours as a guideline. This differs on the operating conditions. The bearings must also be changed if unusual noise or vibration is found during inspection.

(e) Oil seal, V ring

Must be changed in 5,000 hours of operation at rated speed as a guideline. This differs on the operating conditions. These parts must also be changed if oil leakage, etc. is found during inspection.

10. TROUBLESHOOTING

10.1 Trouble at start-up

┌───┐
│ ⚠ CAUTION   · Excessive adjustment or change of parameter setting must not be made as it will │
│   make operation instable.   │
└───┘

┌───┐
│ POINT   │
│ · Using the optional MR Configurator (servo configuration software), you can │
│   refer to unrotated servo motor reasons, etc.   │
└───┘

The following faults may occur at start-up. If any of such faults occurs, take the corresponding action.

10.1.1 Position control mode

(1) Troubleshooting

No.	Start-up sequence	Fault	Investigation	Possible cause	Reference
1	Power on (Note)	· Seven-segment LED is not lit. · Seven-segment LED flickers.	Not improved if connectors CN1, CN2 and CN3 are disconnected.	1. Power supply voltage fault 2. Servo amplifier is faulty.	
			Improved when connectors CN1 is disconnected.	Power supply of CNP1 cabling is shorted.	
			Improved when connector CN2 is disconnected.	1. Power supply of encoder cabling is shorted. 2. Encoder is faulty.	
			Improved when connector CN3 is disconnected.	Power supply of CN3 cabling is shorted.	
		Alarm occurs.	Refer to section 10.2 and remove cause.		Section 10.2
2	Switch on servo-on signal.	Alarm occurs.	Refer to section 10.2 and remove cause.		Section 10.2
		Servo motor shaft is not servo-locked (is free).	1. Check the display to see if the servo amplifier is ready to operate. 2. Check the external I/O signal indication to see if the servo-on (SON) signal is ON.	1. Servo-on signal is not input. (Wiring mistake) 2. 24VDC power is not supplied to COM.	Section 6.6
3	Enter input command. (Test operation)	Servo motor does not rotate.	Check cumulative command pulses.	1. Wiring mistake (a) For open collector pulse train input, 24VDC power is not supplied to OPC. (b) LSP/LSN-VIN are not connected. 2. No pulses is input.	Section 6.2
		Servo motor run in reverse direction.		1. Mistake in wiring to controller. 2. Mistake in setting of parameter No.54.	Chapter 5

No.	Start-up sequence	Fault	Investigation	Possible cause	Reference
4	Gain adjustment	Rotation ripples (speed fluctuations) are large at low speed.	Make gain adjustment in the following procedure. 1. Increase the auto tuning response level. 2. Repeat acceleration and deceleration several times to complete auto tuning.	Gain adjustment fault	Chapter 7
		Large load inertia moment causes the servo motor shaft to oscillate side to side.	If the servo motor may be run with safety, repeat acceleration and deceleration several times to complete auto tuning.	Gain adjustment fault	Chapter 7
5	Cyclic operation	Position shift occurs.	Confirm the cumulative command pulses, cumulative feedback pulses and actual servo motor position.	Pulse counting error, etc. due to noise.	(2) of this section

Note. Switch power on again after making sure that the charge lamp has turned off completely.

(2) How to find the cause of position shift
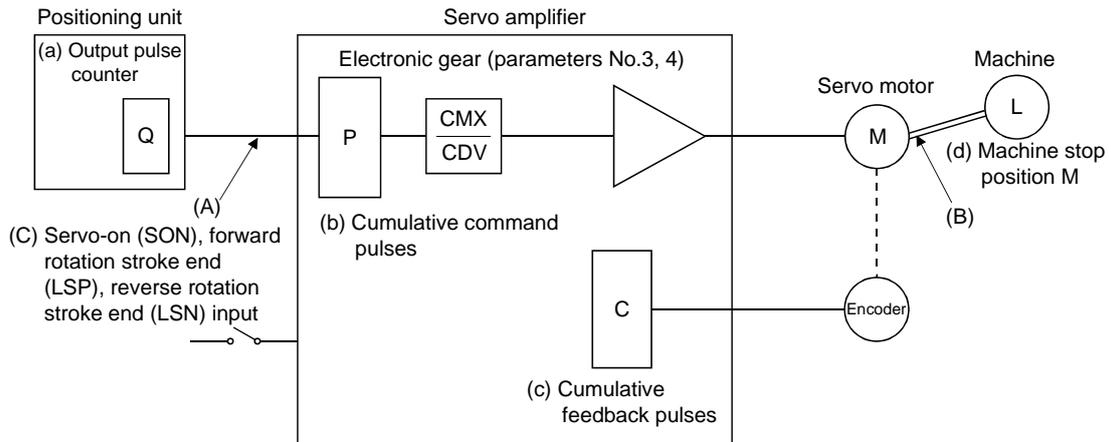
When a position shift occurs, check (a) output pulse counter, (b) cumulative command pulse display, (c) cumulative feedback pulse display, and (d) machine stop position in the above diagram.
(A), (B) and (C) indicate position shift causes. For example, (A) indicates that noise entered the wiring between positioning unit and servo amplifier, causing pulses to be miss-counted.

In a normal status without position shift, there are the following relationships.

    1) $Q = P$ (positioning unit's output counter = servo amplifier's cumulative command pulses)

    2) $P \cdot \dfrac{CMX(\text{parameter No.3})}{CDV(\text{parameter No.4})}$

       $= C$ (cumulative command pulses $\times$ electronic gear = cumulative feedback pulses)

    3) $C \cdot \Delta \ell = M$ (cumulative feedback pulses $\times$ travel per pulse = machine position)

Check for a position shift in the following sequence.

    1) When $Q \neq P$

       Noise entered the pulse train signal wiring between positioning unit and servo amplifier, causing pulses to be miss-counted. (Cause A)

       Make the following check or take the following measures.

       ・Check how the shielding is done.

       ・Change the open collector system to the differential line driver system.

       ・Run wiring away from the power circuit.

       ・Install a data line filter.

    2) When $P \cdot \dfrac{CMX}{CDV} \neq C$

       During operation, the servo-on signal (SON) or forward rotation stroke end (LSP), reverse rotation stroke end (LSN) signal was switched off or the clear signal (CR) and the reset signal (RES) switched on. (Cause C)

       If a malfunction may occur due to much noise, increase the input filter setting (parameter No.1).

    3) When $C \cdot \Delta \ell \neq M$

       Mechanical slip occurred between the servo motor and machine. (Cause B)

10.1.2 Internal speed control mode

No.	Start-up sequence	Fault	Investigation	Possible cause	Reference
1	Power on (Note)	• Seven-segment LED is not lit. • Seven-segment LED flickers.	Not improved if connectors CN1, CN2 and CN3 are disconnected.	1. Power supply voltage fault 2. Servo amplifier is faulty.	
			Improved when connectors CN1 is disconnected.	Power supply of CN1 cabling is shorted.	
			Improved when connector CN2 is disconnected.	1. Power supply of encoder cabling is shorted. 2. Encoder is faulty.	
			Improved when connector CN3 is disconnected.	Power supply of CN3 cabling is shorted.	
		Alarm occurs.	Refer to section 10.2 and remove cause.		Section 10.2
2	Switch on servo-on signal.	Alarm occurs.	Refer to section 10.2 and remove cause.		Section 10.2
		Servo motor shaft is not servo-locked (is free).	1. Check the display to see if the servo amplifier is ready to operate. 2. Check the external I/O signal indication to see if the servo-on (SON) signal is ON.	1. Servo-on signal is not input. (Wiring mistake) 2. 24VDC power is not supplied to COM.	Section 6.6
3	Switch on forward rotation start (ST1) or reverse rotation start (ST2).	Servo motor does not rotate.	Call the external I/O signal display and check the ON/OFF status of the input signal.	LSP, LSN, ST1 or ST2 is off.	Section 6.6
			Check the internal speed commands 1 to 7 (parameters No.8 to 10・72 to 75).	Set value is 0.	Section 5.1.2 (1)
			Check the internal torque limit 1 (parameter No.28).	Torque limit level is too low as compared to the load torque.	
4	Gain adjustment	Rotation ripples (speed fluctuations) are large at low speed.	Make gain adjustment in the following procedure. 1. Increase the auto tuning response level. 2. Repeat acceleration and deceleration several times to complete auto tuning.	Gain adjustment fault	Chapter 7
		Large load inertia moment causes the servo motor shaft to oscillate side to side.	If the servo motor may be run with safety, repeat acceleration and deceleration several times to complete auto tuning.	Gain adjustment fault	Chapter 7

Note. Switch power on again after making sure that the charge lamp has turned off completely.

10.2 When alarm or warning has occurred

```
┌─────────────────────────────────────────────────────────────────┐
│ POINT                                                             │
├─────────────────────────────────────────────────────────────────┤
│ ·As soon as an alarm occurs, turn off Servo-on (SON) and power off the power │
│  supply.                                                          │
└─────────────────────────────────────────────────────────────────┘
```

10.2.1 Alarms and warning list

When a fault occurs during operation, the corresponding alarm or warning is displayed. If any alarm or warning has occurred, refer to section 10.2.2 or 10.2.3 and take the appropriate action. When an alarm occurs, the current circuit between ALM and VIN opens.

Set "□□□1" in parameter No.49 to output the alarm code in ON/OFF status across the corresponding pin and VIN. Warnings (AL.96 to AL.E9) have no alarm codes. Any alarm code is output at occurrence of the corresponding alarm. In the normal status, the signals available before alarm code setting (CN1-12: ZSP, CN1-11: RD, CN1-10: INP or SA) are output.

After its cause has been removed, the alarm can be deactivated in any of the methods marked ○ in the alarm deactivation column.

| | | (Note 2) Alarm code | | | | Alarm deactivation | | |
	Display	CN1-10 pin	CN1-11 pin	CN1-12 pin	Name	Power OFF→ON	Press "SET" on current alarm screen.	Alarm reset (RES) signal
Alarms	AL.10	0	1	0	Undervoltage	○	○	○
	AL.12	0	0	0	Memory error 1	○		
	AL.13	0	0	0	Clock error	○		
	AL.15	0	0	0	Memory error 2	○		
	AL.16	1	0	1	Encoder error 1	○		
	AL.17	0	0	0	Board error	○		
	AL.19	0	0	0	Memory error 3	○		
	AL.1A	1	0	1	Motor combination error	○		
	AL.20	1	1	0	Encoder error 2	○		
	AL.24	0	0	1	Main circuit error	○		
	AL.30	0	1	0	Regenerative error	○ (Note 1)	○ (Note 1)	○ (Note 1)
	AL.31	0	1	1	Overspeed	○	○	○
	AL.32	0	0	1	Overcurrent	○	○	○
	AL.33	0	1	0	Overvoltage	○		
	AL.35	0	1	1	Command pulse frequency error	○	○	○
	AL.37	0	0	0	Parameter error	○		
	AL.45	1	1	0	Main circuit device overheat	○ (Note 1)	○ (Note 1)	○ (Note 1)
	AL.46	1	1	0	Servo motor overheat	○ (Note 1)	○ (Note 1)	○ (Note 1)
	AL.50	1	1	0	Overload 1	○ (Note 1)	○ (Note 1)	○ (Note 1)
	AL.51	1	1	0	Overload 2	○ (Note 1)	○ (Note 1)	○ (Note 1)
	AL.52	0	1	1	Error excessive	○	○	○
	AL.8A	0	0	0	Serial communication time-out error	○	○	○
	AL.8E	0	0	0	Serial communication error	○	○	○
	88888	0	0	0	Watchdog	○		
Warnings	AL.E0				Excessive regenerative warning	Removing the cause of occurrence deactivates the alarm automatically.		
	AL.E1				Overload warning			
	AL.E6				Servo emergency stop warning			
	AL.E9				Undervoltage warning			

Note 1. Deactivate the alarm about 30 minutes of cooling time after removing the cause of occurrence.
  2. 0: off
    1: on

10.2.2 Remedies for alarms

⚠ CAUTION	・When any alarm has occurred, eliminate its cause, ensure safety, then reset the alarm, and restart operation. Otherwise, injury may occur. ・As soon as an alarm occurs, turn off Servo-on (SON) and power off the power supply.

> POINT
> ・When any of the following alarms has occurred, always remove its cause and allow about 30 minutes for cooling before resuming operation. If operation is resumed by switching power off, then on to reset the alarm, the servo amplifier and servo motor may become faulty.
>   ・Regenerative error (AL.30)
>   ・Overload 1 (AL.50)
>   ・Overload 2 (AL.51)
> ・The alarm can be deactivated by switching power off, then on press the "SET" button on the current alarm screen or by turning on the reset signal (RES). For details, refer to section 10.2.1.

When an alarm occurs, the trouble signal (ALM) switches off and the dynamic brake is operated to stop the servo motor. At this time, the display indicates the alarm No.
The servo motor comes to a stop. Remove the cause of the alarm in accordance with this section. Use the optional MR Configurator (servo configuration software) to refer to the cause of the alarm.

Display	Name	Definition	Cause	Action
AL.10	Undervoltage	Power supply voltage dropped to 160VAC or less.	1. Power supply voltage is low.	Check the power supply.
			2. There was an instantaneous control power failure of 60ms or longer.	
			3. Shortage of power supply capacity caused the power supply voltage to drop at start, etc.	
			4. The bus voltage dropped to 200VDC.	
			5. Faulty parts in the servo amplifier	Change the servo amplifier.
AL.12	Memory error 1	RAM, memory fault	Faulty parts in the servo amplifier	Change the servo amplifier.
AL.13	Clock error	Printed board fault		
AL.15	Memory error 2	EEP-ROM fault	1. Faulty parts in the servo amplifier	Change the servo amplifier.
			2. The number of write times to EEP-ROM exceeded 100,000.	
AL.16	Encoder error 1	Communication error occurred between encoder and servo amplifier.	1. Encoder connector (CN2) disconnected.	Connect correctly.
			2. Encoder fault	Change the servo motor.
			3. Encoder cable faulty (Wire breakage or shorted)	Repair or change cable.
AL.17	Board error	CPU/parts fault	1. Faulty parts in the servo amplifier	Change the servo amplifier.
		The output terminals U, V, W of the servo amplifier and the input terminals U, V, W of the servo motor are not connected.	2. The wiring of U, V, W is disconnected or not connected.	Correctly connect the output terminals U, V, W of the servo amplifier and the input terminals U, V, W of the servo motor.
AL.19	Memory error 3	ROM memory fault	Faulty parts in the servo amplifier	Change the servo amplifier.

Display	Name	Definition	Cause	Action
AL.1A	Motor combination error	Wrong combination of servo amplifier and servo motor.	Wrong combination of servo amplifier and servo motor connected.	Use correct combination.
AL.20	Encoder error 2	Communication error occurred between encoder and servo amplifier.	1. Encoder connector (CN2) disconnected.	Connect correctly.
			2. Encoder fault	Change the servo motor.
			3. Encoder cable faulty (Wire breakage or shorted)	Repair or change the cable.
AL.24	Main circuit error	Ground fault occurred at the servo motor powers (U,V and W phases) of the servo amplifier.	1. Power input wires and servo motor power wires are in contact at main circuit terminal block (TE1).	Connect correctly.
			2. Insulators of servo motor power cables deteriorated, resulting in ground fault.	Change the cable.
			3. Main circuit of servo amplifier failed. ⎯ Checking method ⎯ Alarm (AL.24) occurs if the servo is switched on after disconnecting the U, V, W power cables from the servo amplifier.	Change the servo amplifier.
AL.30	Regenerative error	Permissible regenerative power of the built-in regenerative resistor or regenerative option is exceeded.	1. Wrong setting of parameter No.0	Set correctly.
			2. Built-in regenerative resistor or regenerative option is not connected.	Connect correctly.
			3. High-duty operation or continuous regenerative operation caused the permissible regenerative power of the regenerative option to be exceeded. ⎯ Checking method ⎯ Call the status display and check the regenerative load ratio.	1. Reduce the frequency of positioning. 2. Use the regenerative option of larger capacity. 3. Reduce the load.
			4. Power supply voltage is abnormal. MR-E-□A-QW003: 260VAC or more	Check the power supply.
			5. Built-in regenerative resistor or regenerative option faulty.	Change servo amplifier or regenerative option.
		Regenerative transistor fault	6. Regenerative transistor faulty. ⎯ Checking method ⎯ 1) The regenerative option has overheated abnormally. 2) Alarm (AL.30) occurs even after removal of the built-in regenerative resistor or regenerative option.	Change the servo amplifier.

Display	Name	Definition	Cause	Action
AL.31	Overspeed	Speed has exceeded the instantaneous permissible speed.	1. Input command pulse frequency exceeded the permissible instantaneous speed frequency.	Set command pulses correctly.
			2. Small acceleration/deceleration time constant caused overshoot to be large.	Increase acceleration/deceleration time constant.
			3. Servo system is instable to cause overshoot.	1. Re-set servo gain to proper value. 2. If servo gain cannot be set to proper value. 1) Reduce load inertia moment ratio; or 2) Reexamine acceleration/ deceleration time constant.
			4. Electronic gear ratio is large (parameters No.3, 4)	Set correctly.
			5. Encoder faulty.	Change the servo motor.
AL.32	Overcurrent	Current that flew is higher than the permissible current of the servo amplifier. (When the alarm (AL.32) occurs, switch the power OFF and then ON to reset the alarm. Then, turn on the servo-on. When the alarm (AL.32) still occurs at the time, the transistor (IPM・IGBT) of the servo amplifier may be at fault. Do not switch the power OFF/ON repeatedly; check the transistor according to the cause 2 checking method.)	1. Short occurred in servo amplifier output phases U, V and W.	Correct the wiring.
			2. Transistor (IPM) of the servo amplifier faulty. ―――― Checking method ―――― Alarm (AL.32) occurs if power is switched on after U,V and W are disconnected.	Change the servo amplifier.
			3. Ground fault occurred in servo amplifier output phases U, V and W.	Correct the wiring.
			4. External noise caused the overcurrent detection circuit to misoperate.	Take noise suppression measures.
AL.33	Overvoltage	Converter bus voltage exceeded 400VDC.	1. Regenerative option is not used.	Use the regenerative option.
			2. Though the regenerative option is used, the parameter No.0 setting is "□□0□ (not used)".	Make correct setting.
			3. Lead of built-in regenerative resistor or regenerative option is open or disconnected.	1. Change the lead. 2. Connect correctly.
			4. Regenerative transistor faulty.	Change the servo amplifier.
			5. Wire breakage of built-in regenerative resistor or regenerative option	1. For wire breakage of built-in regenerative resistor, change the servo amplifier. 2. For wire breakage of regenerative option, change the regenerative option.
			6. Capacity of built-in regenerative resistor or regenerative option is insufficient.	Add regenerative option or increase capacity.
			7. Power supply voltage high.	Check the power supply.

Display	Name	Definition	Cause	Action
AL.35	Command pulse frequency error	Input pulse frequency of the command pulse is too high.	1. Pulse frequency of the command pulse is too high.	Change the command pulse frequency to a proper value.
			2. Noise entered command pulses.	Take action against noise.
			3. Command device failure	Change the command device.
AL.37	Parameter error	Parameter setting is wrong.	1. Servo amplifier fault caused the parameter setting to be rewritten.	Change the servo amplifier.
			2. Regenerative option or servo motor not used with servo amplifier was selected in parameter No.0.	Set parameter No.0 correctly.
			3. The number of write times to EEP-ROM exceeded 100,000 due to parameter write, etc.	Change the servo amplifier.
AL.45	Main circuit device overheat	Main circuit device overheat	1. Servo amplifier faulty.	Change the servo amplifier.
			2. The power supply was turned on and off continuously by overloaded status.	The drive method is reviewed.
			3. Air cooling fan of servo amplifier stops.	1. Exchange the cooling fan or the servo amplifier. 2. Reduce ambient temperature.
AL.46	Servo motor overheat	Servo motor temperature rise actuated the thermal sensor.	1. Ambient temperature of servo motor is over 40℃ (104℉).	Review environment so that ambient temperature is 0 to 40℃ (104℉).
			2. Servo motor is overloaded.	1. Reduce load. 2. Review operation pattern. 3. Use servo motor that provides larger output.
			3. Thermal sensor in encoder is faulty.	Change the servo motor.
AL.50	Overload 1	Load exceeded overload protection characteristic of servo amplifier.	1. Servo amplifier is used in excess of its continuous output current.	1. Reduce load. 2. Review operation pattern. 3. Use servo motor that provides larger output.
			2. Servo system is instable and hunting.	1. Repeat acceleration/deceleration to execute auto tuning. 2. Change auto tuning response setting. 3. Set auto tuning to OFF and make gain adjustment manually.
			3. Machine struck something.	1. Review operation pattern. 2. Install limit switches.
			4. Wrong connection of servo motor. Servo amplifier's output terminals U, V, W do not match servo motor's input terminals U, V, W.	Connect correctly.
			5. Encoder faulty. ┌─ Checking method ─┐ When the servo motor shaft is rotated with the servo off, the cumulative feedback pulses do not vary in proportion to the rotary angle of the shaft but the indication skips or returns midway.	Change the servo motor.

10 - 9

Display	Name	Definition	Cause	Action
AL.51	Overload 2	Machine collision or the like caused max. output current to flow successively for several seconds. Servo motor locked: 1s or more During rotation: 2.5s or more	1. Machine struck something.	1. Review operation pattern. 2. Install limit switches.
			2. Wrong connection of servo motor. Servo amplifier's output terminals U, V, W do not match servo motor's input terminals U, V, W.	Connect correctly.
			3. Servo system is instable and hunting.	1. Repeat acceleration/deceleration to execute auto tuning. 2. Change auto tuning response setting. 3. Set auto tuning to OFF and make gain adjustment manually.
			4. Encoder faulty. ⎯ Checking method ⎯ When the servo motor shaft is rotated with the servo off, the cumulative feedback pulses do not vary in proportion to the rotary angle of the shaft but the indication skips or returns midway.	Change the servo motor.
AL.52	Error excessive	The difference between the model position and the actual servo motor position exceeds 2.5 rotations. (Refer to the function block diagram in section 1.2)	1. Acceleration/deceleration time constant is too small.	Increase the acceleration/deceleration time constant.
			2. Torque limit value (parameter No.28) is too small.	Increase the torque limit value.
			3. Motor cannot be started due to torque shortage caused by power supply voltage drop.	1. Review the power supply capacity. 2. Use servo motor which provides larger output.
			4. Position control gain 1 (parameter No.6) value is small.	Increase set value and adjust to ensure proper operation.
			5. Servo motor shaft was rotated by external force.	1. When torque is limited, increase the limit value. 2. Reduce load. 3. Use servo motor that provides larger output.
			6. Machine struck something.	1. Review operation pattern. 2. Install limit switches.
			7. Encoder faulty	Change the servo motor.
			8. Wrong connection of servo motor. Servo amplifier's output terminals U, V, W do not match servo motor's input terminals U, V, W.	Connect correctly.
AL.8A	Serial communication time-out error	RS-232C or RS-422 communication stopped for longer than the time set in parameter No.56.	1. Communication cable breakage.	Repair or change communication cable.
			2. Communication cycle longer than parameter No.56 setting.	Set correct value in parameter.
			3. Wrong protocol.	Correct protocol.
AL.8E	Serial communication error	Serial communication error occurred between servo amplifier and communication device (e.g. personal computer).	1. Communication cable fault (Open cable or short circuit)	Repair or change the cable.
			2. Communication device (e.g. personal computer) faulty	Change the communication device (e.g. personal computer).
88888	Watchdog	CPU, parts faulty	Fault of parts in servo amplifier	Change the servo amplifier.

10.2.3 Remedies for warnings

> ┌─────────┐
> │ POINT │
> └─────────┘
> ・When any of the following alarms has occurred, do not resume operation by switching power of the servo amplifier OFF/ON repeatedly. The servo amplifier and servo motor may become faulty. If the power of the servo amplifier is switched OFF/ON during the alarms, allow more than 30 minutes for cooling before resuming operation.
> ・Excessive regenerative warning (AL.E0)
> ・Overload warning 1 (AL.E1)

If AL.E6 occurs, the servo off status is established. If any other warning occurs, operation can be continued but an alarm may take place or proper operation may not be performed. Use the optional MR Configurator (servo configuration software) to refer to the cause of the warning.

Display	Name	Definition	Cause	Action
AL.E0	Excessive regenerative warning	There is a possibility that regenerative power may exceed permissible regenerative power of built-in regenerative resistor or regenerative option.	Regenerative power increased to 85% or more of permissible regenerative power of built-in regenerative resistor or regenerative option. ┌─── Checking method ───┐ Call the status display and check regenerative load ratio.	1. Reduce frequency of positioning. 2. Change regenerative option for the one with larger capacity. 3. Reduce load.
AL.E1	Overload warning	There is a possibility that overload alarm 1 or 2 may occur.	Load increased to 85% or more of overload alarm 1 or 2 occurrence level. ┌─── Cause, checking method ───┐ Refer to AL.50, 51.	Refer to AL.50, AL.51.
AL.E6	Servo emergency stop warning	EMG-VIN are open.	External emergency stop was made valid. (EMG-VIN opened.)	Ensure safety and deactivate emergency stop.
AL.E9	Undervoltage warning	This alarm occurs when the servo motor speed decreases to or below 50r/min with the bus voltage dropping.		Check the power supply.

MEMO

11. OUTLINE DIMENSION DRAWINGS

11.1 Servo amplifiers

(1) MR-E-10A-QW003・MR-E-20A-QW003
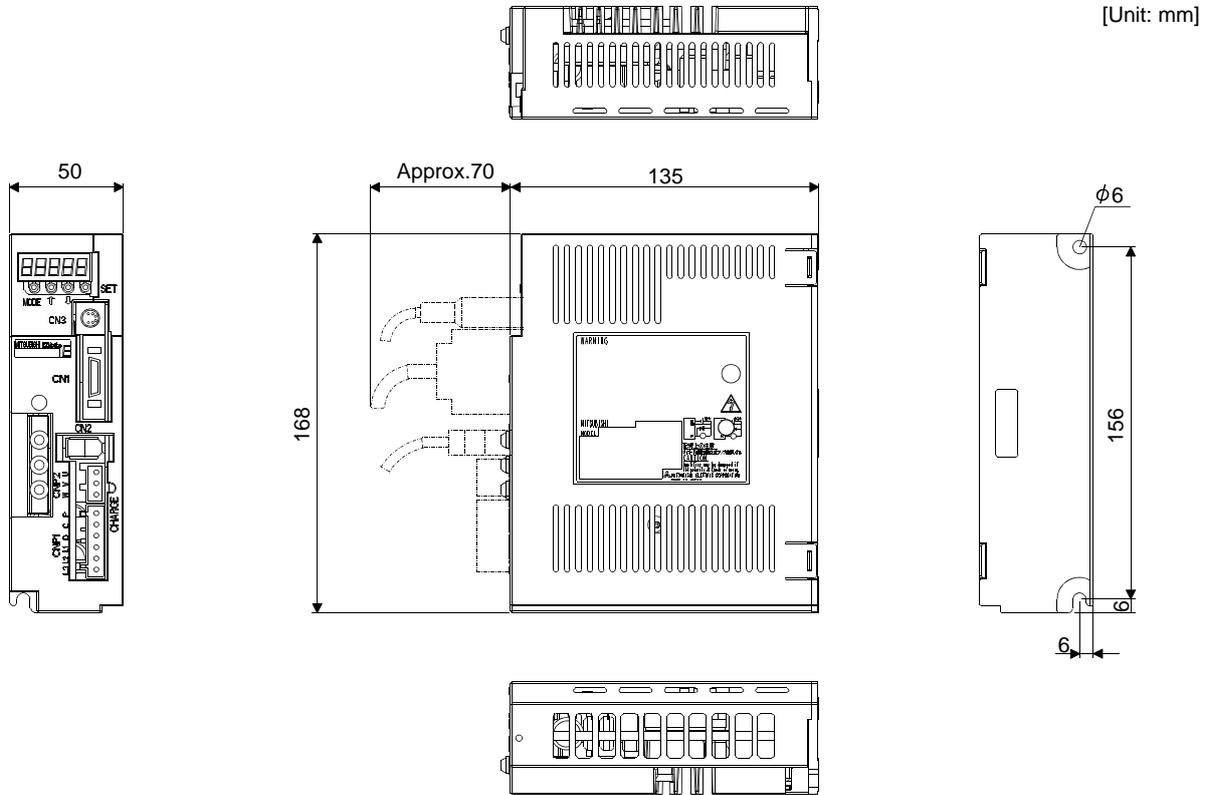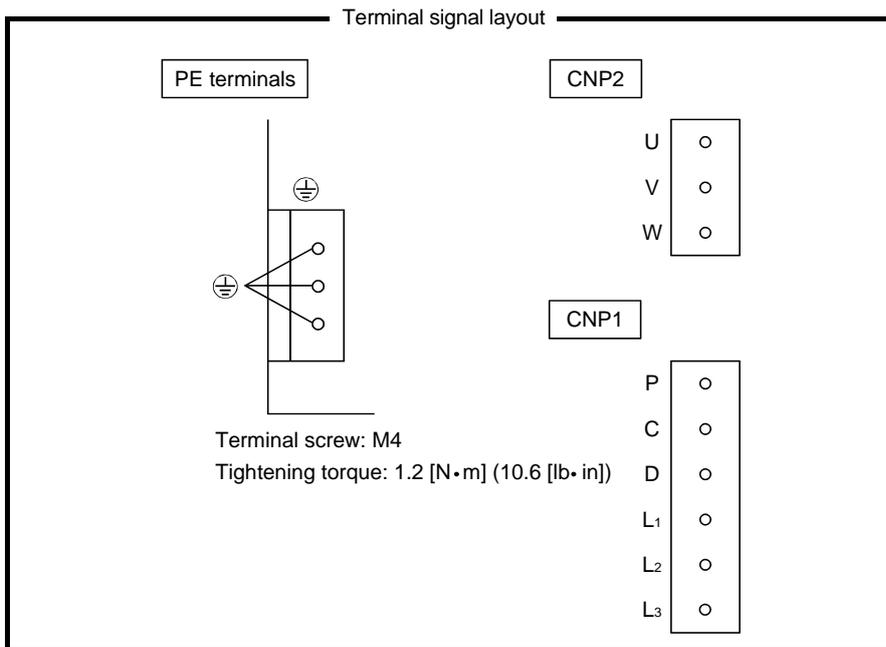
[Unit: mm]

50

Approx.70   135

168

φ6

156

6

6

Mass: 0.7 [kg] (1.54 [lb])

Terminal signal layout

PE terminals

CNP2

U
V
W

CNP1

P
C
D
L₁
L₂
L₃

Terminal screw: M4

Tightening torque: 1.2 [N・m] (10.6 [lb・in])

Mounting Screw
  Screw Size: M5
  Tightening torque: 3.24 [N・m]
                    (28.676 [lb・in])

(2) MR-E-40A-QW003

[Unit: mm]

70   Approx.70   135

φ6

168

156

6

22

Mass: 1.1 [kg] (2.43 [lb])

Terminal signal layout

PE terminals

CNP2

U   ○
V   ○
W   ○

CNP1

P   ○
C   ○
D   ○
L₁   ○
L₂   ○
L₃   ○

Terminal screw: M4
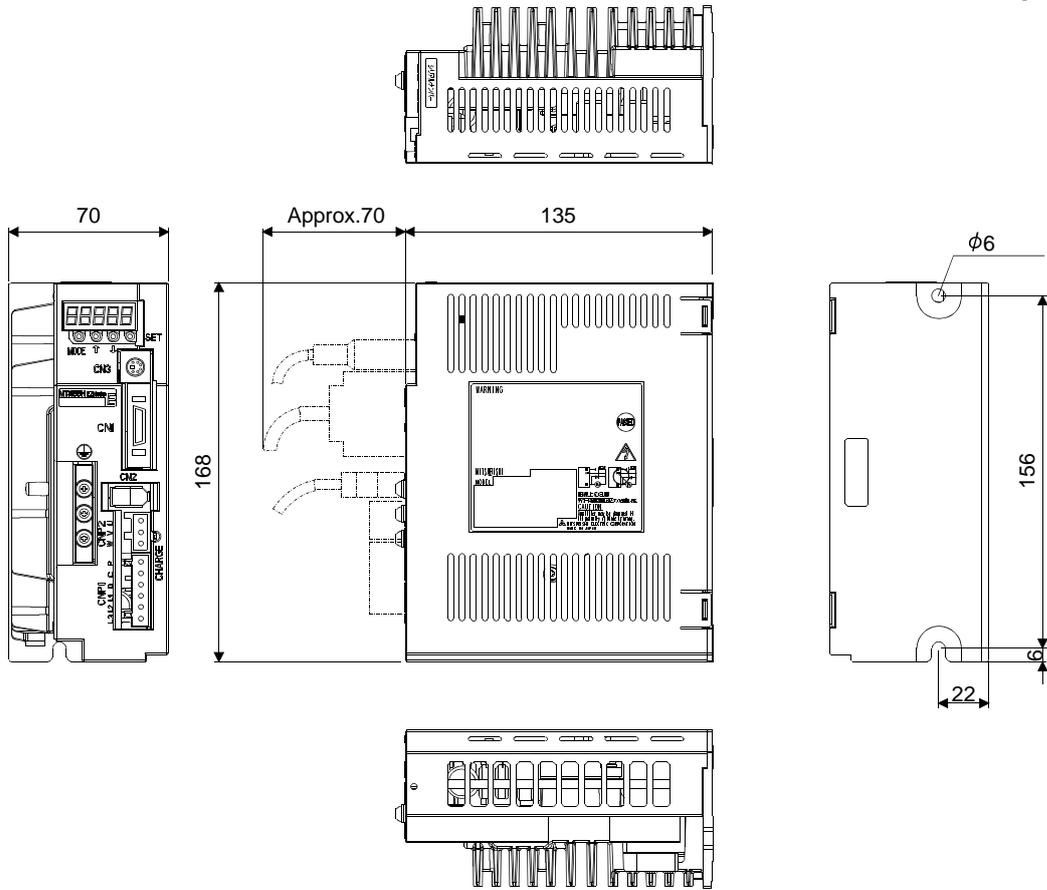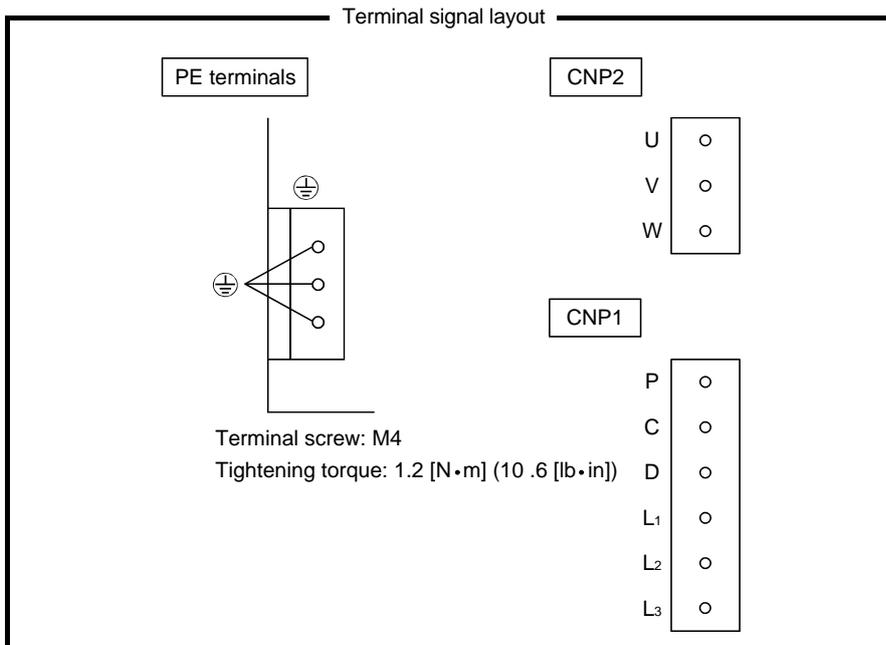
Tightening torque: 1.2 [N・m] (10 .6 [lb・in])

