MITSUBISHI ELECTRIC

General-Purpose AC Servo

MODEL

MR-E-□A/AG

INSTRUCTION MANUAL

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● 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".

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⚠ 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.

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1. To prevent electric shock, note the following:

⚠ WARNING

- Before wiring or inspection, switch power off and wait for more than 10 minutes. Then, confirm the voltage is safe with voltage tester. Otherwise, you may get an electric shock.
- 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.

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2. To prevent fire, note the following:

⚠ CAUTION

- Do not install the servo amplifier, servo motor and regenerative brake resistor on or near combustibles. Otherwise a fire may cause.
- When the servo amplifier has become faulty, switch off the main servo amplifier power side. Continuous flow of a large current may cause a fire.
- When a regenerative brake resistor is used, use an alarm signal to switch main power off. Otherwise, a regenerative brake transistor fault or the like may overheat the regenerative brake resistor, causing a fire.

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.
- During power-on or for some time after power-off, do not touch or close a parts (cable etc.) to the servo amplifier heat sink, regenerative brake resistor, servo motor, etc. 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.

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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 weights.
- Stacking in excess of the specified number of products is not allowed.
- Do not carry the servo motor by the cables, shaft or encoder.
- Do not hold the front cover to transport the servo amplifier. The servo amplifier may drop.
- Install the servo amplifier in a load-bearing place in accordance with the Instruction Manual.
- Do not climb or stand on servo equipment. Do not put heavy objects on 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.
- Provide adequate protection to prevent screws and other conductive matter, oil and other combustible matter from entering the servo amplifier.
- Do not drop or strike servo amplifier or servo motor. Isolate from all impact loads.
- Use the servo amplifier and servo motor under the following environmental conditions:

Environment		Conditions		
		Servo amplifier	Servo motor	
Ambient temperature	[℃]	0 to +55 (non-freezing)	0 to +40 (non-freezing)	
	[°F]	32 to 131 (non-freezing)	32 to 104 (non-freezing)	
Ambient humidity		90%RH or less (non-condensing)	80%RH or less (non-condensing)	
Storage temperature	[℃]	−20 to +65 (non-freezing)	−15 to +70 (non-freezing)	
	[°F]	−4 to 149 (non-freezing)	5 to 158 (non-freezing)	
Storage humidity		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 (3280 ft) above sea level		
(Note) Vibration	[m/s^2]	5.9 or less	HC-KFE Series	X・Y : 49
			HC-SFE52 to 152	X・Y : 24.5
			HC-SFE202	X : 24.5 Y : 49
	[ft/s^2]	19.4 or less	HC-KFE Series	X・Y : 161
			HC-SFE52 to 152	X・Y : 80
			HC-SFE202	X : 80 Y : 161

Note: Except the servo motor with reduction gear.

- Securely attach the servo motor to the machine. If attach insecurely, the servo motor may come off during operation.
- The servo motor with reduction gear must be installed in the specified direction to prevent oil leakage.
- 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.
- When the equipment has been stored for an extended period of time, consult Mitsubishi.

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(2) Wiring

⚠ CAUTION

- Wire the equipment correctly and securely. Otherwise, the servo motor may misoperate.
- Do not install a power capacitor, surge absorber or radio noise filter (FR-BIF option) between the servo motor and servo amplifier.
- Connect the output terminals (U, V, W) correctly. Otherwise, the servo motor will operate improperly.
- 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 must be wired in the specified direction. Otherwise, the emergency stop and other protective circuits may not operate.

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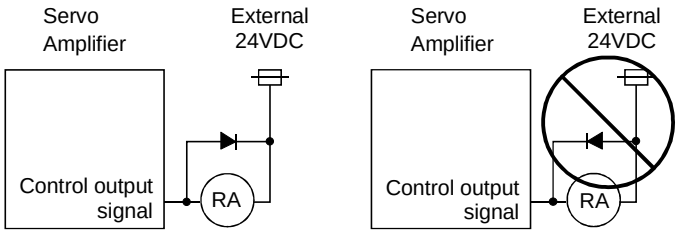

(3) Test run adjustment

⚠ 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 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.
- Use the servo amplifier with the specified servo motor.
- The electromagnetic brake on the servo motor is designed to hold the motor shaft and should not be used for ordinary braking.
- For such reasons as service life and mechanical structure (e.g. where a ballscrew and the servo motor are coupled via a timing belt), the electromagnetic brake may not hold the motor shaft. To ensure safety, install a stopper on the machine side.

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(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 the electromagnetic brake circuit so that it is activated not only by the servo amplifier signals but also by an external emergency stop signal (EMG).

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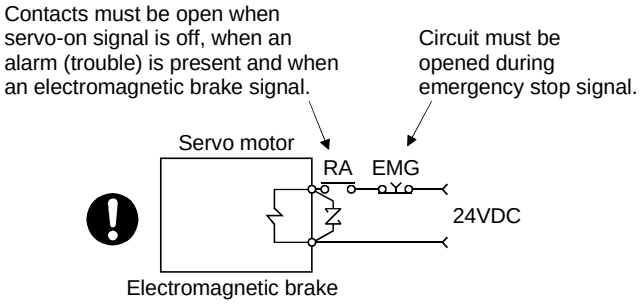

- When any alarm has occurred, eliminate its cause, ensure safety, and deactivate the alarm before restarting operation.
- When power is restored after an instantaneous power failure, keep away from the machine because the machine may be restarted suddenly (design the machine so that it is secured against hazard if restarted).

(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.)

(7) Maintenance, inspection and parts replacement

⚠ CAUTION

- With age, the electrolytic capacitor 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. Please consult our sales representative.

(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.

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● About processing of waste ●

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

⚠ FOR MAXIMUM SAFETY

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

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⚠ 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 and/or converter unit may fail when the EEP-ROM reaches the end of its useful life.

- Write to the EEP-ROM due to parameter setting changes

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COMPLIANCE WITH EC DIRECTIVES

1. WHAT ARE EC DIRECTIVES?

The EC directives were issued to standardize the regulations of the EU countries and ensure smooth distribution of safety-guaranteed products. In the EU countries, the machinery directive (effective in January, 1995), EMC directive (effective in January, 1996) and low voltage directive (effective in January, 1997) of the EC directives require that products to be sold should meet their fundamental safety requirements and carry the CE marks (CE marking). CE marking applies to machines and equipment into which servo amplifiers have been installed.

(1) EMC directive

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The EMC directive applies not to the servo units alone but to 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. For specific EMC directive conforming methods, refer to the EMC Installation Guidelines (IB(NA)67310).

(2) Low voltage directive

The low voltage directive applies also to servo units alone. Hence, they are designed to comply with the low voltage directive.

(3) Machine directive

Not being machines, the servo amplifiers need not comply with this directive.

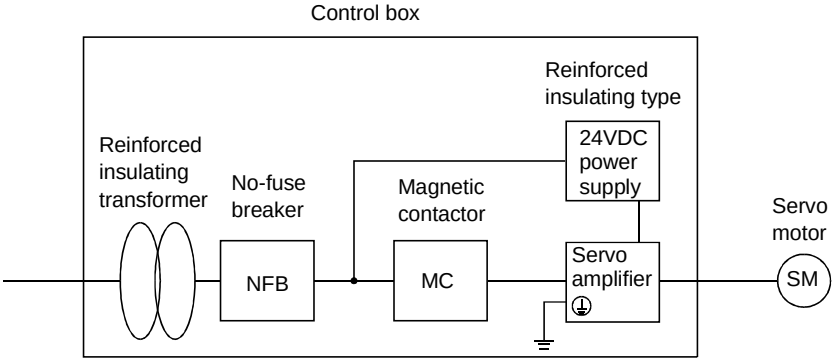
2. PRECAUTIONS FOR COMPLIANCE

(1) Servo amplifiers and servo motors used (Acquisition schedule)

Use the servo amplifiers and servo motors which comply with the standard model.

Servo amplifier :MR-E-10A to MR-E-200A
Servo motor :HC-KFE□
HC-SFE□

(2) Configuration



Use the no-fuse breaker and magnetic contactor which conform to the EN or IEC Standard.
Design notice: Where residual-current-operated protective device (RCD) is used for protection case of direvt or indirect contact, only RCD of type B is allowed on the supply side of this Electronic Equipment(EE).

(3) Environment

Operate the servo amplifier at or above the contamination level 2 set forth in IEC664. For this purpose, install the servo amplifier in a control box which is protected against water, oil, carbon, dust, dirt, etc. (IP54).

(4) Power supply

(a) Operate the servo amplifier to meet the requirements of the overvoltage category II set forth in IEC664. For this purpose, a reinforced insulating transformer conforming to the IEC or EN Standard should be used in the power input section.

(b) As the external power supply for interface, use a 24VDC power supply that has been insulation-reinforced in I/O.

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(5) Grounding

(a) To prevent an electric shock, always connect the protective earth (PE) terminals (marked ⏚) of the servo amplifier to the protective earth (PE) of the control box. Connect PE terminal of the control box to the NEUTRAL of a power supply. Be sure to ground the NEUTRAL of a power supply.

(b) Do not connect two ground cables to the same protective earth (PE) terminal. Always connect the cables to the terminals one-to-one.

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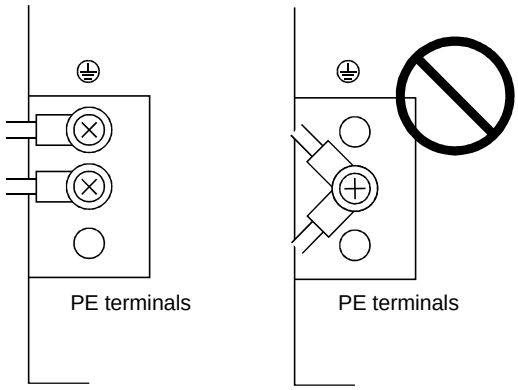
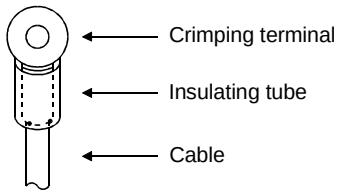


(c) If a leakage current breaker is used to prevent an electric shock, the protective earth (PE) terminals of the servo amplifier must be connected to the corresponding earth terminals.

(6) Wiring

(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.



(b) Use the servo motor side power connector which complies with the EN Standard. The EN Standard-compliant power connector sets are available from us as options. (Refer to Section 13.1.2)

(7) Auxiliary equipment and options

(a) The no-fuse breaker and magnetic contactor used should be the EN or IEC standard-compliant products of the models described in Section 13.2.2.

(b) The sizes of the cables described in Section 13.2.1 meet the following requirements. To meet the other requirements, follow Table 5 and Appendix C in EN60204-1.

- Ambient temperature: 40 (104) [℃ (℉)]
- Sheath: PVC (polyvinyl chloride)
- Installed 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).

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CONFORMANCE WITH UL/C-UL STANDARD

(1) Servo amplifiers and servo motors used (Acquisition schedule)

Use the servo amplifiers and servo motors which comply with the standard model.

Servo amplifier :MR-E-10A to MR-E-200A
Servo motor :HC-KFE□
HC-SFE□

(2) Installation

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Install a fan of 100CFM (2.8 m^3/min) air flow 4 in (10.16 cm) above the servo amplifier or provide cooling of at least equivalent capability.

(3) Short circuit rating

This servo amplifier conforms to the circuit whose peak current is limited to 5000A or less. Having been subjected to the short-circuit tests of the UL in the alternating-current circuit, the servo amplifier conforms to the above circuit.

(4) Capacitor discharge time

The capacitor discharge time is as listed below. To ensure safety, do not touch the charging section for 10 minutes after power-off.

Servo amplifier	Discharge time [min]
MR-E-10A･20A	1
MR-E-40A	2
MR-E-70A to 200A	3

(5) Options and auxiliary equipment

Use UL/C-UL standard-compliant products.

(6) 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.

For installation in Canada, branch circuit protection must be provided, in accordance with the Canada Electrical Code and any applicable provincial codes.

<<About the manuals>>

Relevant manuals

Manual name	Manual No.
MR-E Series To Use the AC Servo Safely	IB(NA)0300057
EMC Installation Guidelines	IB(NA)67310

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1. FUNCTIONS AND CONFIGURATION

1.1 Introduction

The Mitsubishi MR-E series general-purpose AC servo is based on the MR-J2-Super series, and has the same high performance and limited functions.
It has position control and internal speed control modes. Further, it can perform operation with the control modes changed, e.g. position/internal speed control. Hence, it is applicable to a wide range of fields, 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 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 series servo motor is equipped with an incremental position encoder that has the resolution of 10000 pulses/rev to ensure high precision positioning.

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(1) Position control mode

An up to 500kpps high-speed pulse train is used to control the speed and direction of a motor and execute precision positioning of 10000 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.

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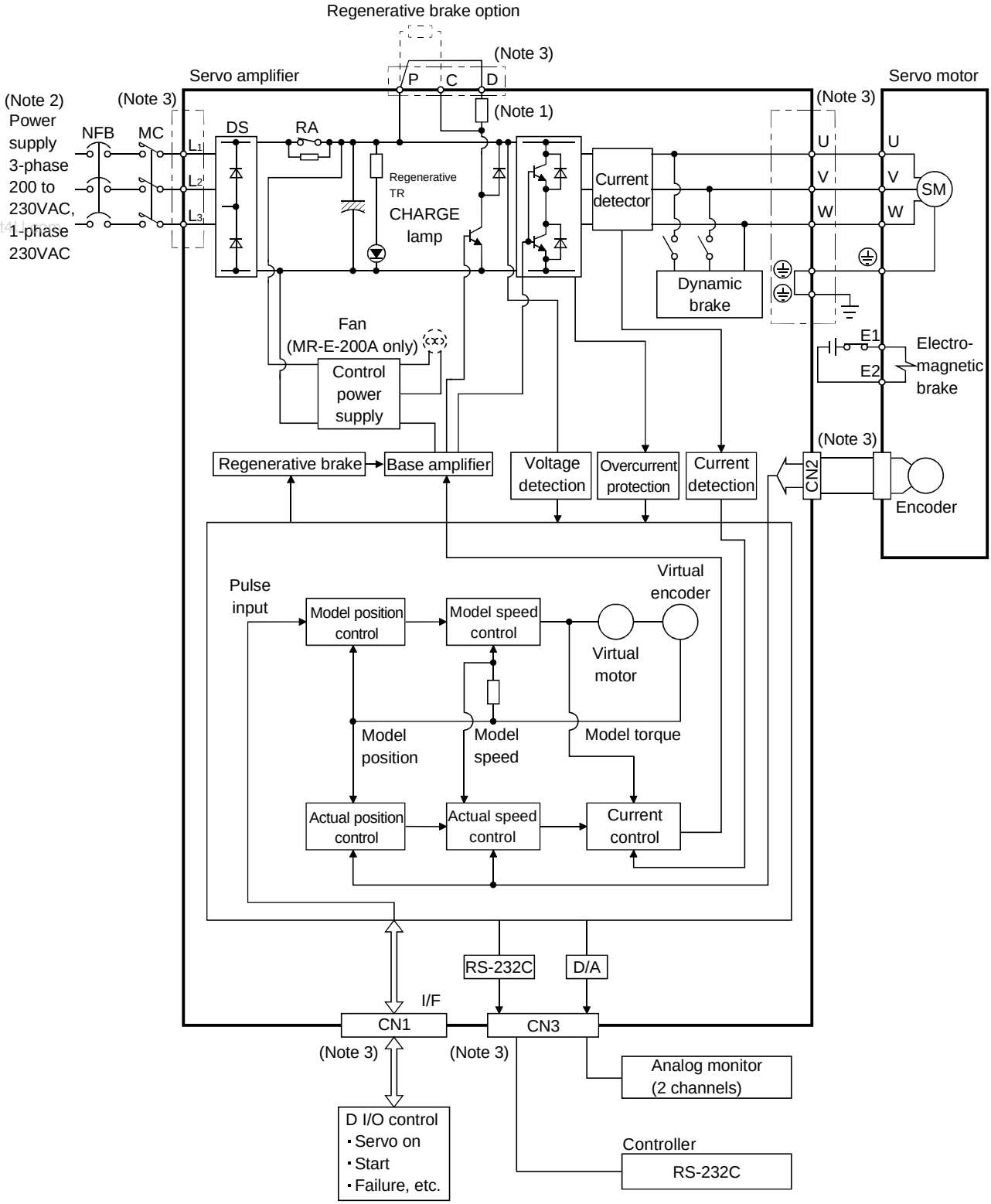
1.2 Function block diagram

The function block diagram of this servo is shown below.



Note:1. The built-in regenerative brake resistor is not provided for the MR-E-10A/20A.
2. The single-phase 230VAC can be used for MR-E-70A or smaller servo amplifier. Connect the power supply cables to L_1 and L_2 while leaving L_3 open.
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).

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1.3 Servo amplifier standard specifications

Item \ Servo Amplifier MR-E-☐				10A	20A	40A	70A	100A	200A
Power supply	Voltage/frequency			3-phase 200 to 230VAC, 50/60Hz or 1-phase 230VAC, 50/60Hz				3-phase 200 to 230VAC, 50/60Hz	
	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 Section12.2					
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 brake error protection, undervoltage, instantaneous power failure protection, overspeed protection, excessive error protection					
Position control mode	Max. input pulse frequency			500kpps (for differential receiver), 200kpps (for open collector)					
	Command pulse multiplying factor			Electronic gear A:1 to 65535 B:1 to 65535, 1/50 < A/B < 50					
	In-position range setting			0 to ±10000 pulse (command pulse unit)					
	Error excessive			±10 revolutions					
	Torque limit			Set by parameter setting					
Internal speed control mode	Speed control range			Internal speed command 1: 5000					
	Speed fluctuation ratio			±0.01% or less (load fluctuation 0 to 100%) 0% or less (power fluctuation ±10%)					
	Torque limit			Set by parameter setting					
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 (3280ft) above sea level					
	Vibration			5.9 [m/s^2] or less					
				19.4 [ft/s^2] or less					
Weight			[kg]	0.8	0.8	1.2	1.8	1.8	2.0
			[lb]	1.8	1.8	2.6	4.0	4.0	4.4

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1.4 Function list

The following table lists the functions of this servo. For details of the functions, refer to the corresponding chapters and sections.

Function	Description	(Note) Control mode	Refer to
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, T	
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 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	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 brake option	Used when the built-in regenerative brake resistor of the servo amplifier does not have sufficient regenerative capability for the regenerative power generated.	P, S	Section 13.1.1

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Function	Description	(Note) Control mode	Refer to
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
Servo configuration software	Using a personal computer, parameter setting, test operation, status display, etc. can be performed.	P, S	Section 13.1.8
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

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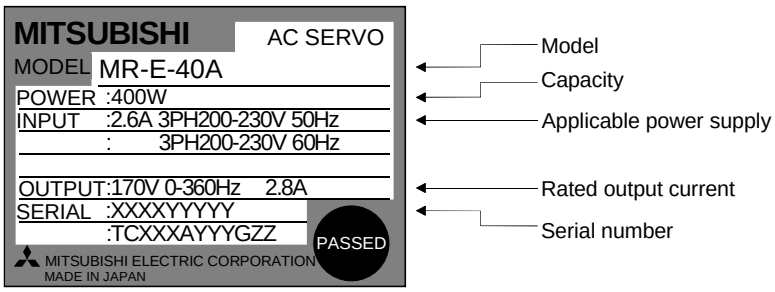
1.5 Model code definition

(1) Rating plate



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(2) Model

MR - E - □ A

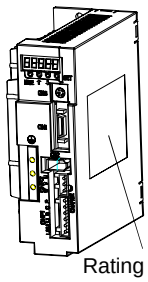
Series

General-purpose interface

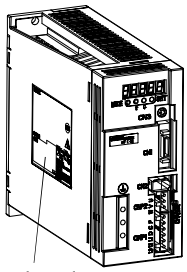
Rated output

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

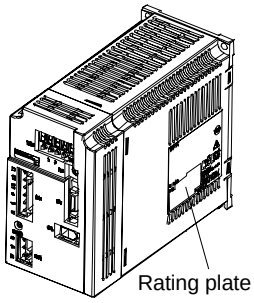
MR-E-40A or less



MR-E-70A, 100A



MR-E-200A



1.6 Combination with servo motor

The following table lists combinations of servo amplifiers and servo motors. The same combinations apply to the models with electromagnetic brakes and the models with reduction gears.