Mounting Screw
  Screw Size: M5
  Tightening torque: 3.24 [N・m]
                (28.676 [lb・in])

(3) MR-E-70A-QW003・MR-E-100A-QW003

[Unit: mm]
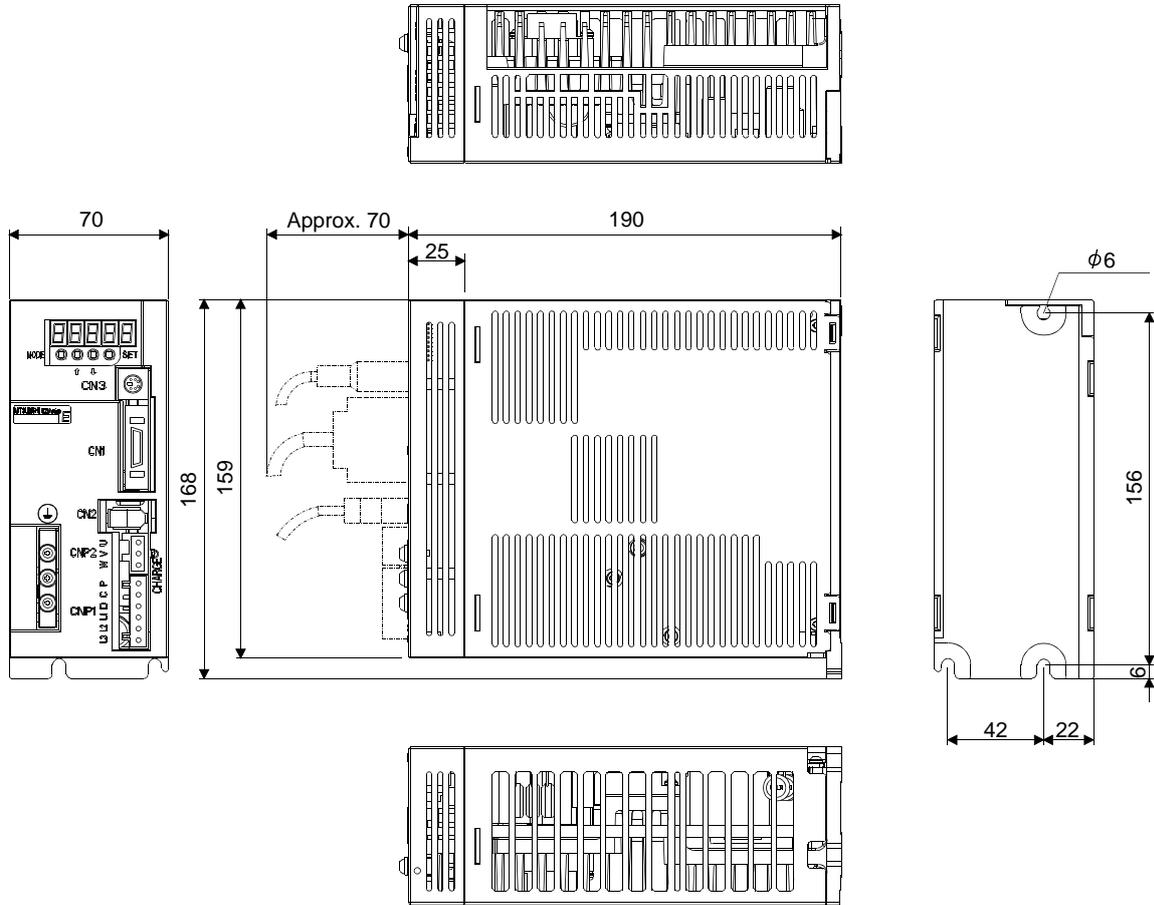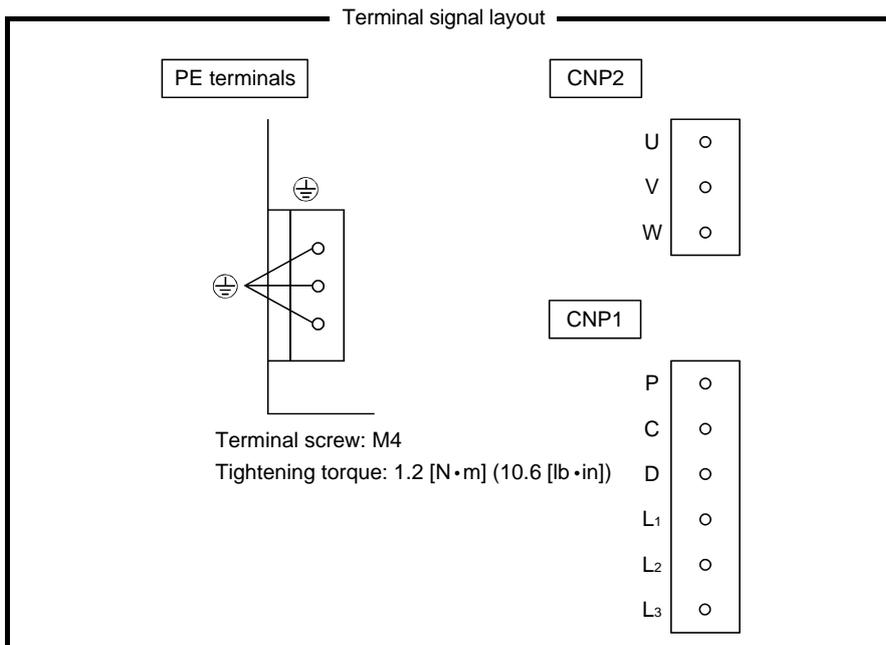
70   Approx. 70   190

25

168   159   190

φ6

156

6

42   22

Mass: 1.7 [kg] (3.75 [lb])

Terminal signal layout

PE terminals

CNP2

U	○
V	○
W	○

CNP1

P	○
C	○
D	○
L₁	○
L₂	○
L₃	○

Terminal screw: M4

Tightening torque: 1.2 [N・m] (10.6 [lb・in])

Mounting Screw
  Screw Size: M5
  Tightening torque: 3.24 [N・m]
                    (28.676 [lb・in])

(4) MR-E-200A-QW003

[Unit: mm]

90

Approx. 70

195

40

Exhaust

168

156

φ6

156

78

6

6

Cooling fan
air intake

Mass: 2.0 [kg] (4.41 [lb])

Terminal signal layout

CNP1

L₁	○
L₂	○
L₃	○
P	○
C	○
D	○

CNP2

U	○
V	○
W	○

PE terminals

Terminal screw: M4
Tightening torque: 1.2 [N·m]
(10.6 [lb·in])
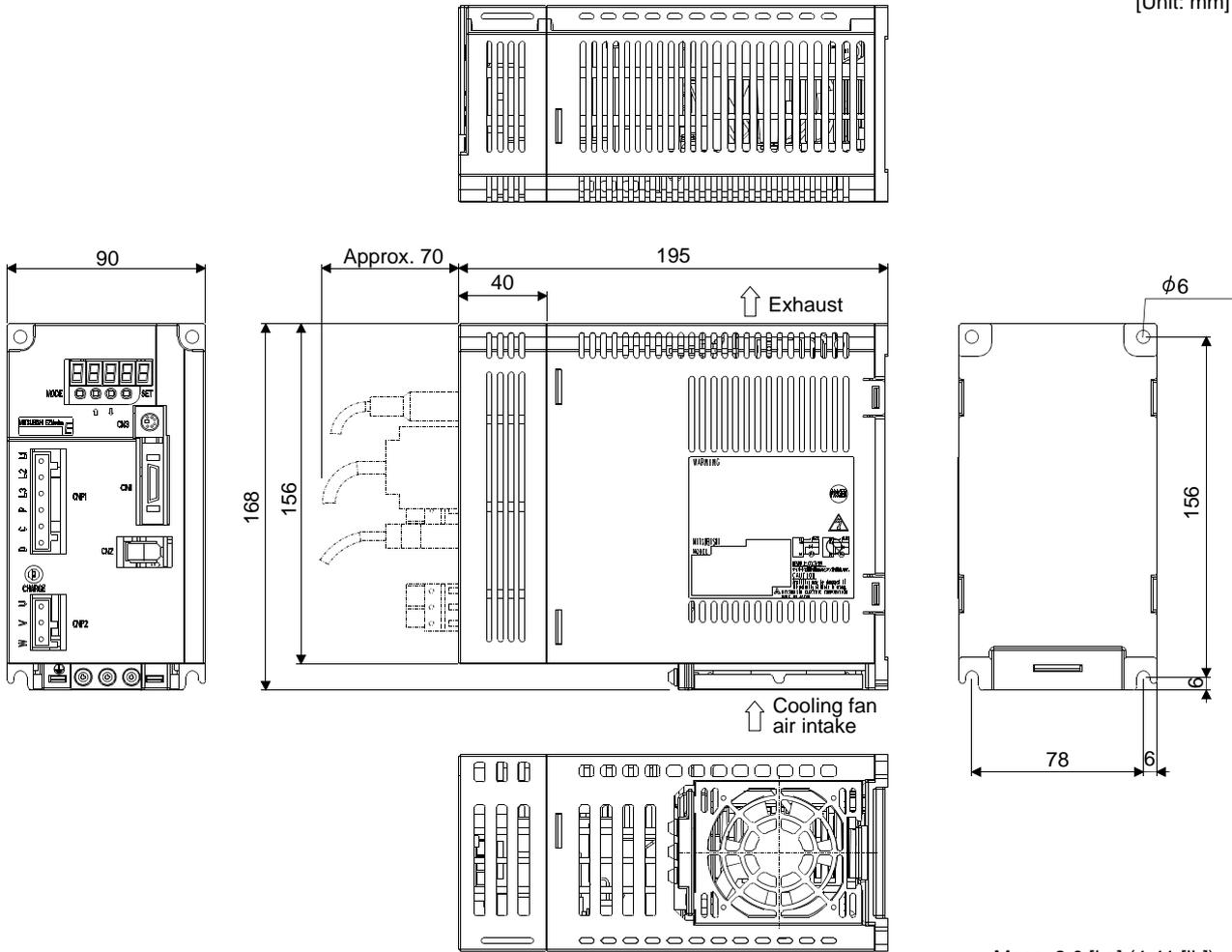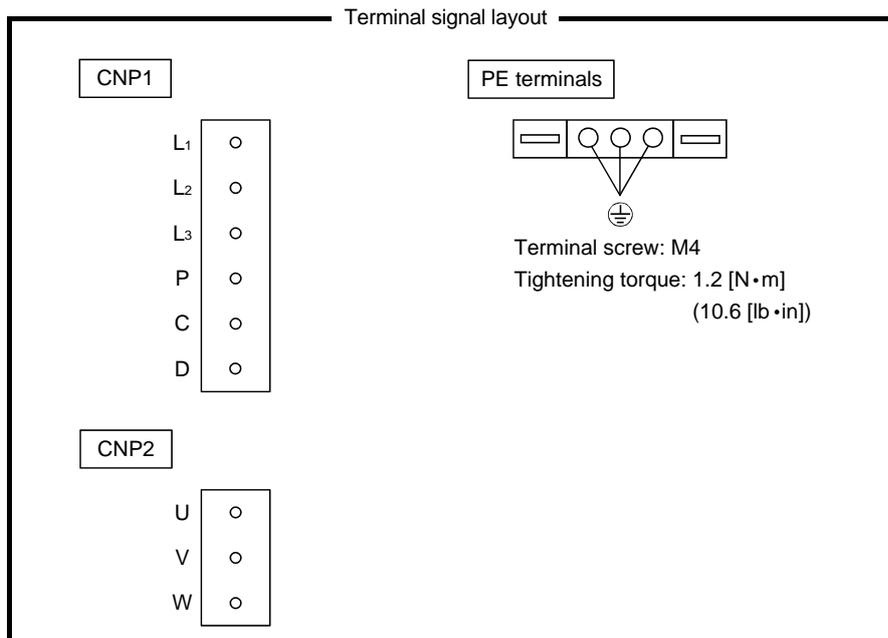
Mounting Screw
  Screw Size: M5
  Tightening torque: 3.24 [N·m]
(28.676 [lb·in])

11.2 Connectors

(1) Miniature delta ribbon (MDR) system (3M)
  (a) One-touch lock type

[Unit: mm]

E

D

A

C

39.0

23.8

B

12.7

Logo etc, are indicated here.
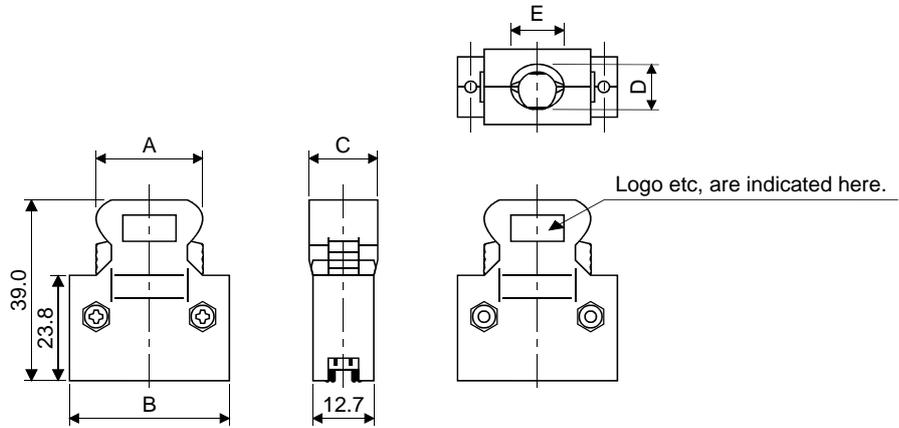
Connector	Shell kit	Each type of dimension				
		A	B	C	D	E
10126-3000PE	10326-52F0-008	25.8	37.2	14.0	10.0	12.0

  (b) Jack screw M2.6 type
    This is not available as option.

[Unit: mm]

E

D

A

C

F

39.0

23.8

5.2

B

12.7

Logo etc, are indicated here.
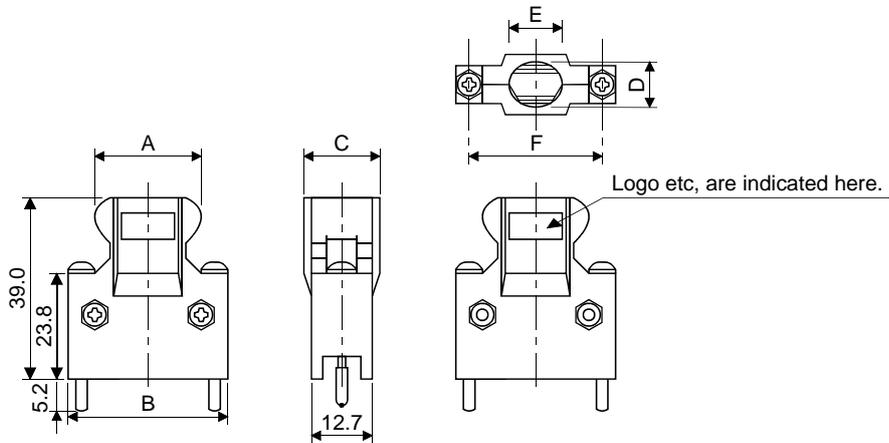
Connector	Shell kit	Each type of dimension					
		A	B	C	D	E	F
10126-3000PE	10326-52A0-008	25.8	37.2	14.0	10.0	12.0	27.4

(2) CN2 Connector (Molex)
   Connector set   : 54599-1019

[Unit: mm]

40

12.5

11

22.7
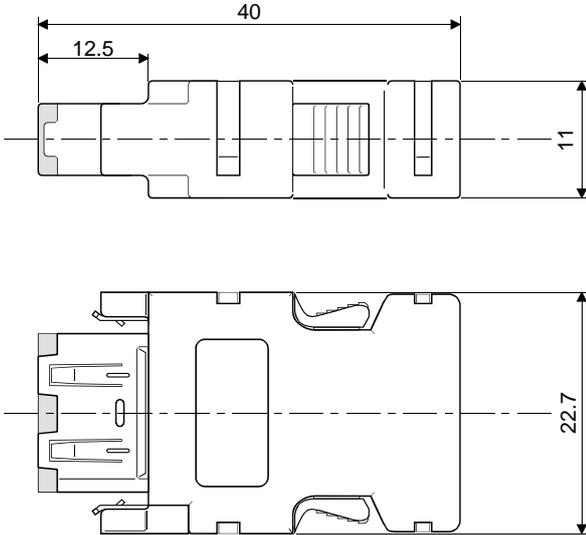
(3) CN3 Connector (Marushin electric mfg)
   Connector: MP371/6

[Unit: mm]

6   44.5   φ5

φ14.8

8.95
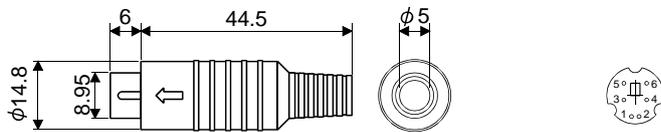
(4) CNP1・CNP2 Connector (Molex)

　(a) Crimping type

[Unit: mm]
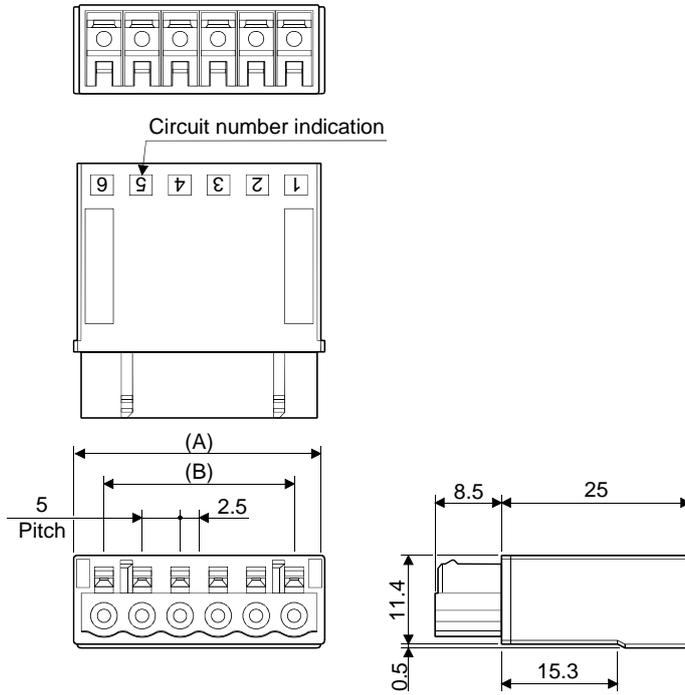
Connector	Variable dimensions [mm] ([in])		Number of poles	Application
	A	B		
51240-0300	17.8	10	3	CNP2 (1kW or less)
51240-0600	32.8	25	6	CNP1 (1kW or less)

Crimping tool: 57349-5300 (Molex)

Circuit number indication

(A)
(B)
5 Pitch
2.5

8.5   25
11.4
0.5
15.3
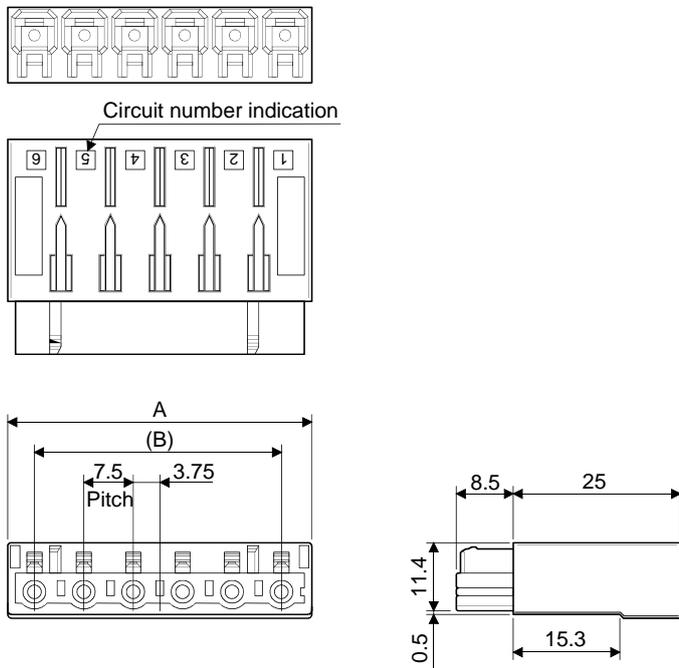
[Unit: mm]

Connector	Variable dimensions [mm] ([in])		Number of poles	Application
	A	B		
51241-0300	22.8	15	3	CNP2 (2kW)
51241-0600	45.3	37.5	6	CNP1 (2kW)

Crimping tool: 57349-5300 (Molex)

Circuit number indication

A
(B)
7.5   3.75
Pitch

8.5   25
11.4
0.5
15.3

(b) Insertion type
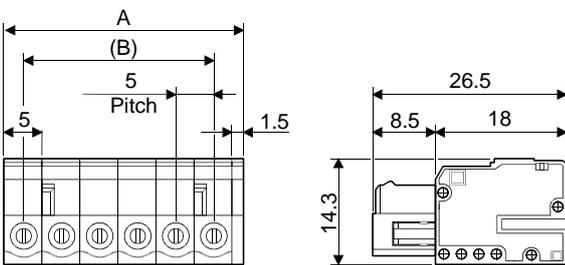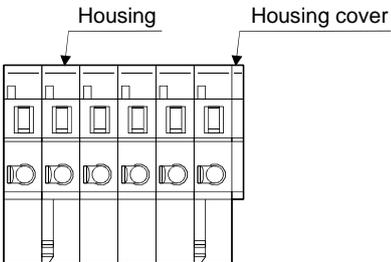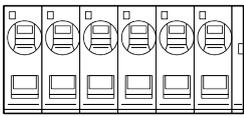
Connector	Variable dimensions [mm]		Number of poles	Application
	A	B		
54927-0310	16.5	10	3	CNP2 (1kW or less)
54927-0610	31.5	25	6	CNP1 (1kW or less)
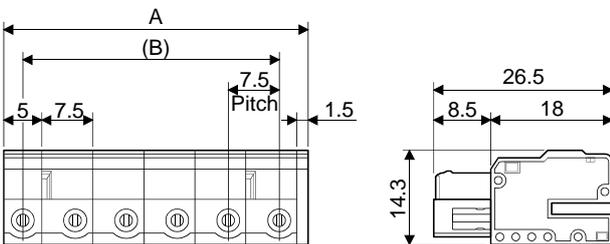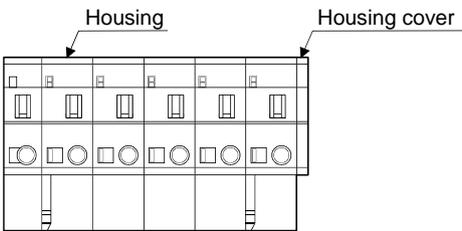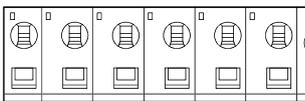
[Unit: mm]

Connector	Variable dimensions [mm]		Number of poles	Application
	A	B		
54928-0310	21.5	22.5	3	CNP2 (2kW)
54928-0610	44	37.5	6	CNP1 (2kW)

12. CHARACTERISTICS

12.1 Overload protection characteristics

An electronic thermal relay is built in the servo amplifier to protect the servo motor, servo amplifier, and servo motor power cable from overloads. Overload 1 (AL.50) occurs if overload operation performed is above the electronic thermal relay protection curve shown in any of Figs 12.1, Overload 2 (AL.51) occurs if the maximum current flew continuously for several seconds due to machine collision, etc. Use the equipment on the left-hand side area of the continuous or broken line in the graph.

In a machine like the one for vertical lift application where unbalanced torque will be produced, it is recommended to use the machine so that the unbalanced torque is 70% or less of the rated torque.
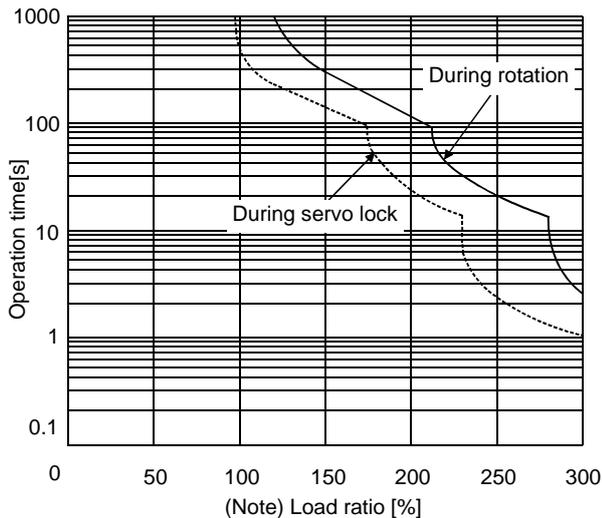
a. MR-E-10A-QW003 to MR-E-100A-QW003   b. MR-E-200A-QW003
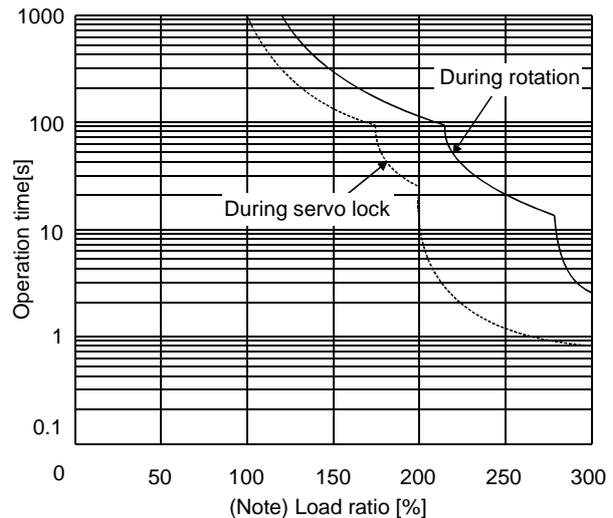
Note. If operation that generates torque more than 100% of the rating is performed with an abnormally high frequency in a servo motor stop status (servo lock status) or in a 30r/min or less low-speed operation status, the servo amplifier may fail even when the electronic thermal relay protection is not activated.

Fig 12.1 Electronic thermal relay protection characteristics

12.2 Power supply equipment capacity and generated loss

(1) Amount of heat generated by the servo amplifier

Table 12.1 indicates servo amplifiers' power supply capacities and losses generated under rated load. For thermal design of an enclosure, use the values in Table 12.1 in consideration for the worst operating conditions. The actual amount of generated heat will be intermediate between values at rated torque and zero torque according to the duty used during operation. When the servo motor is run at less than the maximum speed, the power supply capacity will be smaller than the value in the table, but the servo amplifier's generated heat will not change.

Table 12.1 Power supply capacity and generated heat per servo amplifier at rated output

Servo amplifier	Servo motor	(Note 1) Power supply capacity [kVA]	(Note 2) Servo amplifier-generated heat [W]		Area required for heat dissipation [m²]
			At rated torque	With servo off	
MR-E-10A-QW003	HF-KN13(J)	0.3	25	15	0.5
MR-E-20A-QW003	HF-KN23(J)	0.5	25	15	0.5
MR-E-40A-QW003	HF-KN43(J)	0.9	35	15	0.7
MR-E-70A-QW003	HF-SN52J	1.0	40	15	0.8
	HF-KN73J	1.3	50	15	1.0
MR-E-100A-QW003	HF-SN102J	1.7	50	15	1.0
MR-E-200A-QW003	HF-SN152J	2.5	90	20	1.8
	HF-SN202J	3.5	90	20	1.8

Note 1. Note that the power supply capacity will vary according to the power supply impedance. This value assumes that the power factor improving reactor is not used.

2. Heat generated during regeneration is not included in the servo amplifier-generated heat. To calculate heat generated by the regenerative option, refer to section 13.1.1.

(2) Heat dissipation area for enclosed servo amplifier

The enclosed control box (hereafter called the control box) which will contain the servo amplifier should be designed to ensure that its temperature rise is within ＋10℃ at the ambient temperature of 40℃ (104℉). (With a 5℃ (41℉) safety margin, the system should operate within a maximum 55℃ (131℉) limit.) The necessary enclosure heat dissipation area can be calculated by Equation 12.1.

$$A = \frac{P}{K \cdot \Delta T} \quad\text{...(12.1)}$$

where, A : Heat dissipation area [m^2]
        P : Loss generated in the control box [W]
        ΔT : Difference between internal and ambient temperatures [℃]
        K : Heat dissipation coefficient [5 to 6]

When calculating the heat dissipation area with Equation 12.1, assume that P is the sum of all losses generated in the enclosure. Refer to Table 12.1 for heat generated by the servo amplifier. "A" indicates the effective area for heat dissipation, but if the enclosure is directly installed on an insulated wall, that extra amount must be added to the enclosure's surface area.

The required heat dissipation area will vary wit the conditions in the enclosure. If convection in the enclosure is poor and heat builds up, effective heat dissipation will not be possible. Therefore, arrangement of the equipment in the enclosure and the use of a cooling fan should be considered.

Table 12.1 lists the enclosure dissipation area for each servo amplifier when the servo amplifier is operated at the ambient temperature of 40℃ (104℉) under rated load.

(Outside)　　　(Inside)
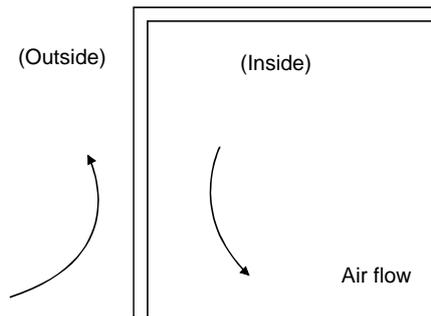
Air flow

Fig. 12.2 Temperature distribution in enclosure

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

12.3 Dynamic brake characteristics

┌───┐
│ POINT   │
│ ・Dynamic brake operates at occurrence of alarm, servo emergency stop   │
│   warning (AL.E6) and when power is turned off. Do not use dynamic brake │
│   to stop in a normal operation as it is the function to stop in emergency.│
│ ・Maximum usage time of dynamic brake for a machine operating under   │
│   recommended load inertia moment ratio is 1000 times while decelerating │
│   from rated speed to a stop with frequency of once in 10 minutes.   │
│ ・Be sure to make emergency stop (EMG) valid after servo motor stops when │
│   using emergency stop (EMG) frequently in other than emergency.   │
└───┘

Fig. 12.3 shows the pattern in which the servo motor comes to a stop when the dynamic brake is operated. Use Equation 12.2 to calculate an approximate coasting distance to a stop. The dynamic brake time constant τ varies with the servo motor and machine operation speeds. (Refer to Fig. 12.4)
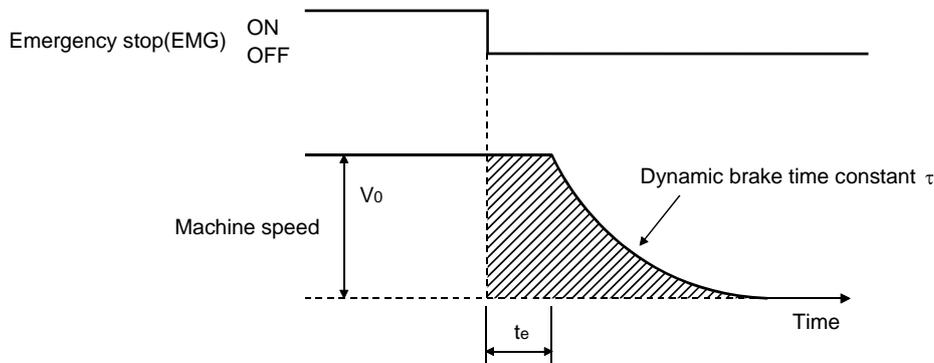
Fig. 12.3 Dynamic brake operation diagram

$$L_{max} = \frac{V_0}{60} \cdot \left\{ t_e + \tau \left[1 + \frac{J_L}{J_M} \right] \right\} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(12.2)$$

L_{max} : Maximum coasting distance...[mm]
V_0 : Machine rapid feed rate..[mm/min]
J_M : Servo motor inertial moment .... [kg・cm^2][oz・in^2]
J_L : Load inertia moment converted into equivalent value on servo motor shaft .... [kg・cm^2][oz・in^2]
τ : Dynamic brake time constant...[s]
t_e : Delay time of control section .... [s]
   (There is internal relay delay time of about 30ms.)
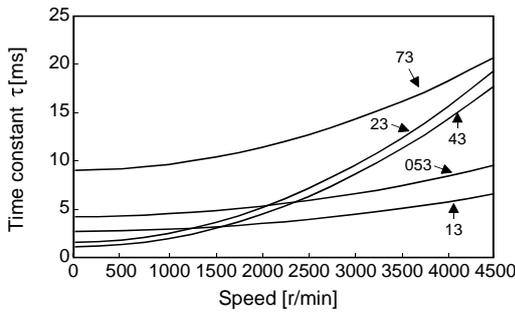
a. HF-KN□(J)
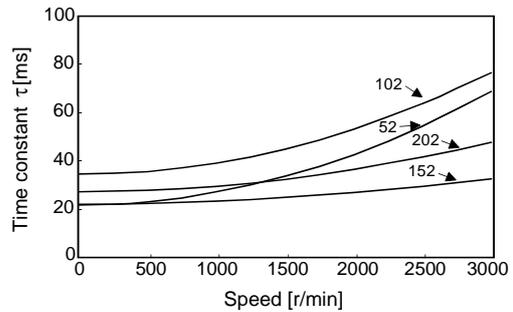
b. HF-SN□J

Fig. 12.4 Dynamic brake time constant

Use the dynamic brake under the load inertia moment ratio indicated in the following table. If the load inertia moment is higher than this value, the built-in dynamic brake may burn. If there is a possibility that the load inertia moment may exceed the value, contact Mitsubishi.