Servo amplifier	Servo motors	
	HC-KFE□	HC-SFE□ 2000r/min
MR-E-10A	13	
MR-E-20A	23	
MR-E-40A	43	
MR-E-70A	73	52
MR-E-100A		102
MR-E-200A		152・202

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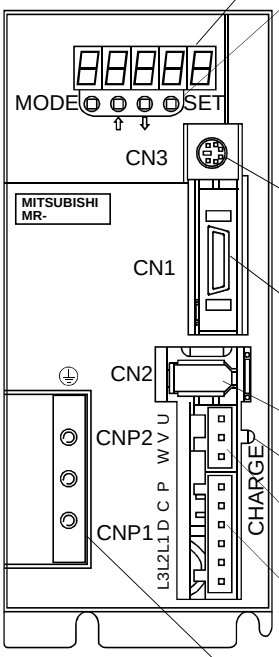
1.7 Parts identification

(1) MR-E-100A or less



Name/Application	Refer to
Display The 5-digit, seven-segment LED shows the servo status and alarm number.	Chapter6
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.	Chapter6
Communication connector (CN3) Used to connect a command device (RS-232C) and output analog monitor data.	Section3.3 Section13.1.2 Chapter14
I/O signal connector (CN1) Used to connect digital I/O signals.	Section3.3
Encoder connector (CN2) Connector for connection of the servo motor encoder.	Section3.3 Section13.1.2
Charge lamp Lit to indicate that the main circuit is charged. While this lamp is lit, do not reconnect the cables.	
Motor power supply connector (CNP2) Used to connect the servo motor.	Section3.7 Section11.1
Power supply/regenerative connector (CNP1) Used to connect the input power supply and regenerative brake option.	Section3.7 Section11.1 Section13.1.1
Protective earth (PE) terminal (⏚) Ground terminal.	Section3.10 Section11.1

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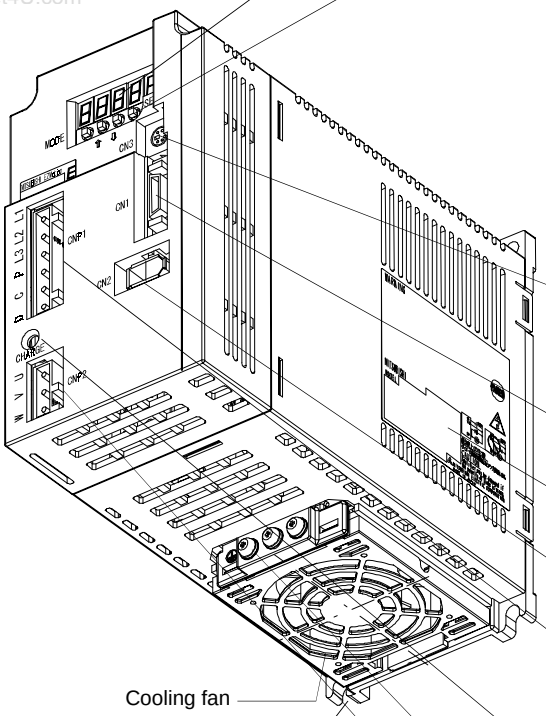
(2) MR-E-200A



Name/Application	Refer to
Display The 5-digit, seven-segment LED shows the servo status and alarm number.	Chapter6
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.	Chapter6
Communication connector (CN3) Used to connect a command device (RS232C) and output analog monitor data.	Section3.3 Section13.1.2 Chapter14
I/O signal connector (CN1) Used to connect digital I/O signals.	Section3.3
Name plate	Section1.5
Encoder connector (CN2) Connector for connection of the servo motor encoder.	Section3.3 Section13.1.2
Power supply/regenerative connector (CNP1) Used to connect the input power supply and regenerative brake option.	Section3.7 Section11.1 Section13.1.1
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.	Section3.10 Section11.1
Motor power supply connector (CNP2) Used to connect the servo motor.	Section3.7 Section11.1

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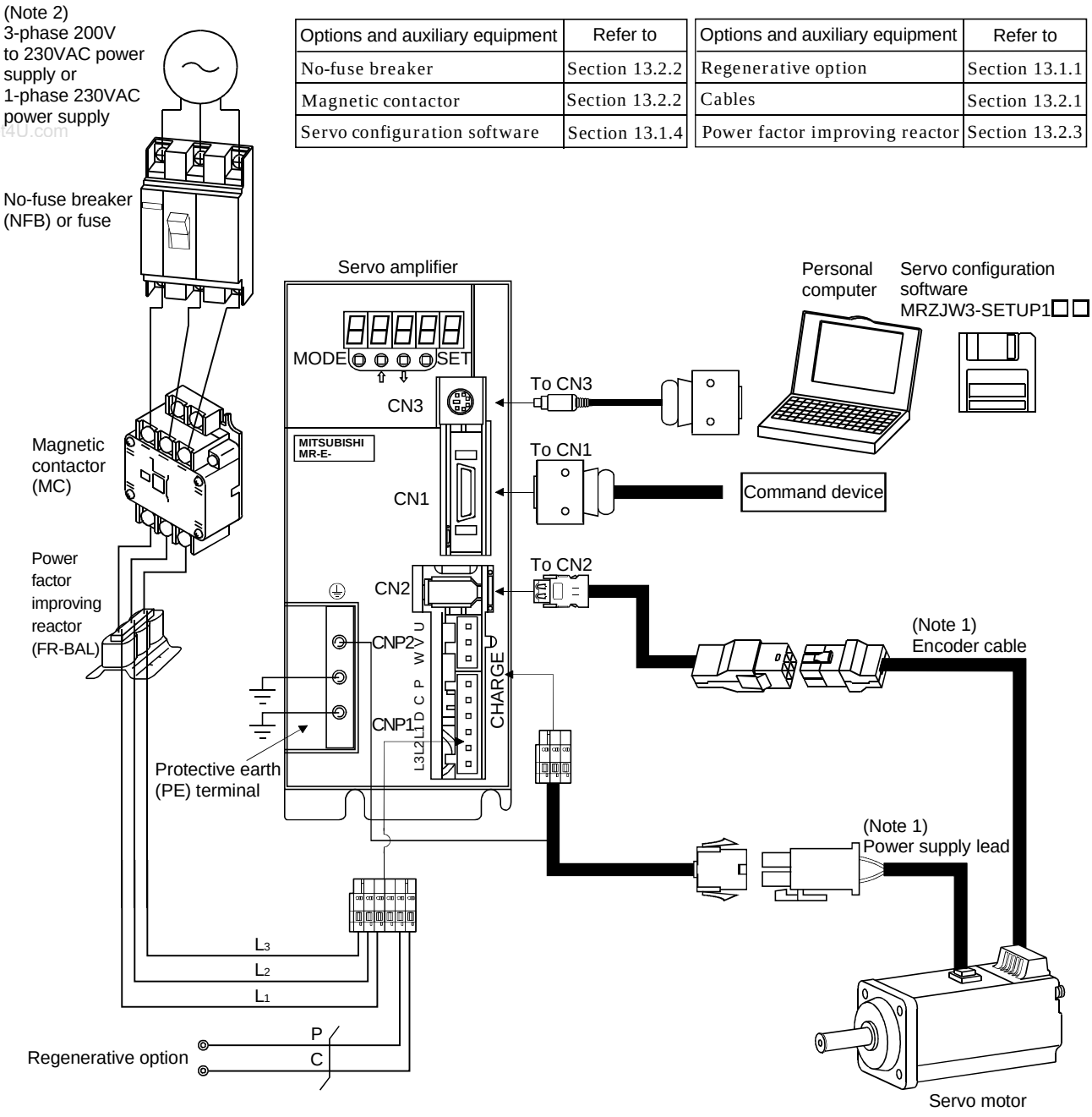
1.8 Servo system with auxiliary equipment

> **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 or less

Options and auxiliary equipment	Refer to
No-fuse breaker	Section 13.2.2
Magnetic contactor	Section 13.2.2
Servo configuration software	Section 13.1.4

Options and auxiliary equipment	Refer to
Regenerative option	Section 13.1.1
Cables	Section 13.2.1
Power factor improving reactor	Section 13.2.3



Note: 1. The HC-SFE series have cannon connectors.
2. A 1-phase 230VAC power supply may be used with the servo amplifier of MR-E-70A or less. Connect the power supply to L_1 and L_2 terminals and leave L_3 open.

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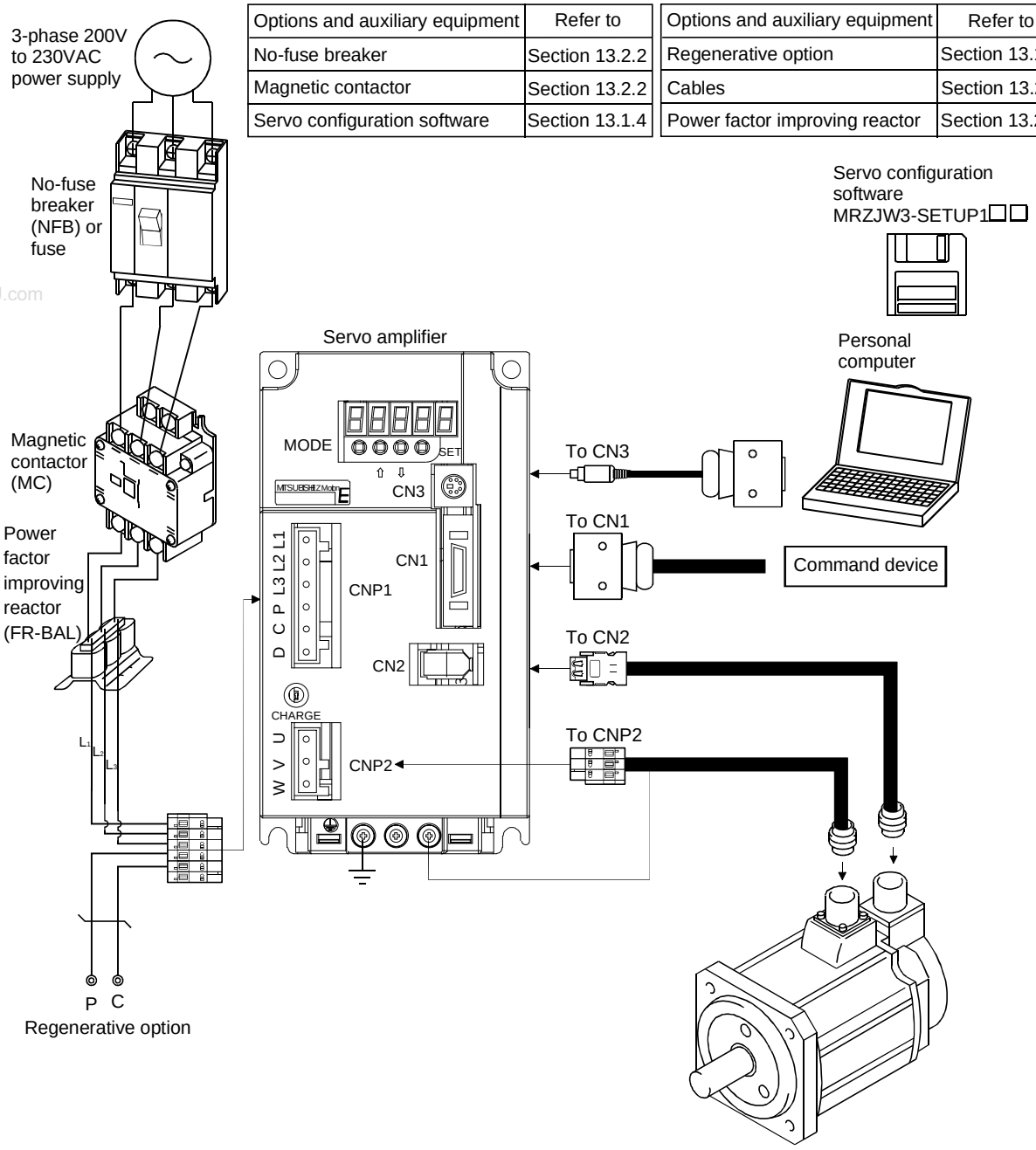
(2) MR-E-200A

Options and auxiliary equipment	Refer to
No-fuse breaker	Section 13.2.2
Magnetic contactor	Section 13.2.2
Servo configuration software	Section 13.1.4

Options and auxiliary equipment	Refer to
Regenerative option	Section 13.1.1
Cables	Section 13.2.1
Power factor improving reactor	Section 13.2.3



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2. INSTALLATION

⚠ CAUTION	・Stacking in excess of the limited number of products is not allowed. ・Install the equipment to incombustibles. Installing them directly or close to combustibles will led 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. ・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, consult Mitsubishi.

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2.1 Environmental conditions

Environment			Conditions
Ambient temperature	Operation	[℃]	0 to +55 (non-freezing)
		[℉]	32 to +131 (non-freezing)
	Storage	[℃]	−20 to +65 (non-freezing)
		[℉]	−4 to +149 (non-freezing)
Ambient humidity	Operation		90%RH or less (non-condensing)
	Storage		
Ambience			Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt
Altitude			Max. 1000m (3280 ft) above sea level
Vibration		[m/s^2]	5.9 [m/s^2] or less
		[ft/s^2]	19.4 [ft/s^2] or less

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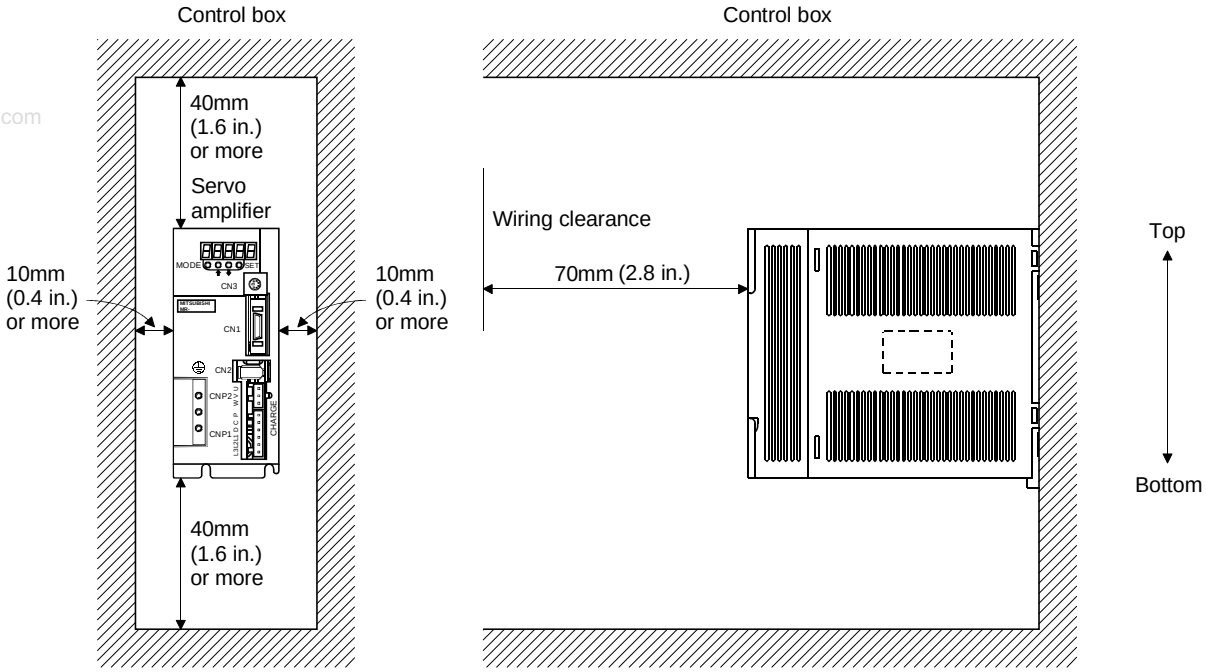
2.2 Installation direction and clearances

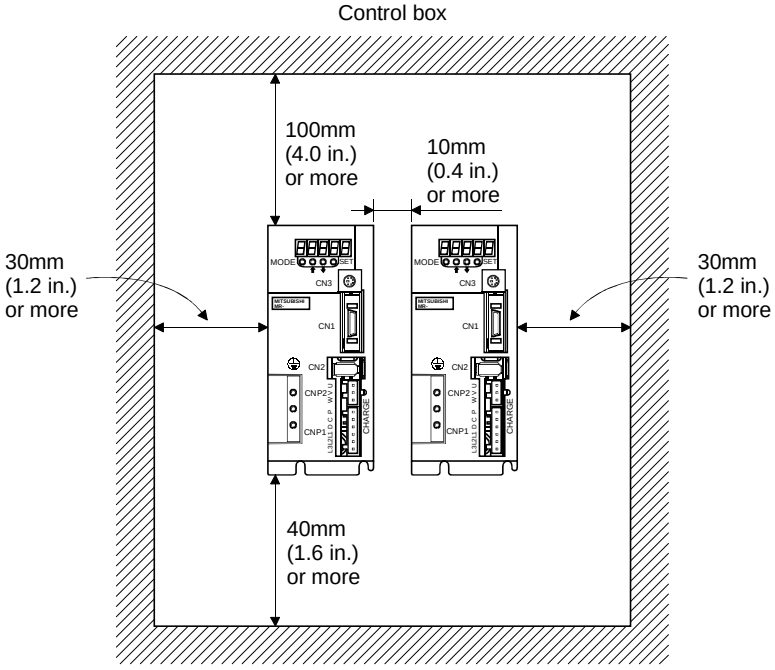
⚠ CAUTION	・The equipment must be installed in the specified direction. Otherwise, a fault may occur. ・Leave specified clearances between the servo amplifier and control box inside walls or other equipment.

(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 fan to prevent the internal temperature of the control box from exceeding the environmental conditions.



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(3) Others

When using heat generating equipment such as the regenerative brake 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 fan installed on the ceiling.

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(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, brake) supplied with the servo motor, and flex the optional encoder cable or the power supply and brake wiring cables. 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 sheath 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.

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3. SIGNALS AND WIRING

⚠ WARNING

- Any person who is involved in wiring should be fully competent to do the work.
- Before starting wiring, switch power off, then wait for more than 10 minutes, and after the charge lamp has gone off, make sure that the voltage is safe in the tester or like. Otherwise, you may get an electric shock.
- 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.

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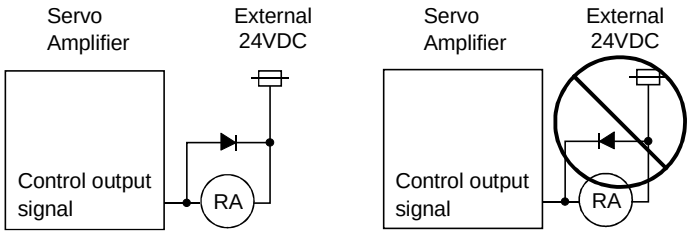
⚠ CAUTION

- Wire the equipment correctly and securely. Otherwise, the servo motor may misoperate, 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.



- 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 brake resistor, switch power off with the alarm signal. Otherwise, a transistor fault or the like may overheat the regenerative brake resistor, causing a fire.
- Do not modify the equipment.

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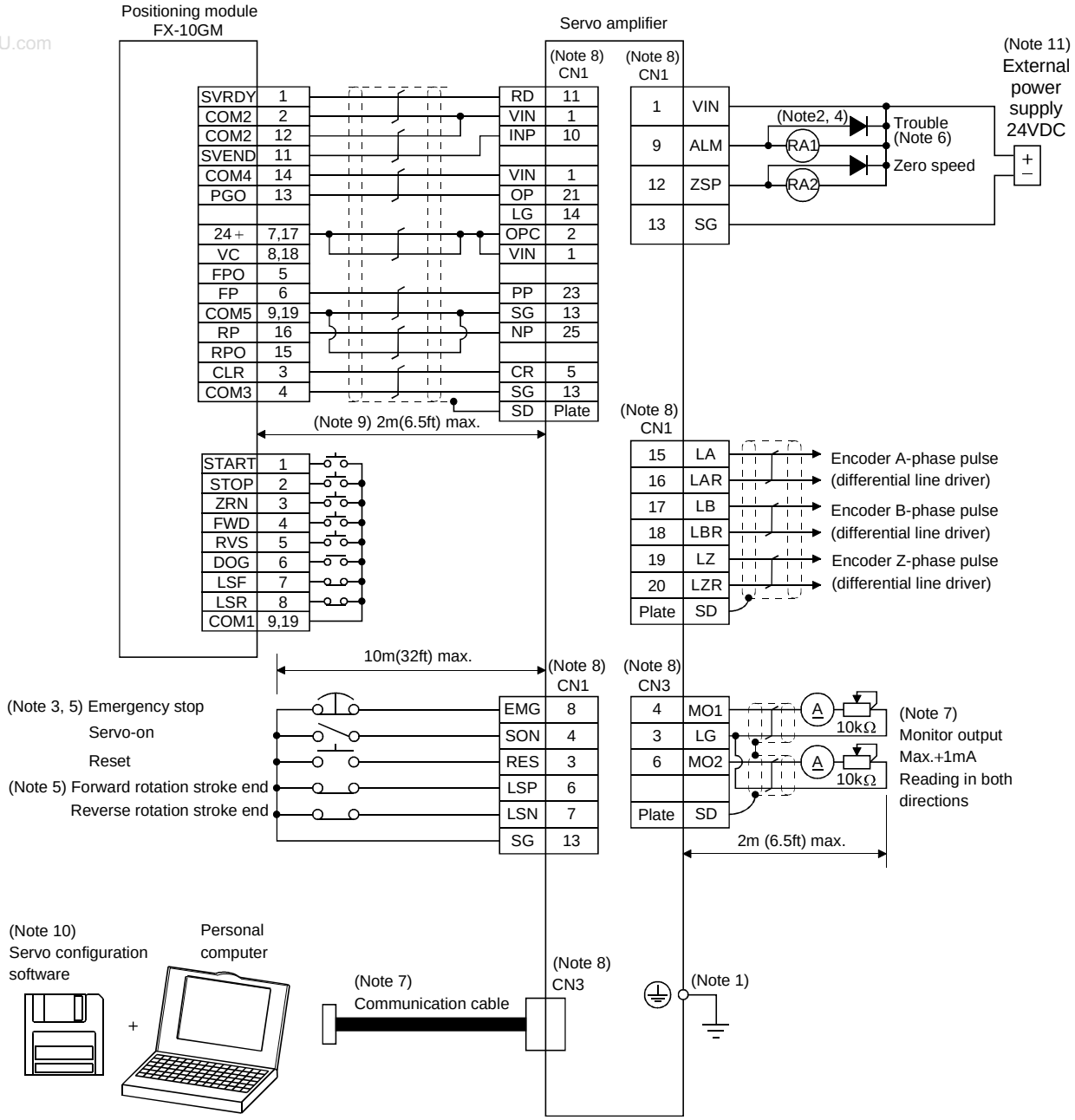
3.1 Standard connection example

> **POINT**
>
> ▪ Refer to Section 3.7.1 for the connection of the power supply system and to Section 3.8 for connection with the servo motor.