Servo amplifier	Load inertia moment ratio [times]
MR-E-10A-QW003 to MR-E-200A-QW003	30

12.4 Encoder cable flexing life

The flexing life of the cables is shown below. This graph calculated values. Since they are not guaranteed values, provide a little allowance for these values.

a : Long flex life encoder cable
Long flex life motor power cable
Long flex life motor brake cable

b : Standard encoder cable
Standard motor power cable
Standard motor brake cable
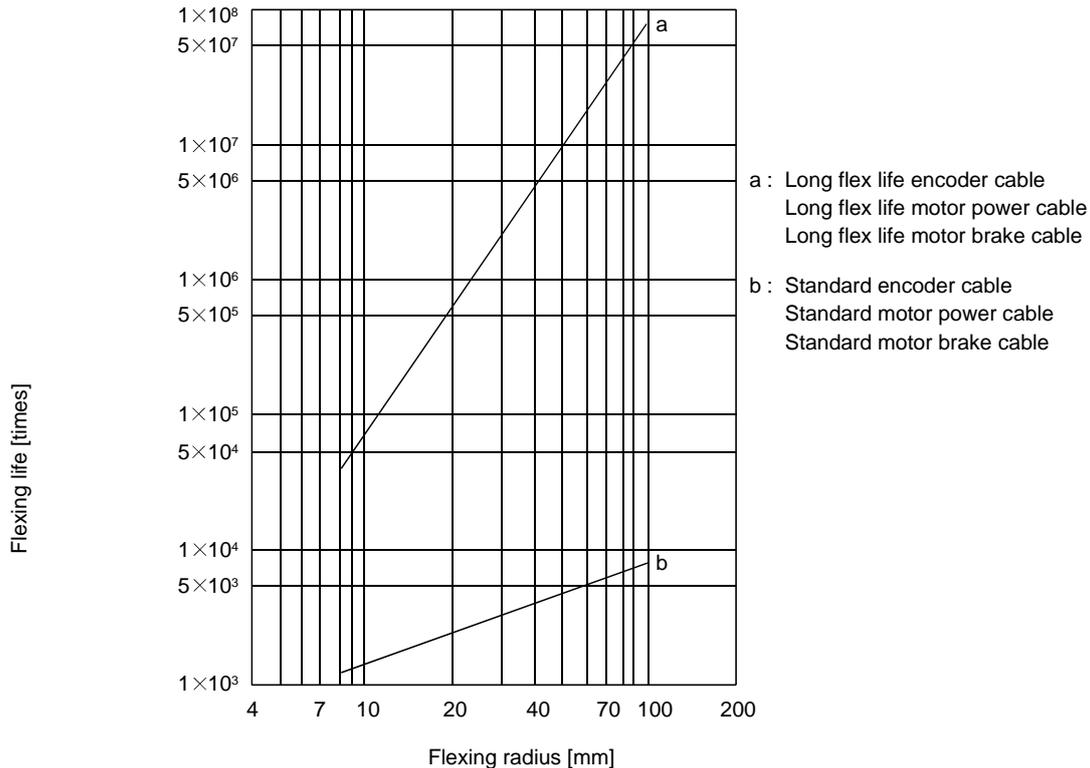
12.5 Inrush currents at power-on of main circuit and control circuit

The following table indicates the inrush currents (reference value) that will flow when the maximum permissible voltage (253VAC) is applied at the power supply capacity of 2500kVA and the wiring length of 1m.

Servo amplifier	Inrush currents (A_{0-p})
	Main circuit power supply (L_1, L_2, L_3)
MR-E-10A-QW003	
MR-E-20A-QW003	50A (Attenuated to approx. 10A in 10ms)
MR-E-40A-QW003	
MR-E-70A-QW003	70A (Attenuated to approx. 20A in 10ms)
MR-E-100A-QW003	
MR-E-200A-QW003	110A (Attenuated to approx. 20A in 10ms)

Since large inrush currents flow in the power supplies, always use circuit breakers and magnetic contactors. (Refer to section 13.2.2.)
When circuit protectors are used, it is recommended to use the inertia delay type that will not be tripped by an inrush current.

13. OPTIONS AND AUXILIARY EQUIPMENT

⚠ WARNING	・Before connecting any option or peripheral equipment, turn off the power and wait for 15 minutes or more until the charge lamp turns off. Otherwise, an electric shock may occur. In addition, always confirm from the front of the servo amplifier whether the charge lamp is off or not.

⚠ CAUTION	・Use the specified auxiliary equipment and options. Unspecified ones may lead to a fault or fire.

13.1 Options

13.1.1 Regenerative options

⚠ CAUTION	・The specified combinations of regenerative options and servo amplifiers may only be used. Otherwise, a fire may occur.

(1) Combination and regenerative power

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

Servo amplifier	Permissible regenerative power [W]					
	Built-in regenerative resistor	MR-RB032 [40Ω]	MR-RB12 [40Ω]	MR-RB32 [40Ω]	MR-RB30 [13Ω]	(Note) MR-RB50 [13Ω]
MR-E-10A-QW003		30				
MR-E-20A-QW003		30	100			
MR-E-40A-QW003	10	30	100			
MR-E-70A-QW003	20	30	100	300		
MR-E-100A-QW003	20	30	100	300		
MR-E-200A-QW003	100				300	500

Note. Always install a cooling fan.

(2) Selection of the regenerative option

Use the following method when regeneration occurs continuously in vertical motion applications or when it is desired to make an in-depth selection of the regenerative option.

(a) Regenerative energy calculation

Use the following table to calculate the regenerative energy.
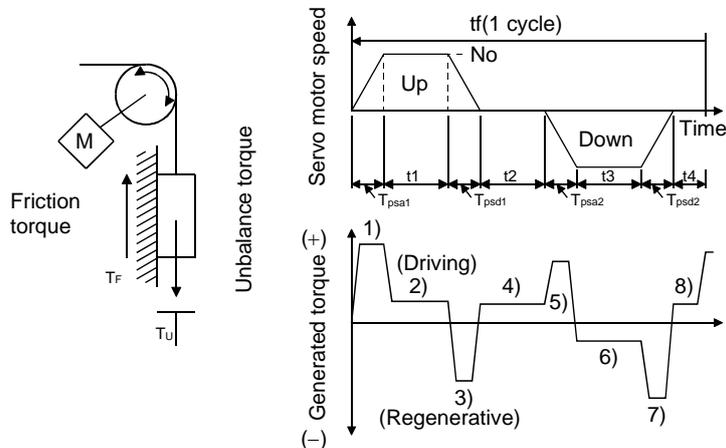
Formulas for calculating torque and energy in operation

Regenerative power	Torque applied to servo motor [N・m]	Energy [J]
1)	$T_1 = \dfrac{(J_L+J_M)\cdot N_0}{9.55\times10^4} \cdot \dfrac{1}{T_{psa1}} + T_U + T_F$	$E_1 = \dfrac{0.1047}{2}\cdot N_0\cdot T_1\cdot T_{psa1}$
2)	$T_2 = T_U + T_F$	$E_2 = 0.1047\cdot N_0\cdot T_2\cdot t_1$
3)	$T_3 = \dfrac{-(J_L+J_M)\cdot N_0}{9.55\times10^4} \cdot \dfrac{1}{T_{psd1}} + T_U + T_F$	$E_3 = \dfrac{0.1047}{2}\cdot N_0\cdot T_3\cdot T_{psd1}$
4), 8)	$T_4 = T_U$	$E_4 \geq 0$ (No regeneration)
5)	$T_5 = \dfrac{(J_L+J_M)\cdot N_0}{9.55\times10^4} \cdot \dfrac{1}{T_{psa2}} - T_U + T_F$	$E_5 = \dfrac{0.1047}{2}\cdot N_0\cdot T_5\cdot T_{psa2}$
6)	$T_6 = -T_U + T_F$	$E_6 = 0.1047\cdot N_0\cdot T_6\cdot t_3$
7)	$T_7 = \dfrac{-(J_L+J_M)\cdot N_0}{9.55\times10^4} \cdot \dfrac{1}{T_{psd2}} - T_U + T_F$	$E_7 = \dfrac{0.1047}{2}\cdot N_0\cdot T_7\cdot T_{psd2}$

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

(b) 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-E-10A-QW003	55	9
MR-E-20A-QW003	70	9
MR-E-40A-QW003	85	11
MR-E-70A-QW003	80	18
MR-E-100A-QW003	80	18
MR-E-200A-QW003	85	40

Inverse efficiency (η) : Efficiency including some efficiencies of the servo motor and servo amplifier when rated (regenerative) torque is generated at rated speed. Since the efficiency varies with the speed and torque, allow for about 10%.

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

Subtract the capacitor charging from the result of multiplying the sum total of regenerative energies by the inverse efficiency to calculate the energy consumed by the regenerative option.

$$ER [J] = \eta \cdot Es - Ec$$

Calculate the power consumption of the regenerative option on the basis of single-cycle operation period tf [s] to select the necessary regenerative option.

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

(3) Connection of the regenerative option

Set parameter No.2 according to the option to be used.

Parameter No.0

Selection of regenerative option
0: Regenerative option is not used
・ For the servo amplifier of 200W or lower, lower, regenerative resistor is not used.
・ For the servo amplifier of 400W or higher, built-in regenerative resistor is used.
2: MR-RB032
3: MR-RB12
4: MR-RB32
5: MR-RB30
6: MR-RB50 (Cooling fan is required)

(4) Connection of the regenerative option

> POINT
> ・When using the MR-RB50, cooling by a cooling fan is required. Please obtain
>   a cooling fan at your discretion.

The regenerative option will cause a temperature rise of 100℃ relative to the ambient temperature. Fully examine heat dissipation, installation position, used cables, etc. before installing the option. For wiring, use flame-resistant cables and keep them clear of the regenerative option body. Always use twisted cables of max. 5m length for connection with the servo amplifier.
Always remove the wiring from across P-D and fit the regenerative option across P-C.
The G3 and G4 terminals act as a thermal sensor. G3-G4 are disconnected when the regenerative option overheats abnormally.

Always remove the lead from across P-D.
Servo amplifier

Regenerative option

D
P
C
P
C
G3
G4
(Note 2)
5m max.
Cooling fan
(Note 1)
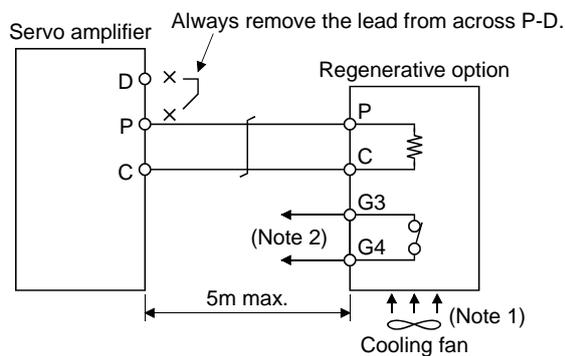
Note 1. When using the MR-RB50, forcibly cool it with a cooling fan (92×92, minimum air flow: 1.0m^3).
       2. Make up a sequence which will switch off the magnetic contactor when abnormal heating occurs.
          G3-G4 contact specifications
          Maximum voltage: 120V AC/DC
          Maximum current: 0.5A/4.8VDC
          Maximum capacity: 2.4VA

(5) Outline drawing
  (a) MR-RB032 ・ MR-RB12

[Unit: mm]

φ6 mounting hole
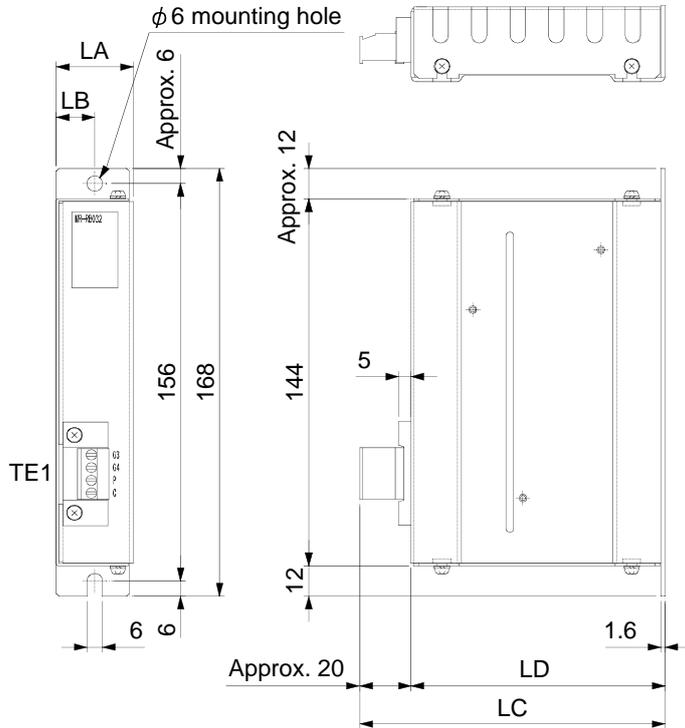
・ TE1
  Terminal block

G3
G4
P
C

Applicable wire size: 0.2mm² (AWG24)
to 2.5mm² (AWG12)
Tightening torque:
0.5 to 0.6 [N・m](4 to 5 [lb・in])
・ Mounting screw
  Screw size: M5
  Tightening torque:
  3.24[N・m](28.68 [lb・in])

Regenerative	Variable dimensions				Mass	
option	LA	LB	LC	LD	[kg]	[lb]
MR-RB032	30	15	119	99	0.5	1.1
MR-RB12	40	15	169	149	1.1	2.4

  (b) MR-RB32 ・ MR-RB30
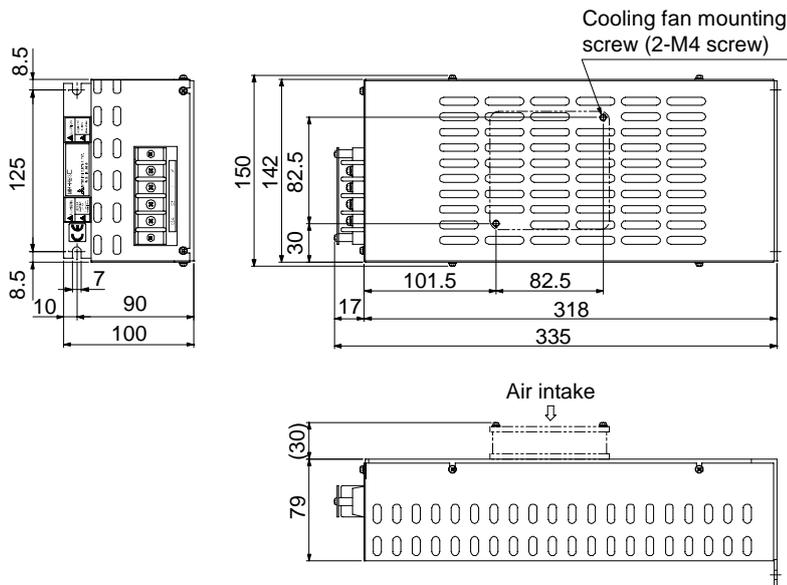
Cooling fan mounting
screw (2-M4 screw)

[Unit: mm]

・ Terminal block

P
C	Terminal screw: M4
G3	Tightening torque: 1.2 [N・m] (10.6 [lb・in])
G4	

Air intake

・ Mounting screw
  Screw : M6
  Tightening torque: 5.4 [N・m](47.79 [lb・in])

Regenerative option	Mass [kg] (lb)
MR-RB30	2.9 (6.4)
MR-RB32	

13 - 4

(c) MR-RB50

Cooling fan mounting screw (2-M3 screw) On opposite side

7×14 slot

Air intake

Approx. 30

49   82.5

12.5

162.5

350

162.5

12.5

82.5

133

2.3

200   17

217

12   7

108

120   8
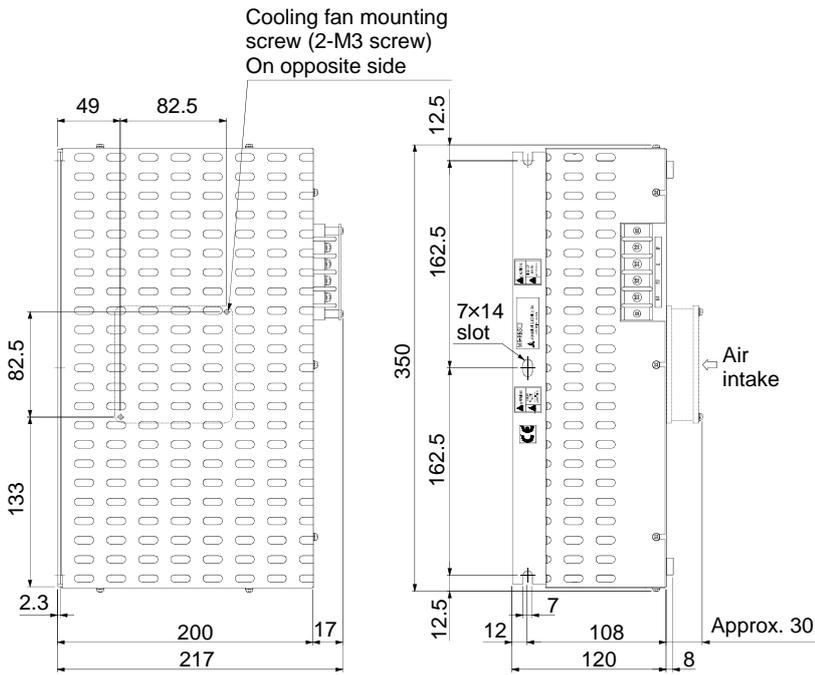
· Terminal block   [Unit: mm (in)]

P	
C	Terminal screw: M4
G3	Tightening torque: 1.2 [N·m](10.6 [lb·in])
G4	

· Mounting screw
  Screw : M6
  Tightening torque: 5.4 [N·m](47.79 [lb·in])

Regenerative option	Mass [kg(lb)]
MR-RB50	5.6 (12.3)

13.1.2 Cables and connectors

> POINT
> ・The IP rating indicated is the cable's or connector's protection against ingress
>   of dust and water when the cable or connector is connected to a servo amplifier
>   or servo motor. If the IP rating of the cable, connector, servo amplifier and
>   servo motor vary, the overall IP rating depends on the lowest IP rating of all
>   components.

(1) Cable make-up

The following cables are used for connection with the servo motor and other models. Those indicated by
broken lines in the figure are not options.
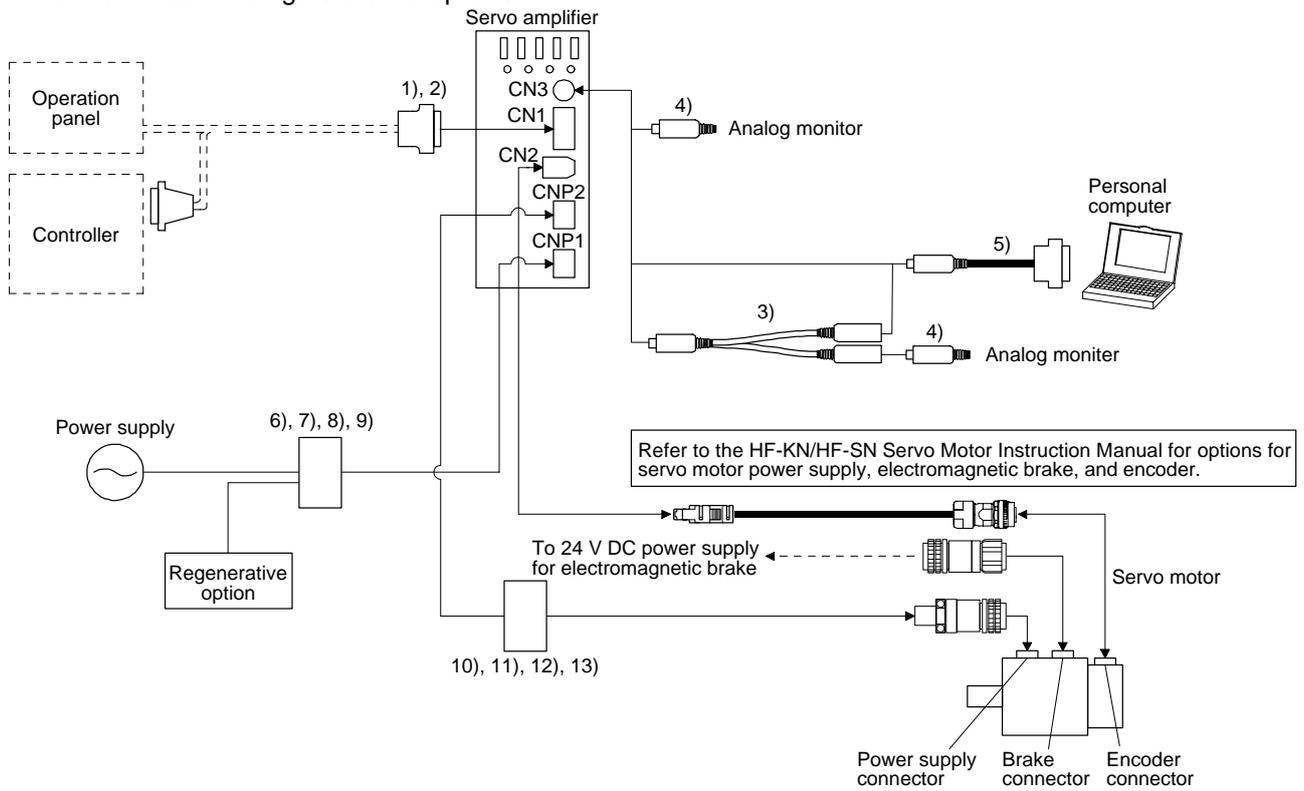
13. OPTIONS AND AUXILIARY EQUIPMENT

No.	Product	Model	Description		Application
1)	Control signal connector set	MR-ECN1 (Unit: 20 pcs/box)	Connector: 10126-3000PE Shell kit: 10326-52F0-008 (3M or equivalent)		
2)		MR-J2CMP2 (Unit: 1 pcs/box)			
3)	Analog monitor, RS-232C branch cable	MR-E3CBL15-P	Connector: MP371/6	Connector: MJ372/6 (Marushin Musen Denki or equivalent)	Analog monitor, RS-232C branch cable
4)	Analog monitor, RS-232C connector	MR-ECN3 (Unit: 20 pcs/box)		Connector: MP371/6 (Marushin Musen Denki or equivalent)	Analog monitor, RS-232C connector
5)	Communication cable	QC30R2	Connector: MP371/6 (Mini-DIN 6-pin male) (Marushin Musen Denki or equivalent)	Connector: DE-9SF-N Case: DE-C1-J6-S6 (JAE)	For connection with PC-AT compatible personal computer
6)	Amplifier power supply connector set (Insulation displacement type) MR-E-10A-QW003 to MR-E-100A-QW003	MR-ECNP1-A (Unit: 20 pcs/box)	Connector: 51240-0600 (Molex or equivalent)	Terminal: 56125-0128 (Molex or equivalent)	Insulation displacement type
7)	Amplifier power supply connector set (Insertion type) MR-E-10A-QW003 to MR-E-100A-QW003	MR-ECNP1-B (Unit: 20 pcs/box)	Connector: 54927-0610 (Molex or equivalent)		Insertion type
8)	Amplifier power supply connector set (Insulation displacement type) MR-E-200A-QW003	MR-ECNP1-A1 (Unit: 20 pcs/box)	Connector: 54241-0600 (Molex or equivalent)	Terminal: 56125-0128 (Molex or equivalent)	Insulation displacement type
9)	Amplifier power supply connector set (Insertion type) MR-E-200A-QW003	MR-ECNP1-B1 (Unit: 20 pcs/box)	Connector: 54928-0610 (Molex or equivalent)		Insertion type
10)	Motor power supply connector (Insulation displacement type) MR-E-10A-QW003 to MR-E-100A-QW003	MR-ECNP2-A (Unit: 20 pcs/box)	Connector: 51240-0300 (Molex or equivalent)	Terminal: 56125-0128 (Molex or equivalent)	Insulation displacement type
11)	Motor power supply connector (Insertion type) MR-E-10A-QW003 to MR-E-100A-QW003	MR-ECNP2-B (Unit: 20 pcs/box)	Connector: 54927-0310 (Molex or equivalent)		Insertion type

No.	Product	Model	Description		Application
12)	Motor power supply connector (Insulation displacement type) MR-E-200A-QW003	MR-ECNP2-A1 (Unit: 20 pcs/box)	Connector: 54241-0300 (Molex or equivalent)	Terminal: 56125-0118 (Molex or equivalent)	Insulation displacement type
13)	Motor power supply connector (Insertion type) MR-E-200A-QW003	MR-ECNP2-B1 (Unit: 20 pcs/box)	Connector: 54928-0310 (Molex or equivalent)		Insertion type

(2) Communication cable

```
POINT
・This cable may not be used with some personal computers. After fully
  examining the signals of the RS-232C connector, refer to this section and
  fabricate the cable.
```

(a) Model definition

Model: QC30R2 (Cable length 3[m])

(b) Connection diagram for fabrication

・MR-CPCATCBL3M
  Personal computer side   Servo amplifier side

TXD	3		Plate	SD
			1	RXD
			3	LG
RXD	2		2	TXD
GND	5			
RTS	7			
CTS	8			
DSR	6			
DTR	4			

D-SUB9 pins   Mini DIN 6 pins
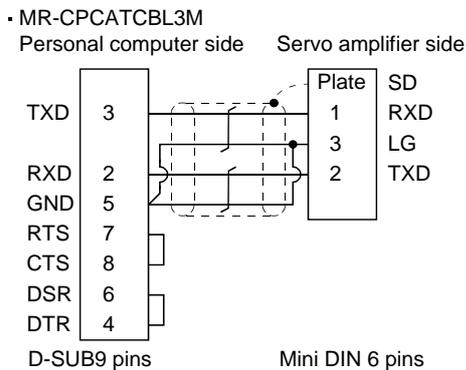
When fabricating the cable, refer to the connection diagram in this section. Though this connection diagram is not the connection diagram of the QC30R2, it is identical in functions.
The following must be observed in fabrication.
1) Always use a shielded, multi-core cable and connect the shield with SD securely.
2) The optional communication cable is 3m long. When the cable is fabricated, its maximum length is 15m in offices of good environment with minimal noise.

13.1.3 Analog monitor, RS-232C branch cable (MR-E3CBL15-P)

(1) Usage

The analog monitor, RS-232C branch cable (MR-E3CBL15-P) is designed for use when a personal computer and analog monitor outputs are used at the same time.
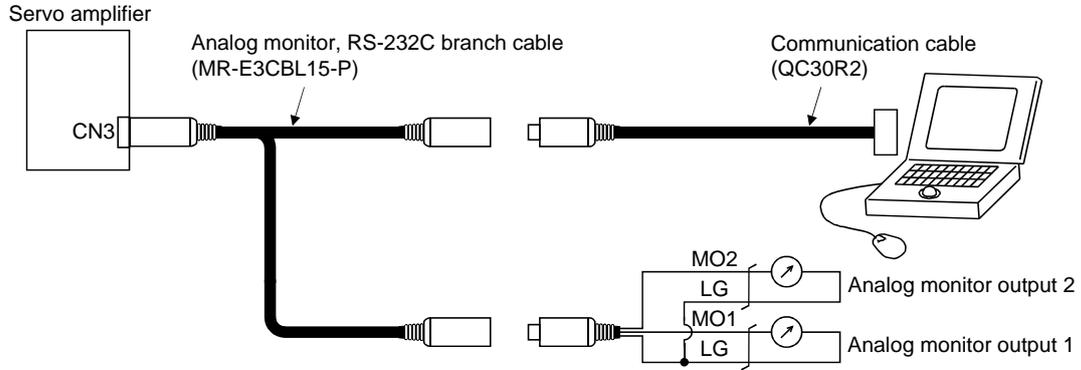
(2) Connection diagram
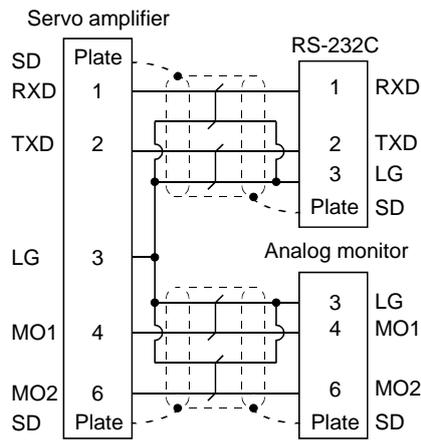
13.1.4 MR Configurator (servo configurations software)

The MR Configurator (servo configurations software MRZJW3-SETUP154E, 154C) uses the communication function of the servo amplifier to perform parameter setting changes, graph display, test operation, etc. on a personal computer.

(1) Specifications

Item	Description
Model	154E: English, 154C: Chinese
Communication signal	Conforms to RS-232C.
Baud rate [bps]	57600, 38400, 19200, 9600
System	Station selection, Automatic demo
Monitor	Display, high speed monitor, trend graph Minimum resolution changes with the processing speed of the personal computer.
Alarm	Display, history, amplifier data
Diagnostic	Digital I/O, no motor rotation, total power-on time, amplifier version info, motor information, tuning data, Automatic VC offset display, Axis name setting.
Parameters	Parameter list, turning, change list, detailed information
Test operation	Jog operation, positioning operation, Operation w/o motor, Forced output, Demo mode.
Advanced function	Machine analyzer, gain search, machine simulation.
File operation	Data read, save, print
Others	Automatic demo, help display

(2) System configuration
   (a) Components
       To use this MR Configurator (servo configurations software), the following components are required in addition to the servo amplifier and servo motor.

Model	(Note 1) Description
(Note 2) Personal computer	IBM PC-AT compatible where the English version and Chinese version of Windows® 95, Windows® 98, Windows® Me, Windows NT® Workstation 4.0, Windows® 2000 Professional, Windows® XP Professional and Windows® XP Home Edition operates Processor: Pentium® 133MHz or more (Windows® 95, Windows® 98, Windows NT® Workstation 4.0, Windows® 2000 Professional) Pentium® 150MHz or more (Windows® Me) Pentium® 300MHz or more (Windows® XP Professional, Windows® XP Home Edition) Memory: 16MB or more (Windows® 95), 24MB or more (Windows® 98) 32MB or more (Windows® Me, Windows NT® Workstation 4.0, Windows® 2000 Professional) 128MB or more (Windows® XP Professional, Windows® XP Home Edition) Free hard disk space: 60MB or more Serial port used
OS	Windows® 95, Windows® 98, Windows® Me, Windows NT® Workstation 4.0, Windows® 2000 Professional, Windows® XP Professional, Windows® XP Home Edition (English version, Chinese version)
Display	One whose resolution is 800×600 or more and that can provide a high color (16 bit) display. Connectable with the above personal computer.
Keyboard	Connectable with the above personal computer.
Mouse	Connectable with the above personal computer. Note that a serial mouse is not used.
Printer	Connectable with the above personal computer.
Communication cable	QC30R2 When this cannot be used, refer to section 13.1.2 (3) and fabricate.

Note 1. Windows and Windows NT are the registered trademarks of Microsoft Corporation in the United States and other countries.
       Pentium is the registered trademarks of Intel Corporation.
     2. On some personal computers, this MR Configurator (servo configurations software) may not run properly.

   (b) Configuration diagram
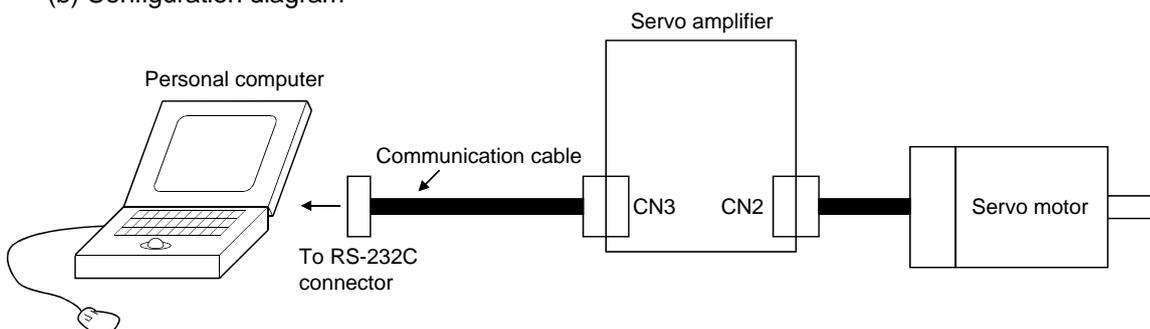
13.2 Auxiliary equipment

Always use the devices indicated in this section or equivalent. To comply with the EN Standard or UL/cUL (CSA) Standard, use the products which conform to the corresponding standard.

13.2.1 Selection example of wires

(1) Wires for power supply wiring
    The following diagram shows the wires used for wiring. Use the wires given in this section or equivalent.
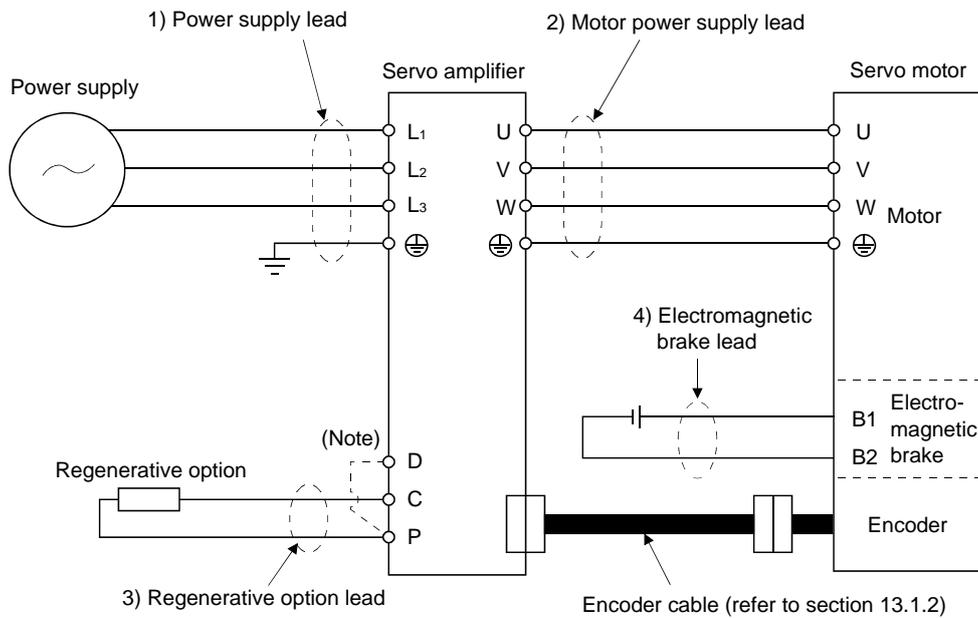
Note. When using the regenerative option, always remove the wiring across D-P.

The following table lists wire sizes. The wires used assume that they are 600V vinyl wires and the wiring distance is 30m max. If the wiring distance is over 30m, choose the wire size in consideration of voltage drop.
Refer to section 3.11 for connection with the connector (CNP1, CNP2).
The servo motor side connection method depends on the type and capacity of the servo motor. Refer to HF-KN/HF-SN Servo Motor Instruction Manual.
To enable the built-in regenerative brake, connect the wiring across D-P. (Refer to section 3.7.2 for the connection method.)
To comply with the UL/cUL (CSA) Standard, use UL-recognized copper wires rated at 60℃ (140℉) or more for wiring.

Table 13.1 Selection example of wires

Servo amplifier	(Note) Wires [mm²]			
	1) L₁・L₂・L₃	3) U・V・W・⏚	4) P・C・D	5) B1・B2
MR-E-10A-QW003	2 (AWG14)	1.25 (AWG16)	2 (AWG14)	1.25 (AWG16)
MR-E-20A-QW003				
MR-E-40A-QW003				
MR-E-70A-QW003				
MR-E-100A-QW003		2 (AWG14)		
MR-E-200A-QW003	(Note) 2.5 (AWG14)	(Note) 2.5 (AWG14)		

Note. Use the heat-resistant PVC cable (rated 105℃ (221℉) or more), if AWG14 cable is used in ambient temperature 40℃ (104℉) or more.

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(2) Wires for cables

When fabricating a cable, use the wire models given in the following table or equivalent.

Table 13.2 Wires for option cables

Type	Model	Length [mm]	Core size [mm^2]	Number of cores	Characteristics of one core			(Note 2) Finishing OD [mm]	Wire model
					Structure [Wires/mm]	Conductor resistance [Ω/mm]	Insulation coating ODd [mm] (Note 1)		
Communication cable	QC30R2	3	0.08	6 (3 pairs)	7/0.127	222	0.38	4.6	UL20276 AWG#28 3pair (BLACK)

Note 1. d is as shown below.

Conductor Insulators
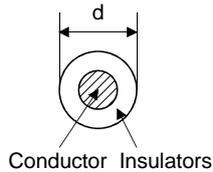
2. Standard OD. Max. OD is about 10% greater.

13.2.2 Circuit breakers, fuses, magnetic contactors

Always use one circuit breaker and one magnetic contactor with one servo amplifier. When using a fuse instead of the circuit breaker, use the one having the specifications given in this section.

Servo amplifier	Circuit breaker	Fuse			Magnetic contactor (Note)
		Class	Current [A]	Voltage AC [V]	
MR-E-10A-QW003	30A frame 5A	K5	10	250	S-N10
MR-E-20A-QW003	30A frame 5A		10		
MR-E-40A-QW003	30A frame 10A		15		
MR-E-70A-QW003	30A frame 15A		15		
MR-E-100A-QW003	30A frame 15A		15		
MR-E-200A-QW003	30A frame 20A		15		S-N18

Note. Be sure to use a magnetic contactor with an operation delay time of 80ms or less. The operation delay time is the time interval between current being applied to the coil until closure of contacts.

13.2.3 Power factor improving AC reactors

The power factor improving AC reactor FR-HAL increases the form factor of the servo amplifier's input current to improve the power factor. It can reduce the power capacity. The input power factor is improved to be about 88%.

When using the power factor improving AC reactors FR-HAL for two or more servo amplifiers, be sure to connect a power factor improving AC reactor FR-HAL to each servo amplifier. If using one power factor improving AC reactor FR-HAL for multiple servo amplifiers, enough improvement effect of phase factor cannot be obtained unless all servo amplifiers are operated.
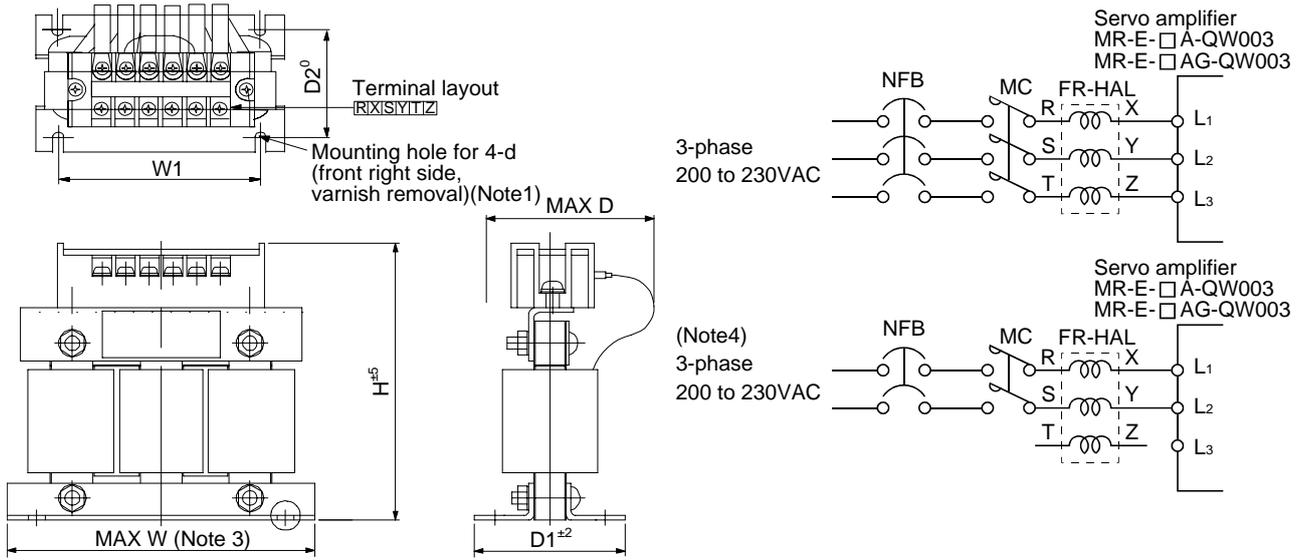
Power factor improving AC reactor (FR-HAL)	Dimensions [mm]							Terminal screw size	Crimping terminal	Mass [kg]
	W	W1	H	D (Note 2)	D1	D2	d			
FR-HAL-0.4K	104	84	99	72	51	40	M5	M4	2-4	0.6
FR-HAL-0.75K	104	84	99	74	56	44	M5	M4	2-4	0.8
FR-HAL-1.5K	104	84	99	77	61	50	M5	M4	2-4	1.1
FR-HAL-2.2K	115 (Note 2)	40	115	77	71	57	M6	M4	2-4	1.5
FR-HAL-3.7K	115 (Note 2)	40	115	83	81	67	M6	M4	5.5-4	2.2

Note. 1.Use this hole for grounding.

2.Maximum dimension (The dimension varies depending on the bending degree of the I/O line.)

3.W±2 for FR-HAL-0.4K to 1.5K.

4.Connect a 1-phase 200 to 230VAC power supply to L_1, L_2 and keep L_3 open.

Power factor improving AC reactor (FR-HAL)	Applicable servo amplifier	
	3-phase power supply	1-phase power supply
FR-HAL-0.4K	MR-E-10A-QW003・MR-E-20A-QW003	
FR-HAL-0.75K	MR-E-40A-QW003	MR-E-10A-QW003・MR-E-20A-QW003
FR-HAL-1.5 K	MR-E-70A-QW003	MR-E-40A-QW003
FR-HAL-2.2K	MR-E-100A-QW003	MR-E-70A-QW003
FR-HAL-3.7K	MR-E-200A-QW003	

13.2.4 Relays

The following relays should be used with the interfaces.

Interface	Selection example
Input signals (interface DI-1) signals	To prevent defective contacts, use a relay for small signal (twin contacts). (Ex.) Omron: type G2A, MY
Relay used for digital output signals (interface DO-1)	Small relay with 12VDC or 24VDC of rating 40mA or less (Ex.) Omron: type MY

13.2.5 Surge absorbers

A surge absorber is required for the electromagnetic brake. Use the following surge absorber or equivalent. Insulate the wiring as shown in the diagram.

Maximum rating				Maximum limit voltage		Static capacity (reference value)	Varistor voltage rating (range) V1mA
Permissible circuit voltage		Surge immunity	Energy immunity	Rated power			
AC[Vma]	DC[V]	[A]	[J]	[W]	[A]	[V]	[pF]	[V]
140	180	(Note) 500/time	5	0.4	25	360	300	220 (198 to 242)

Note. 1 time = 8 × 20μs

(Example) ERZV10D221 (Panasonic)
TNR-10V221K (Nippon chemi-con)
Outline drawing [mm] (ERZ-C10DK221)
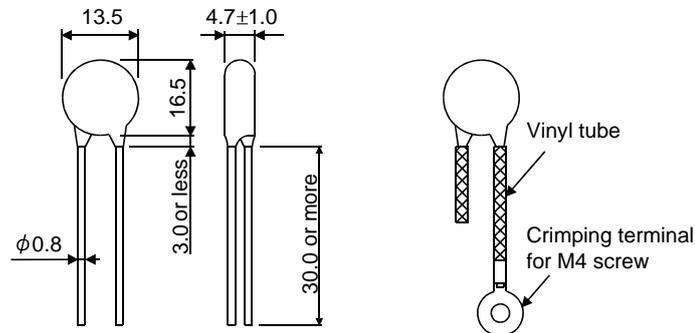
13.2.6 Noise reduction techniques

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 devices to malfunction. Since the servo amplifier is an electronic device which handles small signals, the following general noise reduction techniques are required.
Also, the servo amplifier can be a source of noise as its outputs are chopped by high carrier frequencies. If peripheral devices malfunction due to noises produced by the servo amplifier, noise suppression measures must be taken. The measures will vary slightly with the routes of noise transmission.

(1) Noise reduction techniques
    (a) General reduction techniques
        ・Avoid laying power lines (input and output cables) and signal cables side by side or do not bundle them together. Separate power lines from signal cables.
        ・Use shielded, twisted pair cables for connection with the encoder and for control signal transmission, and connect the shield to the SD terminal.
        ・Ground the servo amplifier, servo motor, etc. together at one point (refer to section 3.9).

    (b) 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 which make a large amount of noise) near the servo amplifier and the servo amplifier may malfunction, the following countermeasures are required.
        ・Provide surge absorbers on the noise sources to suppress noises.
        ・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.

    (c) Techniques for noises radiated by the servo amplifier that cause peripheral devices 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 and output circuits), those induced electromagnetically or statically by the signal cables of the peripheral devices located near the main circuit cables, and those transmitted through the power supply cables.
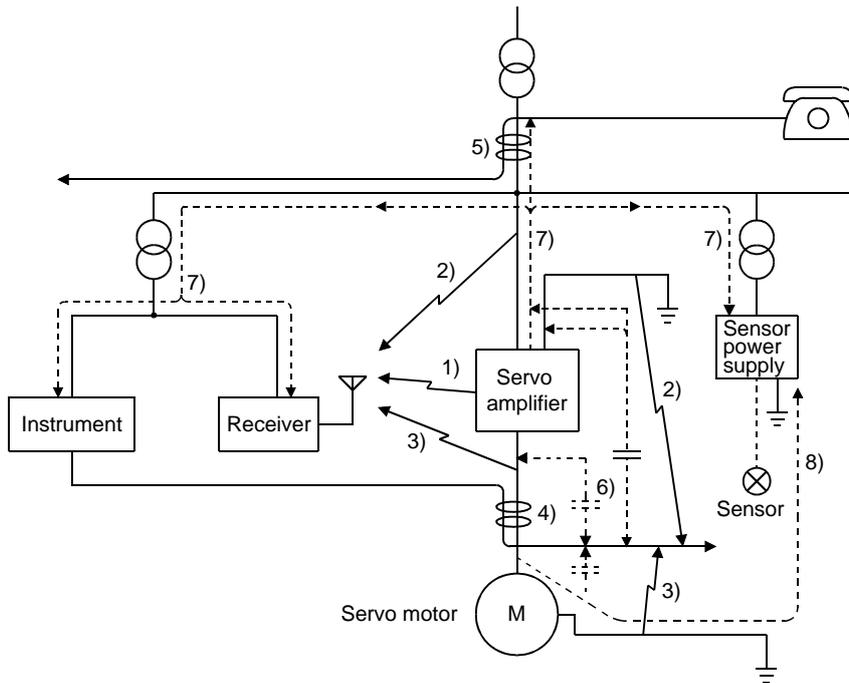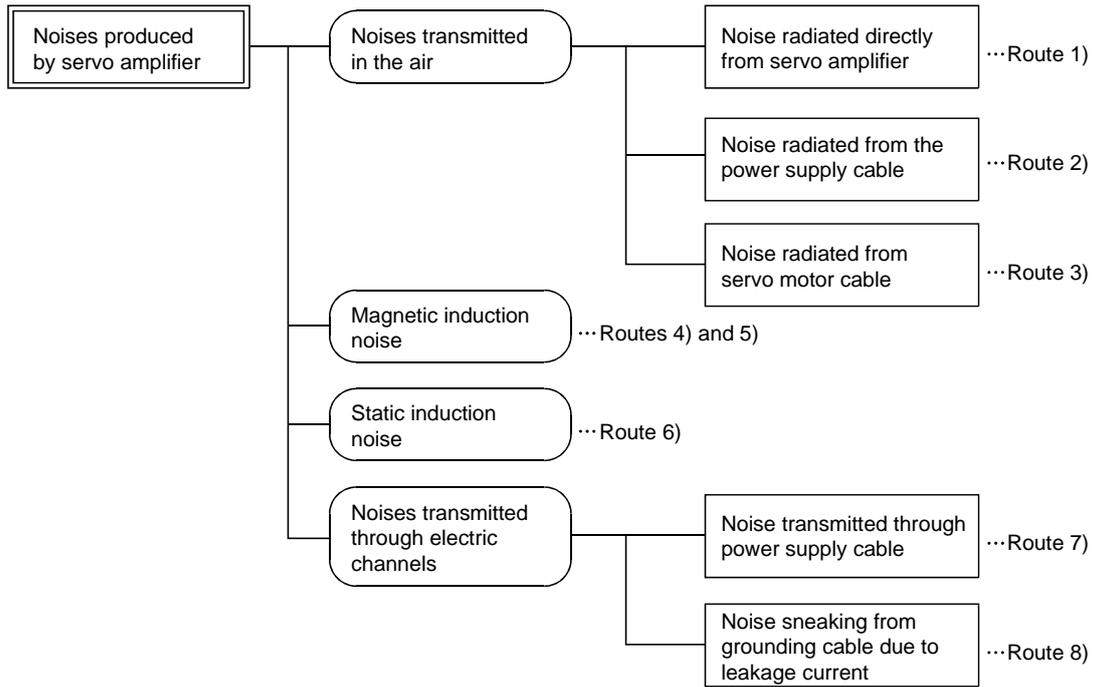
Noise transmission route	Suppression techniques
1) 2) 3)	When measuring instruments, receivers, sensors, etc. which handle weak signals and may malfunction due to noise and/or their signal cables are contained in a control box together with the servo amplifier or run near the servo amplifier, such devices may malfunction due to noises transmitted through the air. The following techniques are required. (1) Provide maximum clearance between easily affected devices and the servo amplifier. (2) Provide maximum clearance between easily affected signal cables and the I/O cables of the servo amplifier. (3) Avoid laying the power lines (Input cables of the servo amplifier) and signal cables side by side or bundling them together. (4) Insert a line noise filter to the I/O cables or a radio noise filter on the input line. (5) Use shielded wires for signal and power cables or put cables in separate metal conduits.
4) 5) 6)	When the power lines and the signal cables are laid side by side or bundled together, magnetic induction noise and static induction noise will be transmitted through the signal cables and malfunction may occur. The following techniques are required. (1) Provide maximum clearance between easily affected devices and the servo amplifier. (2) Provide maximum clearance between easily affected signal cables and the I/O cables of the servo amplifier. (3) Avoid laying the power lines (Input cables of the servo amplifier) and signal cables side by side or bundling them together. (4) Use shielded wires for signal and power cables or put the cables in separate metal conduits.
7)	When the power supply of peripheral devices is connected to the power supply of the servo amplifier system, noises produced by the servo amplifier may be transmitted back through the power supply cable and the devices may malfunction. The following techniques are required. (1) Insert the radio noise filter (FR-BIF) on the power cables (Input cables) of the servo amplifier. (2) Insert the line noise filter (FR-BSF01) on the power cables of the servo amplifier.
8)	When the cables of peripheral devices are connected to the servo amplifier to make a closed loop circuit, leakage current may flow to malfunction the peripheral devices. If so, malfunction may be prevented by disconnecting the grounding cable of the peripheral device.

(2) Noise reduction products

  (a) Data line filter

    Noise can be prevented by installing a data line filter onto the encoder cable, etc.

    For example, the ZCAT3035-1330 of TDK and the ESD-SR-250 of NEC Tokin make are available as data line filters.

    As a reference example, the impedance specifications of the ZCAT3035-1330 (TDK) are indicated below.

    This impedances are reference values and not guaranteed values.

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

[Unit: mm]
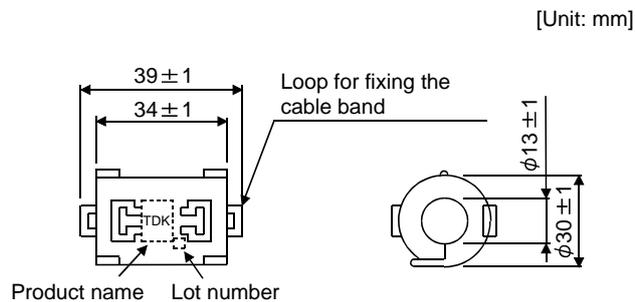
Outline drawing (ZCAT3035-1330)

(b) Surge suppressor

The recommended surge suppressor for installation to an AC relay, AC valve or the like near the servo amplifier is shown below. Use this product or equivalent.

Surge suppressor

Relay

Surge suppressor

This distance should be short (within 20cm).
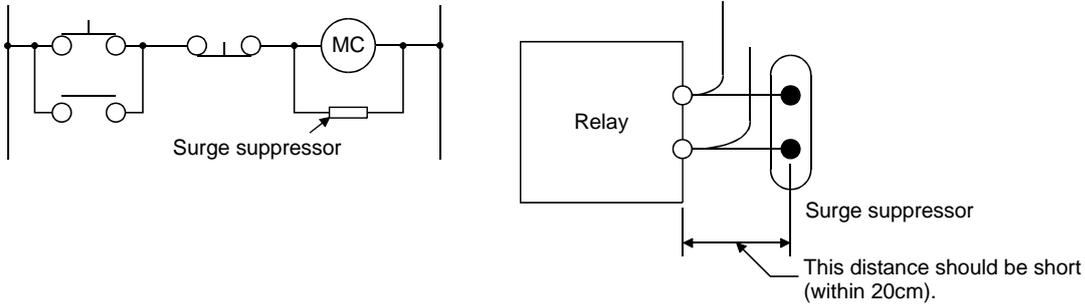
(Ex.) CR-50500
(OKAYA Electric Industries Co., Ltd.)

Rated voltage AC [V]	C [μF±20%]	R [Ω±30%]	Test voltage AC [V]	Outline drawing [Unit: mm]
250	0.5	50 (1/2W)	Between terminals: 625VAC 50/60Hz 60s Between terminal and case: 2,000VAC 50/60Hz 60s	
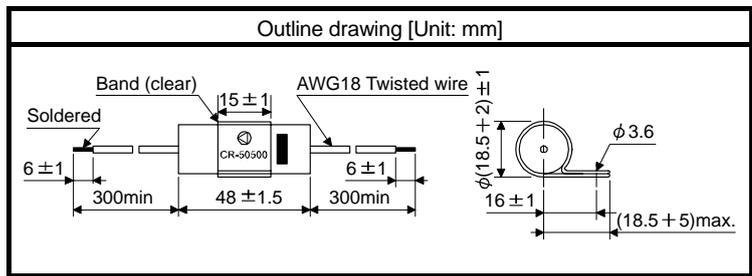
Note that a diode should be installed to a DC relay, DC valve or the like.

Maximum voltage: Not less than 4 times the drive voltage of the relay or the like

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

Diode
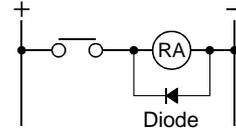
(c) Cable clamp fitting (AERSBAN☐-SET)

Generally, the earth of the shielded cable may only be connected to the connector's SD terminal. However, the effect can be increased by directly connecting the cable to an earth plate as shown below. Install the earth plate near the servo amplifier for the encoder cable. Peel part of the cable insulators to expose the external conductor, and press that part against the earth plate with the cable clamp. If the cable is thin, clamp several cables in a bunch.

The clamp comes as a set with the earth plate.

Strip the cable insulators of the clamped area.

cutter

cable

Cable

Cable clamp (A,B)

Earth plate

External conductor

Clamp section diagram
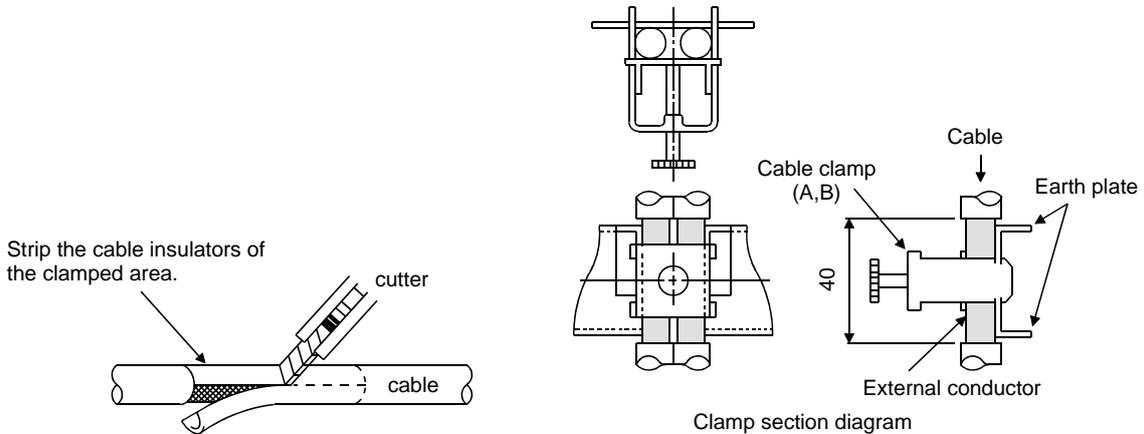
・Outline drawing

[Unit: mm]

Earth plate

Clamp section diagram
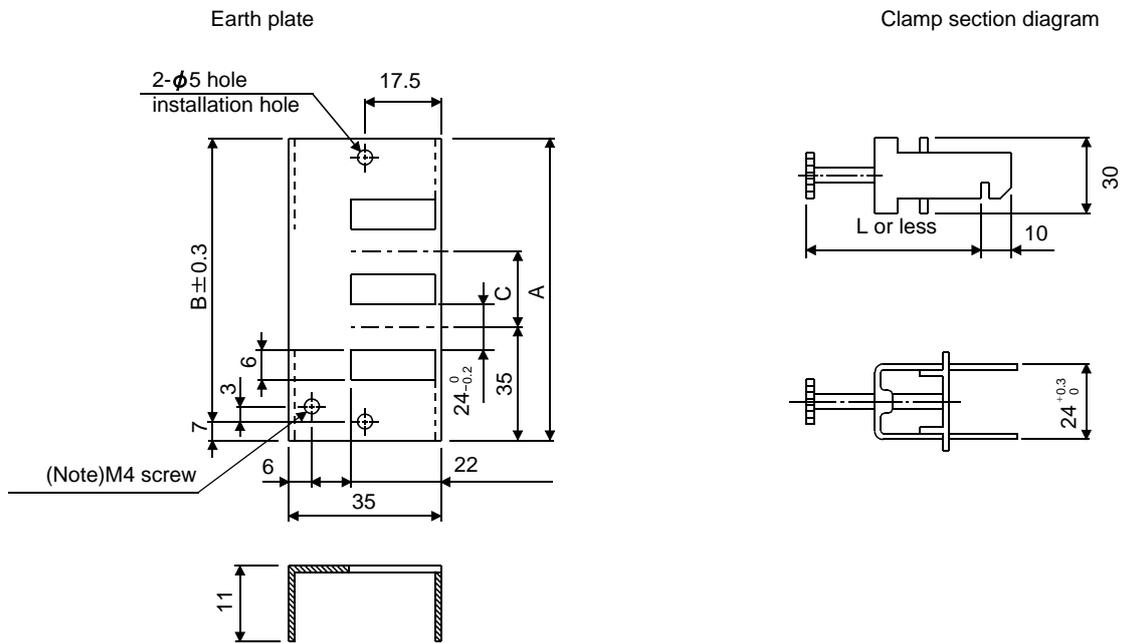
Note. Screw hole for grounding. Connect it to the earth plate of the control box.

Type	A	B	C	Accessory fittings
AERSBAN-DSET	100	86	30	clamp A: 2pcs.
AERSBAN-ESET	70	56		clamp B: 1pc.

Clamp fitting	L
A	70
B	45

(d) Line noise filter (FR-BSF01)

This filter is effective in suppressing noises radiated from the power supply side and output side of the servo amplifier and also in suppressing high-frequency leakage current (zero-phase current) especially within 0.5MHz to 5MHz band.

Connection diagram	Outline drawing [Unit: mm]
Use the line noise filters for wires of the main power supply ($L_1 \cdot L_2 \cdot L_3$) and of the motor power supply ($U \cdot V \cdot W$). Pass each of the 3-phase wires through the line noise filter an equal number of times in the same direction. For the main power supply, the effect of the filter rises as the number of passes increases, but generally four passes would be appropriate. For the motor power supply, passes must be four times or less. Do not pass the grounding (earth) wire through the filter, or the effect of the filter will drop. Wind the wires by passing through the 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 filters to have the required number of passes as shown in Example 2. Place the line noise filters as close to the servo amplifier as possible for their best performance.	FR-BSF01
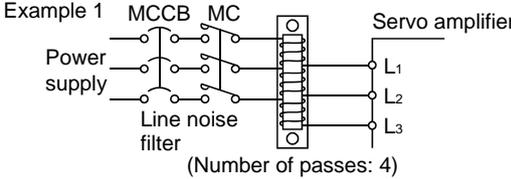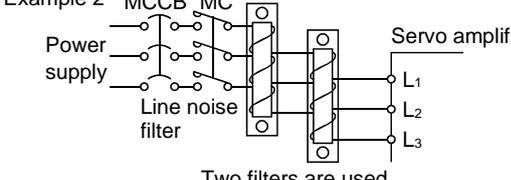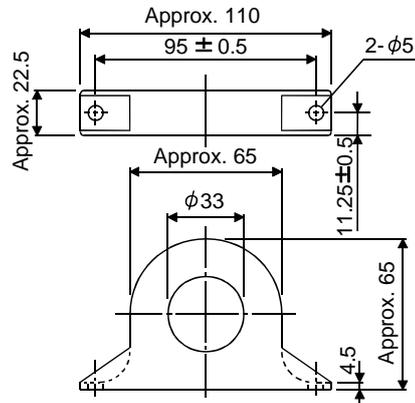
(e) Radio noise filter (FR-BIF)...for the input side only

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

Connection diagram	Outline drawing [Unit: mm]
Make the connection cables as short as possible. Grounding is always required. When using the FR-BIF with a single-phase power supply, always insulate the wires that are not used for wiring.	Leakage current: 4mA
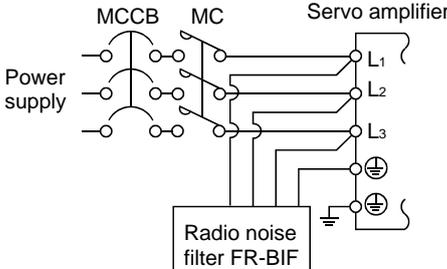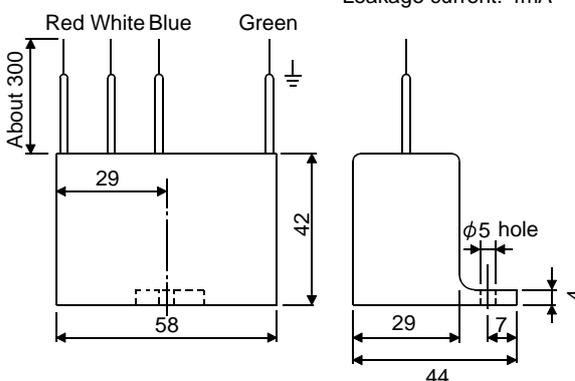
(f) Varistors for input power supply (Recommended)

Varistors are effective to prevent exogenous noise and lightning surge 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) V1mA
		Permissible circuit voltage		Surge current immunity	Energy immunity	Rated pulse power				
		AC [V$_{rms}$]	DC [V]	8/20μs [A]	2ms [J]	[W]	[A]	[V]	[pF]	[V]
100V class	TND20V-431K	275	350	10000/1 time	195	1.0	100	710	1300	430(387 to 473)
200V class	TND20V-471K	300	385	7000/2 time	215			775	1200	470(423 to 517)

[Unit: mm]
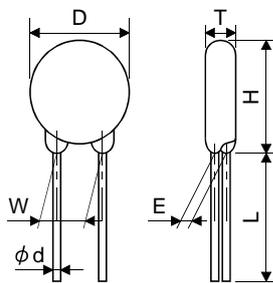
Model	D Max.	H Max.	T Max.	E ±1.0	(Note) L min.	ϕd ±0.05	W ±1.0
TND20V-431K	21.5	24.5	6.4	3.3	20	0.8	10.0
TND20V-471K			6.6	3.5			

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

13.2.7 Leakage current breaker

(1) Selection method

High-frequency chopper currents controlled by pulse width modulation flow in the AC servo circuits. Leakage currents containing harmonic contents are larger than those of the motor which is run with a commercial power supply.

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

Make the input and output cables as short as possible, and also make the grounding cable as long as possible (about 30cm) to minimize leakage currents.

Rated sensitivity current $\geq 10 \cdot \{Ig1 + Ign + Iga + K \cdot (Ig2 + Igm)\}$ [mA]...........(13.1)
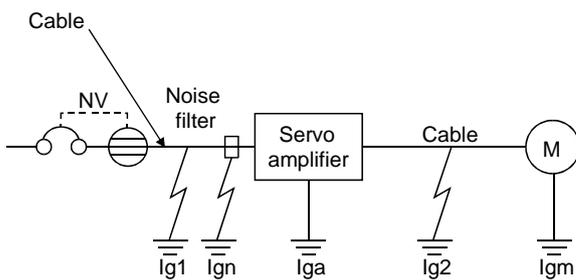
K: Constant considering the harmonic contents

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

Ig1:   Leakage current on the electric channel from the leakage current breaker to the input terminals of the servo amplifier (Found from Fig. 13.1.)

Ig2:   Leakage current on the electric channel from the output terminals of the servo amplifier to the servo motor (Found from Fig. 13.1.)

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

Iga: Leakage current of the servo amplifier (Found from Table 13.4.)

Igm: Leakage current of the servo motor (Found from Table 13.3.)
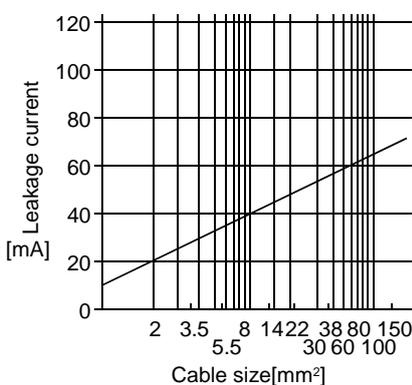
Fig. 13.1 Leakage current example (Ig1, Ig2) for CV cable run in metal conduit

Table 13.3 Servo motor's leakage current example (Igm)

Servo motor output [kW]	Leakage current [mA]
0.1 to 1.0	0.1
1.0 to 2.2	0.2

Table 13.4 Servo amplifier's leakage current example (Iga)

Servo amplifier capacity [kW]	Leakage current [mA]
0.1 to 0.6	0.1
0.7 to 2.0	0.15

Table 13.5 Leakage circuit breaker selection example

Servo amplifier	Rated sensitivity current of leakage circuit breaker [mA]
MR-E-10A-QW003 to MR-E-200A-QW003	15

(2) Selection example

Indicated below is an example of selecting a leakage current breaker under the following conditions.
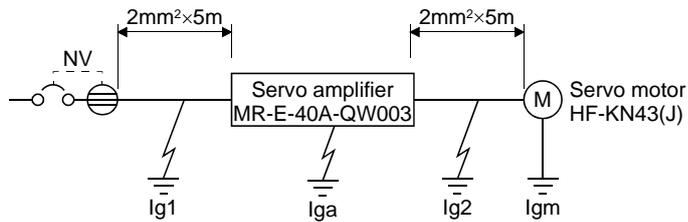
Use a leakage current breaker generally available.

Find the terms of Equation (13.1) from the diagram.

$$Ig1 = 20 \cdot \frac{5}{1000} = 0.1 \ [\text{mA}]$$

$$Ig2 = 20 \cdot \frac{5}{1000} = 0.1 \ [\text{mA}]$$

$$Ign = 0 \ (\text{not used})$$

$$Iga = 0.1 \ [\text{mA}]$$

$$Igm = 0.1 \ [\text{mA}]$$

Insert these values in Equation (13.1).

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

$$\geq 4.0 \ [\text{mA}]$$

According to the result of calculation, use a leakage current breaker having the rated sensitivity current (Ig) of 4.0 [mA] or more. A leakage current breaker having Ig of 15 [mA] is used with the NV-SP/SW/CP/CW/HW series.

13.2.8 EMC filter

For compliance with the EMC Directive of the EN Standard, it is recommended to use the following filter.
Some EMC filters are large in leakage current.

(1) Combination with the servo amplifier

Servo amplifier	Recommended filter		Mass [kg]([lb])
	Model	Leakage current [mA]	
MR-E-10A-QW003 to MR-E-100A-QW003	SF1252	38	0.75 (1.65)
MR-E-200A-QW003	SF1253	57	1.37 (1.65)

(2) Connection example
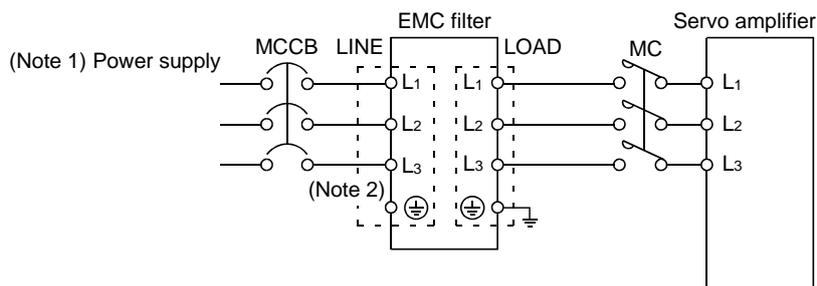
Note 1. For 1-phase 230VAC power supply, connect the power supply to L_1,L_2 and leave L_3 open.
　　　2. Connect when the power supply has earth.