3.1.1 Position control mode

(1) FX-10GM



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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. The sum of currents that flow in the external relays should be 80mA max. If it exceeds 80mA, supply interface power from external. (Refer to Section 3.6.2)
5. When starting operation, always connect the emergency stop signal (EMG) and forward/ reverse rotation stroke end signal (LSN/LSP) with SG. (Normally closed contacts)
6. Trouble (ALM) is connected with COM in normal alarm-free condition. When this signal is switched off (at occurrence of an alarm), the output of the controller should be stopped by the sequence program.
7. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to Section 13.1.3)
8. The pins with the same signal name are connected in the servo amplifier.
9. This length applies to the command pulse train input in the opencollector system. It is 10m (32ft) or less in the differential line driver system.
10. Use MRZJW3-SETUP 154E.
11. Connect the external 24VDC power supply if the output signals are not used.

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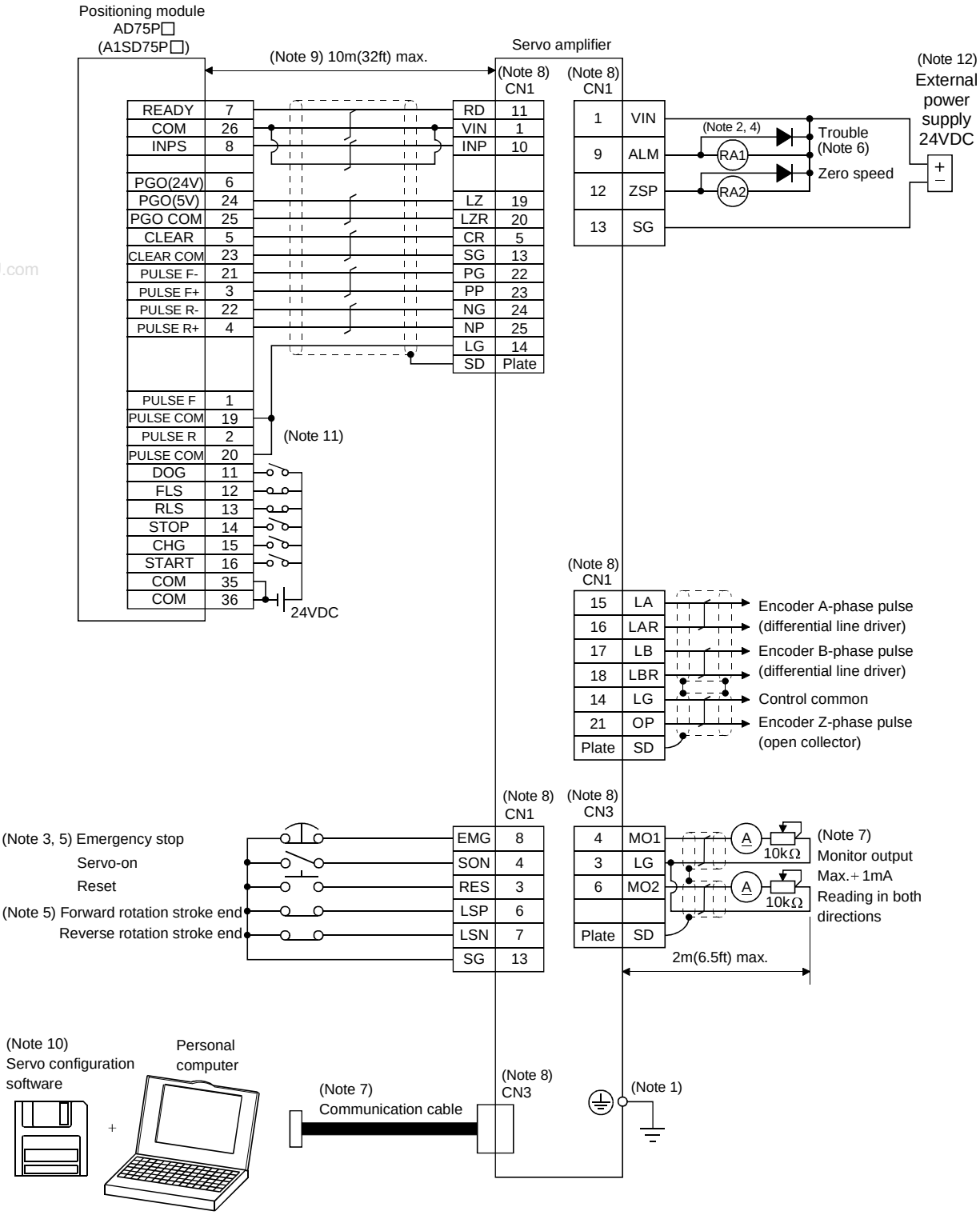
(2) AD75P□(A1SD75P□)



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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. The sum of currents that flow in the external relays should be 80mA max. If it exceeds 80mA, supply interface power from external.(Refer to Section 3.6.2)
5. When starting operation, always connect the emergency stop signal (EMG) and forward/ reverse rotation stroke end signal (LSN/LSP) with SG. (Normally closed contacts)
6. Trouble (ALM) is connected with COM in normal alarm-free condition. When this signal is switched off (at occurrence of an alarm), the output of the controller should be stopped by the sequence program.
7. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to Section 13.1.3)
8. The pins with the same signal name are connected in the servo amplifier.
9. This length applies to the command pulse train input in the differential line driver system.
It is 2m (6.5ft) or less in the opencollector system.
10. Use MRZJW3-SETUP 154E.
11. Connect LG and pulse output COM to increase noise immunity.
12. Connect the external 24VDC power supply if the output signals are not used.

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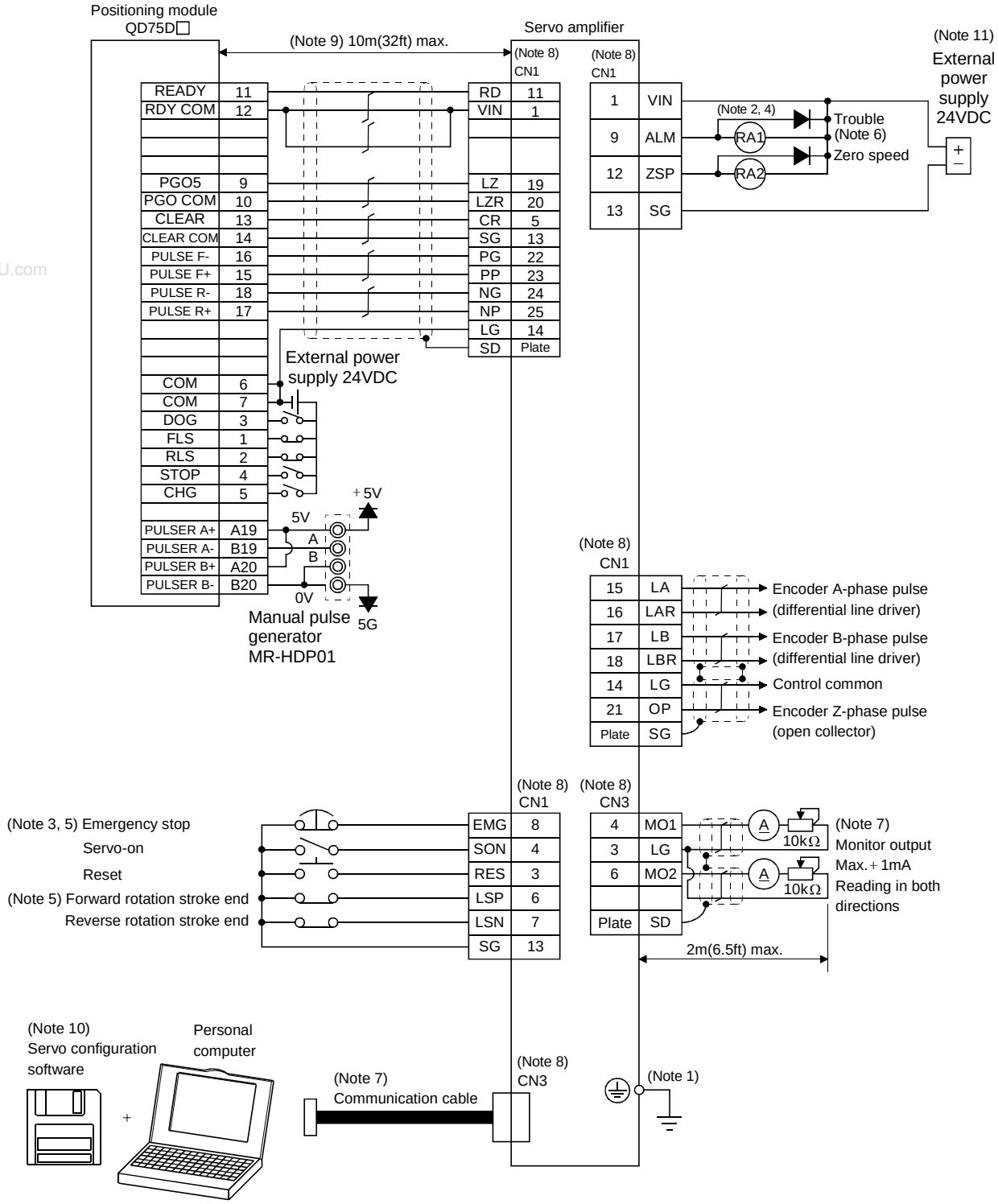
(3) QD75D□ (differential driver)



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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. The sum of currents that flow in the external relays should be 80mA max. If it exceeds 80mA, supply interface power from external.(Refer to Section 3.6.2)
5. When starting operation, always connect the emergency stop signal (EMG) and forward/ reverse rotation stroke end signal (LSN/LSP) with SG. (Normally closed contacts)
6. Trouble (ALM) is connected with COM in normal alarm-free condition. When this signal is switched off (at occurrence of an alarm), the output of the controller should be stopped by the sequence program.
7. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to Section 13.1.3)
8. The pins with the same signal name are connected in the servo amplifier.
9. This length applies to the command pulse train input in the differential line driver system.
It is 2m (6.5ft) or less in the opencollector system.
10. Use MRZJW3-SETUP 154E.
11. Connect the external 24VDC power supply if the output signals are not used.

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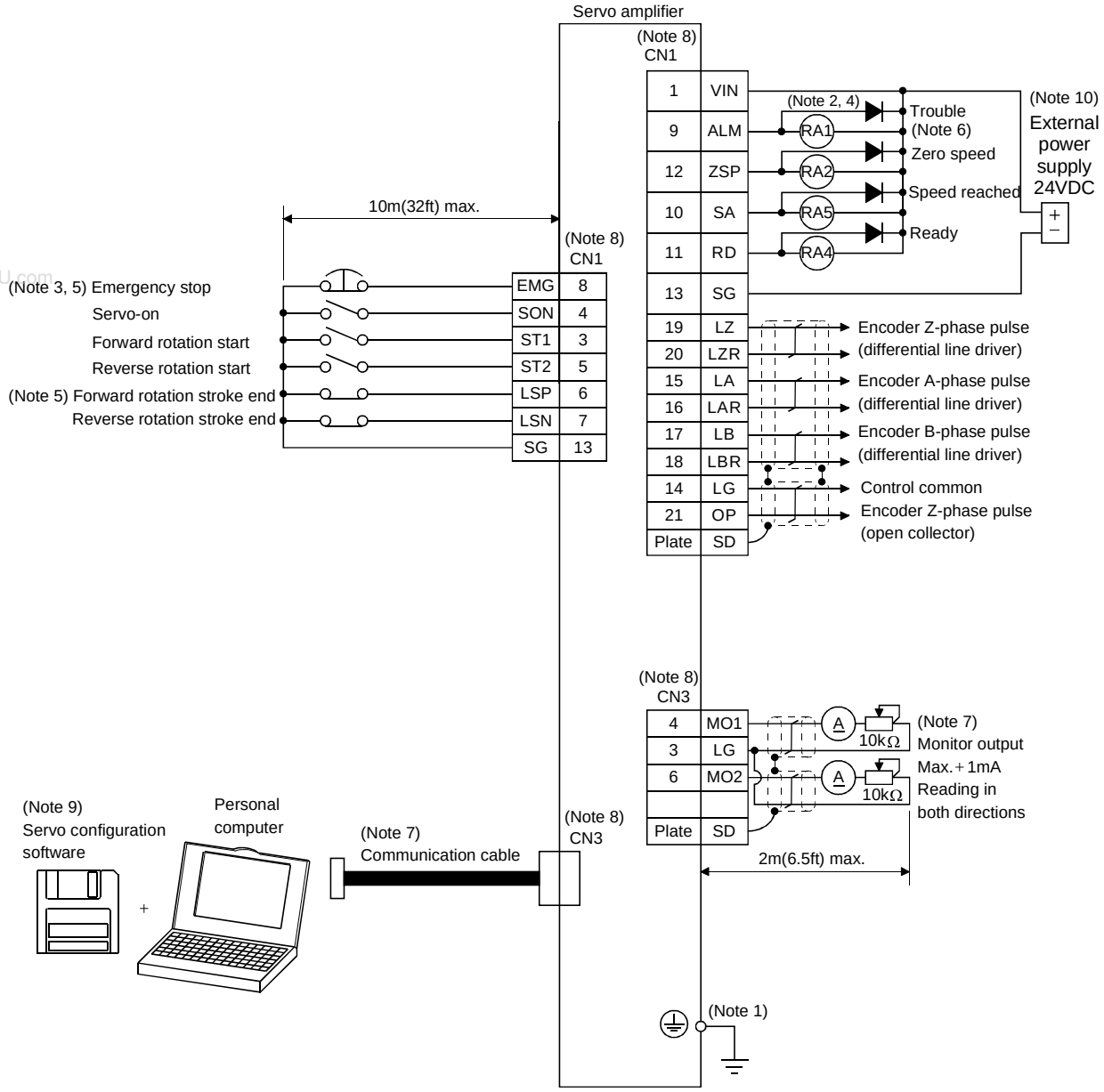
3.1.2 Internal speed control mode



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. The sum of currents that flow in the external relays should be 80mA max. If it exceeds 80mA, supply interface power from external.(Refer to Section 3.6.2)
5. When starting operation, always connect the emergency stop signal (EMG) and forward/ reverse rotation stroke end signal (LSN/LSP) with SG. (Normally closed contacts)
6. Trouble (ALM) is connected with COM in normal alarm-free condition.
7. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to Section 13.1.3)
8. The pins with the same signal name are connected in the servo amplifier.
9. Use MRZJW3-SETUP 154E.
10. Connect the external 24VDC power supply if the output signals are not used.

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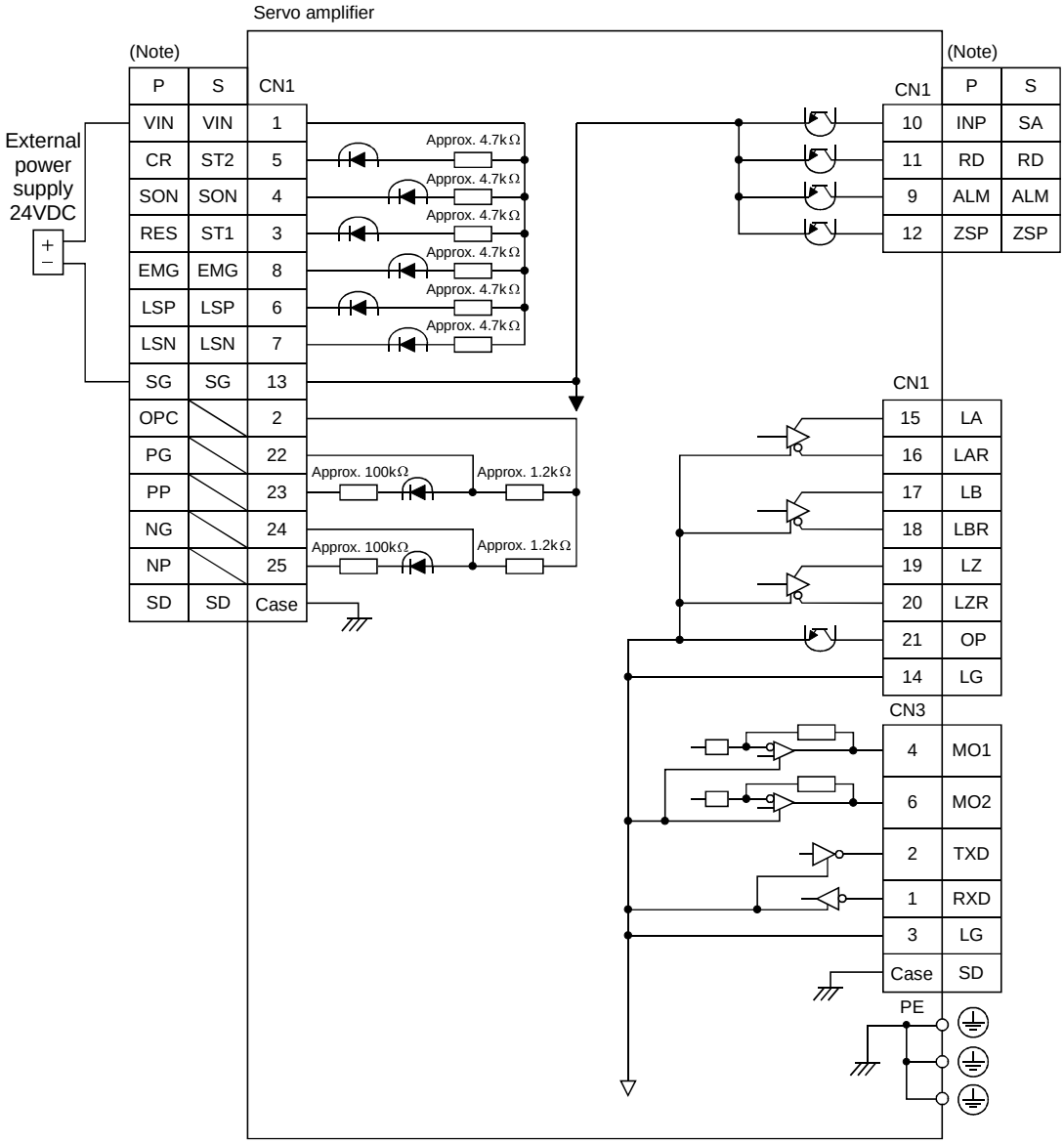
3.2 Internal connection diagram of servo amplifier

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

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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

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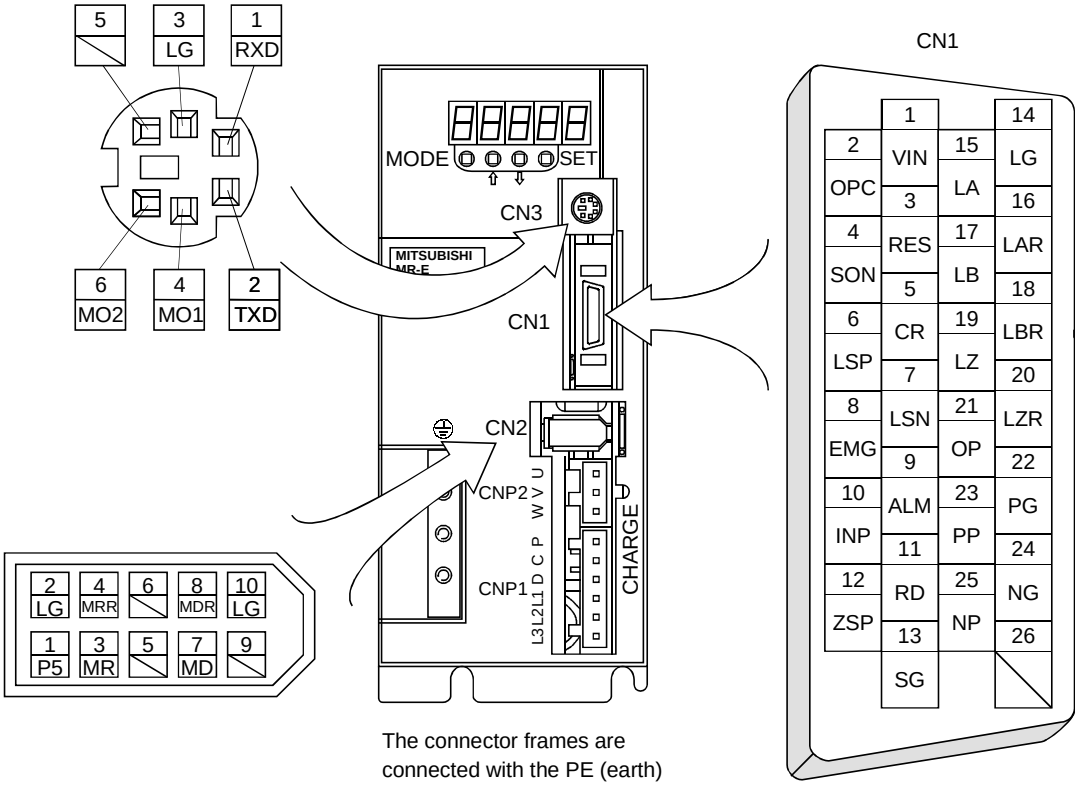

The connector frames are connected with the PE (earth) terminal inside the servo amplifier.

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(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.	(Note1) I/O	(Note2) 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.

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(3) Symbols and signal names

Symbol	Signal name	Symbol	Signal name
SON	Servo-on	ZSP	Zero speed
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)
TL	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

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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 43 to 49.
The pin No.s in the connector pin No. column are those in the initial status.

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(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	S
Servo-on	SON	CN1-4	Connect SON-SG to switch on the base circuit and make the servo amplifier ready to operate (servo-on). Disconnect SON-SG 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-SG for more than 50ms to reset the alarm. Some alarms cannot be deactivated by the reset signal. (Refer to Section 10.2.1.) Shorting RES-SG 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.	DI-1	○	△
Forward rotation stroke end	LSP	CN1-6	To start operation, short LSP-SG and/or LSN-SG. 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-SG off (open)
1: SP/LSN-SG 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

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<table>
<tr><th rowspan="2">Signal</th><th rowspan="2">Symbol</th><th rowspan="2">Connec-tor pin No.</th><th rowspan="2">Functions/Applications</th><th rowspan="2">I/O division</th><th colspan="2">Control mode</th></tr>
<tr><th>P</th><th>S</th></tr>
<tr><td>Internal torque limit selection</td><td>TL1</td><td></td><td>When using this signal, make it usable by making the setting of parameter No. 43 to 48.
(Refer to (5), Section 3.4.1.)</td><td>DI-1</td><td>△</td><td>△</td></tr>
<tr><td>Forward rotation start</td><td>ST1</td><td>CN1-3</td><td rowspan="2">Used to start the servo motor in any of the following directions:
<table><tr><th colspan="2">(Note) Input signals</th><th rowspan="2">Servo motor starting direction</th></tr><tr><th>ST2</th><th>ST1</th></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-SG off (open)
1: ST1/ST2-SG 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.</td><td rowspan="2">DI-1</td><td rowspan="2"></td><td rowspan="2">○</td></tr>
<tr><td>Reverse rotation start</td><td>ST2</td><td>CN1-5</td></tr>
<tr><td>Speed selection 1</td><td>SP1</td><td></td><td rowspan="3"><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.
<table><tr><th colspan="3">(Note) Input signals</th><th rowspan="2">Speed command</th></tr><tr><th>SP3</th><th>SP2</th><th>SP1</th></tr><tr><td>0</td><td>0</td><td>0</td><td>Internal speed command 1 (parameter No. 8)</td></tr><tr><td>0</td><td>0</td><td>1</td><td>Internal speed command 1 (parameter No. 8)</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Internal speed command 2 (parameter No. 9)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Internal speed command 3 (parameter No. 10)</td></tr><tr><td>1</td><td>0</td><td>0</td><td>Internal speed command 4 (parameter No. 72)</td></tr><tr><td>1</td><td>0</td><td>1</td><td>Internal speed command 5 (parameter No. 73)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Internal speed command 6 (parameter No. 74)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Internal speed command 7 (parameter No. 75)</td></tr></table>Note 0: SP1/SP2/SP3-SG off (open)
1: SP1/SP2/SP3-SG on (short)</td><td>DI-1</td><td></td><td>△</td></tr>
<tr><td>Speed selection 2</td><td>SP2</td><td></td><td>DI-1</td><td></td><td>△</td></tr>
<tr><td>Speed selection 3</td><td>SP3</td><td></td><td>DI-1</td><td></td><td>△</td></tr>
<tr><td>Proportion control</td><td>PC</td><td></td><td>Connect PC-SG 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, switch on the proportion control signal and torque control signal (TL) at the same time to make the torque less than the rated by the analog torque limit.</td><td>DI-1</td><td>△</td><td>△</td></tr>
</table>

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<table>
<tr><th rowspan="2">Signal</th><th rowspan="2">Symbol</th><th rowspan="2">Connec-tor pin No.</th><th rowspan="2">Functions/Applications</th><th rowspan="2">I/O division</th><th colspan="2">Control mode</th></tr>
<tr><th>P</th><th>S</th></tr>
<tr><td>Emergency stop</td><td>EMG</td><td>CN1-8</td><td>Disconnect EMG-SG to bring the servo motor to emergency stop state, in which the servo is switched off and the dynamic brake is operated.
Connect EMG-SG in the emergency stop state to reset that state.</td><td>DI-1</td><td>○</td><td>○</td></tr>
<tr><td>Clear</td><td>CR</td><td>CN1-5</td><td>Connect CR-SG 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-SG are connected.</td><td>DI-1</td><td>○</td><td></td></tr>
<tr><td>Electronic gear selection 1</td><td>CM1</td><td></td><td rowspan="2">When using CM1 and CM2, make them usable by the setting of parameters No. 43 to 48.
The combination of CM1-SG and CM2-SG gives you a choice of four different electronic gear numerators set in the parameters.
CM1 and CM2 cannot be used in the absolute position detection system.
<table><tr><th colspan="2">(Note) Input signals</th><th rowspan="2">Electronic gear namerator</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-SG off (open)
1: CM1/CM2-SG on (short)</td><td>DI-1</td><td>△</td><td></td></tr>
<tr><td>Electronic gear selection 2</td><td>CM2</td><td></td><td>DI-1</td><td>△</td><td></td></tr>
<tr><td>Gain changing</td><td>CDP</td><td></td><td>When using this signal, make it usable by the setting of parameter No. 43 to 48.
Connect CDP-SG 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.</td><td>DI-1</td><td>△</td><td>△</td></tr>
<tr><td>Control change</td><td>LOP</td><td></td><td><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-SG off (open)
1: LOP-SG on (short)</td><td>DI-1</td><td colspan="2">Refer to Functions/ Appli-cations.</td></tr>
<tr><td>Forward rotation pulse train
Reverse rotation pulse train</td><td>PP
NP
PG
NG</td><td>CN1-23
CN1-25
CN1-22
CN1-24</td><td>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.</td><td>DI-2</td><td>○</td><td></td></tr>
</table>

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(2) Output signals

Signal	Symbol	Connector pin No.	Functions/Applications	I/O division	Control mode	
					P	S
Trouble	ALM	CN1-9	ALM-SG are disconnected when power is switched off or the protective circuit is activated to shut off the base circuit. Without alarm, ALM-SG are connected within 1 after power on.	DO-1	○	○
Ready	RD	CN1-11	RD-SG are connected when the servo is switched on and the servo amplifier is ready to operate.	DO-1	○	○
In position	INP	CN1-10	INP-SG 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-SG may be kept connected during low-speed rotation.	DO-1	○	
Speed reached	SA		SA-SG are connected when the servo motor speed has nearly reached the preset speed. When the preset speed is 50r/min or less, SA-SG are kept connected.	DO-1		○
Zero speed	ZSP	CN1-12	ZSP-SG 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-SG 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-SG are connected. When there is no warning, WNG-SG are disconnected within 1 second after power-on.	DO-1	△	△

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<table>
<tr><th>Signal</th><th>Symbol</th><th>Connec-tor pin No.</th><th>Functions/Applications</th><th>I/O division</th><th colspan="2">Control mode</th></tr>
<tr><th></th><th></th><th></th><th></th><th></th><th>P</th><th>S</th></tr>
<tr><td>Alarm code</td><td>ACD 0
ACD 1
ACD 2</td><td></td><td>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:
<table>
<tr><th colspan="3">(Note) Alarm code</th><th rowspan="2">Alarm display</th><th rowspan="2">Name</th></tr>
<tr><th>CN1 12 Pin</th><th>CN1 11 Pin</th><th>CN1 10 Pin</th></tr>
<tr><td rowspan="9">0</td><td rowspan="9">0</td><td rowspan="9">0</td><td>88888</td><td>Watchdog</td></tr>
<tr><td>AL.12</td><td>Memory error 1</td></tr>
<tr><td>AL.13</td><td>Clock error</td></tr>
<tr><td>AL.15</td><td>Memory error 2</td></tr>
<tr><td>AL.17</td><td>Board error</td></tr>
<tr><td>AL.19</td><td>Memory error 3</td></tr>
<tr><td>AL.37</td><td>Parameter error</td></tr>
<tr><td>AL.8A</td><td>Serial communication timeout</td></tr>
<tr><td>AL.8E</td><td>Serial communication error</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL.30</td><td>Regenerative error</td></tr>
<tr><td>AL.33</td><td>Overvoltage</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>AL.10</td><td>Undervoltage</td></tr>
<tr><td rowspan="4">0</td><td rowspan="4">1</td><td rowspan="4">1</td><td>AL.45</td><td>Main circuit device</td></tr>
<tr><td>AL.46</td><td>Servo motor overheat</td></tr>
<tr><td>AL.50</td><td>Overload 1</td></tr>
<tr><td>AL.51</td><td>Overload 2</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">0</td><td rowspan="2">0</td><td>AL.24</td><td>Main circuit error</td></tr>
<tr><td>AL.32</td><td>Overcurrent</td></tr>
<tr><td rowspan="3">1</td><td rowspan="3">1</td><td rowspan="3">0</td><td>AL.31</td><td>Overspeed</td></tr>
<tr><td>AL.35</td><td>Command pulse frequency alarm</td></tr>
<tr><td>AL.52</td><td>Error excessive</td></tr>
<tr><td rowspan="3">1</td><td rowspan="3">0</td><td rowspan="3">1</td><td>AL.16</td><td>Encoder error 1</td></tr>
<tr><td>AL.1A</td><td>Monitor combination error</td></tr>
<tr><td>AL.20</td><td>Encoder error 2</td></tr>
</table>
Note.0: Pin-SG off (open)
1: Pin-SG on (short)</td><td>DO-1</td><td>△</td><td>△</td></tr>
</table>

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Signal	Symbol	Connector pin No.	Functions/Applications	I/O division	Control mode	
					P	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 π/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	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	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 input signals such as SON and EMG. Pins are connected internally. 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.		○	○

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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.

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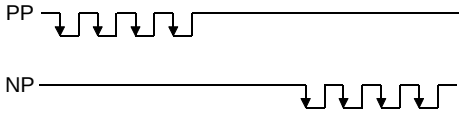
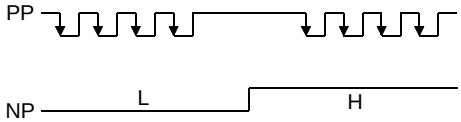
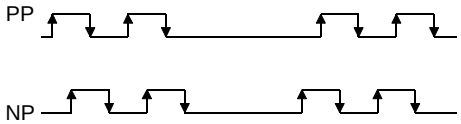
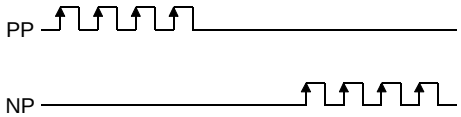
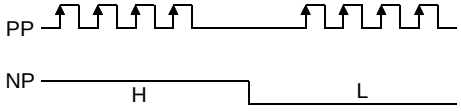
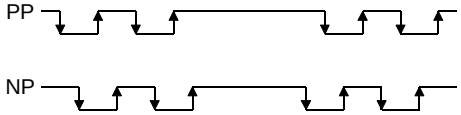
Pulse train form		Forward rotation command / Reverse rotation command	Parameter No. 21 (Command pulse train)
Negative logic	Forward rotation pulse train Reverse rotation pulse train		0010
	Pulse train + sign		0011
	A-phase pulse train B-phase pulse train		0012
Positive logic	Forward rotation pulse train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

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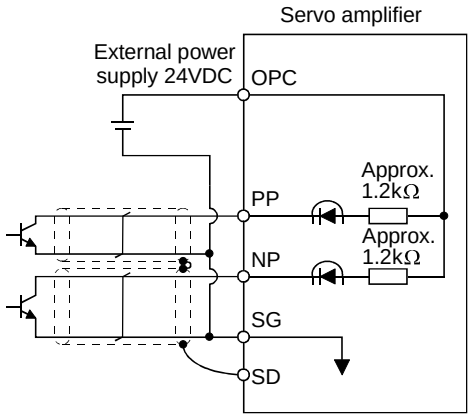
(b) Connections and waveforms

1) Open collector system

Connect as shown below:



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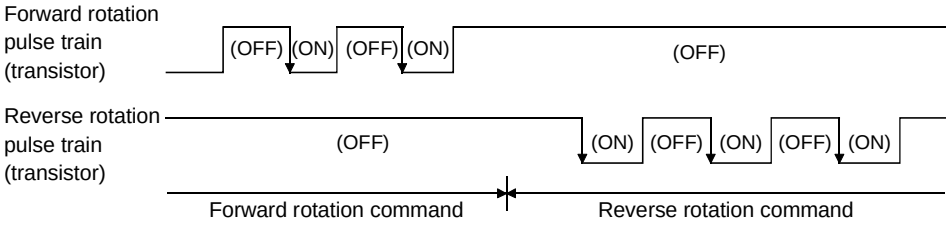
The explanation assumes that the input waveform has been set to the negative logic and forward and reverse rotation pulse trains (parameter No.21 has been set to 0010). The waveforms in the table in (a), (1) of this section are voltage waveforms of PP and NP based on SG. Their relationships with transistor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



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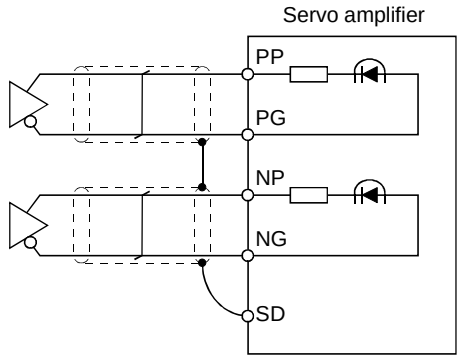
2) Differential line driver system
Connect as shown below:



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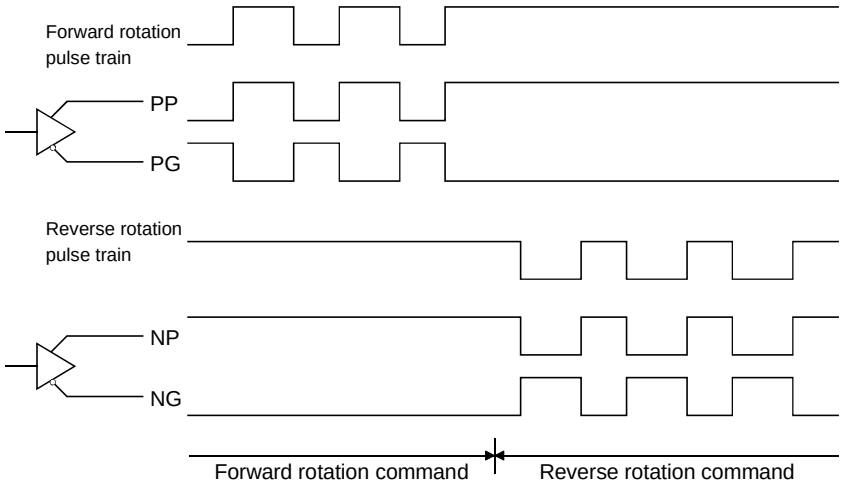
The explanation assumes that the input waveform has been set to the negative logic and forward and reverse rotation pulse trains (parameter No.21 has been set to 0010).
For the differential line driver, the waveforms in the table in (a), (1) of this section are as follows. The waveforms of PP, PG, NP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



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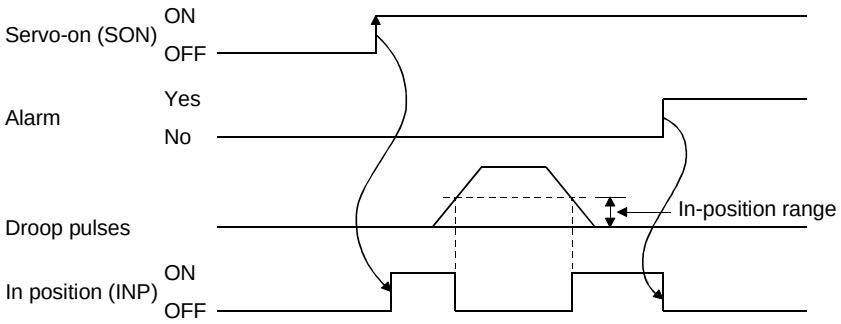
(2) In-position (INP)

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



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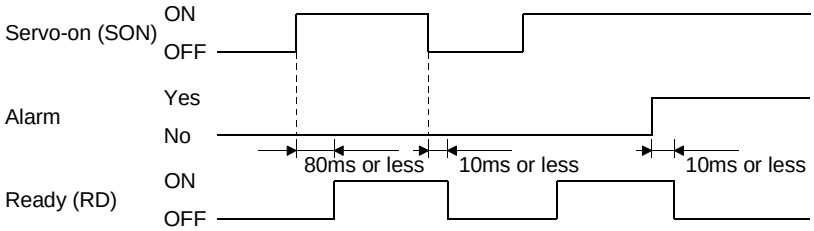
(3) Ready (RD)



(4) Electronic gear switching

The combination of CM1-SG and CM2-SG 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 namerator 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 namerator
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-SG off(open)

1: CM1/CM2-SG on(short)

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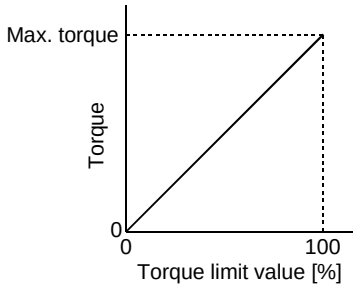
(5) Torque limit

(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.



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(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 TL1	Torque limit value made valid
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-SG off (open)
1: TL/TL1-SG on (short)

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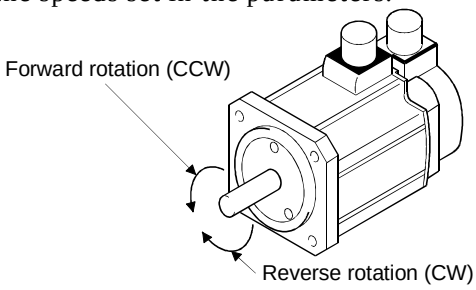
3.4.2 Internal speed control mode

(1) Speed setting

(a) Speed command and speed

The servo motor is run at the speeds set in the parameters.