(3) Outline drawing
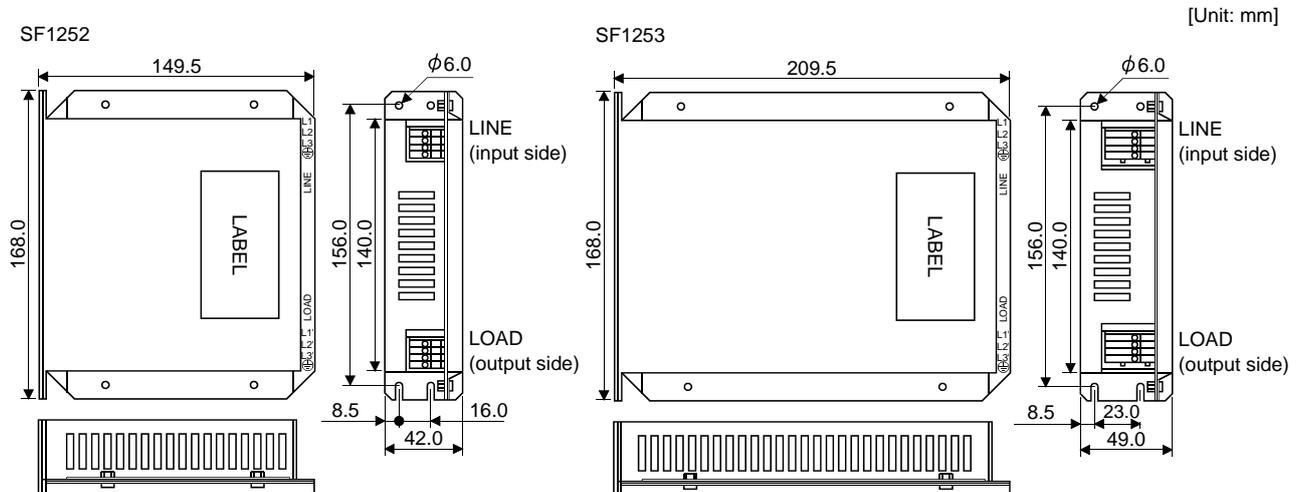
[Unit: mm]

14. MR-E-□AG-QW003 SERVO AMPLIFIER COMPATIBLE WITH ANALOG INPUT

<div style="border:1px solid">

POINT

· In this chapter, difference of the operation of MR-E-□AG-QW003 from that of MR-E-□A-QW003 is described. For description not given in this chapter, refer to chapters 1 through 13.

</div>

14.1 Functions and configuration

14.1.1 Introduction

The analog input MR-E-□AG-QW003 Servo Amplifier is based on the MR-E-□A-QW003 Servo Amplifier with capability of speed control and torque control.

(1) Speed control mode

An external analog speed command (0 to ±10VDC) or parameter-driven internal speed command (max. 7 speeds) is used to control the speed and direction of a servo motor smoothly.

There are also the acceleration/deceleration time constant setting in response to speed command, the servo lock function at a stop time, and automatic offset adjustment function in response to external analog speed command.

(2) Torque control mode

An external analog torque command (0 to ±8VDC) or parameter-driven internal torque command is used to control the torque output by the servo motor.

To prevent unexpected operation under no load, the speed limit function (external or internal setting) is also available for application to tension control and the like.

14.1.2 Function block diagram

The function block diagram of this servo is shown below.
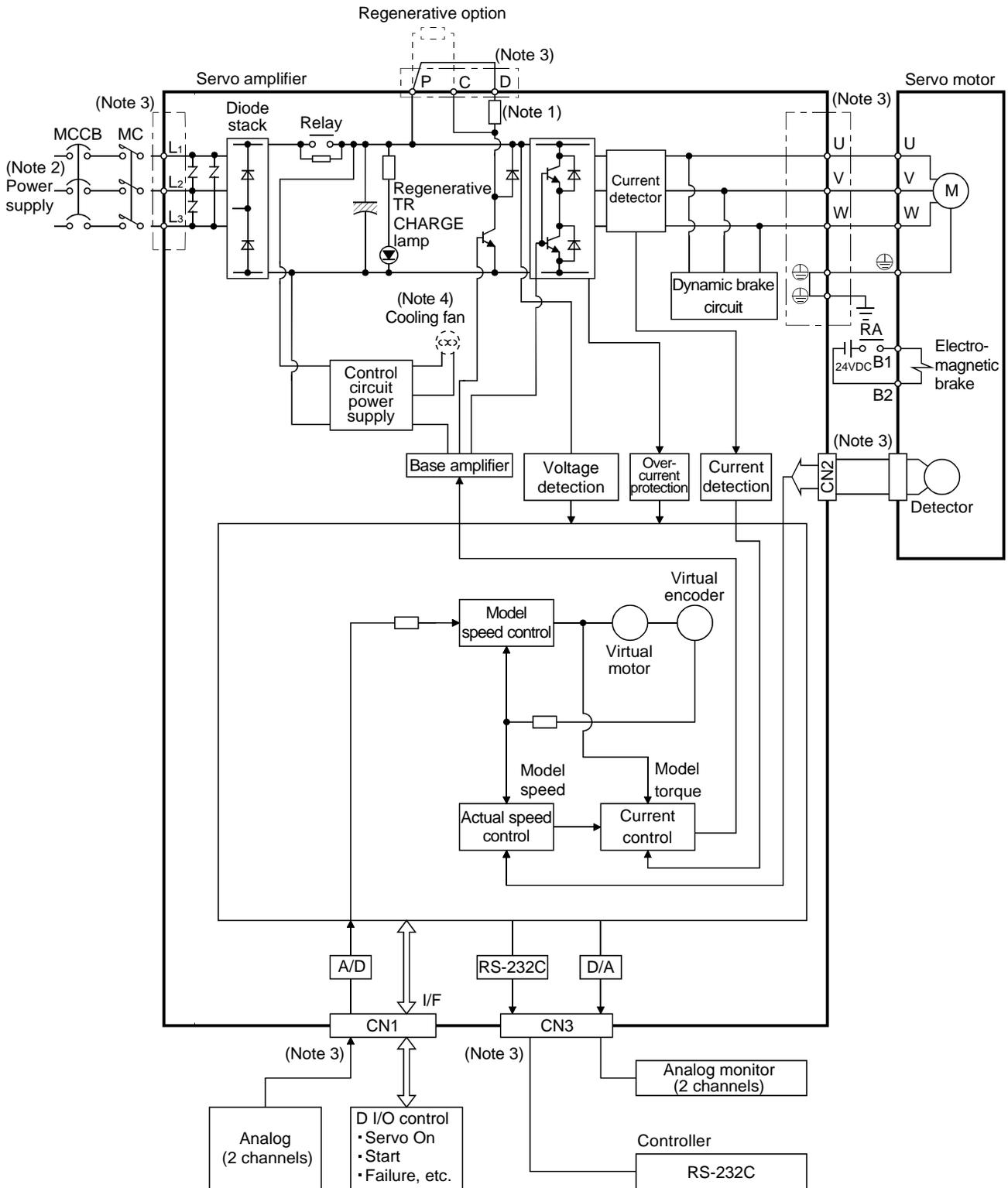
Note 1. The built-in regenerative resistor is not provided for the MR-E-10AG-QW003/MR-E-20AG-QW003.
    2. Single-phase 230VAC power supply can be used for MR-E-70AG-QW003 or servo amplifiers with smaller capacities. Connect the
       power cables to L_1 and L_2 while leaving L_3 open. Refer to section 15.1.3 for the power supply specification.
    3. The control circuit connectors (CN1, CN2 and CN3) are safely isolated from main circuit terminals (L_1, L_2, L_3, U, V, W, P, C and D).
    4. Servo amplifiers MR-E-200AG-QW003 have a cooling fan.

14.1.3 Servo amplifier standard specifications

Servo amplifier MR-E-□-QW003 / Item				10AG	20AG	40AG	70AG	100AG	200AG
Output	Rated voltage			3-phase 170VAC					
	Rated current		[A]	0.7	1.1	2.3	5.8	6.0	11.0
Power supply	Voltage/frequency			3-phase 200 to 230VAC, 50/60Hz or 1-phase 230VAC, 50/60Hz				3-phase 200 to 230VAC, 50/60Hz	
	Rated current		[A]	0.9	1.5	2.6	3.8	5.0	10.5
	Permissible voltage fluctuation			3-phase 200 to 230VAC: 170 to 253VAC 1-phase 230VAC: 207 to 253VAC				3-phase 170 to 253VAC	
	Permissible frequency fluctuation			Within ±5%					
	Power supply capacity			Refer to section 12.2					
	Inrush current		[A]	Refer to section 12.5					
Control system				Sine-wave PWM control, current control system					
Dynamic brake				Built-in					
Protective functions				Overcurrent shut-off, regenerative overvoltage shut-off, overload shut-off (electronic thermal relay), encoder error protection, regenerative error protection, undervoltage, instantaneous power failure protection, overspeed protection, excessive error protection					
Speed control mode	Speed control range			Analog speed command 1: 2000, internal speed command 1: 5000					
	Analog speed command input			0 to ±10VDC/rated speed					
	Speed fluctuation ratio			±0.01% or less (load fluctuation 0 to 100%) 0% (power fluctuation ±10%) ±0.2% or less (ambient temperature 25℃±10℃ (77°F ±50°F)), when using analog speed command					
	Torque limit			Set by parameter setting or external analog input (0 to +10VDC/maximum torque)					
Torque control mode	Analog torque command input			0 to ±8VDC/Maximum torque (input impedance 10 to 12kΩ)					
	Speed limit			Set by parameter setting or external analog input (0 to ±10VDC/Rated speed)					
Structure				Self-cooled, open (IP00)					Force-cooling, open (IP00)
Environment	Ambient temperature	Operation	[℃]	0 to 55 (non-freezing)					
			[°F]	32 to 131 (non-freezing)					
		Storage	[℃]	−20 to 65 (non-freezing)					
			[°F]	−4 to 149 (non-freezing)					
	Ambient humidity	Operation		90%RH or less (non-condensing)					
		Storage							
	Ambient			Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt					
	Altitude			Max. 1000m above sea level					
	Vibration resistance			5.9m/s² at 10 to 55Hz (directions of X,Y and Z axes)					
Mass			[kg]	0.7	0.7	1.1	1.7	1.7	2.0
			[lb]	1.54	1.54	2.43	3.75	3.75	4.41

14.1.4 Model code definition

MR-E - ☐ AG - QW003

Series name

MR-E super servo amplifier (Source I/O interface)

Analog input interface
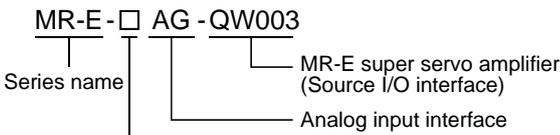
Rated output

Symbol	Rated output [W]	Symbol	Rated output [W]
10	100	70	750
20	200	100	1000
40	400	200	2000

MR-E-40AG-QW003 or less
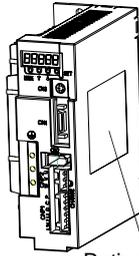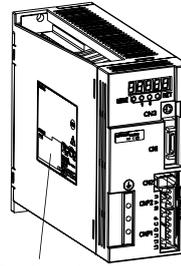
MR-E-70AG-QW003, MR-E-100AG-QW003

MR-E-200AG-QW003
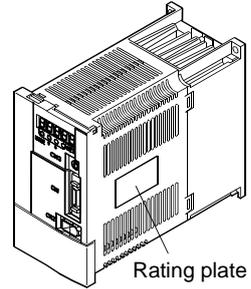
Rating plate   Rating plate   Rating plate

14.1.5 Parts identification

(1) MR-E-100AG-QW003 or less

Name/application	Reference
Display The 5-digit, seven-segment LED shows the servo status and alarm number.	Section 14.5
Operation section Used to perform status display, diagnostic, alarm and parameter setting operations. MODE UP DOWN SET Used to set data. Used to change the display or data in each mode. Used to change the mode.	Section 14.5
Communication connector (CN3) Used to connect a command device (RS-232C) and output analog monitor data.	Section 3.3 Section 13.1.2
I/O signal connector (CN1) Used to connect digital I/O signals.	Section 14.2
Encoder connector (CN2) Connector for connection of the servo motor encoder.	Section 3.3 Section 13.1.2
Charge lamp Lit to indicate that the main circuit is charged. While this lamp is lit, do not reconnect the cables.	
Servo motor power connector (CNP2) Used to connect the servo motor.	Section 3.7 Section 11.1
Power supply/regenerative connector (CNP1) Used to connect the input power supply and regenerative option.	Section 3.7 Section 11.1 Section 13.1.1
Protective earth (PE) terminal (⏚) Ground terminal.	Section 3.10 Section 11.1

MITSUBISHI MR-

CN3

CN1

CN2

CNP2

CNP1

CHARGE

L3 L2 L1 D C P W V U

Fixed part
(MR-E-10AG-QW003 to MR-E-40AG-QW003: 2 places
MR-E-70AG-QW003 ・MR-E-100AG-QW003: 3 places)

14.1.6 Servo system with auxiliary equipment

⚠ WARNING	To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

(1) MR-E-100AG-QW003 or less

Options and auxiliary equipment	Reference	Options and auxiliary equipment	Reference
Circuit breaker	Section 13.2.2	Regenerative option	Section 13.1.1
Magnetic contactor	Section 13.2.2	Cables	Section 13.2.1
MR Configurator (Servo configuration software)	Section 13.1.4	Power factor improving reactor	Section 13.2.3
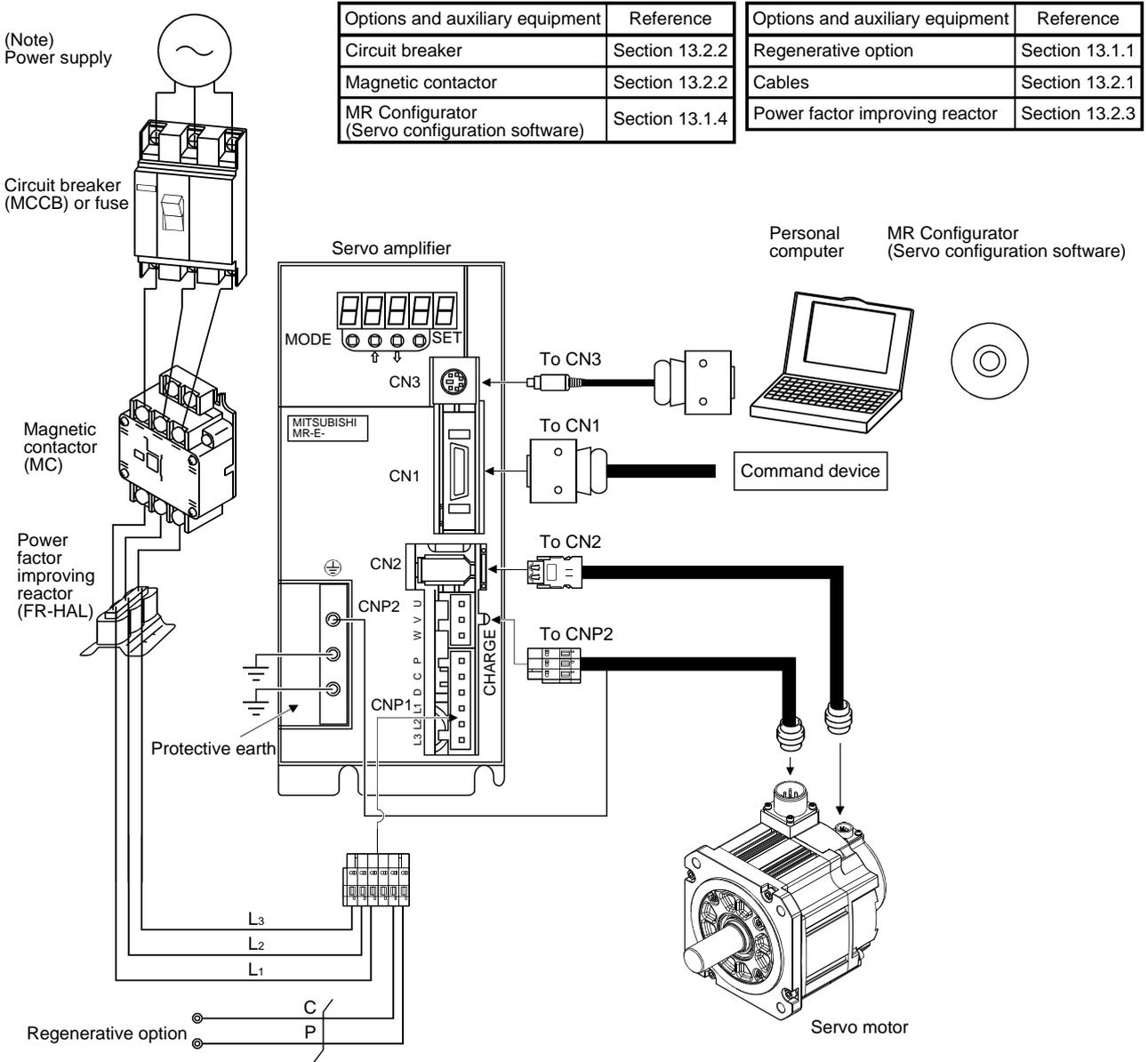
Note. A 1-phase 230VAC power supply may be used with the servo amplifier of MR-E-70AG-QW003 or less. Connect the power supply to L_1 and L_2 terminals and leave L_3 open. Refer to section 15.1.3 for the power supply specification.

(2) MR-E-200AG-QW003

Options and auxiliary equipment	Reference	Options and auxiliary equipment	Reference
Circuit breaker	Section 13.2.2	Regenerative option	Section 13.1.1
Magnetic contactor	Section 13.2.2	Cables	Section 13.2.1
MR Configurator (Servo configuration software)	Section 13.1.4	Power factor improving reactor	Section 13.2.3
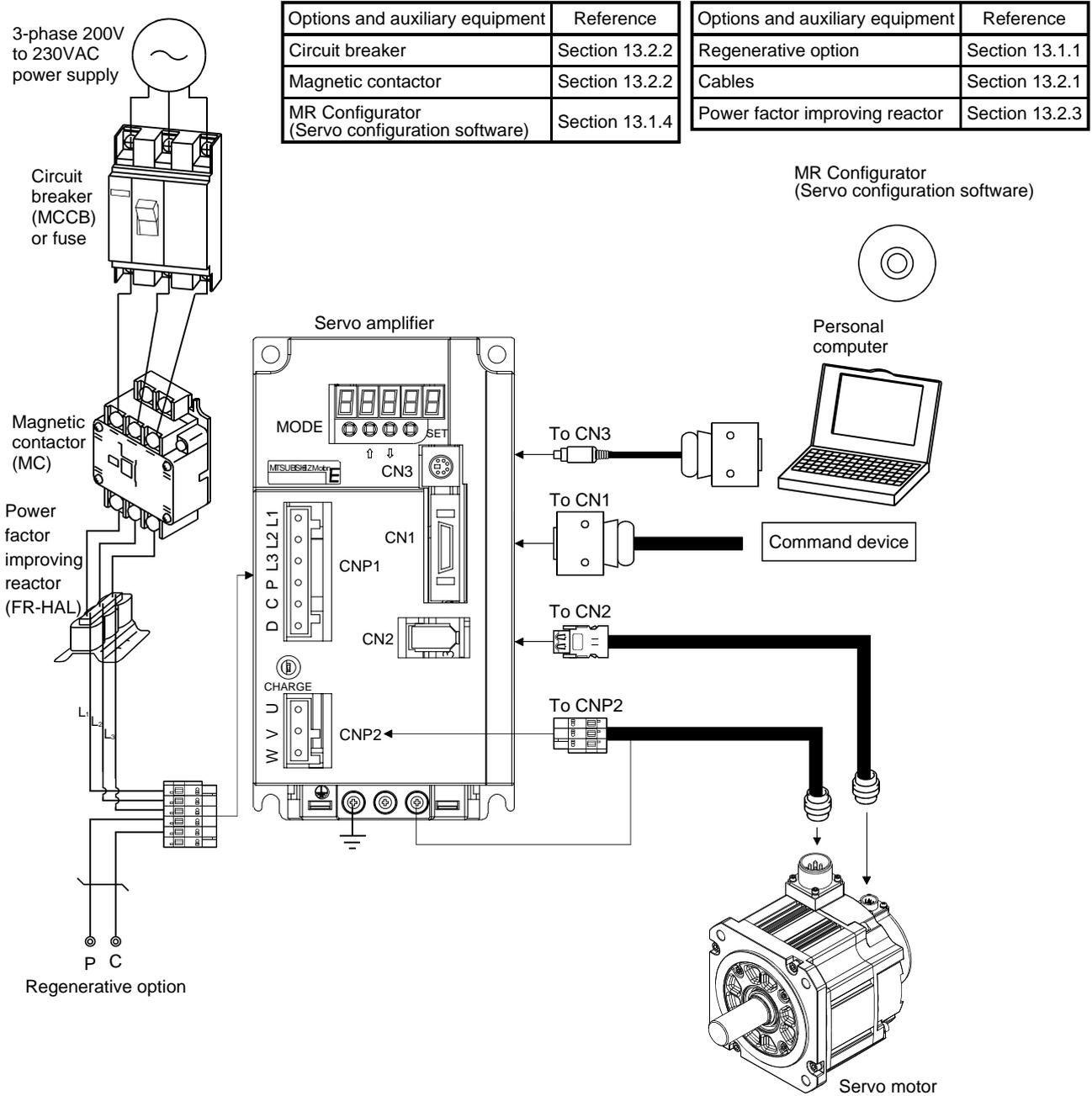
14.2 Signals and wiring

14.2.1 Standard connection example

(1) Speed control mode
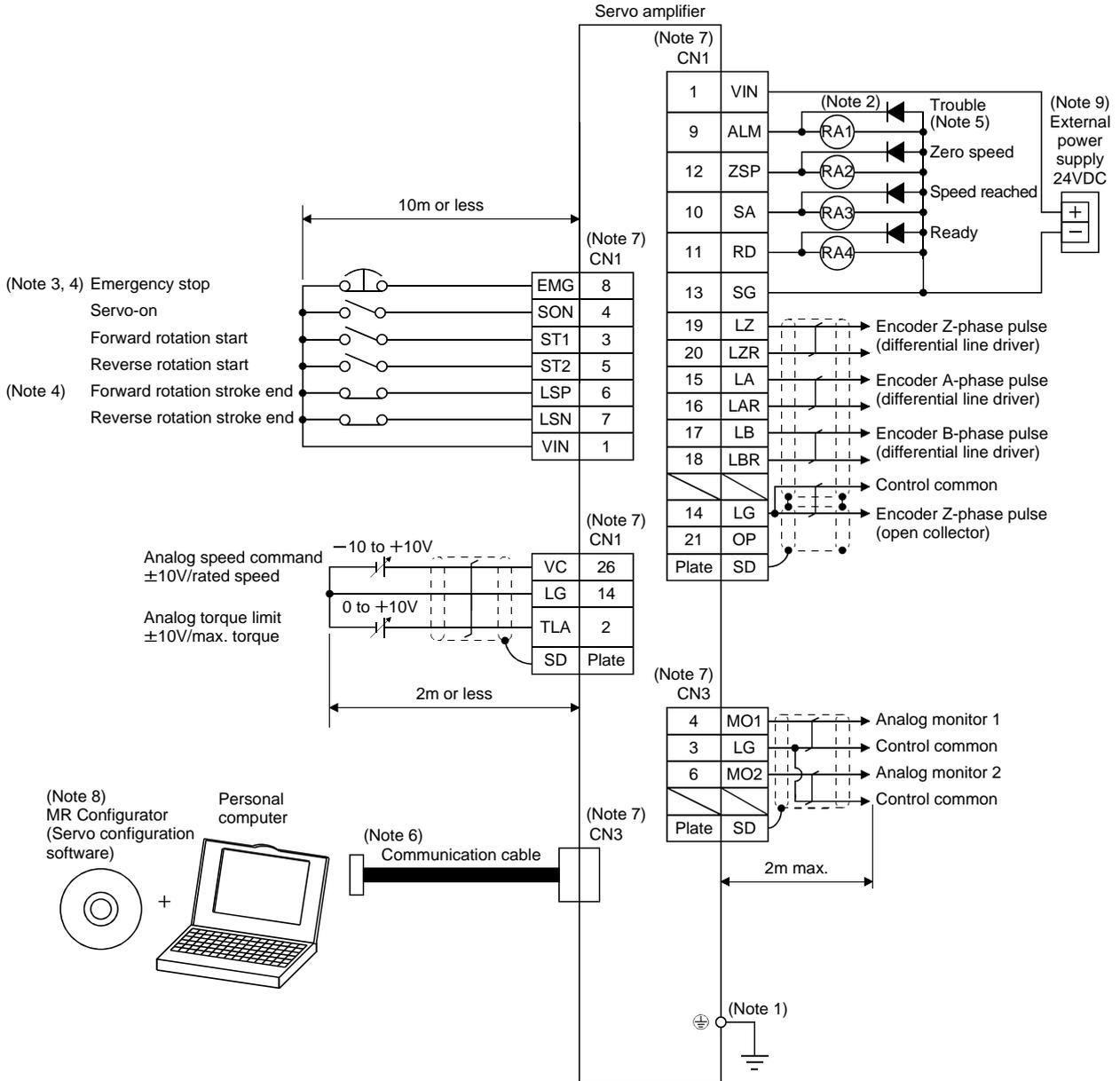
Note 1. To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

2. Connect the diode in the correct direction. If it is connected reversely, the servo amplifier will be faulty and will not output signals, disabling the emergency stop and other protective circuits.

3. The emergency stop switch (normally closed contact) must be installed.

4. When starting operation, always connect the emergency stop (EMG) and forward rotation stroke end (LSP), reverse rotation stroke end (LSN) with VIN. (Normally closed contacts)

5. Trouble (ALM) is connected with VIN in normal alarm-free condition. (Normally closed contacts)

6. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to section 13.1.3)

7. The pins with the same signal name are connected in the servo amplifier.

8. Use MRZJW3-SETUP 154E or 154C.

9. Externally supply 24VDC ±10%, 200mA power for the interface. 200mA is a value applicable when all I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to the current necessary for the interface described in section 3.6.2. Connect the external 24VDC power supply if the output signals are not used.

(2) Torque control mode

Note 1. To prevent an electric shock, always connect the protective earth (PE) terminal (terminal marked ⏚) of the servo amplifier to the protective earth (PE) of the control box.

2. Connect the diode in the correct direction. If it is connected reversely, the servo amplifier will be faulty and will not output signals, disabling the emergency stop and other protective circuits.

3. The emergency stop switch (normally closed contact) must be installed.

4. When starting operation, always connect the emergency stop (EMG) with VIN. (Normally closed contacts)

5. Trouble (ALM) is connected with VIN in normal alarm-free condition. (Normally closed contacts)

6. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to section 13.1.3)

7. The pins with the same signal name are connected in the servo amplifier.

8. Use MRZJW3-SETUP 154E or 154C.

9. Externally supply 24VDC ±10%, 200mA power for the interface. 200mA is a value applicable when all I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to the current necessary for the interface described in section 3.6.2. Connect the external 24VDC power supply if the output signals are not used.

14.2.2 Internal connection diagram of servo amplifier

The following is the internal connection diagram where the signal assignment has been made in the initial status in each control mode.

Note. S: Speed control mode, T: Torque control mode

14.2.3 Connectors and signal arrangements

```
POINT
・The pin configurations of the connectors are as viewed from the cable
  connector wiring section.
・Refer to the next page for CN1 signal assignment.
```

(1) Signal arrangement

Refer to section 3.3.2
CN2

The connector frames are
connected with the earth (PE)
terminal (⏚) inside the servo amplifier.

CN1(Speed control mode)

2	1	15	14
TLA	VIN	LA	LG
4	3	17	16
SON	ST1	LAR	
6	5	19	LB
LSP	ST2	LBR	18
8	7	21	LZ
EMG	LSN	LZR	20
10	9	23	OP
SA	ALM		22
12	11	25	24
ZSP	RD		26
	13		VC
	SG		

CN1(Torque control mode)

2	1	15	14
TC	VIN	LA	LG
4	3	17	16
SON	RS2	LAR	
6	5	19	LB
	RS1	LBR	18
8	7	21	LZ
EMG		LZR	20
10	9	23	OP
	ALM		22
12	11	25	24
ZSP	RD		26
	13		VLA
	SG		

(2) CN1 signal assignment

The signal assignment of connector changes with the control mode as indicated below.

For the pins which are given parameter No.s in the related parameter column, their signals can be changed using those parameters.

Connector	Pin No.	(Note 1) I/O	(Note 2) I/O Signals in control modes			Related parameter
			S	S/T	T	
CN1	1		VIN	VIN	VIN	
	2	I	TLA	TLA/TC	TC	
	3	I	ST1	ST1/RS2	RS2	No.43 to 48
	4	I	SON	SON	SON	No.43 to 48
	5	I	ST2	LOP	RS1	No.43 to 48
	6	I	LSP	LSP/−		No.43・48
	7	I	LSN	LSN/−		No.43・48
	8	I	EMG	EMG	EMG	
	9	O	ALM	ALM	ALM	No.49
	10	O	SA	SA/−		No.49
	11	O	RD	RD	RD	No.49
	12	O	ZSP	ZSP	ZSP	No.1, 49
	13		SG	SG	SG	
	14		LG	LG	LG	
	15	O	LA	LA	LA	
	16	O	LAR	LAR	LAR	
	17	O	LB	LB	LB	
	18	O	LBR	LBR	LBR	
	19	O	LZ	LZ	LZ	
	20	O	LZR	LZR	LZR	
	21	O	OP	OP	OP	
	22					
	23					
	24					
	25					
	26	I	VC	VC/VLA	VLA	

Note 1. I: Input signal, O: Output signal

2. S: Speed control mode, T: Torque control mode, S/T: Speed/torque control switching mode

14.2.4 Signal explanations

For the I/O interfaces (symbols in I/O column in the table), refer to section 3.6.2.

In the control mode field of the table

S: speed control mode, T: Torque control mode

○: Denotes that the signal may be used in the initial setting status.

△: Denotes that the signal may be used by setting the corresponding parameter among parameters 43 to 49.
   The pin No.s in the connector pin No. column are those in the initial status.

(1) Input signals

```
┌──────────────────────────────────────────────────────────────────┐
│  POINT                                                             │
│ ・The acceptance delay time of each input signal is less than 10ms. │
└──────────────────────────────────────────────────────────────────┘
```

Signal	Symbol	Connector pin No.	Functions/Applications	I/O division	Control mode S	Control mode T
Forward rotation stroke end	LSP	CN1-6	To start operation, short LSP-VIN and/or LSN-VIN. Open them to bring the motor to a sudden stop and make it servo-locked. Set "□□□1" in parameter No.22 to make a slow stop. (Refer to section 5.2.3.) **(Note) Input signals / Operation** | LSP	LSN	CCW direction	CW direction
---	---	---	---
1	1	○	○
0	1		○
1	0	○	
0	0			 Note. 0: LSP/LSN-VIN off (open) 1: SP/LSN-VIN on (short) Set parameter No.41 as indicated below to switch on the signals (keep terminals connected) automatically in the servo amplifier. 	Parameter No.41	Automatic ON
---	---
□□1□	LSP
□1□□	LSN		DI-1	○	
Reverse rotation stroke end	LSN	CN1-7				
Outside torque limit selection	TL		Turn TL off to make Internal torque limit 1 (parameter No.28) valid, or turn it on to make Analog torque limit (TLA) valid. When using this signal, make it usable by making the setting of parameter No.43 to 48. For details, refer to, section 15.2.5 (1)(C).	DI-1	△	
Internal torque limit selection	TL1		When using this signal, make it usable by making the setting of parameter No.43 to 48. (Refer to, section 3.4.1 (5).)	DI-1	△	△

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode	
					P	S
Forward rotation start	ST1	CN1-3	Used to start the servo motor in any of the following directions.	DI-1		○
Reverse rotation start	ST2	CN1-5	<table><tr><td colspan="2">(Note) Input signals</td><td rowspan="2">Servo motor starting direction</td></tr><tr><td>ST2</td><td>ST1</td></tr><tr><td>0</td><td>0</td><td>Stop (servo lock)</td></tr><tr><td>0</td><td>1</td><td>CCW</td></tr><tr><td>1</td><td>0</td><td>CW</td></tr><tr><td>1</td><td>1</td><td>Stop (servo lock)</td></tr></table> Note. 0: ST1/ST2-VIN off (open) 1: ST1/ST2-VIN on (short) If both ST1 and ST2 are switched on or off during operation, the servo motor will be decelerated to a stop according to the parameter No.12 setting and servo-locked.			
Forward rotation selection	RS1	CN1-5	Used to select any of the following servo motor torque generation directions.	DI-1		○
Reverse rotation selection	RS2	CN1-3	<table><tr><td colspan="2">(Note) Input signals</td><td rowspan="2">Torque generation direction</td></tr><tr><td>ST2</td><td>ST1</td></tr><tr><td>0</td><td>0</td><td>Torque is not generated.</td></tr><tr><td>0</td><td>1</td><td>Forward rotation in driving mode/reverse rotation in regenerative mode</td></tr><tr><td>1</td><td>0</td><td>Reverse rotation in driving mode/forward rotation in regenerative mode</td></tr><tr><td>1</td><td>1</td><td>Torque is not generated.</td></tr></table> Note. 0: ST1/ST2-VIN off (open) 1: ST1/ST2-VIN on (short)			

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode	
					P	S
Speed selection 1	SP1		<Speed control mode> Used to select the command speed for operation. When using SP1 to SP3, make it usable by making the setting of parameter No.43 to 48.	DI-1	△	△
Speed selection 2	SP2			DI-1	△	△
Speed selection 3	SP3			DI-1	△	△

| (Note) Input signals			Speed command
SP3	SP2	SP1	
0	0	0	Analog speed command (VC)
0	0	1	Internal speed command 1 (parameter No.8)
0	1	0	Internal speed command 2 (parameter No.9)
0	1	1	Internal speed command 3 (parameter No.10)
1	0	0	Internal speed command 4 (parameter No.72)
1	0	1	Internal speed command 5 (parameter No.73)
1	1	0	Internal speed command 6 (parameter No.74)
1	1	1	Internal speed command 7 (parameter No.75)

Note. 0: SP1/SP2/SP3-VIN off (open)
1: SP1/SP2/SP3-VIN on (short)

<Speed control mode>
Used to select the command speed for operation.
When using SP1 to SP3, make it usable by making the setting of
parameter No.43 to 48.

(Note) Input signals			Speed limit
SP3	SP2	SP1	
0	0	0	Analog speed limit (VLA)
0	0	1	Internal speed limit 1 (parameter No.8)
0	1	0	Internal speed limit 2 (parameter No.9)
0	1	1	Internal speed limit 3 (parameter No.10)
1	0	0	Internal speed limit 4 (parameter No.72)
1	0	1	Internal speed limit 5 (parameter No.73)
1	1	0	Internal speed limit 6 (parameter No.74)
1	1	1	Internal speed limit 7 (parameter No.75)

Note. 0: SP1/SP2/SP3-VIN off (open)
1: SP1/SP2/SP3-VIN on (short)

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode	
Control change	LOP		<Position/speed control change mode> Used to select the control mode in the position/speed control change mode.	DI-1	Refer to functions/applications.	

(Note) LOP	Control mode
0	Position
1	Speed

Note. 0: LOP-VIN off (open)
1: LOP-VIN on (short)

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	P	S
Servo-on	SON	CN1-4	Same as MR-E-□A-QW003. (Refer to section 3.3.2 (1).)	DI-1	○	△
Reset	RES			DI-1	△	△
Proportion control	PC			DI-1	△	△
Emergency stop	EMG	CN1-8		DI-1	○	○
Gain changing	CDP			DI-1	△	△

Signal	Symbol	Connector pin No.	Functions/applications	I/O division	Control mode	
					P	S
Analog torque limit	TLA	CN1-2	To use this signal in the speed control mode, set any of parameters No.43 to 48 to make TL available. When the analog torque limit (TLA) is valid, torque is limited in the full servo motor output torque range. Apply 0 to +10VDC across TLA-LG. Connect the positive terminal of the power supply to TLA. Maximum torque is generated at +10V. (Refer to section 15.2.5 (1)(a).) Resolution:10bit	Analog input	△	
Analog torque command	TC		Used to control torque in the full servo motor output torque range. Apply 0 to ±8VDC across TC-LG. Maximum torque is generated at ±8V. (Refer to section 15.2.5 (2)(a).) The torque at ±8V input can be changed using parameter No.26.	Analog input		○
Analog speed command	VC	CN1-26	Apply 0 to ±10VDC across VC-LG. Speed set in parameter No.25 is provided at ±10V. (Refer to section 15.2.5 (1)(a).) Resolution:14bit or equivalent	Analog input	○	
Analog speed limit	VLA		Apply 0 to +10VDC across VLA-LG. Speed set in parameter No.25 is provided at +10V. (Refer to section 15.2.5 (2)(c).)	Analog input		○

(2) Output signals

Signal	Symbol	Connector pin No.	Functions/Applications	I/O division	Control mode S	T
Speed reached	SA		SA turns off when servo on (SON) turns off or the servo motor speed has not reached the preset speed with both forward rotation start (ST1) and reverse rotation start (ST2) turned off. SA turns on when the servo motor speed has nearly reached the preset speed. When the preset speed is 30r/min or less, SA always turns on.	DO-1		○
Limiting speed	VLC		VLC turns on when speed reaches the value limited using any of the internal speed limits 1 to 7 (parameter No.8 to 10, 72 to 75) or the analog speed limit (VLA) in the torque control mode. VLC turns off when servo on (SON) turns off.	DO-1		○
Limiting torque	TLC		TLC turns on when the torque generated reaches the value set to the internal torque limit 1 (parameter No.28) or analog torque limit (TLA). TLC turns off when servo on (SON) turns off.	DO-1	○	
Trouble	ALM	CN1-9	Same as MR-E-□A-QW003. (Refer to section 3.3.2 (2).)	DO-1	○	○
Ready	RD	CN1-11		DO-1	○	○
Zero speed detection	ZSP	CN1-12		DO-1	○	○
Electromagnetic brake interlock	MBR	[CN1-12]		DO-1	△	△
Warning	WNG			DO-1	△	△
Alarm code	ACD0 ACD1 ACD2			DO-1	△	△
Encoder Z-phase pulse (Open collector)	OP	CN1-21		DO-2	○	○
Encoder A-phase pulse (Differential line driver)	LA LAR	CN1-15 CN1-16				
Encoder B-phase pulse (Differential line driver)	LB LBR	CN1-17 CN1-18				
Encoder Z-phase pulse (Differential line driver)	LZ LZR	CN1-19 CN1-20				
Analog monitor 1	MO1	CN3-4		Analog output	○	○
Analog monitor 2	MO2	CN3-6		Analog output	○	○

(3) Power

Signal	Symbol	Connector pin No.	Functions/Applications	I/O division	Control mode	
					S	T
Digital I/F power supply input	VIN	CN1-1	Same as MR-E-☐A-QW003. (Refer to section 3.3.2 (4).)		○	○
Open collector power input	OPC	CN1-2			○	○
Digital I/F common	SG	CN1-13			○	○
Control common	LG	CN1-14			○	○
Shield	SD	Plate			○	○

14.2.5 Detailed description of the signals

(1) Speed control mode
  (a) Speed setting
    1) Speed command and speed
       The servo motor is run at the speeds set in the parameters or at the speed set in the applied voltage of the analog speed command (VC). A relationship between the analog speed command (VC) applied voltage and the servo motor speed is shown below.
       In the initial setting, rated speed is ±10V. The speed at ±10V can be changed using parameter No.25.
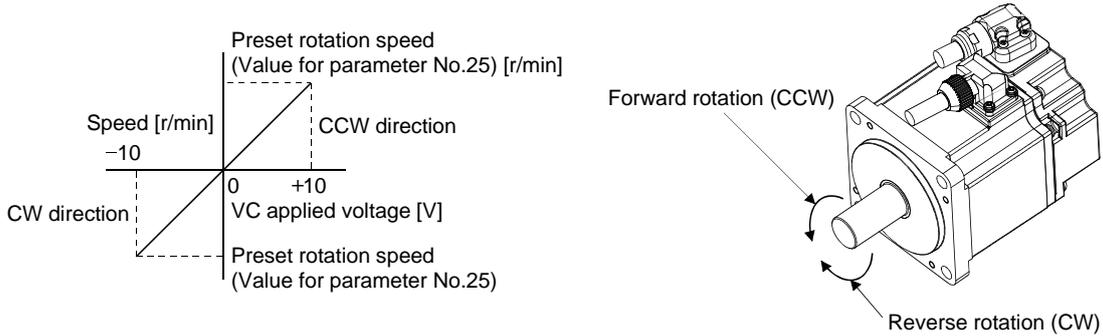
       The following table indicates the rotation direction according to forward rotation start (ST1) and reverse rotation start (ST2) combination.

(Note 1) External input signals		(Note 2) Rotation direction			
ST2	ST1	Analog speed command (VC)			Internal speed commands
		+Polarity	0V	-Polarity	
0	0	Stop (Servo lock)	Stop (Servo lock)	Stop (Servo lock)	Stop (Servo lock)
0	1	CCW	Stop (No servo lock)	CW	CCW
1	0	CW		CCW	CW
1	1	Stop (Servo lock)	Stop (Servo lock)	Stop (Servo lock)	Stop (Servo lock)

Note 1. 0: off
        1: on
     2. Releasing the torque limit during servo lock may cause the servo motor to suddenly rotate according to the position deviation from the instructed position.

       The forward rotation start (ST1) and reverse rotation start (ST2) can be assigned to any pins of the connector CN1 using parameters No.43 to 48.
       Generally, make connection as shown below.

2) Speed selection 1 (SP1), speed selection 2 (SP2), speed selection 3 (SP3) and speed command value by making speed selection 1 (SP1), speed selection 2 (SP2) and speed selection 3 (SP3) usable by setting of parameter No.43 to 47, you can choose the speed command values of internal speed commands 1 to 7.

(Note) External input signals			Speed command value
SP3	SP2	SP1	
0	0	0	Analog speed command (VC)
0	0	1	Internal speed command 1 (parameter No.8)
0	1	0	Internal speed command 2 (parameter No.9)
0	1	1	Internal speed command 3 (parameter No.10)
1	0	0	Internal speed command 4 (parameter No.72)
1	0	1	Internal speed command 5 (parameter No.73)
1	1	0	Internal speed command 6 (parameter No.74)
1	1	1	Internal speed command 7 (parameter No.75)

Note. 0: SP1/SP2/SP3-VIN off (open)
  1: SP1/SP2/SP3-VIN on (short)

The speed may be changed during rotation. In this case, the values set in parameters No.11 and 12 are used for acceleration/deceleration.
When the speed has been specified under any internal speed command, it does not vary due to the ambient temperature.

(b) Speed reached (SA)
SA-VIN are connected when the servo motor speed nearly reaches the speed set to the internal speed command.
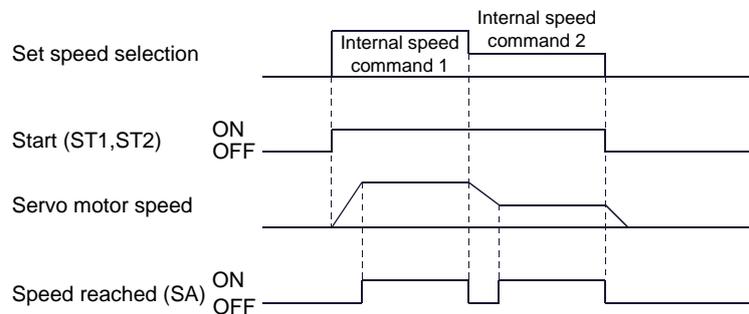
(c) Torque limit

⚠ CAUTION	· Releasing the torque limit during servo lock may cause the servo motor to suddenly rotate according to the position deviation from the instructed position.

1) Torque limit and torque

By setting parameter No.28 (internal torque limit 1), torque is always limited to the maximum value during operation. A relationship between the limit value and servo motor torque is shown below.
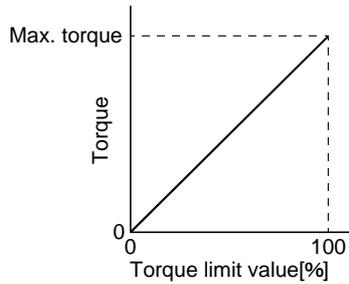
A relationship between the applied voltage of the analog torque limit (TLA) and the torque limit value of the servo motor is shown below. Torque limit values will vary about 5% relative to the voltage depending on products.

At the voltage of less than 0.05V, torque may vary as it may not be limited sufficiently. Therefore, use this function at the voltage of 0.05V or more.

TLA application voltage vs. torque limit value
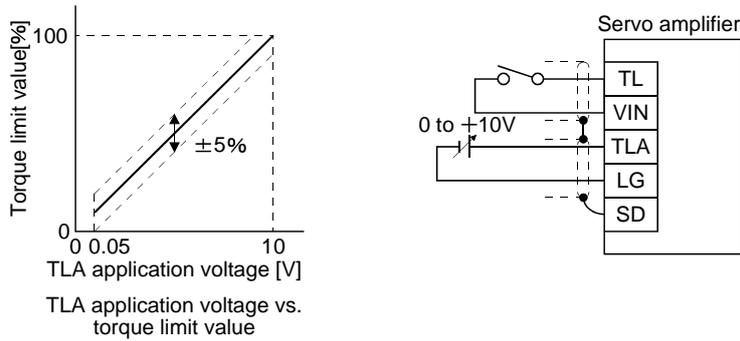
2) Torque limit value selection

Use parameters No.43 through 48 to enable external torque limit (TL) and internal torque limit (TL1). Torque limit values can be selected as shown in the following table. However, if the parameter No.28 value is less than the limit value selected by TL/TL1, the parameter No.28 value is made valid.

(Note) External input signals		Torque limit value made valid
TL1	TL	
0	0	Internal torque limit 1 (parameter No.28)
0	1	TLA > Parameter No.28: Parameter No.28 TLA < Parameter No.28: TLA
1	0	Parameter No.76 > Parameter No.28: Parameter No.28 Parameter No.76 < Parameter No.28: Parameter No.76
1	1	TLA > Parameter No.76: Parameter No.76 TLA < Parameter No.76: TLA

Note.0: off
　　 1: on

(2) Torque control mode
   (a) Torque command
     1) Torque command and torque
       A relationship between the applied voltage of the analog torque command (TC) and the torque by the servo motor is shown below.
       The maximum torque is generated at ±8V. Note that the torque at ±8V input can be changed with parameter No.26.
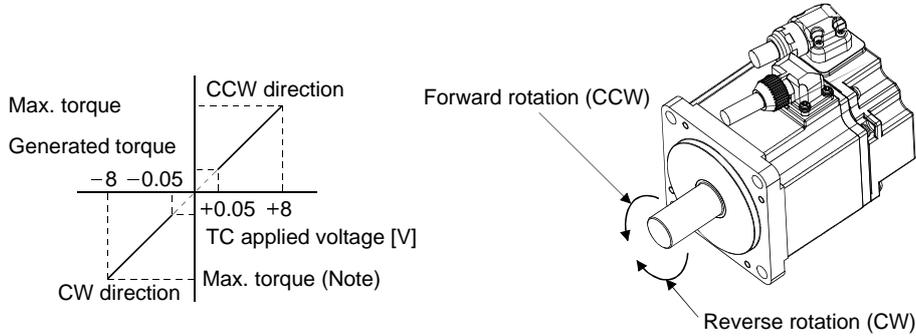
Generated torque limit values will vary about 5% relative to the voltage depending on products.

Also the torque may vary if the voltage is low (−0.05 to +0.05V) and the actual speed is close to the limit value. In such a case, increase the speed limit value.

The following table indicates the torque generation directions determined by the forward rotation selection (RS1) and reverse rotation selection (RS2) when the analog torque command (TC) is used.

(Note) External input signals		Rotation direction		
		Torque control command (TC)		
RS2	RS1	+ Polarity	0V	− Polarity
0	0	Torque is not generated.		Torque is not generated.
0	1	CCW (reverse rotation in driving mode/forward rotation in regenerative mode)	Torque is not generated.	CW (forward rotation in driving mode/reverse rotation in regenerative mode)
1	0	CW (forward rotation in driving mode/reverse rotation in regenerative mode)		CCW (reverse rotation in driving mode/forward rotation in regenerative mode)
1	1	Torque is not generated.		Torque is not generated.

Note. 0: off
     1: on

Generally, make connection as shown below.
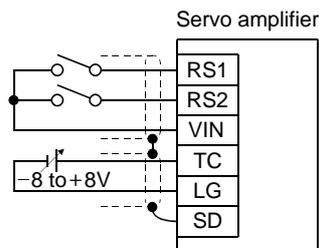
2) Analog torque command offset

Using parameter No.30, the offset voltage of -999 to $+999$mV can be added to the TC applied voltage as shown below.
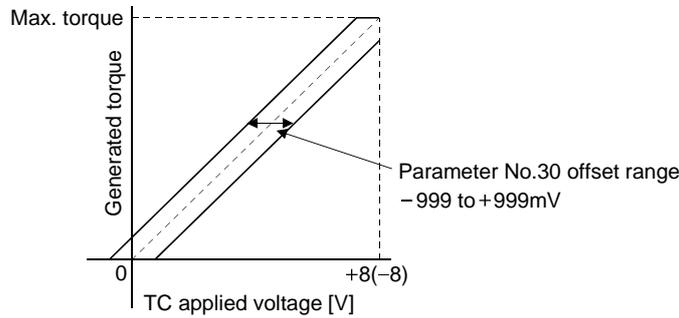
(b) Torque limit

By setting parameter No.28 (internal torque limit 1), torque is always limited to the maximum value during operation. A relationship between limit value and servo motor torque is as in (1)(c) of this section. Note that the analog torque limit (TLA) is unavailable.

(c) Speed limit

1) Speed limit value and speed

The speed is limited to the values set in parameters No.8 to 10, 72 to 75 (internal speed limits 1 to 7) or the value set in the applied voltage of the analog speed limit (VLA).

A relationship between the analog speed limit (VLA) applied voltage and the servo motor speed is shown below.

When the servo motor speed reaches the speed limit value, torque control may become unstable. Make the set value more than 100r/min greater than the desired speed limit value.
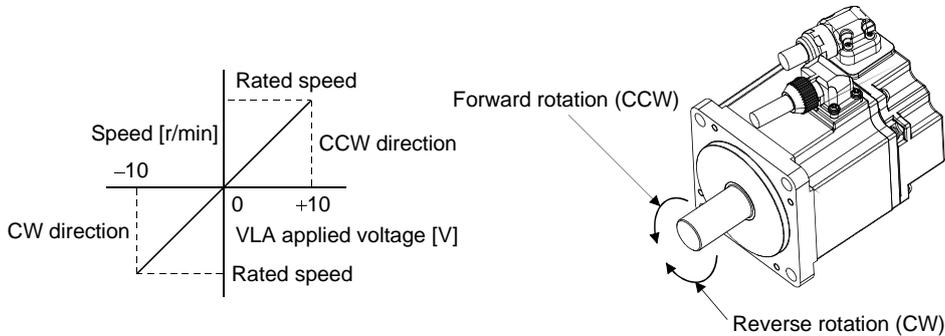
The following table indicates the limit direction according to forward rotation selection (RS1) and reverse rotation selection (RS2) combination.

(Note) External input signals		Speed limit direction		
RS1	RS2	Analog speed limit (VLA)		Internal speed commands
		$+$ Polarity	$-$ Polarity	
1	0	CCW	CW	CCW
0	1	CW	CCW	CW

Note.0: off
    1: on

Generally, make connection as shown below.
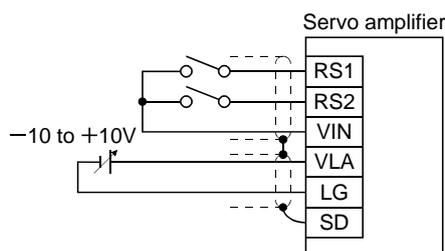
2) Speed selection 1(SP1)/speed selection 2(SP2)/speed selection 3(SP3) and speed limit values

Choose any of the speed settings made by the internal speed limits 1 to 7 using speed selection 1(SP1), speed selection 2(SP2) and speed selection 3(SP3) or the speed setting made by the analog speed limit (VLA), as indicated below.

(Note) External input signals			Speed limit value
SP3	SP2	SP1	
0	0	0	Analog speed limit (VLA)
0	0	1	Internal speed limit 1 (parameter No.8)
0	1	0	Internal speed limit 2 (parameter No.9)
0	1	1	Internal speed limit 3 (parameter No.10)
1	0	0	Internal speed limit 4 (parameter No.72)
1	0	1	Internal speed limit 5 (parameter No.73)
1	1	0	Internal speed limit 6 (parameter No.74)
1	1	1	Internal speed limit 7 (parameter No.75)

Note.0: off
1: on

When the internal speed limits 1 to 7 are used to command the speed, the speed does not vary with the ambient temperature.

3) Limiting speed (VLC)

VLC turns on when the servo motor speed reaches the speed limited using any of the internal speed limits 1 to 7 or the analog speed limit (VLA).

(3) Speed/torque control change mode
Set "0003" in parameter No.0 to switch to the speed/torque control change mode.

(a) Control change (LOP)
Use control change (LOP) to switch between the speed control mode and the torque control mode from an external contact. Relationships between LOP and control modes are indicated below.

(Note) LOP	Servo control mode
0	Speed control mode
1	Torque control mode

Note.0: off
　　　1: on

The control mode may be changed at any time. A change timing chart is shown below.
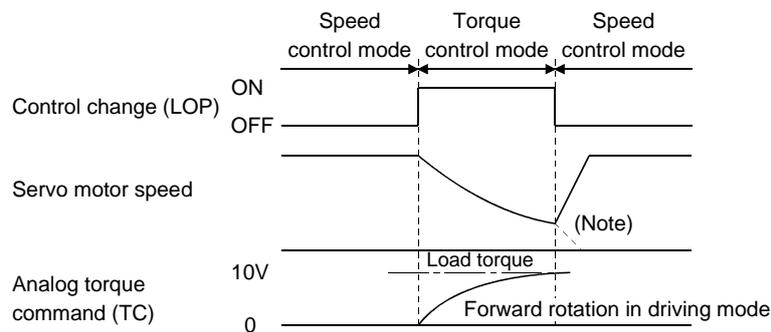
Note. When the start (ST1・ST2) is switched off as soon as the mode is changed to speed control, the servo motor comes to a stop according to the deceleration time constant.

(b) Speed setting in speed control mode
Same as (1)(a).

(c) Torque limit in speed control mode
Same as (1)(c).

(d) Speed limit in torque control mode
Same as (2)(c).

(e) Torque control in torque control mode
Same as (2)(a).

(f) Torque limit in torque control mode
Same as (2)(b).

14.3 Startup

⚠ WARNING	・Do not operate the switches with wet hands. You may get an electric shock.

⚠ CAUTION	・Before starting operation, check the parameters. Some machines may perform unexpected operation. ・Take safety measures, e.g. provide covers, to prevent accidental contact of hands and parts (cables, etc.) with the servo amplifier heat sink, regenerative resistor, servo motor, etc. since they may be hot while power is on or for some time after power-off. Their temperatures may be high and you may get burnt or a parts may damaged. ・During operation, never touch the rotating parts of the servo motor. Doing so can cause injury.

Perform pre-operation checks while referring to section 4.1. Connect the servo motor with a machine after confirming that the servo motor operates properly alone.
Use parameter No.0 to choose the control mode used. After setting, this parameter is made valid by switching power off, then on.

14.3.1 Speed control mode

(1) Power on
   1) Switch off the servo-on (SON).

   2) When power is switched on, the display shows "r (servo motor speed)", and in two second later, shows data.

(2) Test operation
   Confirm servo motor operation by operating JOG of test operation mode at lowest speed possible. (Refer to section 6.8.2.)

(3) Parameter setting

Set the parameters according to the structure and specifications of the machine. Refer to chapter 5 for the parameter definitions and to section 6.5 for the setting method.

Parameter No.	Name	Setting	Description
0	Control mode, regenerative option selection	□0□2	Speed control mode / Regenerative option is not used.
1	Function selection 1	□□12	Input filter 3.555ms (initial value) / Electromagnetic brake interlock (MBR) is used.
2	Auto tuning	□1□5	Middle response (initial value) is selected. / Auto tuning mode 1 is selected.
8	Internal speed command 1	1000	Set 1000r/min.
9	Internal speed command 1	1500	Set 1500r/min.
10	Internal speed command 1	2000	Set 2000r/min.
11	Acceleration time constant	1000	Set 1000ms.
12	Deceleration time constant	500	Set 500ms.
13	S-pattern acceleration/deceleration time constant	0	Not used

Turn the power off to validate changes in parameters No.0 and 1. Then switch power on again to make the set parameter values valid.

(4) Servo-on

Switch the servo-on in the following procedure.

1) Switch on power supply.

2) Switch on the servo-on (SON).

When placed in the servo-on status, the servo amplifier is ready to operate and the servo motor is locked.

(5) Start

Using speed selection 1 (SP1) and speed selection 2 (SP2), choose the servo motor speed. Turn on forward rotation start (ST1) to run the motor in the forward rotation (CCW) direction or reverse rotation start (ST2) to run it in the reverse rotation (CW) direction. At first, set a speed as low as possible and check the rotation direction, etc. If it does not run in the intended direction, check the input signal.
On the status display, check the speed, load factor, etc. of the servo motor.
When machine operation check is over, check automatic operation with the host controller or the like.
This servo amplifier has a real-time auto tuning function under model adaptive control. Performing operation automatically adjusts gains. The optimum tuning results are provided by setting the response level appropriate for the machine in parameter No.2. (Refer to chapter 7.)

(6) Stop

In any of the following statuses, the servo amplifier interrupts and stops the operation of the servo motor.
Refer to section 3.8 for the servo motor equipped with electromagnetic brake. Note that simultaneous ON or simultaneous OFF of forward rotation stroke end (LSP), reverse rotation stroke end (LSN) OFF and forward rotation start (ST1) or reverse rotation start (ST2) has the same stop pattern as described below.
(a) Servo-on (SON) OFF

The base circuit is shut off and the servo motor coasts.

(b) Alarm occurrence

When an alarm occurs, the base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop.

(c) Emergency stop (EMG) OFF
The base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop. Alarm AL.E6 (servo emergency stop warning) occurs.

(d) Forward rotation stroke end (LSP), reverse rotation stroke end (LSN) OFF
The servo motor is brought to a sudden stop and servo-locked. The motor may be run in the opposite direction.

(e) Simultaneous ON or simultaneous OFF of forward rotation start (ST1) and reverse rotation start (ST2)
The servo motor is decelerated to a stop.

```
POINT
・A sudden stop indicates deceleration to a stop at the deceleration time constant
  of zero.
```

14.3.2 Torque control mode

(1) Power on
    1) Switch off the servo-on (SON).

    2) When power is switched on, the display shows "U (torque command voltage)", and in two second later, shows data.

(2) Test operation
    Using jog operation in the test operation mode, make sure that the servo motor operates. (Refer to section 6.8.2.)

(3) Parameter setting
    Set the parameters according to the structure and specifications of the machine. Refer to chapter 5 for the parameter definitions and to section 6.5 for the setting method.

Parameter No.	Name	Setting	Description
0	Control mode, regenerative option selection	□0□4	Torque control mode Regenerative option is not used.
1	Function selection 1	□□02	Input filter 3.555ms (initial value) Electromagnetic brake interlock (MBR) is used.
8	Internal speed command 1	1000	Set 1000r/min.
9	Internal speed command 1	1500	Set 1500r/min.
10	Internal speed command 1	2000	Set 2000r/min.
11	Acceleration time constant	1000	Set 1000ms.
12	Deceleration time constant	500	Set 500ms.
13	S-pattern acceleration/deceleration time constant	0	Not used
14	Torque command time constant	2000	Set 2000r/min.
28	Internal torque limit 1	50	Controlled to 50% output

    Turn the power off after setting parameters No.0 and 1. Then switch power on again to make the set parameter values valid.

(4) Servo-on
    Switch the servo-on in the following procedure.
    1) Switch on power supply.

    2) Switch on the servo-on (SON).
    When placed in the servo-on status, the servo amplifier is ready to operate and the servo motor is locked.

(5) Start
    Using speed selection 1 (SP1) and speed selection 2 (SP2), choose the servo motor speed. Turn on forward rotation select (DI4) to run the motor in the forward rotation (CCW) direction or reverse rotation select (DI3) to run it in the reverse rotation (CW) direction, generating torque. At first, set a low speed and check the rotation direction, etc. If it does not run in the intended direction, check the input signal.
    On the status display, check the speed, load factor, etc. of the servo motor.
    When machine operation check is over, check automatic operation with the host controller or the like.

(6) Stop

In any of the following statuses, the servo amplifier interrupts and stops the operation of the servo motor.

Refer to section 3.8 for the servo motor equipped with electromagnetic brake.

(a) Servo-on (SON) OFF

The base circuit is shut off and the servo motor coasts.

(b) Alarm occurrence

When an alarm occurs, the base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop.

(c) Emergency stop (EMG) OFF

The base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop. Alarm AL.E6 (servo emergency stop warning) occurs.

(d) Simultaneous ON or simultaneous OFF of forward rotation selection (RS1) and reverse rotation selection (RS2)

The servo motor coasts.

POINT

· A sudden stop indicates deceleration to a stop at the deceleration time constant of zero.

14.4 Parameters

```
┌─────────────────────────────────────────────────────────────┐
│  POINT                                                        │
│ ・Before changing the settings of parameters No.20 through 84,│
│   cancel write protection while referring to section 5.1.1.   │
│ ・For any parameter whose symbol is preceded by *, set the    │
│   parameter value and switch power off once, then switch it on │
│   again to make that parameter setting valid.                 │
└─────────────────────────────────────────────────────────────┘
```

The symbols in the control mode column of the table indicate the following modes:
S: Speed control mode
T: Torque control mode

14.4.1 Item list

Class	No.	Symbol	Name	Control mode	Initial value	Unit	Customer setting
Basic parameters	0	*STY	Control mode, regenerative option selection	S・T	(Note 1)		
	1	*OP1	Function selection 1	S・T	0002		
	2	ATU	Auto tuning	S	0105		
	3		For manufacturer setting		1		
	4				1		
	5				100		
	6	PG1	Position loop gain 1	S	35	rad/s	
	7		For manufacture setting		3		
	8	SC1	Internal speed command 1	S	100	r/min	
			Internal speed limit 1	T	100	r/min	
	9	SC2	Internal speed command 2	S	500	r/min	
			Internal speed limit 2	T	500	r/min	
	10	SC3	Internal speed command 3	S	1000	r/min	
			Internal speed limit 3	T	1000	r/min	
	11	STA	Acceleration time constant	S・T	0	ms	
	12	STB	Deceleration time constant	S・T	0	ms	
	13	STC	S-pattern acceleration/deceleration time constant	S・T	0	ms	
	14	TQC	Torque command time constant	T	0	ms	
	15	*SNO	Station number setting	S・T	0	station	
	16	*BPS	Serial communication function selection, alarm history clear	S・T	0000		
	17	MOD	Analog monitor output	S・T	0100		
	18	*DMD	Status display selection	S・T	0000		
	19	*BLK	Parameter block	S・T	0000		

Class	No.	Symbol	Name	Control mode	Initial value	Unit	Customer setting
Expansion parameters 1	20	*OP2	Function selection 2	S・T	0000		
	21		For manufacturer setting		0000		
	22	*OP4	Function selection 4	S・T	0000		
	23		For manufacturer setting		0		
	24	ZSP	Zero speed	S・T	50	r/min	
	25	VCM	Analog speed command maximum speed	S	(Note 3)0	(r/min)	
			Analog speed limit maximum speed	T	(Note 3)0	(r/min)	
	26	TLC	Analog torque command maximum output	T	100	%	
	27	*ENR	Encoder output pulses	S・T	4000	pulse /rev	
	28	TL1	Internal torque limit 1	S・T	100	%	
	29	VCO	Analog speed command offset	S	(Note 2)	mV	
			Analog speed limit offset	T	(Note 2)	mV	
	30	TLO	Analog torque command offset	T	0	mV	
			Analog torque limit offset	S	0	mV	
	31	MO1	Analog monitor 1 offset	S・T	0	mV	
	32	MO2	Analog monitor 2 offset	S・T	0	mV	
	33	MBR	Electromagnetic brake sequence output	S・T	100	ms	
	34	GD2	Ratio of load inertia moment to servo motor inertia moment	S・T	70	Multiplier $(\times 10^{-1})$	
	35	PG2	Position loop gain 2	S	35	rad/s	
	36	VG1	Speed loop gain 1	S	177	rad/s	
	37	VG2	Speed loop gain 2	S	817	rad/s	
	38	VIC	Speed integral compensation	S	48	ms	
	39	VDC	Speed differential compensation	S	980		
	40		For manufacturer setting		0		
	41	*DIA	Input signal automatic ON selection	S・T	0000		
	42	*DI1	Input signal selection 1	S/T	0002		
	43	*DI2	Input signal selection 2 (CN1-4)	S・T	0111		
	44	*DI3	Input signal selection 3 (CN1-3)	S・T	0882		
	45	*DI4	Input signal selection 4 (CN1-5)	S・T	0995		
	46	*DI5	Input signal selection 5 (CN1-6)	S・T	0000		
	47	*DI6	Input signal selection 6 (CN1-7)	S・T	0000		
	48	*LSPN	LSP/LSN input terminals selection	S	0403		
	49	*DO1	Output signal selection 1	S・T	0000		
Expansion parameters 2	50		For manufacturer setting		0000		
	51	*OP6	Function selection 6	S・T	0000		
	52		For manufacturer setting		0000		
	53	*OP8	Function selection 8	S・T	0000		
	54	*OP9	Function selection 9	S・T	0000		
	55		For manufacturer setting		0000		
	56	SIC	Serial communication time-out selection	S・T	0	s	
	57		For manufacturer setting		10		
	58	NH1	Machine resonance suppression filter 1	S・T	0000		
	59	NH2	Machine resonance suppression filter 2	S・T	0000		
	60	LPF	Low-pass filter/adaptive vibration suppression control	S・T	0000		
	61	GD2B	Ratio of load inertia moment to Servo motor inertia moment 2	S	70	Multiplier $(\times 10^{-1})$	
	62		For manufacturer setting		100		
	63	VG2B	Speed control gain 2 changing ratio	S	100	%	
	64	VICB	Speed integral compensation changing ratio	S	100	%	

Class	No.	Symbol	Name	Control mode	Initial value	Unit	Customer setting
Expansion parameters 2	65	*CDP	Gain changing selection	S	0000		
	66	CDS	Gain changing condition	S	10	(Note 2)	
	67	CDT	Gain changing time constant	S	1	ms	
	68		For manufacturer setting		0		
	69				1		
	70				1		
	71				1		
	72	SC4	Internal speed command 4	S	200	r/min	
			Internal speed limit 4	T			
	73	SC5	Internal speed command 5	S	300	r/min	
			Internal speed limit 5	T			
	74	SC6	Internal speed command 6	S	500	r/min	
			Internal speed limit 6	T			
	75	SC7	Internal speed command 7	S	800	r/min	
			Internal speed limit 7	T			
	76	TL2	Internal torque limit 2	S・T	100	%	
	77		For manufacturer setting		100		
	78				10000		
	79				10		
	80				10		
	81				100		
	82				100		
	83				100		
	84				0000		

Note 1. Depends on the capacity of the servo amplifier.