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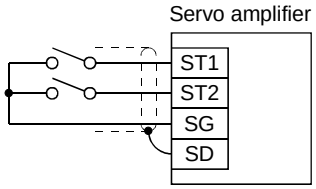
The following table indicates the rotation direction according to forward rotation start (ST1) and reverse rotation start (ST2) combination:

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

Note.0: ST1/ST2-SG off (open)
1: ST1/ST2-SG on (short)

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



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(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-SG off (open)
1 : SP1/SP2/SP3-SG on (short)

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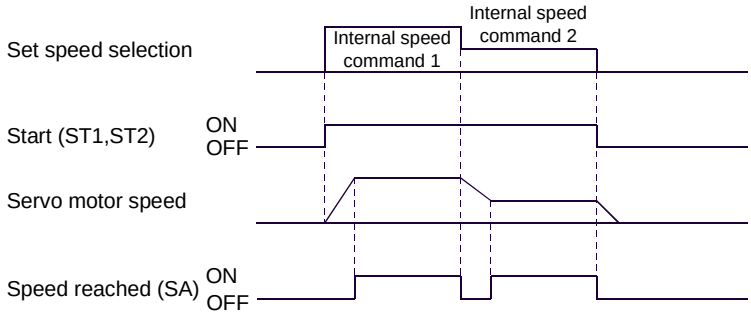
The speed may be changed during rotation. In this case, the values set in parameters No. 11 and 12 are used for acceleration/deceleration.

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-SG 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).

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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. This function is not available in the absolute position detection system.

(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-SG status and control modes are indicated below:

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

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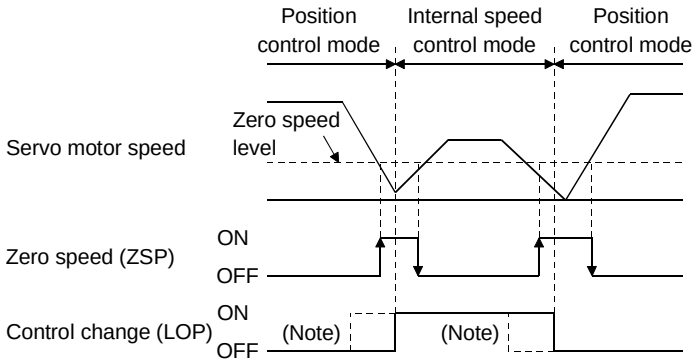
Note.0: LOP-SG off (open)
1: LOP-SG on (short)

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 signal 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 ZSP is not on, control cannot be changed if LOP is switched on-off.
If ZSP switches on after that, control cannot not be changed.

(2) Torque limit in position control mode

As in Section 3.4.1 (5).

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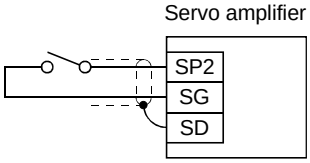
(3) Internal speed setting in speed control mode

(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 signal (ST1) and reverse rotation start signal (ST2) are as in (a), (1) in section 3.4.2. Generally, make connection as shown below:



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

Note.0: SP1-SG off (open)
1: SP1-SG 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).

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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.

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 signal (RES) from off to on. However, the alarm cannot be reset unless its cause is removed.

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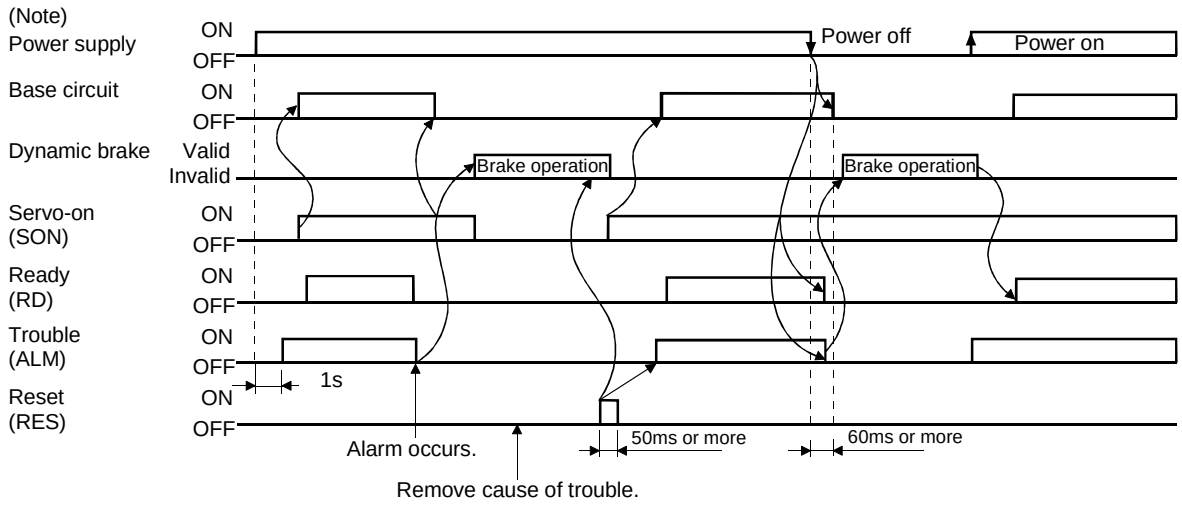

Note: Shut off the power as soon as an alarm occurs.

(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 alarm

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

(3) Instantaneous power failure

Undervoltage (AL.10) occurs if power is restored after a 60ms or longer power failure of the power supply or after a drop of the bus voltage to or below 200VDC. If the power failure persists further, the power switches off. When the power failure is reset in this state, the alarm is reset and the servo motor will start suddenly if the servo-on signal (SON) is on. To prevent hazard, make up a sequence which will switch off the servo-on signal (SON) if an alarm occurs.

(4) In position control mode (incremental)

When an alarm occurs, the home position is lost. When resuming operation after deactivating the alarm, make a home position return.

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3.6 Interfaces

3.6.1 Common line

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

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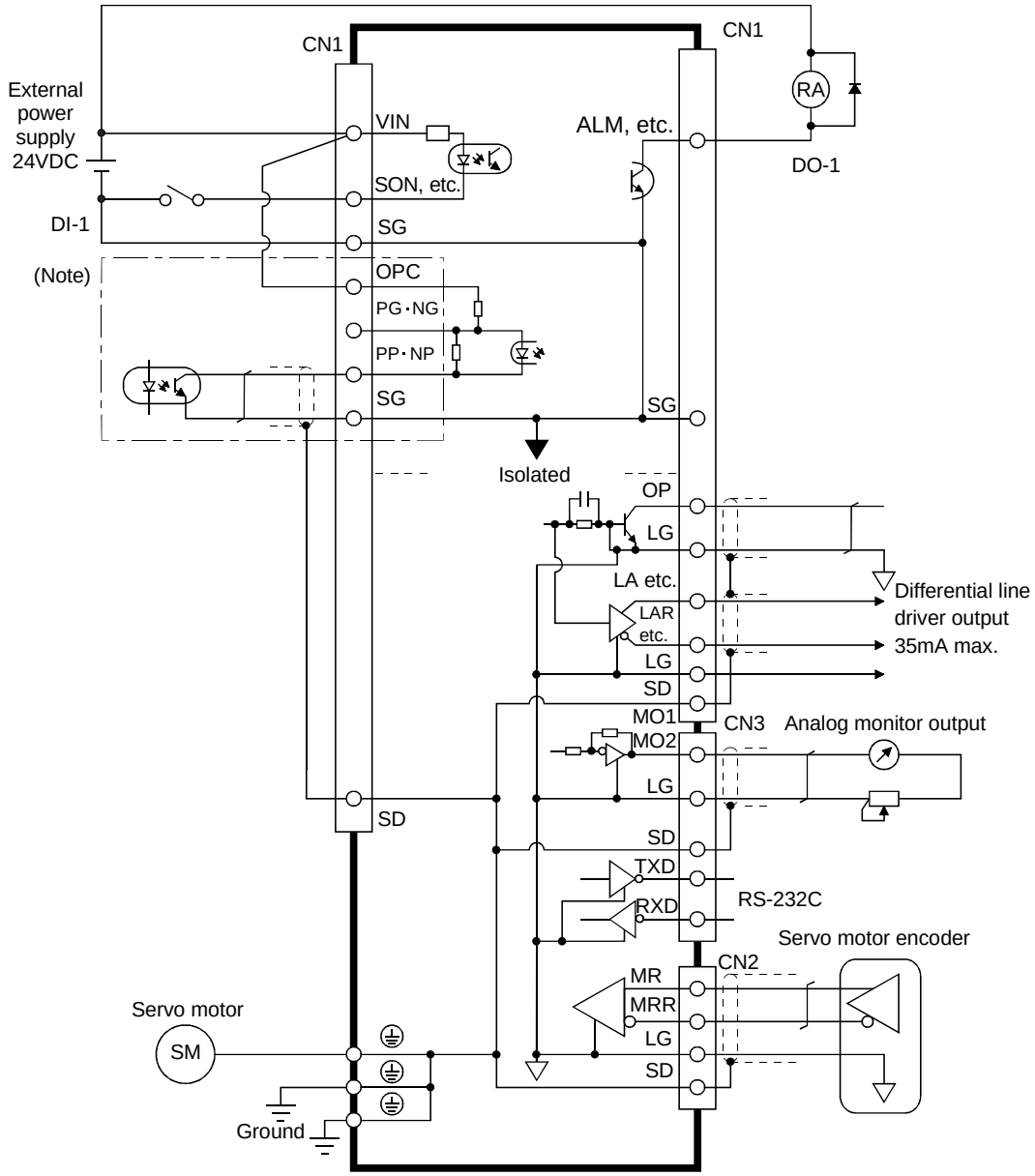
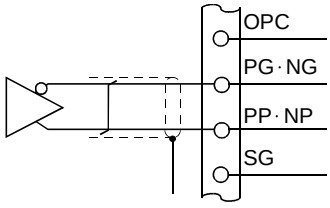


Note: For the open collection pulse train input. Make the following connection for the different line driver pulse train input.



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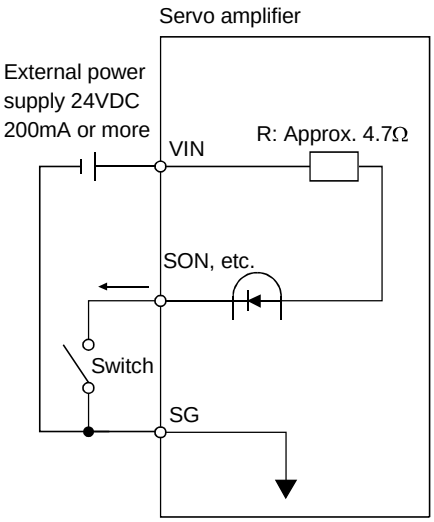
3.6.2 Detailed description of the interfaces

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



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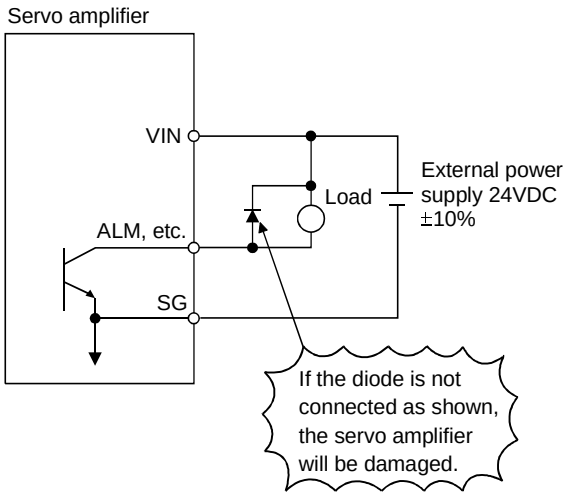
(2) Digital output interface DO-1

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

(a) Inductive load



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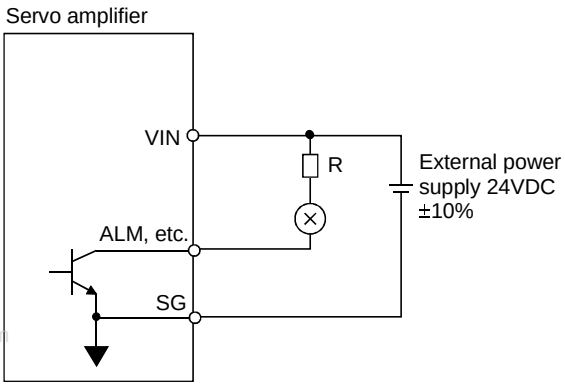
(b) Lamp load



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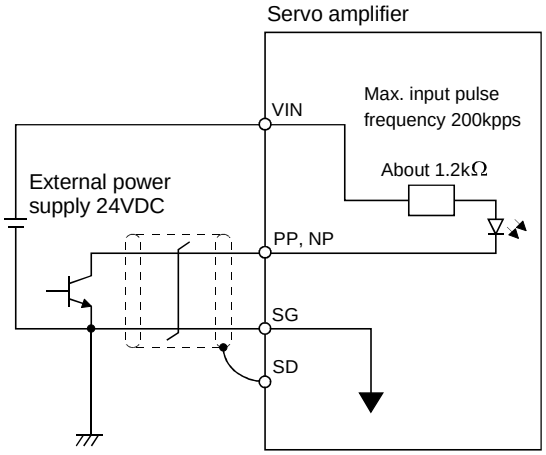
(3) Pulse train input interface DI-2

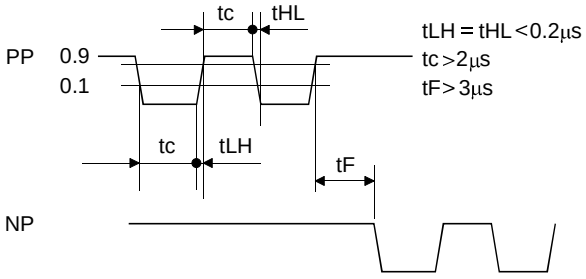
Provide a pulse train signal in the open collector or differential line driver system.

(a) Open collector system

1) Interface



2) Conditions of the input pulse



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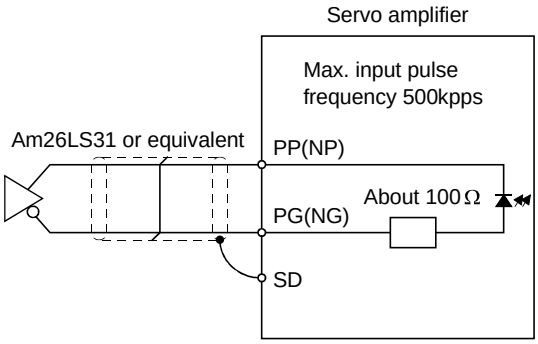
(b) Differential line driver system

1) Interface



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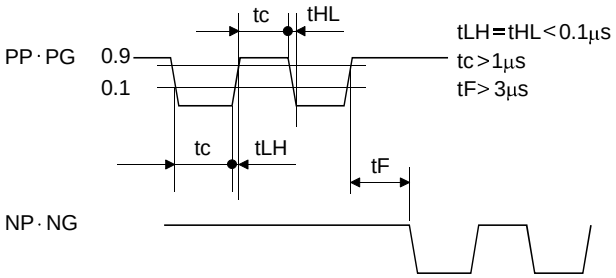
2) Conditions of the input pulse

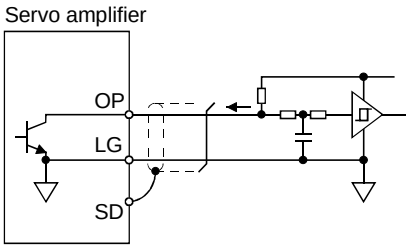


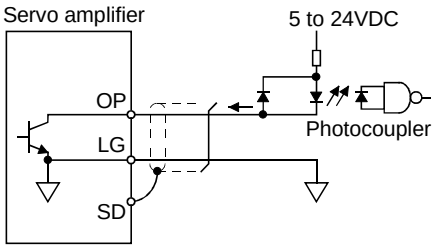
(4) Encoder pulse output

(a) Open collector system

Interface

Max. output current : 35mA





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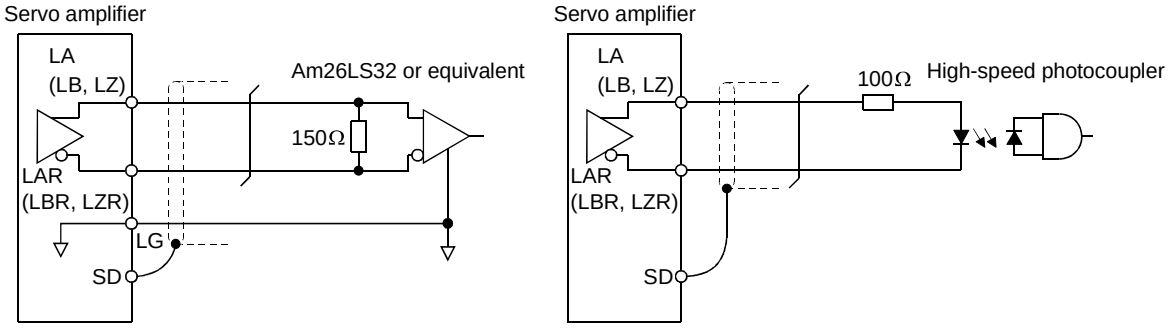
(b) Differential line driver system

1) Interface

Max. output current: 35mA



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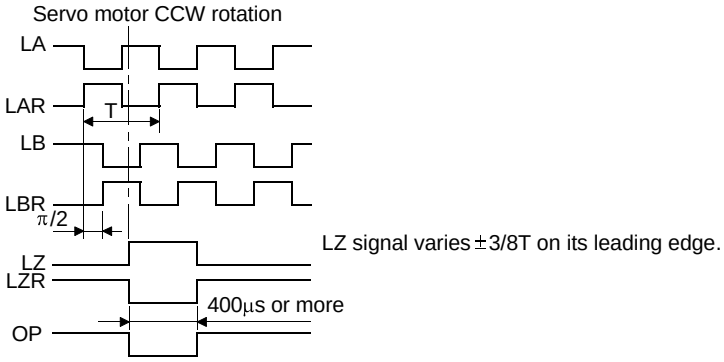
2) Output pulse



(5) Analog output

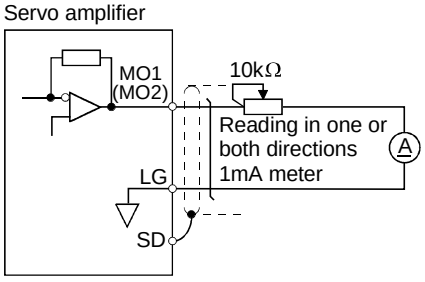
Output voltage ±10V

Max.1mA

Max. output current

Resolution : 10bit

Servo amplifier



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3.7 Input power supply circuit

⚠ CAUTION	▪ When the servo amplifier has become faulty, switch power off on the servo amplifier power side. Continuous flow of a large current may cause a fire. ▪ Use the trouble signal to switch power off. Otherwise, a regenerative brake transistor fault or the like may overheat the regenerative brake resistor, causing a fire.

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

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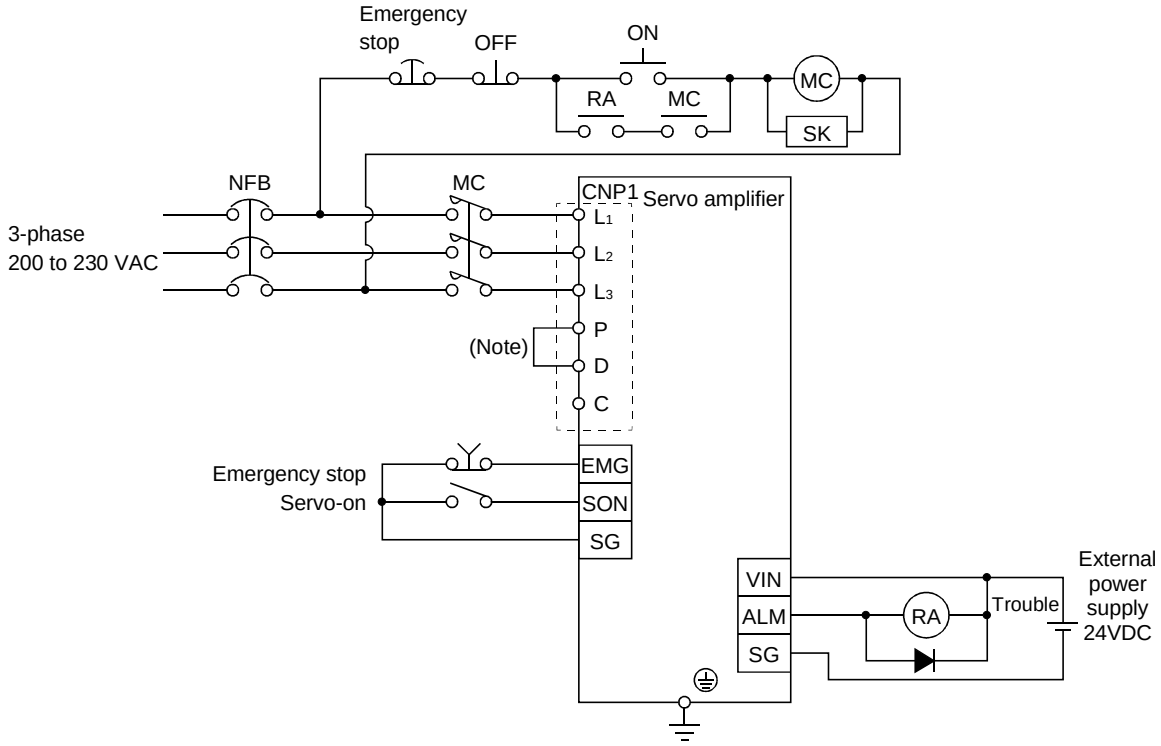
3.7.1 Connection example

Wire the power supply and main circuit as shown below so that the servo-on signal turns off as soon as alarm occurrence is detected and power is shut off.
A no-fuse breaker (NFB) must be used with the input cables of the power supply.