2. Depends on the parameter No.65 setting.

3. The setting of "0" provides the rated servo motor speed.

14.4.2 Details list

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	0	*STY	Control mode, regenerative option selection 　Used to select the control mode and regenerative option. 　　☐☐☐☐ 　　　Select the control mode. 　　　0: Speed 　　　1: Speed and torque 　　　2: Torque 　　　Motor series selection 　　　0: HF-KN☐(J) 　　　1: HF-SN☐J 　　　Selection of regenerative option 　　　0: Regenerative option is not used 　　　　・For the servo amplifier of 200W or lower, regenerative resistor is not used. 　　　　・For the servo amplifier of 400W or higher, built-in regenerative resistor is used. 　　　2: MR-RB032 　　　3: MR-RB12 　　　4: MR-RB32 　　　5: MR-RB30 　　　6: MR-RB50 (Cooling fan is required) 　　　Motor capacity selection 　　　0: 100W 　　　1: 200W 　　　2: 400W 　　　3: 500W 　　　4: 750W 　　　5: 1kW 　　　6: 1.5kW 　　　7: 2kW 　┌─ POINT ─────────────┐ 　│ Wrong setting may cause the regenerative option to burn. │ 　│ If the regenerative option selected is not for use with the servo amplifier, parameter error (AL.37) occurs. │ 　└───────────────────┘	100W : 0000 200W : 1000 400W : 2000 700W : 4000 1kW : 5010 2kW : 6010		Refer to name and function column.	S・T
	1	*OP1	Function selection 1 　Used to select the input signal filter, the function of pin CN1-12. 　0 0 ☐ ☐ 　　　Input signal filter 　　　If external input signal causes chattering due to noise, etc., input filter is used to suppress it. 　　　0: None 　　　1: 1.777[ms] 　　　2: 3.555[ms] 　　　3: 5.333[ms] 　　　CN1-12 function selection 　　　0: Zero Speed detection signal 　　　1: Electromagnetic brake interlock (MBR)	0002		Refer to name and function column.	S・T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	2	ATU	Auto tuning Used to selection the response level, etc. for execution of auto tuning. Refer to chapter 7. 0 □ 0 □ └─ Auto tuning response level setting 	Set value	Response level	Machine resonance frequency guideline
---	---	---
1	Low response	15Hz
2		20Hz
3		25Hz
4		30Hz
5		35Hz
6		45Hz
7		55Hz
8	Middle response	70Hz
9		85Hz
A		105Hz
B		130Hz
C		160Hz
D		200Hz
E	High response	240Hz
F		300Hz	 · If the machine hunts or generates large gear sound, decrease the set value. · To improve performance, e.g. shorten the settling time, increase the set value. └─ Gain adjustment mode selection (For more information, refer to section 7.1.1.) 	Set value	Gain adjustment mode	Description
---	---	---
0	Interpolation mode	Fixes position control gain 1 (parameter No.6).
1	Auto tuning mode 1	Ordinary auto tuning.
2	Auto tuning mode 2	Fixes the load inertia moment ratio set in parameter No.34. Response level setting can be changed.
3	Manual mode 1	Simple manual adjustment.
4	Manual mode 2	Manual adjustment of all gains.		0105		Refer to name and function column.	S
	3		For manufacturer setting	1			
	4		Do not change this value by any means.	1			
	5			100			
	6	PG1	Position loop gain 1 Used to set the gain of position loop. Increase the gain to improve track ability in response to the position command. When auto turning mode 1,2 is selected, the result of auto turning is automatically used. To use this parameter, set "□□1□" to parameter No.20 to validate servo lock at stop.	35			S
	7		For manufacturer setting Do not change this value by any means.	3			

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	8	SC1	Internal speed command 1 Used to set speed 1 of internal speed commands.	100	r/min	0 to instan-taneous permi-ssible speed	S
			Internal speed limit 1 Used to set speed 1 of internal speed limits.				T
	9	SC2	Internal speed command 2 Used to set speed 2 of internal speed commands.	500	r/min	0 to instan-taneous permi-ssible speed	S
			Internal speed limit 2 Used to set speed 2 of internal speed limits.				T
	10	SC3	Internal speed command 3 Used to set speed 3 of internal speed commands.	1000	r/min	0 to instan-taneous permi-ssible speed	S
			Internal speed limit 3 Used to set speed 3 of internal speed limits.				T
	11	STA	Acceleration time constant Used to set the acceleration time required to reach the rated speed from 0r/min in response to the analog speed command and internal speed commands 1 to 7. If the preset speed command is lower than the rated speed, acceleration/deceleration time will be shorter. For example for the servo motor of 3000r/min rated speed, set 3000 (3s) to increase speed from 0r/min to 1000r/min in 1 second.	0	ms	0 to 20000	S・T
	12	STB	Deceleration time constant Used to set the deceleration time required to reach 0r/min from the rated speed in response to the analog speed command and internal speed commands 1 to 7.	0			
	13	STC	S-pattern acceleration/deceleration time constant Used to smooth start/stop of the servo motor. Set the time of the arc part for S-pattern acceleration/deceleration. STA: Acceleration time constant (parameter No.11) STB: Deceleration time constant (parameter No.12) STC: S-pattern acceleration/deceleration time constant (parameter No.13) Long setting of STA (acceleration time constant) or STB (deceleration time constant) may produce an error in the time of the arc part for the setting of the S-pattern acceleration/deceleration time constant. The upper limit value of the actual arc part time is limited by $\dfrac{2000000}{STA}$ for acceleration or by $\dfrac{2000000}{STB}$ for deceleration. (Example) At the setting of STA=20000, STB=5000 and STC=200, the actual arc part times are as follows. During acceleration: 100[ms] [Limited to 100[ms] since $\dfrac{2000000}{20000}$ = 100[ms]<200[ms].] During deceleration: 200[ms] [200[ms] as set since $\dfrac{2000000}{5000}$ = 400[ms]>200[ms].]	0	ms	0 to 1000	S・T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	14	TQC	Torque command time constant Used to set the constant of a low-pass filter in response to the torque command. Torque Torque command After filtered TQC　　　TQC　　Time TQC: Torque command time constant	0	ms	0 to 20000	T
	15	*SNO	Station number setting 　Used to specify the station number for serial communication. 　Always set one station to one axis of servo amplifier. If one station number 　is set to two or more stations, normal communication cannot be made.	0	station	0 to 31	S・T
	16	*BPS	Serial communication function selection, alarm history clear 　Used to select the serial communication baud rate, select various 　communication conditions, and clear the alarm history. ０ Serial baud rate selection 0: 9600 [bps] 1: 19200[bps] 2: 38400[bps] 3: 57600[bps] Alarm history clear 0: Invalid (not cleared) 1: Valid (cleared) When alarm history clear is made valid, the alarm history is cleared at next power-on. After the alarm history is cleared, the setting is automatically made invalid (reset to 0). Serial communication response delay time 0: Invalid 1: Valid, reply sent after delay time of 800µs or more	0000		Refer to name and function column.	S・T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	17	MOD	Analog monitor output Used to selection the signal provided to the analog monitor (MO1) · analog monitor (MO2) output. (Refer to section 5.2.2) 0 ☐ 0 ☐ | Setting	Analog monitor 2 (MO2)	Analog monitor 1 (MO1) | |---|---|---| | 0 | Servo motor speed (±8V/max. speed) || | 1 | Torque (±8V/max. torque) || | 2 | Servo motor speed (+8V/max. speed) || | 3 | Torque (+8V/max. torque) || | 4 | Current command (±8 V/max. current command) || | 5 | Cannot be used. || | 6 ||| | 7 ||| | 8 ||| | 9 ||| | A ||| | B | Bus voltage (+8V/400V) ||	0100		Refer to name and function column.	S · T
	18	*DMD	Status display selection Used to select the status display shown at power-on. 0 0 ☐ ☐ Selection of status display at power-on 0: Cumulative feedback pulses 1: Servo motor speed 2: Cannot be used 3: Cannot be used 4: Cannot be used 7: Regenerative load ratio 8: Effective load ratio 9: Peak load ratio A: Instantaneous torque B: Within one-revolution position low C: Within one-revolution position high D: Load inertia moment ratio E: Bus voltage Status display at power-on in corresponding control mode 0: Depends on the control mode. | Control Mode | Status display at power-on | |---|---| | Speed | Servo motor speed | | Speed/torque | Servo motor speed/ analog torque command voltage | | Torque | Analog torque command voltage | 1: Depends on the first digit setting of this parameter.	0000		Refer to name and function column.	S · T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	19	*BLK	Parameter block Used to select the reference and write ranges of the parameters. Operation can be performed for the parameters marked ○.	0000		Refer to name and function column.	S・T

Set value	Operation	Basic parameters No.0 to No.19	Expansion parameters 1 No.20 to No.49	Expansion parameters 2 No.50 to No.84
0000 (Initial value)	Reference	○		
	Write	○		
000A	Reference	No.19 only		
	Write	No.19 only		
000B	Reference	○	○	
	Write	○		
000C	Reference	○	○	
	Write	○	○	
000E	Reference	○	○	○
	Write	○	○	○
100B	Reference	○		
	Write	No.19 only		
100C	Reference	○	○	
	Write	No.19 only		
100E	Reference	○	○	○
	Write	No.19 only		

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	20	*OP2	Function selection 2 Used to select restart after instantaneous power failure, servo lock at a stop in speed control mode, and slight vibration suppression control. ☐☐☐☐ Restart after instantaneous power failure If the power supply voltage has returned to normal after an undervoltage status caused by the reduction of the input power supply voltage in the speed control mode, the servo motor can be restarted by merely turning on the start signal without resetting the alarm. 　0: Invalid (Undervoltage alarm (AL.10) occurs.) 　1: Valid Stop-time servo lock selection The shaft can be servo-locked to remain still at a stop in the internal speed control mode. 　0: Valid 　1: Invalid Slight vibration suppression control Made valid when auto tuning selection is set to "0400" in parameter No.2. Used to suppress vibration at a stop. 　0: Invalid 　1: Valid Encoder cable communication system selection 　0: Two-wire type 　1: Four-wire type Incorrect setting will result in an encoder alarm 1 (AL.16) or encoder alarm 2 (AL.20).	0000		Refer to name and function column.	S S S·T
	21		For manufacturer setting Do not change this value by any means.	0000			

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	22	*OP4	Function selection 4 Used to select stop processing at forward rotation stroke end (LSP)・reverse rotation stroke end (LSN) off, choose TLC/VLC output and choose VC/VLA voltage averaging. 0 ☐ ☐ ☐ How to make a stop when forward rotation stroke end (LSP)・reverse rotation stroke end (LSN) is valid. (Refer to section 5.2.3.) 0: Sudden stop 1: Slow stop TLC/VLC output selection Select the connector pin at which Torque Limit (TLC) or Speed Limit (VLC) is output. | Set value	Connector pin No. | |---|---| | 0 | Not output | | 1 | CN1-11 | | 2 | CN1-9 | | 3 | CN1-10 | | 4 | CN1-12 | VC/VLA voltage averaging Used to set the filtering time when the analog speed command (VC) voltage or analog speed limit (VLA) is imported. Set 0 to vary the speed to voltage fluctuation in real time. Increase the set value to vary the speed slower to voltage fluctuation. | Set value	Filtering time [ms] | |---|---| | 0 | 0 | | 1 | 0.444 | | 2 | 0.888 | | 3 | 1.777 | | 4 | 3.555 |	0000		Refer to name and function column.	S S・T
	23		For manufacturer setting Do not change this value by any means.	0			
	24	ZSP	Zero speed Used to set the output range of the zero speed detection (ZSP).	50	r/min	0 to 10000	S・T
	25	VCM	Analog speed command maximum speed Used to set the speed at the maximum input voltage (10V) of the analog speed command (VC). Set "0" to select the rated speed of the servo motor connected.	0		0	S
					r/min	1 to 50000	
			Analog speed limit maximum speed Used to set the speed at the maximum input voltage (10V) of the analog speed limit (VLA). Set "0" to select the rated speed of the servo motor connected.	0		0	T
					r/min	1 to 50000	
	26	TLC	Analog torque command maximum output Used to set the output torque at the analog torque command voltage (TC = ±8V) of +8V on the assumption that the maximum torque is 100[%]. For example, set 50 to output (maximum torque × 50/100) at the TC of +8V.	100	%	0 to 1000	T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	27	*ENR	Encoder output pulses Used to set the encoder pulses (A-phase or B-phase) output by the servo amplifier. Set the value 4 times greater than the A-phase or B-phase pulses. You can use parameter No.54 to choose the output pulse designation or output division ratio setting. The number of A・B-phase pulses actually output is 1/4 times greater than the preset number of pulses. The maximum output frequency is 1.3Mpps (after multiplication by 4). Use this parameter within this range. ・For output pulse designation Set "0□□□" (initial value) in parameter No.54. Set the number of pulses per servo motor revolution. Output pulse ＝ set value [pulses/rev] At the setting of 5600, for example, the actually A・B-phase pulses output are as indicated below. $$A\cdot B\text{-phase output pulses } = \frac{5600}{4} = 1400[pulse]$$ ・For output division ratio setting Set "1□□□" in parameter No.54. The number of pulses per servo motor revolution is divided by the set value. $$Output\ pulse = \frac{Resolution\ per\ servo\ motor\ revolution}{Set\ value}\ [pulses/rev]$$ At the setting of 8, for example, the actually A・B-phase pulses output are as indicated below. $$A\cdot B\text{-phase output pulses } = \frac{10000}{8}\cdot\frac{1}{4} \fallingdotseq 313[pulse]$$	4000	pulse/ rev	1 to 65535	S・T
	28	TL1	Internal torque limit 1 Set this parameter to limit servo motor torque on the assumption that the maximum torque is 100[%]. When 0 is set, torque is not produced. （表） Note. 0 :off 　　　1 :on When torque is output in analog monitor output, this set value is the maximum output voltage (＋8V). (Refer to section 15.2.5 (1)(c).)	100	%	0 to 100	S・T
	29	VCO	Analog speed command offset Used to set the offset voltage of the analog speed command (VC). For example, if CCW rotation is provided by switching on forward rotation start (ST1) with 0V applied to VC, set a negative value. When automatic VC offset is used, the automatically offset value is set to this parameter. (Refer to section 15.5.3.) The initial value is the value provided by the automatic VC offset function before shipment at the VC-LG voltage of 0V.	Depends on servo amplifier	mV	－999 to 999	S
			Analog speed limit offset Used to set the offset voltage of the analog speed limit (VLA). For example, if CCW rotation is provided by switching on forward rotation selection (RS1) with 0V applied to VLA, set a negative value. When automatic VC offset is used, the automatically offset value is set to this parameter. (Refer to section 15.5.3.) The initial value is the value provided by the automatic VC offset function before shipment at the VLA-LG voltage of 0V.				T

The torque limit table inside parameter No.28:

(Note) TL	Torque limit
0	Internal torque limit 1 (Parameter No.28)
1	Analog torque limit < internal torque limit 1 : Analog torque limit Analog torque limit > internal torque limit 1 : Internal torque limit 1

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	30	TLO	Analog torque command offset Used to set the offset voltage of the analog torque command (TC).	0	mV	−999 to 999	T
			Analog torque limit offset Used to set the offset voltage of the analog torque limit (TLA).				S
	31	MO1	Analog monitor 1 offset Used to set the offset voltage of the analog monitor 1 (MO1).	0	mV	−999 to 999	S・T
	32	MO2	Analog monitor 2 offset Used to set the offset voltage of the analog monitor 2 (MO2).	0	mV	−999 to 999	S・T

	33	MBR	Electromagnetic brake sequence output
			   Used to set the delay time (Tb) between electronic brake interlock (MBR)
			   and the base drive circuit is shut-off.
				100	ms	0
						to
						1000
							S・T

	34	GD2	Ratio of load inertia moment to servo motor inertia moment
			   Used to set the ratio of the load inertia moment to the servo motor shaft
			   inertia moment. When auto tuning mode 1 and interpolation mode is
			   selected, the result of auto tuning is automatically used.
			   (Refer to section 7.1.1.)
			   In this case, it varies between 0 and 1000.
				70	Multi-
					plier
					$(\times 10^{-1})$
						0
						to
						3000
							S・T

	35	PG2	Position loop gain 2
			   Used to set the gain of the position loop.
			   Set this parameter to increase the position response to level load
			   disturbance. Higher setting increases the response level but is liable to
			   generate vibration and/or noise.
			   When auto tuning mode 1,2 and interpolation mode is selected, the result
			   of auto tuning is automatically used.
			   To use this parameter, set "□□1□" to parameter No.20 to validate servo
			   lock at stop.
				35	rad/s	1
						to
						1000
							S

	36	VG1	Speed loop gain 1
			   Normally this parameter setting need not be changed.
			   Higher setting increases the response level but is liable to generate
			   vibration and/or noise.
			   When auto tuning mode 1・2, manual mode and interpolation mode is
			   selected, the result of auto tuning is automatically used.
				177	rad/s	20
						to
						8000
							S

	37	VG2	Speed loop gain 2
			   Set this parameter when vibration occurs on machines of low rigidity or
			   large backlash. Higher setting increases the response level but is liable to
			   generate vibration and/or noise.
			   When auto tuning mode 1・2 and interpolation mode is selected, the
			   result of auto tuning is automatically used.
				817	rad/s	20
						to
						20000
							S

	38	VIC	Speed integral compensation
			   Used to set the integral time constant of the speed loop.
			   Higher setting increases the response level but is liable to generate
			   vibration and/or noise.
			   When auto tuning mode 1・2 and interpolation mode is selected, the
			   result of auto tuning is automatically used.
				48	ms	1
						to
						1000
							S

	39	VDC	Speed differential compensation
			   Used to set the differential compensation.
			   Made valid when the proportion control (PC) is switched on.
				980		0
						to
						1000
							S

	40		For manufacturer setting Do not change this value by any means.	0			

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	41	*DIA	Input signal automatic ON selection Used to set automatic servo-on (SON)・forward rotation stroke end (LSP)・reverse rotation stroke end (LSN). 0 □ □ □ Servo-on (SON) input selection 0: Switched on/off by external input. 1: Switched on automatically in servo amplifier. (No need of external wiring) Forward rotation stroke end (LSP) input selection 0: Switched on/off by external input. 1: Switched on automatically in servo amplifier. (No need of external wiring) Reverse rotation stroke end (LSN) input selection 0: Switched on/off by external input. 1: Switched on automatically in servo amplifier. (No need of external wiring)	0000		Refer to name and function column.	S・T - - - - - S
	42	*DI1	Input signal selection 1 Used to assign the control mode changing signal input pins and to set the clear (CR). 0 0 0 □ Control change (LOP) input pin assignment Used to set the control mode change signal input connector pins. Note that this parameter is made valid when parameter No.0 is set to select internal speed/torque change mode. | Set value	Connector pin No. | |---|---| | 0 | CN1-4 | | 1 | CN1-3 | | 2 | CN1-5 | | 3 | CN1-6 | | 4 | CN1-7 | If forward rotation stroke end (LSP) or reverse rotation stroke end (LSN) is assigned to any pin with parameter No.48, this parameter cannot be used.	0002		Refer to name and function column.	S/T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	43	*DI2	Input signal selection 2 (CN1-4) Allows any input signal to be assigned to CN1-pin 4. Note that the setting digit and assigned signal differ according to the control mode. `0    1` Speed control mode ⎫ Input signals of CN1-pin 4 Torque control mode ⎭ selected. Signals that may be assigned in each control mode are indicated below by their symbols. Setting of any other signal will be invalid. Set value — (Note) Control mode S / T: 0 — / — 1 — SON / SON 2 — RES / RES 3 — PC / PC 4 — TL / TL 5 — CR / CR 6 — SP1 / SP1 7 — SP2 / SP2 8 — ST1 / RS2 9 — ST2 / RS1 A — SP3 / SP3 B — / — C — / — D — TL1 / TL1 E — CDP / CDP F — / — Note: P: Position control mode S: Internal speed control mode This parameter is unavailable when parameter No.42 is set to assign the control change (LOP) to CN1-pin 4. If rotation stroke end (LSP) or reverse rotation stroke end (LSN) is assigned to pin 4 of CN1 with parameter No.48, this parameter cannot be used.	0111		Refer to name and function column.	S · T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	44	*DI3	Input signal selection 3 (CN1-3) Allows any input signal to be assigned to CN1-pin 3. The assignable signals and setting method are the same as in input signal selection 2 (parameter No.43). `0 [ ] [ ] 2` — Speed control mode — Torque control mode Input signals of CN1-pin 3 selected. This parameter is unavailable when parameter No.42 is set to assign the control change (LOP) to CN1-pin 3. If forward rotation stroke end (LSP) or reverse rotation stroke end (LSN) is assigned to pin 3 of CN1 with parameter No.48, this parameter cannot be used.	0882		Refer to name and function column.	S・T
	45	*DI4	Input signal selection 4 (CN1-5) Allows any input signal to be assigned to CN1-pin 5. The assignable signals and setting method are the same as in input signal selection 2 (parameter No.43). `0 [ ] [ ] 5` — Speed control mode — Torque control mode Input signals of CN1-pin 5 selected. This parameter is unavailable when parameter No.42 is set to assign the control change (LOP) to CN1-pin 5. If forward stroke end (LSP) or reverse rotation stroke end (LSN) is assigned to pin 5 of CN1 with parameter No.48, this parameter cannot be used.	0995		Refer to name and function column.	S・T
	46	*DI5	Input signal selection 5 (CN1-6) Allows any input signal to be assigned to CN1-pin 6. The assignable signals and setting method are the same as in input signal selection 2 (parameter No.43). `0 [ ] [ ] 0` — Speed control mode — Torque control mode Input signals of CN1-pin 6 selected. This parameter is unavailable when parameter No.42 is set to assign the control change (LOP) to CN1-pin 6. If reverse rotation stroke end (LSN) is assigned to pin 6 of CN1 with parameter No.48, this parameter cannot be used.	0000		Refer to name and function column.	S・T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	47	*DI6	Input signal selection 6 (CN1-7) Allows any input signal to be assigned to CN1-pin 7. The assignable signals and setting method are the same as in input signal selection 2 (parameter No.43). `0 [ ] [ ] 0` — Speed control mode ⎤ — Torque control mode ⎦ Input signals of CN1-pin 7 selected. This parameter is unavailable when parameter No.42 is set to assign the control change signal (LOP) to CN1-pin 7. If forward rotation stroke end (LSP) is assigned to pin 7 of CN1 with parameter No.48, this parameter cannot be used.	0000		Refer to name and function column.	S · T
	48	*LSPN	LSP/LSN input terminal selection Select the pins where the forward rotation stroke end (LSP) and reverse rotation stroke end (LSN) will be assigned. If the signals have already been assigned using parameter No.42 to 47, this parameter setting has preference. However, if forward rotation stroke end (LSP) is assigned to pin 6 of CN1 (default setting), the setting of parameter No.46 takes priority. Similarly, if reverse rotation stroke end (LSN) is assigned to pin 7 of CN1 (default setting), the setting of parameter No .47 takes priority. `0 [ ] 0 [ ]` — Select the pin where the forward rotation stroke end (LSP) will be assigned. Set value / Connector pin No. 0 / — 1 / CN1-5 2 / CN1-4 3 / CN1-6 4 / CN1-7 5 / CN1-3 — Select the pin where the reverse rotation stroke end (LSN) will be assigned. The settings are the same as those of the first digit.	0403		Refer to name and function column.	S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	49	*DO1	Output signal selection 1 Used to select the connector pins to output the alarm code and warning (WNG).	0000		Refer to name and function column.	S・T

Setting of alarm code output

Set value	Connector pins		
	CN1-10	CN1-11	CN1-12
0	SA	RD	ZP
1	Alarm code is output at alarm occurrence.		

(Note) Alarm code			Alarm display	Name
CN1 pin 10	CN1 pin 11	CN1 pin 12		
0	0	0	88888	Watchdog
			AL.12	Memory error 1
			AL.13	Clock error
			AL.15	Memory error 2
			AL.17	Board error 2
			AL.19	Memory error 3
			AL.37	Parameter error
			AL.8A	Serial communication time-out error
			AL.8E	Serial communication error
0	1	0	AL.30	Regenerative error
			AL.33	Overvoltage
1	0	0	AL.10	Undervoltage
1	1	0	AL.45	Main circuit device overheat
			AL.46	Servo motor overheat
			AL.50	Overload 1
			AL.51	Overload 2
0	0	1	AL.24	Main circuit
			AL.32	Overcurrent
0	1	1	AL.31	Overspeed
1	0	1	AL.16	Encoder error 1
			AL.1A	Motor combination error
			AL.20	Encoder error 2

Note. 0: Pin-VIN off (open)
1: Pin-VIN on (short)

Setting of warning (WNG) output
Select the connector pin to output warning. The old signal before selection will be unavailable.

Set value	Connector pin No.
0	Not output.
1	CN1-11
2	CN1-9
3	CN1-10
4	CN1-12

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
	50		For manufacturer setting Do not change this value by any means.	0000			
	51	*OP6	Function selection 6 Used to select the operation to be performed when the reset (RES) switches on. 0 □ 0 0 Operation to be performed when the reset (RES) switches on 0: Base circuit not switched off 1: Base circuit switched off	0000		Refer to name and function column.	S・T
	52		For manufacturer setting Do not change this value by any means.	0000			
	53	*OP8	Function selection 8 Used to select the protocol of serial communication. 0 □ □ 0 Protocol checksum selection 0: Yes (checksum added) 1: No (checksum not added) Protocol checksum selection 0: With station numbers 1: No station numbers	0000		Refer to name and function column.	S・T
Expansion parameters 2	54	*OP9	Function selection 9 Use to select the command pulse rotation direction, encoder output pulse direction and encoder pulse output setting. □ □ 0 0 Encoder pulse output phase changing Changes the phases of A・B-phase encoder pulses output . Set value / Servo motor rotation direction CCW / CW 0: A-phase, B-phase (CCW); A-phase, B-phase (CW) 1: A-phase, B-phase (CCW); A-phase, B-phase (CW) Encoder output pulse setting selection (refer to parameter No.27) 0: Output pulse designation 1: Division ratio setting	0000		Refer to name and function column.	S・T
	55		For manufacturer setting Do not change this value by any means.	0000			
	56	SIC	Serial communication time-out selection Used to set the communication protocol time-out period in [s]. When you set "0", time-out check is not made.	0	s	0 1 to 60	S・T
	57		For manufacturer setting Do not change this value by any means.	10			

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	58	NH1	Machine resonance suppression filter 1 Used to selection the machine resonance suppression filter. (Refer to section 8.2.) Notch frequency selection Set "00" when you have set adaptive vibration suppression control to be "valid" or "held" (parameter No.60: □1□□ or □2□□). Notch depth selection	0000		Refer to name and function column.	S・T
	59	NH2	Machine resonance suppression filter 2 Used to set the machine resonance suppression filter. Notch frequency Same setting as in parameter No.58 However, you need not set "00" if you have set adaptive vibration suppression control to be "valid" or "held". Notch depth Same setting as in parameter No.58	0000		Refer to name and function column.	S・T

Notch frequency selection table:

Setting value	Frequency	Setting value	Frequency	Setting value	Frequency	Setting value	Frequency
00	Invalid	08	562.5	10	281.3	18	187.5
01	4500	09	500	11	264.7	19	180
02	2250	0A	450	12	250	1A	173.1
03	1500	0B	409.1	13	236.8	1B	166.7
04	1125	0C	375	14	225	1C	160.1
05	900	0D	346.2	15	214.3	1D	155.2
06	750	0E	321.4	16	204.5	1E	150
07	642.9	0F	300	17	195.7	1F	145.2

Notch depth selection table:

Setting value	Depth	Gain
0	Deep	−40dB
1	to	−14dB
2		−8dB
3	Shallow	−4dB

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	60	LPF	Low-pass filter/adaptive vibration suppression control 　Used to selection the low-pass filter and adaptive vibration suppression control. (Refer to chapter 8.) 　　　　　　0 Low-pass filter selection 　0: Valid (Automatic adjustment) 　1: Invalid 　When you choose "valid", $\dfrac{\text{VG2 setting} \times 10}{2\pi(1+\text{GD2 setting} \times 0.1)}$ [Hz] bandwidth filter is set automatically. Adaptive vibration suppression control selection 　Choosing "valid" or "held" in adaptive vibration suppression control selection makes the machine resonance suppression filter 1 (parameter No.58) invalid. 　0: Invalid 　1: Valid 　　Machine resonance frequency is always detected and the filter is generated in response to resonance to suppress machine vibration. 　2: Held 　　The characteristics of the filter generated so far are held, and detection of machine resonance is stopped. Adaptive vibration suppression control sensitivity selection 　Used to set the sensitivity of machine resonance detection. 　0: Normal 　1: Large sensitivity	0000		Refer to name and function column.	S・T
	61	GD2B	Ratio of load inertia moment to servo motor inertia moment 2 　Used to set the ratio of load inertia moment to servo motor inertia moment when gain changing is valid.	70	Multi-plier ($\times 10^{-1}$)	0 to 3000	S
	62		For manufacturer setting 　Do not change this value by any means.	100			
	63	VG2B	Speed control gain 2 changing ratio 　Used to set the ratio of changing the speed control gain 2 when gain changing is valid. 　Made valid when auto tuning is invalid.	100	%	10 to 200	S
	64	VICB	Speed integral compensation changing ratio 　Used to set the ratio of changing the speed integral compensation when gain changing is valid. Made valid when auto tuning is invalid.	100	%	50 to 1000	S

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	65	*CDP	Gain changing selection Used to select the gain changing condition. (Refer to section 8.5.) 0 0 0 ☐ Gain changing selection Gains are changed in accordance with the settings of parameters No.61 to 64 under any of the following conditions: 0: Invalid 1: Gain changing (CDP) is ON 2: For manufacturer setting 3: For manufacturer setting 4: Servo motor speed is equal to higher than parameter No.66 setting	0000		Refer to name and function column.	S
	66	CDS	Gain changing condition Used to set the value of gain changing condition (command frequency, droop pulses, servo motor speed) selected in parameter No.65. The set value unit changes with the changing condition item. (Refer to section 8.5.)	10	kpps pulse r/min	10 to 9999	S
	67	CDT	Gain changing time constant Used to set the time constant at which the gains will change in response to the conditions set in parameters No.65 and 66. (Refer to section 8.5.)	1	ms	0 to 100	S
	68		For manufacturer setting Do not change this value by any means.	0			
	69			1			
	70			1			
	71			1			
	72	SC4	Internal speed command 4 Used to set speed 4 of internal speed commands.	200	r/min	0 to instantaneous permissible speed	S
			Internal speed limit 4 Used to set speed 4 of internal speed limits.				T
	73	SC5	Internal speed command 5 Used to set speed 5 of internal speed commands.	300	r/min	0 to instantaneous permissible speed	S
			Internal speed limit 5 Used to set speed 5 of internal speed limits.				T
	74	SC6	Internal speed command 6 Used to set speed 6 of internal speed commands.	500	r/min	0 to instantaneous permissible speed	S
			Internal speed limit 6 Used to set speed 6 of internal speed limits.				T
	75	SC7	Internal speed command 7 Used to set speed 7 of internal speed commands.	800	r/min	0 to instantaneous permissible speed	S
			Internal speed limit 7 Used to set speed 7 of internal speed limits.				T

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	76	TL2	Internal torque limit 2 Set this parameter to limit servo motor torque on the assumption that the maximum torque is 100[%]. When 0 is set, torque is not produced. When torque is output in analog monitor output, this set value is the maximum output voltage (×8V).	100	%	0 to 100	S·T
	77		For manufacturer setting Do not change this value by any means.	100			
	78			10000			
	79			10			
	80			10			
	81			100			
	82			100			
	83			100			
	84			0000			

14.5 Display and operation

> POINT
> ・For the alarm mode, parameter mode output signal (DO) forcible output and test operation mode, refer to chapter 6.

14.5.1 Display flowchart

Use the display (5-digit, 7-segment LED) on the front panel of the servo amplifier for status display, parameter setting, etc. Set the parameters before operation, diagnose an alarm, confirm external sequences, and/or confirm the operation status. Press the "MODE" "UP" or "DOWN" button once to move to the next screen.
To refer to or set the expansion parameters, make them valid with parameter No.19 (parameter write disable).
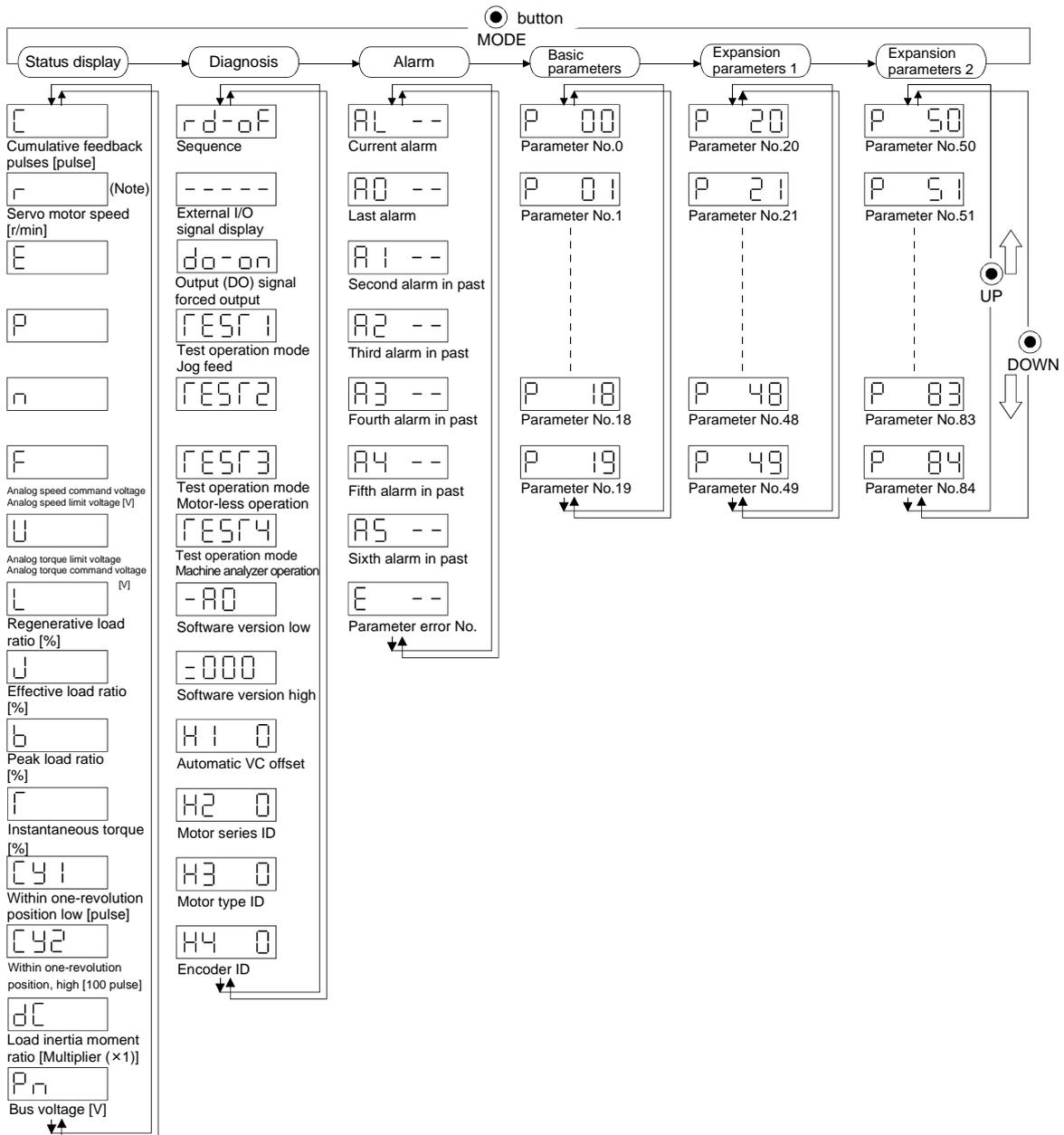
Note. The initial status display at power-on depends on the control mode.
Speed control mode: Servo Motor speed(r),
Torque control mode: Torque command voltage (U)
Also, parameter No.18 can be used to change the initial indication of the status display at power-on.

14.5.2 Status display

(1) Status display list
   The following table lists the servo statuses that may be shown.

Name	Symbol	Unit	Description	Display range
Cumulative feedback pulses	C	pulse	Feedback pulses from the servo motor encoder are counted and displayed. The value in excess of ±99999 is counted, bus since the servo amplifier display is five digits, it shows the lower five digits of the actual value. Press the "SET" button to reset the display value to zero. Reverse rotation is indicated by the lit decimal points in the upper four digits.	−99999 to 99999
Servo motor speed	r	r/min	The servo motor speed is displayed. The value rounded off is displayed in ×0.1r/min.	−5400 to 5400
Analog speed command voltage Analog speed limit voltage	F	V	(1) Torque control mode Analog speed limit (VLA) voltage is displayed.	−10.00 to 10.00
			(2) Speed control mode Analog speed command (VC) voltage is displayed.	
Analog torque command voltage Analog torque limit voltage	U	V	(1) Speed control mode Analog torque limit (TLA) voltage is displayed.	0 to +10V
			(2) Torque control mode Analog torque command (TLA) voltage is displayed.	−8.0 to +8.0
Regenerative load ratio	L	%	The ratio of regenerative power to permissible regenerative power is displayed in .	0 to 100
Effective load ratio	J	%	The continuous effective load torque is displayed. The effective value in the past is seconds is displayed relative to the rated torque of 100%.	0 to 300
Peak load ratio	b	%	The maximum torque generated during acceleration/deceleration, etc. The highest value in the past 15 seconds is displayed relative to the rated torque of 100%.	0 to 400
Instantaneous torque	T	%	Torque that occurred instantaneously is displayed. The value of the torque that occurred is displayed in real time relative to the rate torque of 100%.	0 to 400
Within one-revolution position low	Cy1	pulse	Position within one revolution is displayed in encoder pulses. The value returns to "0" when it exceeds the maximum number of pulses. The value is incremented in the CCW direction of rotation.	0 to 99999
Within one-revolution position high	Cy2	100 pulse	The within one-revolution position is displayed in 100 pulse increments of the encoder. The value returns to "0" when it exceeds the maximum number of pulses. The value is incremented in the CCW direction of rotation.	0 to 1310
Load inertia moment ratio	dC	Multiplier (×1)	The estimated ratio of the load inertia moment to the servo motor shaft inertia moment is displayed.	0.0 to 300.0
Bus voltage	Pn	V	The voltage (across P-N) of the main circuit converter is displayed.	0 to 450

(2) Changing the status display screen

The status display item of the servo amplifier display shown at power-on can be changed by changing the parameter No.18 settings.

The item displayed in the initial status changes with the control mode as follows.

Control mode	Status display at power-on
Speed	Servo motor speed
Speed/torque	Servo motor speed/analog torque command voltage
Torque	Analog torque command voltage

14.5.3 Diagnostic mode

Name		Display	Description
Sequence		**rd-oF**	Not ready. Indicates that the servo amplifier is being initialized or an alarm has occurred.
		rd-on	Ready. Indicates that the servo was switched on after completion of initialization and the servo amplifier is ready to operate.
External I/O signal display		Refer to section 15.5.4.	Indicates the ON-OFF states of the external I/O signals. The upper segments correspond to the input signals and the lower segments to the output signals. Lit: ON Extinguished: OFF The I/O signals can be changed using parameters No.43 to 49.
Output (DO) signal forced output		**do-on**	The digital output signal can be forced on/off. For more information, refer to section 6.7.
Test operation mode	Jog feed	**rESr1**	Jog operation can be performed when there is no command from the external command device. For details, refer to section 6.8.2.
		rESr2	Screen for manufacturer setting. When this screen is being displayed, do not press any other buttons than "UP" and "DOWN".
	Motor-less operation	**rESr3**	Without connection of the servo motor, the servo amplifier provides output signals and displays the status as if the servo motor is running actually in response to the external input signal. For details, refer to section 6.8.4.
	Machine analyzer operation	**rESr4**	Merely connecting the servo amplifier allows the resonance point of the mechanical system to be measured. The MR Configurator (servo configuration software) is required for machine analyzer operation. Gain search cannot be used.
Software version low		**-A0**	Indicates the version of the software.
Software version high		**=000**	Indicates the system number of the software.
Automatic VC offset		**H1　0**	If offset voltages in the analog circuits inside and outside the servo amplifier cause the servo motor to rotate slowly at the analog speed command (VC) or analog speed limit (VLA) of 0V, this function automatically makes zero-adjustment of offset voltages. When using this function, make it valid in the following procedure. Making it valid causes the parameter No.29 value to be the automatically adjusted offset voltage. 1) Press "SET" once. 2) Set the number in the first digit to 1 with "UP"/"DOWN". 3) Press "SET". 　You cannot use this function if the input voltage of VC or VLA is ±0.4V or more.

Name	Display	Description
Motor series ID	H2 0	Press the "SET" button to show the motor series ID of the servo motor currently connected.
Motor type ID	H3 0	Press the "SET" button to show the motor type ID of the servo motor currently connected.
Encoder ID	H4 0	Press the "SET" button to show the encoder ID of the servo motor currently connected.

14.5.4 External I/O signal display

The ON/OFF states of the digital I/O signals connected to the servo amplifier can be confirmed.

(1) Operation
    Call the display screen shown after power-on.
    Using the "MODE" button, show the diagnostic screen.

Press UP once.

........External I/O signal display screen

(2) Display definition
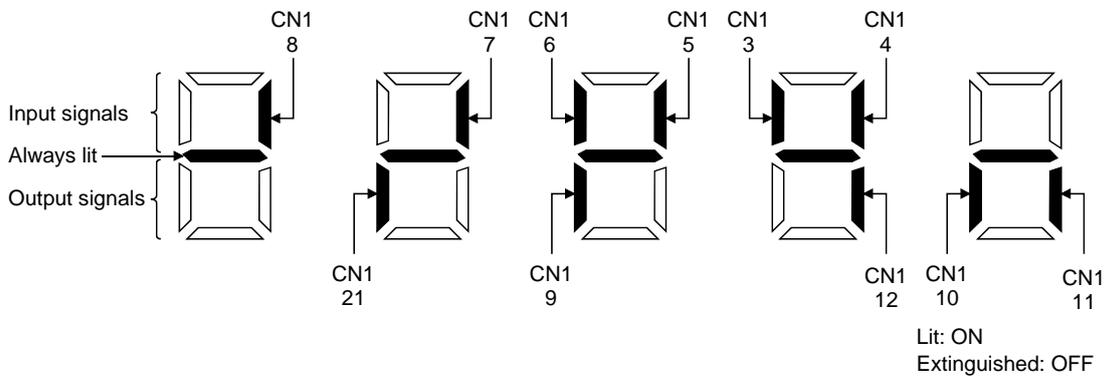
Lit: ON
Extinguished: OFF

    The 7-segment LED shown above indicates ON/OFF.
    Each segment at top indicates the input signal and each segment at bottom indicates the output signal. The signals corresponding to the pins in the respective control modes are indicated below.

CN1 Pin No.	Input/Output (Note 1) I/O	(Note 2) Signal abbreviation		Related parameter No.
		S	T	
3	I	ST1	RS2	43 to 47
4	I	SON	SON	43 to 47
5	I	ST2	RS1	43 to 47
6	I	LSP		43 to 48
7	I	LSN		43 to 48
8	I	EMG	EMG	
9	O	ALM	ALM	49
10	O	SA		49
11	O	RD	RD	49
12	O	ZSP	ZSP	49
21	O	OP	OP	

Note 1. I: Input signal, O: Output signal
    2. S: Speed control mode, T: Torque control mode.
    3. CN1B-4 and CN1A-18 output signals are the same.

(3) Default signal indications

(a) Speed control mode

EMG (CN 1-8) Emergency stop
LSN (CN 1-7) Reverse rotation stroke end
LSP (CN 1-6) Forward rotation stroke end
ST2 (CN 1-5) Reverse rotation start
ST1 (CN 1-3) Forward rotation start
SON (CN 1-4) Servo-on

Input signals

Output signals

Lit: ON
Extinguished: OFF
RD (CN 1-11) Ready
SA (CN 1-10) Limiting speed
ZSP (CN 1-12) Zero speed detection

ALM (CN 1-9) Trouble
OP (CN 1-21) Encoder Z-phase pulse

(b) Torque control mode

EMG (CN 1-8) Emergency stop
(CN 1-7)
(CN 1-6)
RS1 (CN 1-5) Forward rotation selection
RS2 (CN 1-3) Reverse rotation selection
SON (CN 1-4) Servo-on

Input signals

Output signals

Lit: ON
Extinguished: OFF
RD (CN 1-11) Ready
(CN 1-10)
ZSP (CN 1-12) Zero speed detection

ALM (CN 1-9) Trouble
OP (CN 1-21) Encoder Z-phase pulse

14.6 Troubleshooting

14.6.1 Trouble at start-up

The following faults may occur at start-up. If any of such faults occurs, take the corresponding action.
(1) Speed control mode

No.	Start-up sequence	Fault	Investigation	Possible cause	Reference
1	Power on (Note)	· 7-segment LED is not lit. · 7-segment LED flickers.	Not improved if connectors CN1, CN2 and CN3 are disconnected.	1. Power supply voltage fault 2. Servo amplifier is faulty.	
			Improved when connectors CN1 is disconnected.	Power supply of CN1 cabling is shorted.	
			Improved when connector CN2 is disconnected.	1. Power supply of encoder cabling is shorted. 2. Encoder is faulty.	
			Improved when connector CN3 is disconnected.	Power supply of CN3 cabling is shorted.	
		Alarm occurs.	Refer to section 10.2 and remove cause.		Section 10.2
2	Switch on servo-on (SON).	Alarm occurs.	Refer to section 10.2 and remove cause.		Section 10.2
		Servo motor shaft is not servo-locked (is free).	1. Check the display to see if the servo amplifier is ready to operate. 2. Check the external I/O signal indication to see if the servo-on (SON) is ON.	1. Servo-on (SON) is not input. (Wiring mistake) 2. 24VDC power is not supplied to COM.	Section 6.6
3	Switch on forward rotation start (ST1) or reverse rotation start (ST2).	Servo motor does not rotate.	Call the status display and check the input voltage of the analog speed command (VC).	Analog speed command is 0V.	Section 6.2
			Call the external I/O signal display and check the ON/OFF status of the input signal.	LSP, LSN, ST1 or ST2 is off.	Section 6.6
			Check the internal speed commands 1 to 7 (parameters No.8 to 10 · 72 to 75).	Set value is 0.	Section 5.1.2 (1)
			Check the internal torque limit 1 (parameter No.28).	Torque limit level is too low as compared to the load torque.	
			When the analog torque limit (TLA) is usable, check the input voltage on the status display.	Torque limit level is too low as compared to the load torque.	
4	Gain adjustment	Rotation ripples (speed fluctuations) are large at low speed.	Make gain adjustment in the following procedure. 1. Increase the auto tuning response level. 2. Repeat acceleration and deceleration several times to complete auto tuning.	Gain adjustment fault	Chapter 7
		Large load inertia moment causes the servo motor shaft to oscillate side to side.	If the servo motor may be run with safety, repeat acceleration and deceleration several times to complete auto tuning.	Gain adjustment fault	Chapter 7

Note. Switch power on again after making sure that the change lamp has turned off completely.

(2) Torque control mode

No.	Start-up sequence	Fault	Investigation	Possible cause	Reference
1	Power on (Note)	• 7-segment LED is not lit. • 7-segment LED flickers.	Not improved if connectors CN1, CN2 and CN3 are disconnected.	1. Power supply voltage fault 2. Servo amplifier is faulty.	
			Improved when connectors CN1 is disconnected.	Power supply of CN1 cabling is shorted.	
			Improved when connector CN2 is disconnected.	1. Power supply of encoder cabling is shorted. 2. Encoder is faulty.	
			Improved when connector CN3 is disconnected.	Power supply of CN3 cabling is shorted.	
		Alarm occurs.	Refer to section 10.2 and remove cause.		Section 10.2
2	Switch on servo-on (SON).	Alarm occurs.	Refer to section 10.2 and remove cause.		Section 10.2
		Servo motor shaft is free.	Call the external I/O signal display and check the ON/OFF status of the input signal.	1. Servo-on (SON) is not input. (Wiring mistake) 2. 24VDC power is not supplied to COM.	Section 6.6
3	Switch on forward rotation start (RS1) or reverse rotation start (RS2).	Servo motor does not rotate.	Call the status display and check the analog torque command (TC).	Analog torque command is 0V.	Section 6.2
			Call the external I/O signal display and check the ON/OFF status of the input signal.	RS1 or RS2 is off.	Section 6.6
			Check the internal speed limits 1 to 7 (parameters No.8 to 10・72 to 75).	Set value is 0.	Section 5.1.2 (1)
			Check the analog torque command maximum output (parameter No.26) value.	Torque command level is too low as compared to the load torque.	
			Check the internal torque limit 1 (parameter No.28).	Set value is 0.	

Note. Switch power on again after making sure that the change lamp has turned off completely.

14.6.2 Alarms and warning list

> POINT
> ・Configure up a circuit which will detect the trouble (ALM) signal and turn off the servo-on (SON) signal at occurrence of an alarm.

When a fault occurs during operation, the corresponding alarm or warning is displayed. If any alarm or warning has occurred, refer to section 10.2.2 or 10.2.3 and take the appropriate action. When an alarm occurs, the current circuit between ALM and VIN opens.

Set "□□□1" in parameter No.49 to output the alarm code in ON/OFF status across the corresponding pin and VIN. Warnings (AL.E0 to AL.E9) have no alarm codes. Any alarm code is output at occurrence of the corresponding alarm. In the normal status, the signals available before alarm code setting (CN1-12: ZSP, CN1-11: RD, CN1-10: SA) are output.

After its cause has been removed, the alarm can be deactivated in any of the methods marked ○ in the alarm deactivation column.

| | Display | (Note 2) Alarm code | | | Name | Alarm deactivation | | |
		CN1-10 pin	CN1-11 pin	CN1-12 pin		Power OFF→ON	Press "SET" on current alarm screen.	Alarm reset (RES) signal
Alarms	AL.10	0	1	0	Undervoltage	○	○	○
	AL.12	0	0	0	Memory error 1	○		
	AL.13	0	0	0	Clock error	○		
	AL.15	0	0	0	Memory error 2	○		
	AL.16	1	0	1	Encoder error 1	○		
	AL.17	0	0	0	Board error	○		
	AL.19	0	0	0	Memory error 3	○		
	AL.1A	1	0	1	Motor combination error	○		
	AL.20	1	1	0	Encoder error 2	○		
	AL.24	0	0	1	Main circuit error	○		
	AL.30	0	1	0	Regenerative error	○ (Note 1)	○ (Note 1)	○ (Note 1)
	AL.31	0	1	1	Overspeed	○	○	○
	AL.32	0	0	1	Overcurrent	○	○	○
	AL.33	0	1	0	Overvoltage	○		
	AL.37	0	0	0	Parameter error	○		
	AL.45	1	1	0	Main circuit device overheat	○	○	○
	AL.46	1	1	0	Servo motor overheat	○	○	○
	AL.50	1	1	0	Overload 1	○ (Note 1)	○ (Note 1)	○ (Note 1)
	AL.51	1	1	0	Overload 2	○ (Note 1)	○ (Note 1)	○ (Note 1)
	AL.8A	0	0	0	Serial communication time-out error	○	○	○
	AL.8E	0	0	0	Serial communication error	○	○	○
	88888	0	0	0	Watchdog	○		
Warnings	AL.E0				Excessive regenerative warning	Removing the cause of occurrence deactivates the alarm automatically.		
	AL.E1				Overload warning			
	AL.E6				Servo emergency stop warning			
	AL.E9				Undervoltage warning			

Note 1. Deactivate the alarm about 30 minutes of cooling time after removing the cause of occurrence.
   2. 0: off
     1: on

APPENDIX

App. 1 COMPLIANCE WITH CE MARKING

App. 1.1 What is CE marking?

The CE marking is mandatory and must be affixed to specific products placed on the European Union. When a product conforms to the requirements, the CE marking must be affixed to the product. The CE marking also applies to machines and equipment incorporating servos.

(1) EMC directive

The EMC directive applies to the servo units alone. This servo is designed to comply with the EMC directive. The EMC directive also applies the servo-incorporated machines and equipment. This requires the EMC filters to be used with the servo-incorporated machines and equipment to comply with the EMC directive.

(2) Low voltage directive

The low voltage directive applies also to servo units alone. This servo is designed to comply with the low voltage directive.

App. 1.2 For compliance

Be sure to perform an appearance inspection of every unit before installation. In addition, have a final performance inspection on the entire machine/system, and keep the inspection record.

(1) Servo amplifiers and servo motors used

Use the servo amplifiers and servo motors which standard product.
Servo amplifier   : MR-E-☐A-QW003, MR-E-☐AG-QW003
Servo motor series : HF-KN☐ (J), HF-SN☐J

(2) Structure

The control circuit provide safe separation to the main circuit in the servo amplifier.
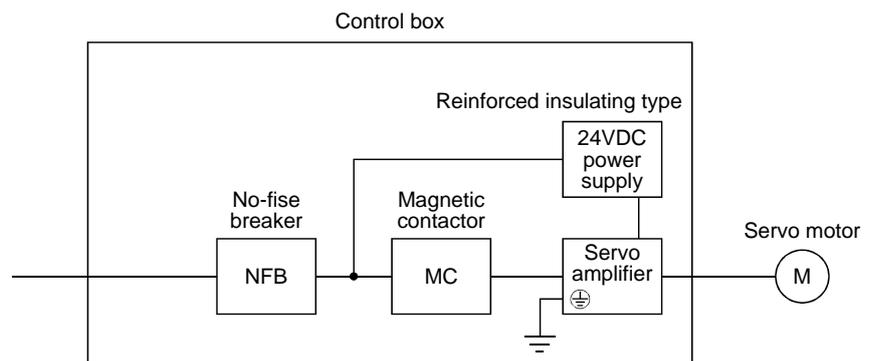
(3) Environment
  (a) Operate the servo amplifier at or above pollution degree 2 set forth in IEC/EN 60664-1. For this purpose, install the servo amplifier in a control box which is protected against water, oil, carbon, dust, dirt, etc. (IP54).

  (b) Environment

Environment			Conditions
(Note) Ambient Temperature	In operation	[℃]	0 to 55
		[℉]	32 to 131
	In storage, In transportation	[℃]	－20 to 65
		[℉]	－4 to 149
Ambient Humidity	In operation, In storage, In transportation		90% RH or less
Maximum Altitude	In operation, In storage		1000m or less
	In transportation		10000m or less

Note. Ambient temperature is the internal temperature of the control box.

(4) Power supply
  (a) This servo amplifier can be supplied from star-connected supply with earthed neutral point of overvoltage category II set forth in IEC/EN 60664-1.

  (b) For the interface power supply, use a 24VDC power supply with reinforced insulation on I/O terminals.

(5) Grounding
  (a) To prevent an electric shock, the protective earth (PE) terminal (marked ⏚) of the servo amplifier must be connected to the protective earth (PE) of the control box.

  (b) Do not connect two ground cables to the same protective earth (PE) terminal. Always connect cables to the terminals one-to-one.

PE terminals   PE terminals
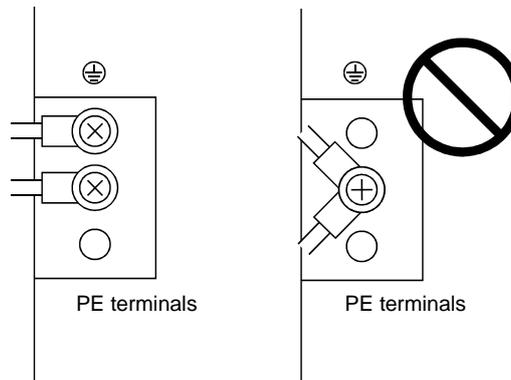
  (c) If an earth leakage circuit breaker is used, always earth the protective earth (PE) terminal of the servo amplifier to prevent an electric shock.

(6) Wiring and installation
  (a) The cables to be connected to the terminal block of the servo amplifier must have crimping terminals provided with insulating tubes to prevent contact with adjacent terminals.

Insulating tube
Cable
Crimping terminal
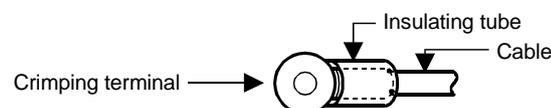
(b) Use the servo motor side power connector which complies with the IEC/EN Standard.
The IEC/EN Standard-compliant power connector sets are available from us as options.

(c) The servo amplifier must be installed in the metal cabinet (control box).

(7) Peripheral devices, options
(a) Use the circuit breaker and magnetic contactor models which are EN/IEC Standard-compliant products given this Servo Amplifier Instruction Manual.
Use a type B (Note) breaker. When it is not used, provide insulation between the servo amplifier and other device by double insulation or reinforced insulation, or install a transformer between the main power supply and servo amplifier.
Note. Type A: AC and pulse detectable
         Type B: Both AC and DC detectable

(b) The sizes of the wires given this Servo Amplifier Instruction Manual meet the following conditions. For use in any other conditions, follow Table 5 and Annex C of IEC/EN 60204-1.
・Ambient temperature: 40℃ (104℉)
・Sheath   : PVC (polyvinyl chloride)
・Installation on wall surface or open table tray

(c) Use the EMC filter for noise reduction.

(8) Performing EMC tests
When EMC tests are run on a machine/device into which the servo amplifier has been installed, it must conform to the electromagnetic compatibility (immunity/emission) standards after it has satisfied the operating environment/electrical equipment specifications.
For the other EMC directive guidelines on the servo amplifier, refer to the EMC Installation Guidelines (IB(NA)67310).

App. 2 COMPLIANCE WITH UL/cUL STANDARD

This servo amplifier complies with UL 508C, and CSA C22.2 No.14 standard.

(1) Servo amplifiers and servo motors used
Use the servo amplifiers and servo motors which standard product.

Servo amplifier	Servo motors	
	HF-KN□(J)	HF-SN□J
MR-E-10A-QW003	13	
MR-E-20A-QW003	23	
MR-E-40A-QW003	43	
MR-E-70A-QW003	73	52
MR-E-100A-QW003		102
MR-E-200A-QW003		152・202

(2) Installation
The MR-E-□A-QW003 series and MR-E-□AG-QW003 series have been approved as the products which have been installed in the electrical enclosure.
The minimum enclosure size is based on 150% of each MR-E combination.
And also, design the enclosure so that the ambient temperature in the enclosure is 55℃ (131℉) or less, refer to the spec manual.
The servo amplifier must be installed in the metal cabinet (control box).

(3) Short circuit rating (SCCR: Short Circuit Current Rating)
Suitable For Use In A Circuit Capable Of Delivering Not More Than 100 kA rms Symmetrical Amperes, 500 Volts Maximum.

(4) Flange
Mount the servo motor on a flange which has the following size or produces an equivalent or higher heat dissipation effect.

Flange size	Servo motor	
	HF-KN□(J)	HF-SN□J
250×250×6	13・23	
250×250×12	43	52 to 152
300×300×12	73	
550×550×20		202

(5) Capacitor discharge time
The capacitor discharge time is as follows. To ensure safety, do not touch the charging section for 15 minutes after power-off.

Servo amplifier	Discharge time [min]
MR-E-10A-QW003 MR-E-10AG-QW003 MR-E-20A-QW003 MR-E-20AG-QW003	1
MR-E-40A-QW003 MR-E-40AG-QW003	2
MR-E-70A-QW003 to MR-E-200A-QW003 MR-E-70AG-QW003 to MR-E-200AG-QW003	3

(6) Overload protection characteristics

An electronic thermal relay is built in the servo amplifier to protect the servo motor and servo amplifier from overloads. The operation characteristics of the electronic thermal relay are shown below. It is recommended to use an unbalanced torque-generated machine, such as a vertical motion shaft, so that unbalanced torque is not more than 70% of the rated torque.

Servo amplifier MR-E series have each solid-state servo motor overload protection. (The motor full load current is 115% rated current.)
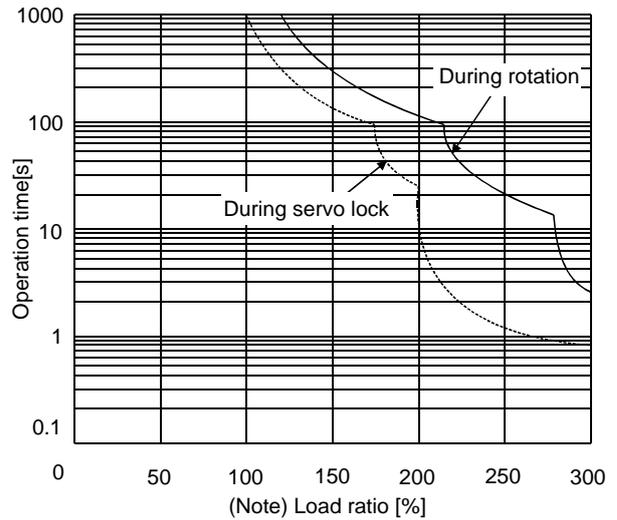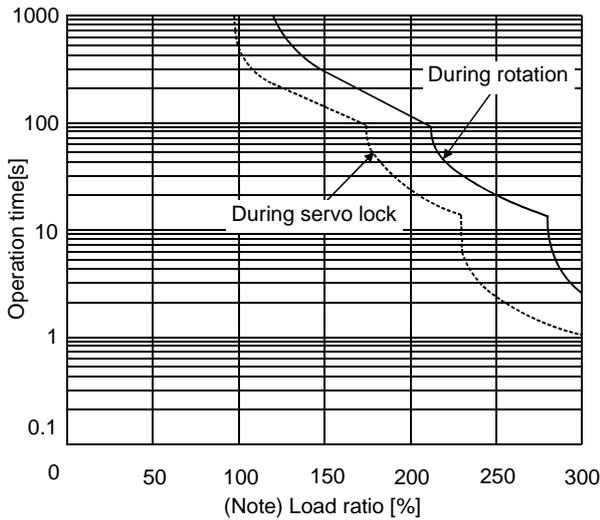
a. MR-E-10A-QW003 to MR-E-100A-QW003

b. MR-E-200A-QW003

Note. If operation that generates torque more than 100% of the rating is performed with an abnormally high frequency in a servo motor stop status (servo lock status) or in a 30r/min or less low-speed operation status, the servo amplifier may fail even when the electronic thermal relay protection is not activated.

(7) Selection example of wires

To comply with the UL/cUL Standard, use UL-approved copper wires rated at 60/75℃ (140/167℉) for wiring.

Servo amplifier	(Note) Wires [mm²]			
	1) L₁・L₂・L₃	3) U・V・W・⏚	4) P・C・D	5) B1・B2
MR-E-10A-QW003	2 (AWG14)	1.25 (AWG16)	2 (AWG14)	1.25 (AWG16)
MR-E-20A-QW003				
MR-E-40A-QW003				
MR-E-70A-QW003				
MR-E-100A-QW003		2 (AWG14)		
MR-E-200A-QW003	(Note) 2.5 (AWG14)	(Note) 2.5 (AWG14)		

Note. Use the heat-resistant PVC cable (rated temperature 105℃ (221℉) or more), if AWG14 cable is used in ambient temperature 40℃ (104℉) or more.

(8) About wiring protection

For installation in United States, branch circuit protection must be provided, in accordance with the National Electrical Code and any applicable local codes and per the table below.

For installation in Canada, branch circuit protection must be provided, in accordance with the Canada Electrical Code and any applicable provincial codes and per the table below.

Use the molded-case circuit breaker or a Class T fuse indicated in the table below.

Servo amplifier	Circuit breaker	Fuse			Magnetic contactor (note)
		Class	Current [A]	Voltage AC [V]	
MR-E-10A-QW003	30A frame 5A	K5	10	250	S-N10
MR-E-20A-QW003	30A frame 5A		10		
MR-E-40A-QW003	30A frame 10A		15		
MR-E-70A-QW003	30A frame 15A		15		
MR-E-100A-QW003	30A frame 15A		15		
MR-E-200A-QW003	30A frame 20A		15		S-N18

(9) Options, peripheral devices

Use the UL/cUL Standard-compliant products.

(10) Connection example

REVISIONS

Print data	*Manual number	Revision	
May 2008	SH(NA)030075-A	First edition	
Oct. 2012	SH(NA)030075-B	The chapter of servo motor is deleted.	
		Front cover	Description of HF-KN/HF-SN motor is added.
		1. To prevent electric shock, note the following	The sentences are added.
		2. To prevent fire, note the following	The sentences are added.
		4. Additional instructions (1) Transportation and installation	The sentences are added, and the table is changed.
		4. Additional instructions (2) Wiring	The diagram is changed.
		4. Additional instructions (5) Corrective actions	The sentences are changed, and the diagram is changed.
		COMPLIANCE WITH CE MARKING	The title is changed, and descriptions of the compliance with CE marking are moved to APPENDIX.
		COMPLIANCE WITH UL/cUL STANDARD	The title is changed, and descriptions of the compliance with UL/cUL standard are moved to APPENDIX.
		<<About the manuals>>	HF-KN/HF-SN Servo Motor Instruction Manual is added.
		<<Wiring>>	Added.
		Section 1.2	The diagram is changed.
		Section 1.3	The table is changed.
		Section 1.5 (1)	The rating plate is changed.
		Section 1.6	Description of HF-KN/HF-SN motor is added, and the model name of servo motor in the table is changed.
		Section 1.8 (1)	The diagram is changed.
		Section 1.8 (2)	The diagram is changed.
		Chapter 2	WARNING is added, and the sentences are added to CAUTION.
		Section 2.1	The table is changed.
		Section 2.4 (2)	The sentences are changed.
		Chapter 3	The sentences are added to WARNING.
		Section 3.1	The sentences of POINT are changed.
		Section 3.1.1 (1)	The diagram is changed.
		Section 3.1.1 (2)	The diagram is changed.
		Section 3.1.1 (3)	The diagram is changed.
		Section 3.1.2	The diagram is changed.
		Section 3.3.2	The table is changed.
		Section 3.4.3	The sentences are partially changed.
		Section 3.6.2 (5)	The diagram is changed.
		Section 3.7	The sentences are added to CAUTION.
		Section 3.7.1 (1)	Note 2 and 3 are added.

Print data	*Manual number	Revision	
Oct. 2012	SH(NA)030075-B	Section 3.7.1 (2)	Note 2 and 3 are added.
		Section 3.8	The former section 3.8 is deleted, and section 3.9 is raised to section 3.8.
		Section 3.8.1	The sentences are added and changed for CAUTION, the diagram is changed, and the sentences of POINT are changed.
		Section 4.2.2 (3)	The table is changed.
		Chapter 5	The sentences are added to CAUTION.
		Section 5.1.2 (2)	The servo motor series name of Parameter No. 0 is changed.
		Section 5.2.1	The number in POINT is changed.
		Section 5.2.1 (1)	The calculation details are changed.
		Section 5.2.1 (2)	The calculation details are changed, and POINT is added.
		Section 5.2.1 (3)	Newly added.
		Section 5.2.2	The sentences are partially changed.
		Section 6.8.1	The sentences are changed, and the explanation is added to the diagram.
		Section 6.8.4 (2)	The sentences are changed.
		Chapter 7	POINT is added.
		Section 7.3.2 (1) (b)	The table is changed.
		Section 8.5.4 (2) (b)	The diagram is changed.
		Chapter 9	The sentences of WARNING are changed, and POINT is changed to CAUTION.
		Chapter 9 (2)	The table is changed.
		Section 10.1.1 (1)	The table is changed.
		Section 10.1.2	The table is changed.
		Section 11.1 (4)	The diagram is changed.
		Section 12.2 (1)	The model name of servo motor in the table is changed.
		Section 12.3	POINT is added, and the diagram is changed.
		Section 13.1.1 (2)	The sentences are partially changed.
		Section 13.1.1 (5) (a)	The diagram is changed, and terminal screw is changed to applicable wire size.
		Section 13.1.1 (5) (b)	The diagram is changed.
		Section 13.1.1 (5) (c)	The diagram is changed.
		Section 13.1.2	The sentences of POINT are changed.
		Section 13.1.2 (1)	The diagram is changed, and the table is changed.
		Section 13.1.2 (2)	The former section 13.1.2(2) is deleted, and section 13.1.2(3) is raised to section 13.1.2(2).
		Section 13.1.2 (4)	Deleted.
		Section 13.1.2 (5)	Deleted.
		Section 13.2.1 (2)	The table is changed.
		Section 13.2.2	The sentences are added.
		Section 13.2.3	The sentences are added, the diagram is changed, the table is changed, and Note 1, 2, 3, and 4 are added.
		Section 13.2.6 (2) (a)	The model name of data line filter is changed.

Print data	*Manual number	Revision	
Oct. 2012	SH(NA)030075-B	Section 13.2.6 (2) (b)	The diagram is changed, and the table is changed.
		Section 13.2.6 (2) (d)	The diagram is changed.
		Section 13.2.7 (2)	The model name of servo motor in the diagram is changed.
		Chapter 14	The former chapter 14 is deleted, and chapter 15 is raised to chapter 14.
		Section 14.1.2	The diagram is changed.
		Section 14.1.3	The table is changed.
		Section 14.1.6 (1)	The diagram is changed.
		Section 14.1.6 (2)	The diagram is changed.
		Section 14.2.1 (1)	The diagram is changed.
		Section 14.2.1 (2)	The diagram is changed.
		Section 14.4.2	The servo motor series name of Parameter No.0 is changed.
		Section 14.6.1 (1)	The table is changed.
		Section 14.6.1 (2)	The table is changed.
		Appendix 1	Appendix 1 is changed to COMPLIANCE WITH CE MARKING.
		Appendix 2	Appendix 2 is changed to COMPLIANCE WITH UL/cUL STANDARD.
		Warranty	Added.

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]

The term of warranty for Product is twelve (12) months after your purchase or delivery of the Product to a place designated by you or eighteen (18) months from the date of manufacture whichever comes first ("Warranty Period"). Warranty period for repaired Product cannot exceed beyond the original warranty period before any repair work.

[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;
    (i)   a failure caused by your improper storing or handling, carelessness or negligence, etc., and a failure caused by your hardware or software problem
    (ii)   a failure caused by any alteration, etc. to the Product made on your side without our approval
    (iii)   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
    (iv)   a failure which may be regarded as avoidable if consumable parts designated in the instruction manual, etc. are duly maintained and replaced
    (v)   any replacement of consumable parts (battery, fan, smoothing capacitor, etc.)
    (vi)   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
    (vii)   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
    (viii) 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 responsibility for compensation against loss of opportunity, secondary loss, etc.
Whether under or after the term of warranty, we assume no responsibility for any damages arisen from causes for which we are not responsible, any losses of opportunity and/or profit incurred by you due to a failure of the Product, any damages, secondary damages or compensation for accidents arisen under a specific circumstance that are foreseen or unforeseen by our company, any damages to products other than the Product, and also compensation for any replacement work, readjustment, start-up test run of local machines and the Product and any other operations conducted by you.

5. Change of Product specifications
Specifications listed in our catalogs, manuals or technical documents may be changed without notice.

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

(2) Our General-Purpose 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.

MITSUBISHI ELECTRIC CORPORATION