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



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

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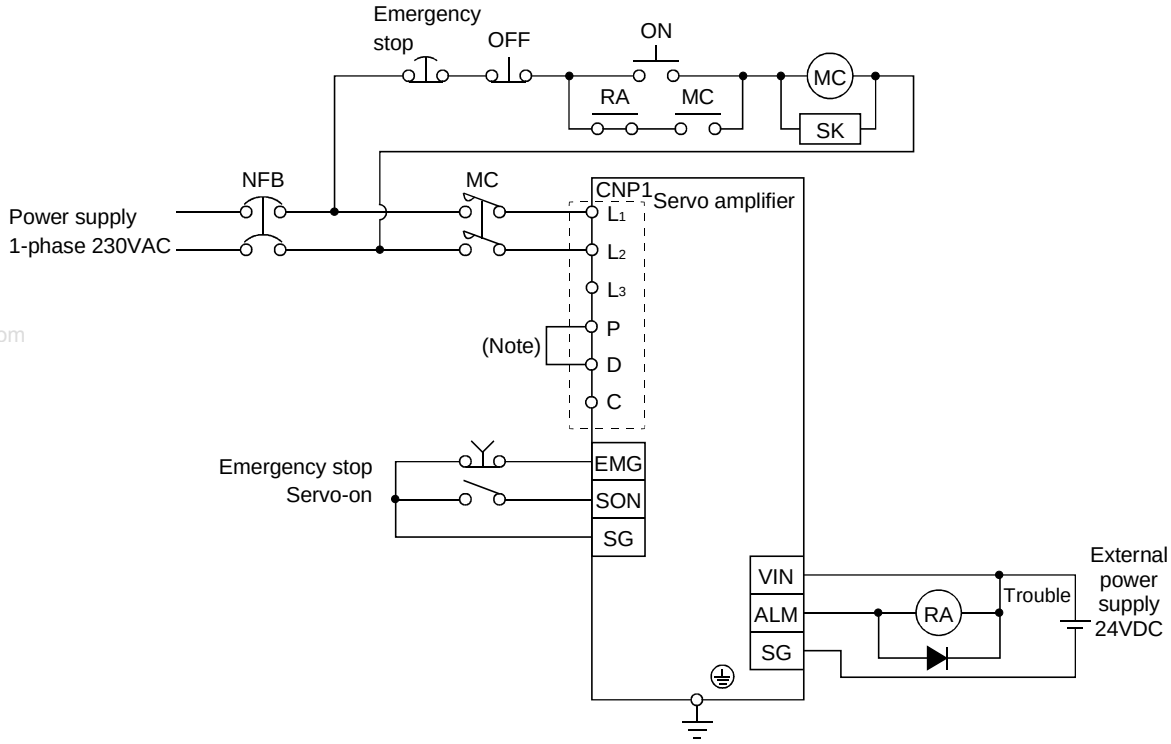
(2) For 1-phase 230VAC power supply



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

3.7.2 Terminals

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

Connected terminal (Application)	Symbol	Description
Power supply	L_1 L_2 L_3	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 leave L_3 open. Servo amplifier / Power supply: MR-E-10A to 70A — MR-E-100A/200A 3-phase 200 to 230VAC, 50/60Hz — L_1 • L_2 • L_3 1-phase 230VAC, 50/60Hz — L_1 • L_2
Servo motor output	U V W	Connect to the servo motor power supply terminals (U, V, W).
Regenerative brake option	P C D	To use the built-in regenerative brake resistor of the servo amplifier, connect the wiring across P-D of the power supply connector (CNP1). When using the regenerative brake option, always remove the wiring from across P-D and connect the regenerative brake option across P-C. Refer to Section 13.1.1 for details.
Protective earth (PE)	⏚	Connect this terminal to the protective earth (PE) terminals of the servo motor and control box for grounding.

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

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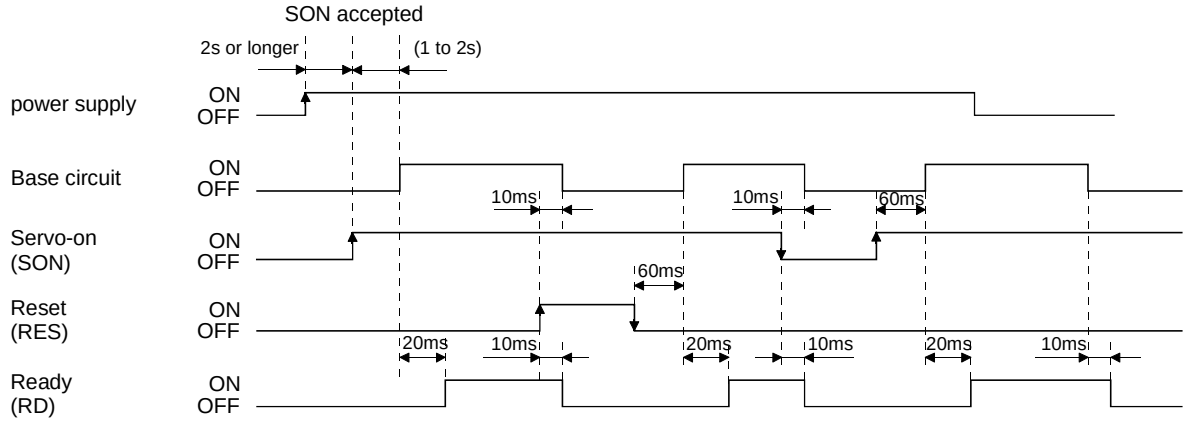
(2) Timing chart

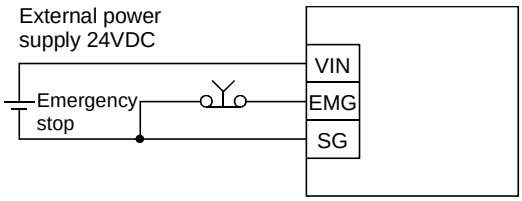


(3) Emergency stop

Make up a circuit which shuts off power as soon as EMG-SG are opened at an emergency stop. To ensure safety, always install an external emergency stop switch across EMG-SG. By disconnecting EMG-SG, 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.



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3.8 Connection of servo amplifier and servo motor

3.8.1 Connection instructions

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

⚠ CAUTION	・Connect the wires to the correct phase terminals (U, V, W) of the servo amplifier and servo motor. Otherwise, the servo motor will operate improperly. ・Do not connect AC power supply directly to the servo motor. Otherwise, a fault may occur.

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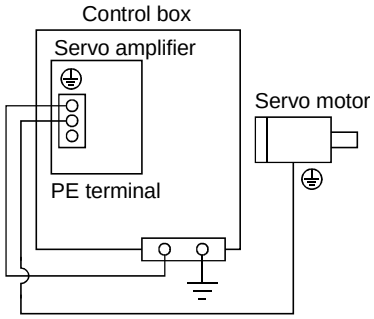
POINT

・Do not apply the test lead bars or like of a tester directly to the pins of the connectors supplied with the servo motor. Doing so will deform the pins, causing poor contact.

・The connector (CNP2) for supplying the power to the motor is optional. Be sure to purchase it.

The connection method differs according to the series and capacity of the servo motor and whether or not the servo motor has the electromagnetic brake. Perform wiring in accordance with this section.

(1) For grounding, connect the earth cable of the servo motor to the protective earth (PE) terminal of the servo amplifier and connect the ground cable of the servo amplifier to the earth via the protective earth of the control box. Do not connect them directly to the protective earth of the control panel.



(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.

3.8.2 Connection diagram

The following table lists wiring methods according to the servo motor types. Use the connection diagram which conforms to the servo motor used. For cables required for wiring, refer to Section 13.2.1. For encoder cable connection, refer to Section 13.1.4. For the signal layouts of the connectors, refer to Section 3.8.3.
For the servo motor connector, refer to Chapter 3 of the Servo Motor Instruction Manual.

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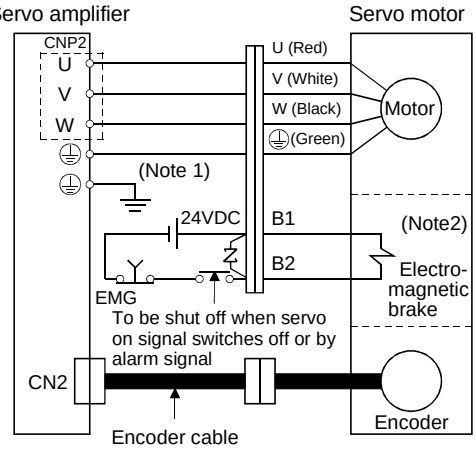
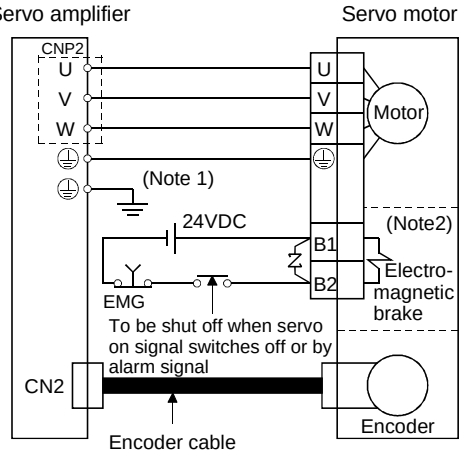
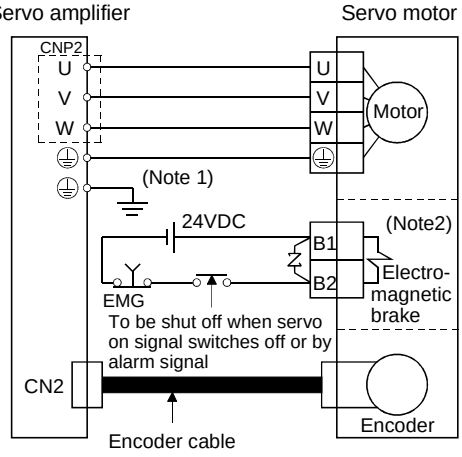
Servo motor	Connection diagram
HC-KFE13 (B) to 73 (B)	 Note:1. To prevent an electric shock, always connect the protective earth (PE) terminal of the servo amplifier to the protective earth (PE) of the control box. 2. This circuit applies to the servo motor with electromagnetic brake.
HC-SFE52 (B) to 152 (B)	 Note:1. To prevent an electric shock, always connect the protective earth (PE) terminal of the servo amplifier to the protective earth (PE) of the control box. 2. This circuit applies to the servo motor with electromagnetic brake.
HC-SFE202 (B)	 Note:1. To prevent an electric shock, always connect the protective earth (PE) terminal of the servo amplifier to the protective earth (PE) of the control box. 2. This circuit applies to the servo motor with electromagnetic brake.

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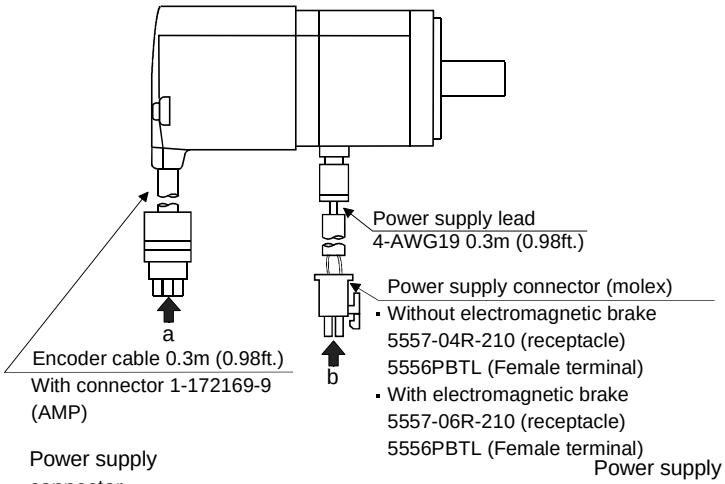
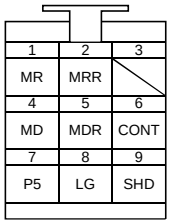
3.8.3 I/O terminals

(1) HC-KFE series

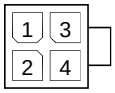


Encoder connector signal arrangement



View a

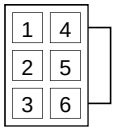
Power supply connector 5557-04R-210



View b

Pin	Signal
1	U
2	V
3	W
4	Earth

Power supply connector 5557-06R-210



View b

Pin	Signal
1	U
2	V
3	W
4	Earth
5	(Note) B1
6	(Note) B2

Note: Supply electromagnetic brake power (24VDC). There is no polarity.

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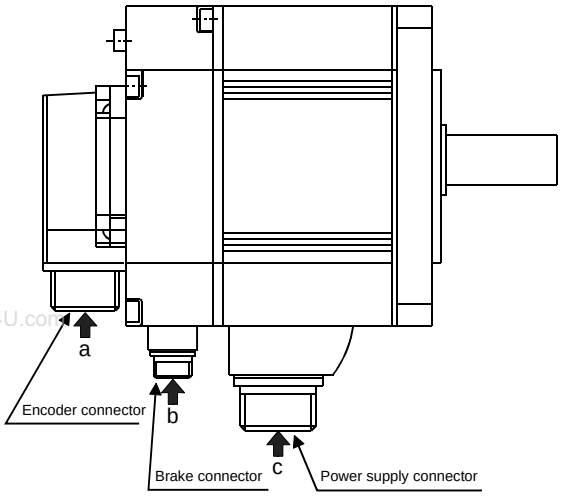
(2) HC-SFE series



Servo motor	Servo motor side connectors		
	For power supply	For encoder	Electromagnetic brake connector
HC-SFE52(B) to 152(B)	CE05-2A22-23PD-B	MS3102A20-29P	The connector for power is shared.
HC-SFE202(B)	CE05-2A24-17PD-B		MS3102A10SL-4P

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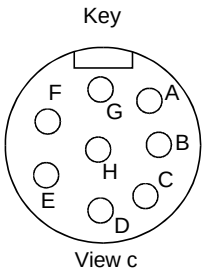
Power supply connector signal arrangement

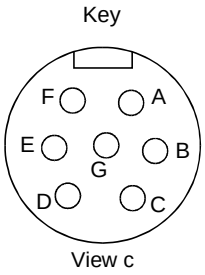
CE05-2A22-23PD-B



Pin	Signal
A	U
B	V
C	W
D	⏚ (Earth)
E	
F	
G	(Note) B1
H	(Note) B2

Note: Supply electromagnetic brake power (24VDC). There is no polarity.

CE05-2A24-10PD-B

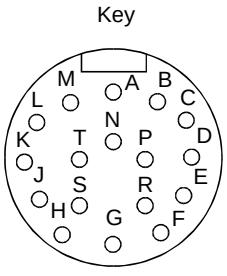


Pin	Signal
A	U
B	V
C	W
D	⏚ (Earth)
E	(Note) B1
F	(Note) B2
G	

Note: Supply electromagnetic brake power (24VDC). There is no polarity.

Encoder connector signal arrangement

MS3102A20-29P

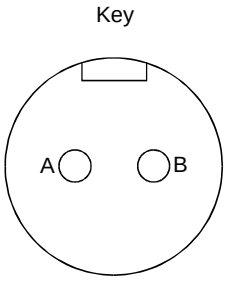


Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	
G	
H	
J	

Pin	Signal
K	
L	
M	CONT
N	SHD
P	
R	LG
S	P5
T	

Electromagnetic brake connector signal arrangement

MS3102A10SL-4P



Pin	Signal
A	(Note)B1
B	(Note)B2

Note: Supply electromagnetic brake power (24VDC). There is no polarity.

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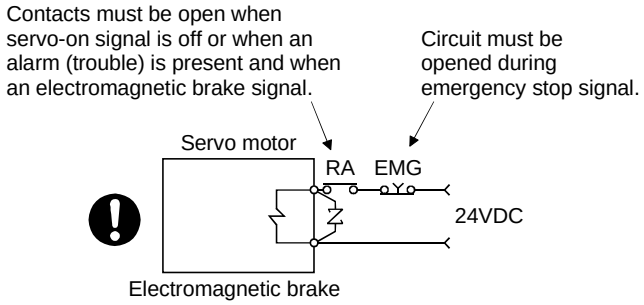
3.9 Servo motor with electromagnetic brake

CAUTION

- Configure the electromagnetic brake operation circuit so that it is activated not only by the servo amplifier signals but also by an external emergency stop signal.



- The electromagnetic brake is provided for holding purpose and must not be used for ordinary braking.

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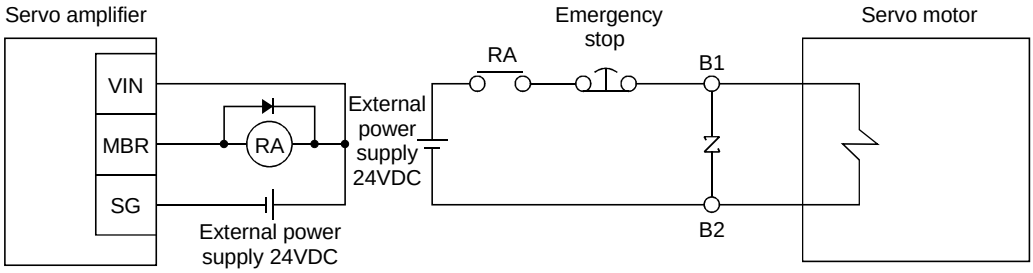
POINT

- Refer to the Servo Motor Instruction Manual for specifications such as the power supply capacity and operation delay time of the electromagnetic brake.

Note the following when the servo motor equipped with electromagnetic brake is used for applications requiring a brake to hold the motor shaft (vertical lift applications):

1) Set "□□1□"in parameter No.1 to make the electromagnetic brake interlock signal (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 signal is on, the base circuit is shut off. When using the servo motor with a vertical shaft, use the electromagnetic brake interlock signal (MBR).
5) Switch off the servo-on signal after the servo motor has stopped.

(1) Connection diagram



(2) Setting

1) Set "□□1□"in parameter No.1 to make the electromagnetic brake interlock signal (MBR) valid.
2) Using parameter No. 33 (electromagnetic brake sequence output), set a time delay (Tb) at servo-off from electromagnetic brake operation to base circuit shut-off as in the timing chart shown in (3) in this section.

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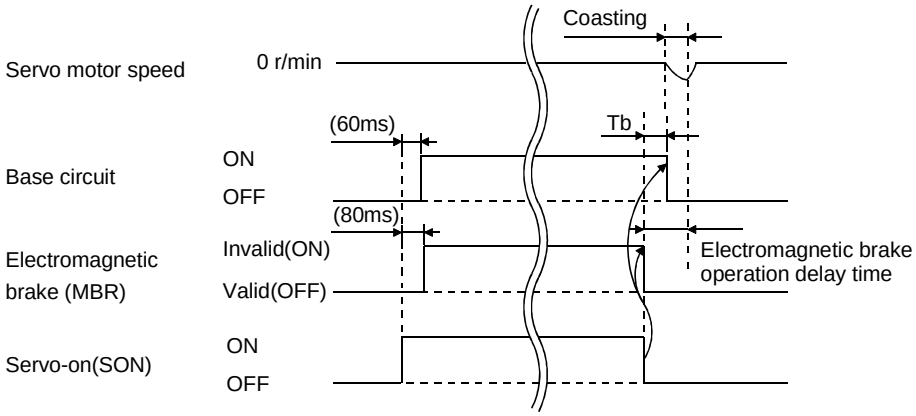
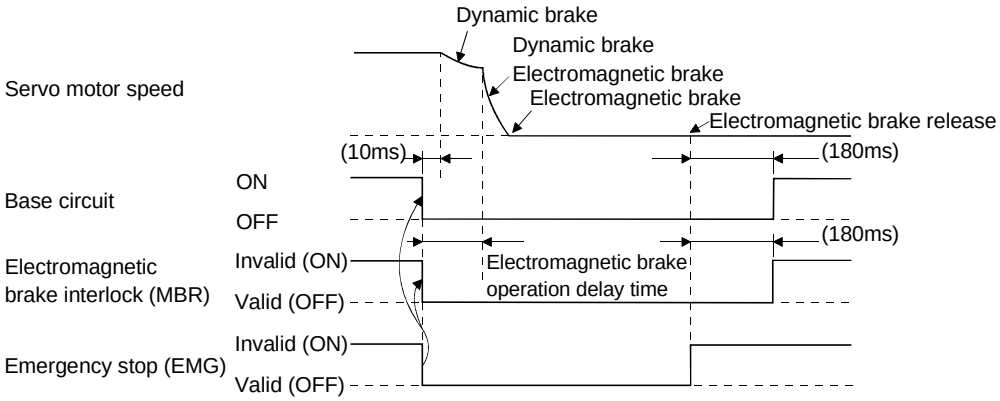
(3) Timing charts

(a) 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 Tb to about the same as the electromagnetic brake operation delay time to prevent a drop.



(b) Emergency stop signal (EMG) ON/OFF



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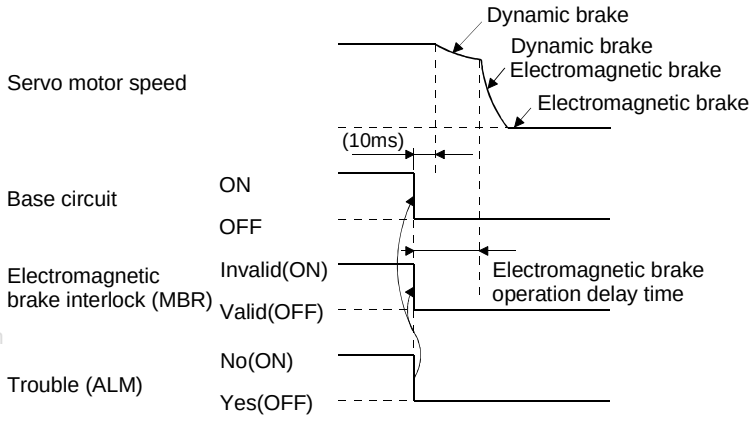
(c) Alarm occurrence



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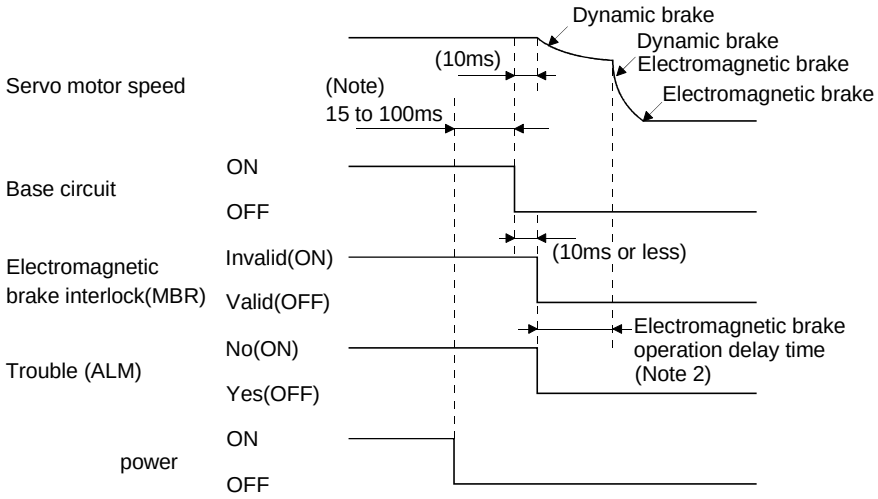
(d) Power off



Note: Changes with the operating status.

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3.10 Grounding

> **WARNING**
> - Ground the servo amplifier and servo motor securely.
> - To prevent an electric shock, always connect the protective earth (PE) terminal 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 cablerouting, 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.

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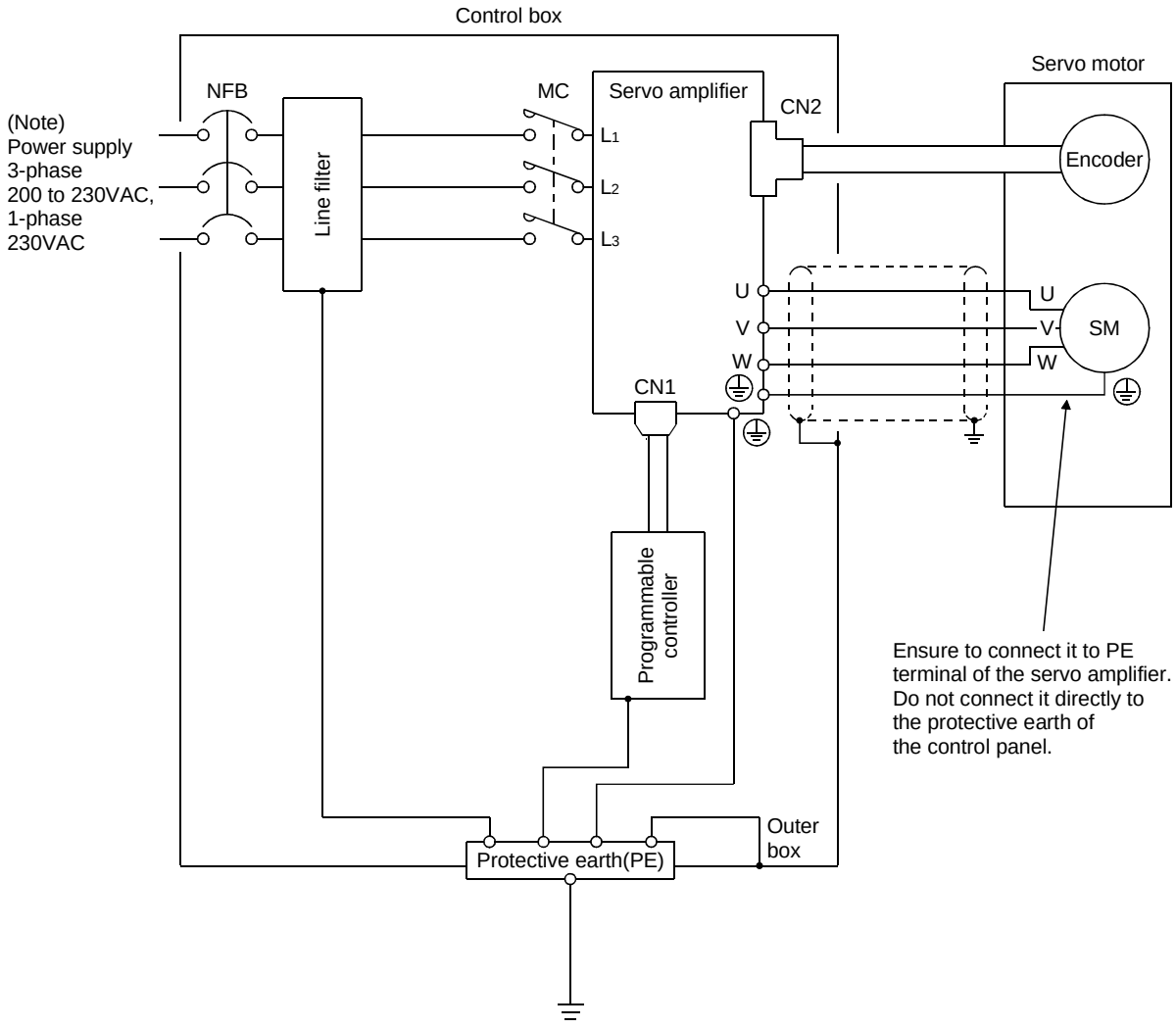
To conform to the EMC Directive, refer to the EMC Installation Guidelines (IB(NA)67310).



Note: For 1-phase 230VAC, connect the power supply to $L_1 \cdot L_2$ and leave L_3 open.

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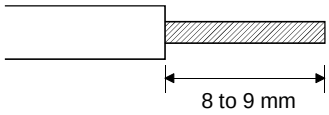
3.11 Servo amplifier connectors (CNP1, CNP2) wiring method (When MR-ECPN1-B and MR-ECPN2-B of an option are used.)

(1) Termination of the cables

Solid wire: After the sheath has been stripped, the cable can be used as it is. (Cable size: 0.2 to 2.5mm²)



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Twisted wire: Use the cable after stripping the sheath 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. (Cable size: 0.2 to 2.5mm²)Alternatively, a bar terminal may be used to put the wires together.(Phoenix contact make)

Cable size		Bar terminal type		Crimping tool	Maker
[mm²]	AWG	For 1 cable	For 2 cables		
1.25	16	BT1.25-9-1		NH1	NICHIFU
		TUB-1.25		YHT-2210	JST
1.5	16	AI1.5-8BK	AI-TWIN2 × 1.5-8BK	CRIMPFOX-UD6	Phoenix Contact
			AI-TWIN2 × 1.5-12BK		
2	14	BT2-9-1		NH1	NICHIFU
		TUB-2		YHT-2210	JST
2.5	14	AI2.5-8BU AI2.5-8BK-1000	AI-TWIN2 × 2.5-10BU AI-TWIN2 × 2.5-13BU	CRIMPFOX-UD6	Phoenix Contact

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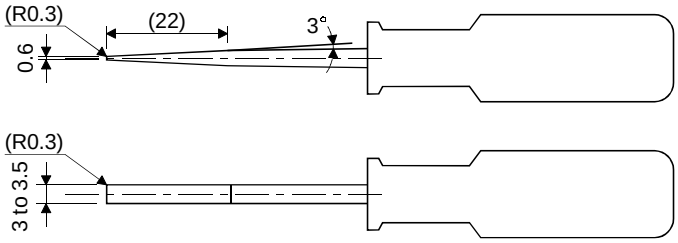
(2) Inserting the cable into the connector

(a) Applicable flat-blade screwdriver dimensions

Always use the screwdriver shown here to do the work.

[Unit: mm]



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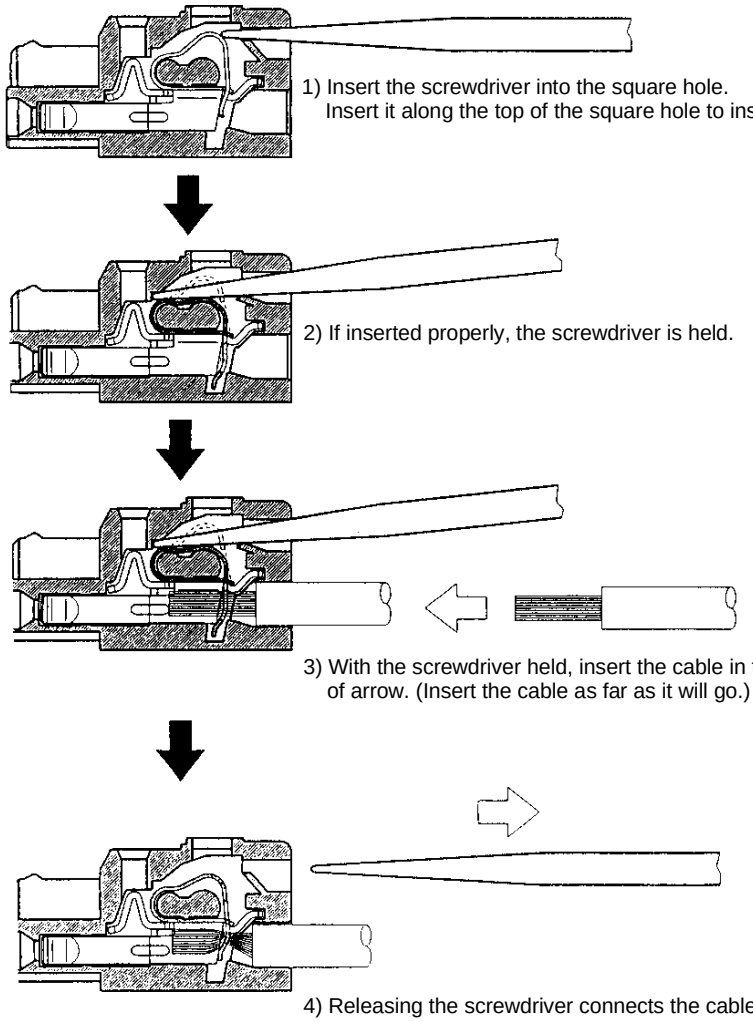
(b) When using the flat-blade screwdriver - part 1



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.

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(c) When using the flat-blade screwdriver - part 2

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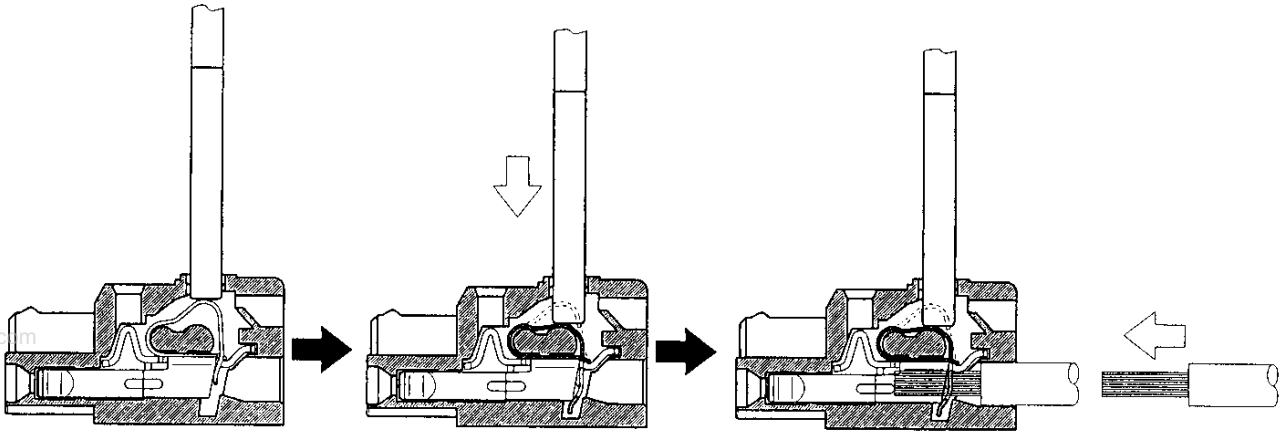
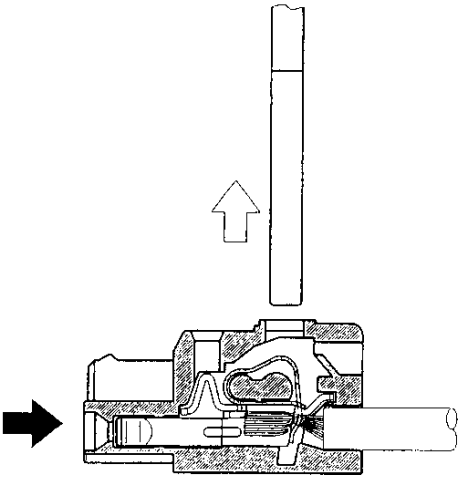


1) Insert the screwdriver into the square window at top of the connector.

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.

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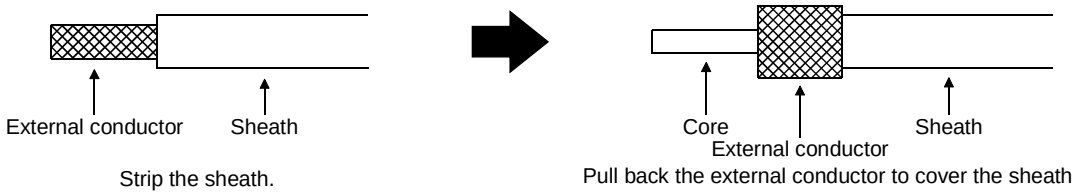
3.12 Instructions for the 3M connector

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.



Strip the sheath.

Pull back the external conductor to cover the sheath

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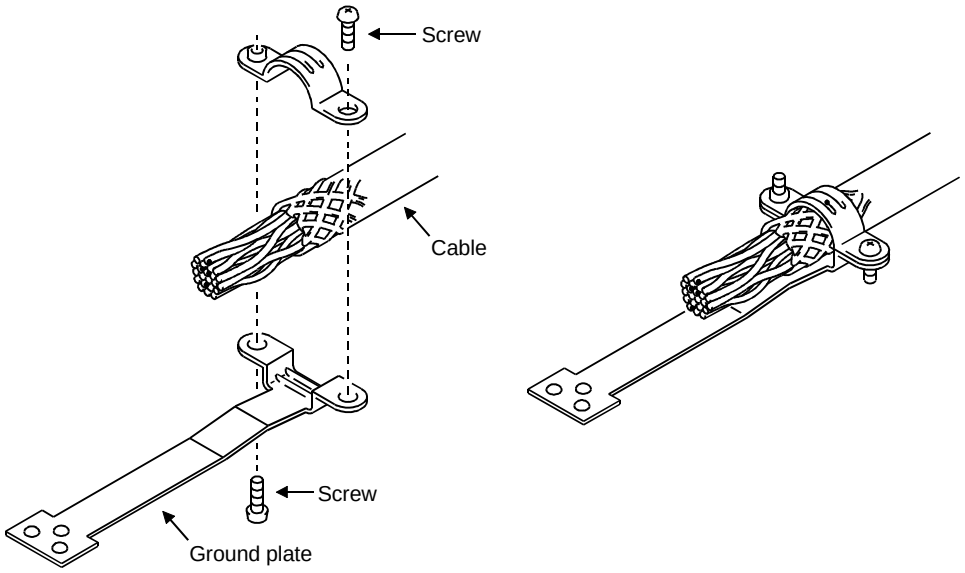

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4. OPERATION

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.

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

(f) When stroke end limit switches are used, the signals across LSP-SG and LSN-SG 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.

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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. ・During power-on for some after power-off, do not touch or close a parts (cable etc.) to the servo amplifier heat sink, regenerative brake resistor, the servo motor, etc. Their temperatures may be high and you may get burnt or a parts may damaged.

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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

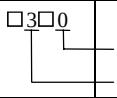
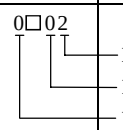
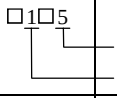
1) Switch off the servo-on (SON) signal.
2) When power is switched on, the display shows "C (Cumulative feedback pulses)", and in two second later, shows data.

(2) Test operation 1

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 Sections 6.5 for the setting method.

Parameter No.	Name	Setting	Description
0	Control mode, regenerative brake option selection		Position control mode MR-RB12 regenerative brake option is used.
1	Function selection 1		Input filter 3.555ms (initial value) Electromagnetic brake interlock signal is not used. Used in incremental positioning system.
2	Auto tuning		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.

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(4) Servo-on

Switch the servo-on in the following procedure:

1) Switch on power supply.

2) Switch on the servo-on signal (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 low speed and check the rotation direction, etc. If it does not run in the intended direction, check the input signal.

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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 3.9, (2) for the servo motor equipped with electromagnetic brake. Note that the stop pattern of stroke end (LSP/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 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.

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4.2.3 Internal speed control mode

(1) Power on

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

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.)

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(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 Sections 6.5 for the setting method.

Parameter No.	Name	Setting	Description
0	Control mode, regenerative brake option selection	□0□2	Internal speed control mode Regenerative brake option is not used.
1	Function selection 1	□□12	Input filter 3.555ms (initial value) Electromagnetic brake interlock signal (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 2	1500	Set 1500r/min.
10	Internal speed command 3	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 signal (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 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)

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(6) Stop

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

Refer to Section 3.9, (2) for the servo motor equipped with electromagnetic brake. Note that simultaneous ON or simultaneous OFF of stroke end (LSP, 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.

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(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 occurs.

(d) Stroke end (LSP/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.

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5. PARAMETERS

> ⚠ CAUTION
> ▪ Never adjust or change the parameter values extremely as it will make operation instable.

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.

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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 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		

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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

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(1) Item list

	No.	Symbol	Name	Control mode	Initial value	Unit	Customer setting
Basic parameters	0	*STY	Control mode ,regenerative brake 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 (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 block	P▪S	0000		

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	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	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	0.1 times	
	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		

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	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	0.1 times	
	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.

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(2) Details list

Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	0	*STY	Control mode, regenerative brake option selection Used to select the control mode and regenerative brake option. [ ][ ][ ][ ] Select the control mode. 0:Position 1:Position and internal speed 2:Internal speed Motor series selection 0:HC-KFE 1:HC-SFE Selection of regenerative brake option 0:Not used (The built-in regenerative brake resistor used.) 2:MR-RB032 3:MR-RB12 4:MR-RB32 5:MR-RB30 6:MR-RB50 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 brake option to burn. · If the regenerative brake 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 signal	0002		Refer to Name and function column.	P·S

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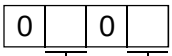
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="4">Basic parameters</td><td>2</td><td>ATU</td><td>Auto tuning
Used to selection the response level, etc. for execution of auto tuning.
Refer to Chapter 7.
 

Auto tuning response level setting
<table><tr><th>Set value</th><th>Response level</th><th>Machine resonance frequency guideline</th></tr><tr><td>1</td><td rowspan="16">Low response
↑
Middle response
↑
High response</td><td>15Hz</td></tr><tr><td>2</td><td>20Hz</td></tr><tr><td>3</td><td>25Hz</td></tr><tr><td>4</td><td>30Hz</td></tr><tr><td>5</td><td>35Hz</td></tr><tr><td>6</td><td>45Hz</td></tr><tr><td>7</td><td>55Hz</td></tr><tr><td>8</td><td>70Hz</td></tr><tr><td>9</td><td>85Hz</td></tr><tr><td>A</td><td>105Hz</td></tr><tr><td>B</td><td>130Hz</td></tr><tr><td>C</td><td>160Hz</td></tr><tr><td>D</td><td>200Hz</td></tr><tr><td>E</td><td>240Hz</td></tr><tr><td>F</td><td>300Hz</td></tr></table>· 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.)
<table><tr><th>Set value</th><th>Gain adjustment mode</th><th>Description</th></tr><tr><td>0</td><td>Interpolation mode</td><td>Fixes position control gain 1 (parameter No. 6).</td></tr><tr><td>1</td><td>Auto tuning mode 1</td><td>Ordinary auto tuning.</td></tr><tr><td>2</td><td>Auto tuning mode 2</td><td>Fixes the load inertia moment ratio set in parameter No. 34. Response level setting can be changed.</td></tr><tr><td>3</td><td>Manual mode 1</td><td>Simple manual adjustment.</td></tr><tr><td>4</td><td>Manual mode 2</td><td>Manual adjustment of all gains.</td></tr></table></td><td>0105</td><td></td><td>Refer to Name and function column.</td><td>P·S</td></tr>
<tr><td>3</td><td>CMX</td><td>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.</td><td>1</td><td></td><td>0
1
to
65535</td><td>P</td></tr>
<tr><td>4</td><td>CDV</td><td>Electronic gear denominator
Used to set the electronic gear denominator value.
For the setting, refer to Section 5.2.1.</td><td>1</td><td></td><td>1
to
65535</td><td>P</td></tr>
</table>

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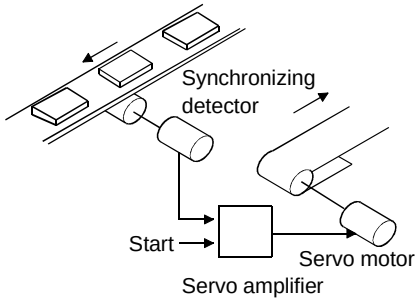
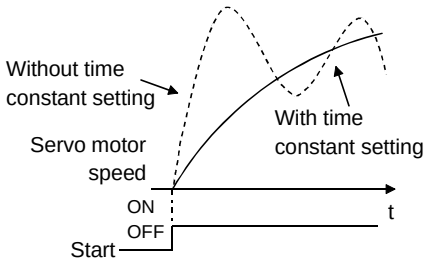
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	5	INP	In-position range Used to set the in-position signal (INP) output range in the command pulse increments prior to electronic gear calculation.	100	pulse	0 to 10000	P
	6	PG1	Position loop gain 1 Used to set the gain of position loop. Increase the gain to improve trackability 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

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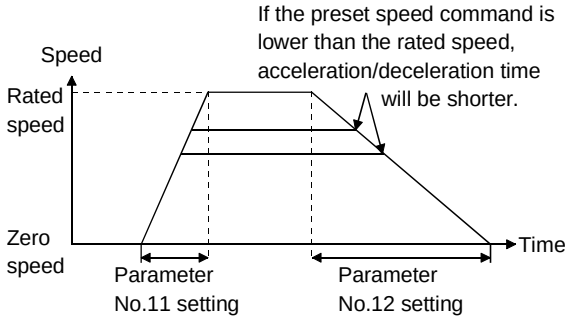
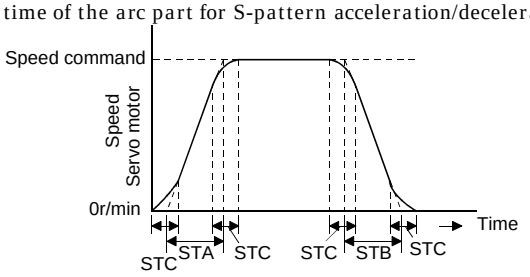
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="4">Basic parameters</td><td>9</td><td>SC2</td><td>Internal speed command 2
Used to set speed 2 of internal speed commands.</td><td>500</td><td>r/min</td><td>0 to instantaneous permissible speed</td><td>S</td></tr>
<tr><td>10</td><td>SC3</td><td>Internal speed command 3
Used to set speed 3 of internal speed commands.</td><td>1000</td><td>r/min</td><td>0 to instantaneous permissible speed</td><td>S</td></tr>
<tr><td>11</td><td>STA</td><td>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.
 

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.</td><td>0</td><td>ms</td><td>0 to 20000</td><td>S</td></tr>
<tr><td>12</td><td>STB</td><td>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.</td><td>0</td><td></td><td></td><td></td></tr>
<tr><td>13</td><td>STC</td><td>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 $\frac{2000000}{STA}$ 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]. }</td><td>0</td><td>ms</td><td>0 to 1000</td><td>S</td></tr>
</table>

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="4">Basic parameters</td><td>14</td><td></td><td>For manufacturer setting
Don't change this value by any means.</td><td>0</td><td></td><td></td><td></td></tr>
<tr><td>15</td><td>*SNO</td><td>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.</td><td>0</td><td>sta-tion</td><td>0 to 31</td><td>P･S</td></tr>
<tr><td>16</td><td>*BPS</td><td>Serial communication function selection, alarm history clear
Used to select the serial communication baudrate, select various communication conditions, and clear the alarm history.
[ ][0][ ][ ]
Serial baudrate selection
0: 9600 [bps]
1: 19200[bps]
2: 38400[bps]
3: 57600[bps]
Alarm history clear
0: Invalid
1: Valid
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</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P･S</td></tr>
<tr><td>17</td><td>MOD</td><td>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][ ]
<table><tr><th>Setting</th><th>Analog monitor 2 (MO2)</th><th>Analog monitor 1 (MO1)</th></tr><tr><td>0</td><td colspan="2">Servo motor speed (±8V/max. speed)</td></tr><tr><td>1</td><td colspan="2">Torque (±8V/max. torque)</td></tr><tr><td>2</td><td colspan="2">Servo motor speed (+8V/max. speed)</td></tr><tr><td>3</td><td colspan="2">Torque (+8V/max. torque)</td></tr><tr><td>4</td><td colspan="2">Current command (±8V/max. current command)</td></tr><tr><td>5</td><td colspan="2">Command pulse frequency (±10V/500kpulse/s)</td></tr><tr><td>6</td><td colspan="2">Droop pulses (±10V/128 pulses)</td></tr><tr><td>7</td><td colspan="2">Droop pulses (±10V/2048 pulses)</td></tr><tr><td>8</td><td colspan="2">Droop pulses (±10V/8192 pulses)</td></tr><tr><td>9</td><td colspan="2">Droop pulses (±10V/32768 pulses)</td></tr><tr><td>A</td><td colspan="2">Droop pulses (±10V/131072 pulses)</td></tr><tr><td>B</td><td colspan="2">Bus voltage (+8V/400V)</td></tr></table></td><td>0100</td><td></td><td>Refer to Name and function column.</td><td>P･S</td></tr>
</table>

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="2">Basic parameters</td><td>18</td><td>*DMD</td><td>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><th>Control Mode</th><th>Status display at power-on</th></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.</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
<tr><td>19</td><td>*BLK</td><td>Parameter block
Used to select the reference and write ranges of the parameters.
Operation can be performed for the parameters marked ○.
<table><tr><th>Set value</th><th>Operation</th><th>Basic parameters No. 0 to No. 19</th><th>Expansion parameters 1 No. 20 to No. 49</th><th>Expansion parameters 2 No. 50 to No. 84</th></tr><tr><td rowspan="2">0000 (Initial value)</td><td>Reference</td><td>○</td><td></td><td></td></tr><tr><td>Write</td><td>○</td><td></td><td></td></tr><tr><td rowspan="2">000A</td><td>Reference</td><td>No. 19 only</td><td></td><td></td></tr><tr><td>Write</td><td>No. 19 only</td><td></td><td></td></tr><tr><td rowspan="2">000B</td><td>Reference</td><td>○</td><td>○</td><td></td></tr><tr><td>Write</td><td>○</td><td></td><td></td></tr><tr><td rowspan="2">000C</td><td>Reference</td><td>○</td><td>○</td><td></td></tr><tr><td>Write</td><td>○</td><td>○</td><td></td></tr><tr><td rowspan="2">000E</td><td>Reference</td><td>○</td><td>○</td><td>○</td></tr><tr><td>Write</td><td>○</td><td>○</td><td>○</td></tr><tr><td rowspan="2">100B</td><td>Reference</td><td>○</td><td></td><td></td></tr><tr><td>Write</td><td>No. 19 only</td><td></td><td></td></tr><tr><td rowspan="2">100C</td><td>Reference</td><td>○</td><td>○</td><td></td></tr><tr><td>Write</td><td>No. 19 only</td><td></td><td></td></tr><tr><td rowspan="2">100E</td><td>Reference</td><td>○</td><td>○</td><td>○</td></tr><tr><td>Write</td><td>No. 19 only</td><td></td><td></td></tr></table></td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
</table>

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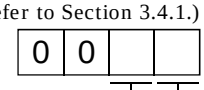
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	20	*OP2	Function selection 2 Used to select restart after instantaneous power failure, servo lock at a stop in internal speed control mode, and slight vibration suppression control. Restart after instantaneous power failure If the input power supply voltage had reduced in the internal speed control mode to stop the servo motor due to the undervoltage alarm (AL.10) but the supply voltage has returned to normal, the servo motor can be restarted by merely switching on the start signal without resetting the alarm. 0: Invalid 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 In case of the internal speed control mode, set "1" at the second digit and validate servo lock at stop to use this setting. 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.)  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

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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. 0 0 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	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/deceleration 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 (ZSP).	50	r/min	0 to 10000	P·S
	25		For manufacturer setting Don't change this value by any means.	0			
	26		For manufacturer setting Don't change this value by any means.	100			

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="11">Expansion parameters 1</td><td>27</td><td>*ENR</td><td>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 output A/B-phase pulses are as indicated below:
A・B-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 = $\frac{\text{Resolution per servo motor revolution}}{\text{Set value}}$ [pulses/rev]
At the setting of 8, for example, the actually output A/B-phase pulses are as indicated below:
A・B-phase output pulses = $\frac{10000}{8} \cdot \frac{1}{4} \fallingdotseq 313$[pulse]</td><td>4000</td><td>pulse/ rev</td><td>1 to 65535</td><td>P・S</td></tr>
<tr><td>28</td><td>TL1</td><td>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><th>(Note) External input signals TL1</th><th>Torque limit value made valid</th></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 :off
1 :on
When torque is output in analog monitor output, this set value is the maximum output voltage (+8V). (Refer to Section 3.4.1, (5))</td><td>100</td><td>%</td><td>0 to 100</td><td>P・S</td></tr>
<tr><td>29</td><td></td><td>For manufacturer setting
Don't change this value by any means.</td><td>0</td><td></td><td></td><td></td></tr>
<tr><td>30</td><td></td><td>For manufacturer setting
Don't change this value by any means.</td><td>0</td><td></td><td></td><td></td></tr>
<tr><td>31</td><td>MO1</td><td>Analog monitor 1 offset
Used to set the offset voltage of the analog monitor 1 (MO1).</td><td>0</td><td>mV</td><td>−999 to 999</td><td>P・S</td></tr>
<tr><td>32</td><td>MO2</td><td>Analog monitor 2 offset
Used to set the offset voltage of the analog monitor 2 (MO2).</td><td>0</td><td>mV</td><td>−999 to 999</td><td>P・S</td></tr>
<tr><td>33</td><td>MBR</td><td>Electromagnetic brake sequence output
Used to set the delay time (Tb) between electronic brake interlock (MBR) and the base drive circuit is shut-off.</td><td>100</td><td>ms</td><td>0 to 1000</td><td>P・S</td></tr>
<tr><td>34</td><td>GD2</td><td>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.</td><td>70</td><td>0.1 times</td><td>0 to 3000</td><td>P・S</td></tr>
</table>

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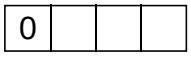
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	35	PG2	Position loop gain 2 Used to set the gain of the position loop. Set this parameter to increase the position response to level load disturbance. Higher setting increases the response level but 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
	40		For manufacturer setting Don't 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).  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

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td>Expansion parameters 1</td><td>42</td><td>*DI1</td><td>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.

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 setting is invalid.

Clear (CR) selection
0: Droop pulses are cleared on the leading edge.
1: While turning on, droop pulses are always cleared.</td><td>0002</td><td></td><td>Refer to Name and function column.</td><td>P/S

P▪S</td></tr>
</table>

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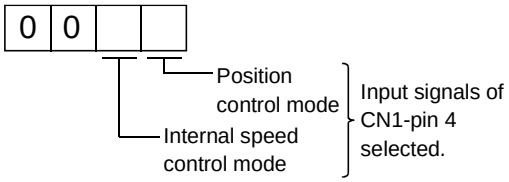
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td>Expansion parameters 1</td><td>43</td><td>*DI2</td><td>
Input signal selection 2 (CN1-4)
Allows any input signal to be assigned to CN1-pin 4.
Note that the setting digit and assigned signal differ according to the control mode.


Signals that may be assigned in each control mode are indicated below by their symbols.
Setting of any other signal will be invalid.
<table>
<tr><th rowspan="2">Set value</th><th colspan="2">(Note) Control mode</th></tr>
<tr><th>P</th><th>S</th></tr>
<tr><td>0</td><td></td><td></td></tr>
<tr><td>1</td><td>SON</td><td>SON</td></tr>
<tr><td>2</td><td>RES</td><td>RES</td></tr>
<tr><td>3</td><td>PC</td><td>PC</td></tr>
<tr><td>4</td><td></td><td></td></tr>
<tr><td>5</td><td>CR</td><td>CR</td></tr>
<tr><td>6</td><td></td><td>SP1</td></tr>
<tr><td>7</td><td></td><td>SP2</td></tr>
<tr><td>8</td><td></td><td>ST1</td></tr>
<tr><td>9</td><td></td><td>ST2</td></tr>
<tr><td>A</td><td></td><td>SP3</td></tr>
<tr><td>B</td><td>CM1</td><td></td></tr>
<tr><td>C</td><td>CM2</td><td></td></tr>
<tr><td>D</td><td>TL1</td><td>TL1</td></tr>
<tr><td>E</td><td>CDP</td><td>CDP</td></tr>
<tr><td>F</td><td></td><td></td></tr>
</table>
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.
</td><td>0111</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
</table>

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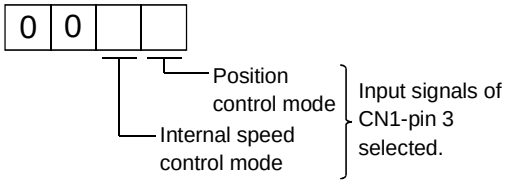
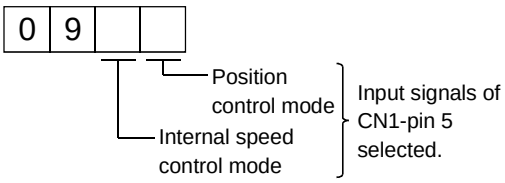
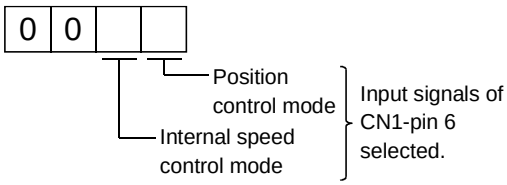
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	44	*DI3	Input signal selection 3 (CN1-3) Allows any input signal to be assigned to CN1-pin 3. The assignable signals and setting method are the same as in input signal selection 2 (parameter No. 43).  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).  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).  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

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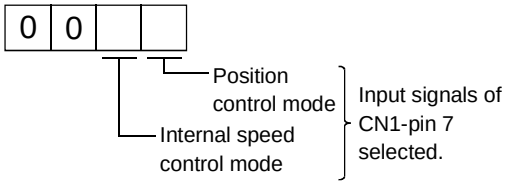
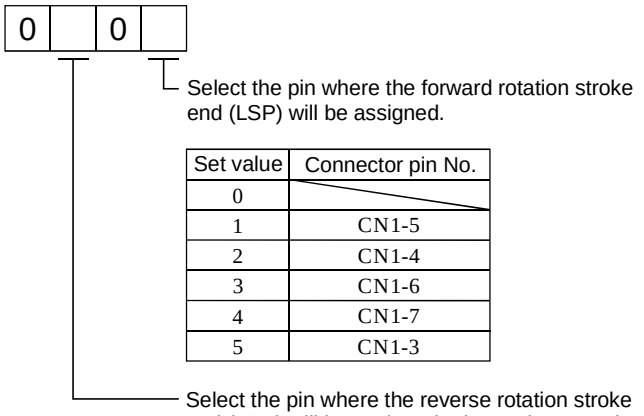
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="2">Expansion parameters 1</td><td>47</td><td>*DI6</td><td>Input signal selection 6 (CN1-7)
Allows any input signal to be assigned to CN1-pin 7.
The assignable signals and setting method are the same as in input signal selection 2 (parameter No. 43).
 

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.</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
<tr><td>48</td><td>*LSPN</td><td>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.
 

<table><tr><th>Set value</th><th>Connector pin No.</th></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></td><td>0403</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
</table>

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td>Expansion parameters 1</td><td>49</td><td>*DO1</td><td>
Output signal selection 1
Used to select the connector pins to output the alarm code and warning (WNG).
<table><tr><td>0</td><td>0</td><td></td><td></td></tr></table>
Setting of alarm code output
<table>
<tr><th rowspan="2">Set value</th><th colspan="3">Connector pins</th></tr>
<tr><th>CN1-10</th><th>CN1-11</th><th>CN1-12</th></tr>
<tr><td>0</td><td>INP or SA</td><td>RD</td><td>ZSP</td></tr>
<tr><td>1</td><td colspan="3">Alarm code is output at alarm occurrence.</td></tr>
</table>
<table>
<tr><th colspan="3">(Note) Alarm code</th><th rowspan="2">Alarm display</th><th rowspan="2">Name</th></tr>
<tr><th>CN1 pin 10</th><th>CN1 pin 11</th><th>CN1 pin 12</th></tr>
<tr><td rowspan="9">0</td><td rowspan="9">0</td><td rowspan="9">0</td><td>88888</td><td>Watchdog</td></tr>
<tr><td>AL.12</td><td>Memory error 1</td></tr>
<tr><td>AL.13</td><td>Clock error</td></tr>
<tr><td>AL.15</td><td>Memory error 2</td></tr>
<tr><td>AL.17</td><td>Board error 2</td></tr>
<tr><td>AL.19</td><td>Memory error 3</td></tr>
<tr><td>AL.37</td><td>Parameter error</td></tr>
<tr><td>AL.8A</td><td>Serial communication time-out error</td></tr>
<tr><td>AL.8E</td><td>Serial communication error</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL.30</td><td>Regenerative error</td></tr>
<tr><td>AL.33</td><td>Overvoltage</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>AL.10</td><td>Undervoltage</td></tr>
<tr><td rowspan="4">1</td><td rowspan="4">1</td><td rowspan="4">0</td><td>AL.45</td><td>Main circuit device overheat</td></tr>
<tr><td>AL.46</td><td>Servo motor overheat</td></tr>
<tr><td>AL.50</td><td>Overload 1</td></tr>
<tr><td>AL.51</td><td>Overload 2</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">1</td><td>AL.24</td><td>Main circuit</td></tr>
<tr><td>AL.32</td><td>Overcurrent</td></tr>
<tr><td rowspan="3">0</td><td rowspan="3">1</td><td rowspan="3">1</td><td>AL.31</td><td>Overspeed</td></tr>
<tr><td>AL.35</td><td>Command pulse frequency error</td></tr>
<tr><td>AL.52</td><td>Error excessive</td></tr>
<tr><td rowspan="3">1</td><td rowspan="3">0</td><td rowspan="3">1</td><td>AL.16</td><td>Encoder error 1</td></tr>
<tr><td>AL.1A</td><td>Motor combination error</td></tr>
<tr><td>AL.20</td><td>Encoder error 2</td></tr>
</table>
Note: 0:off
1:on
Setting of warning (WNG) output
Select the connector pin to output warning. The old signal before selection will be unavailable.
<table>
<tr><th>Set value</th><th>Connector pin No.</th></tr>
<tr><td>0</td><td>Not output.</td></tr>
<tr><td>1</td><td>CN1-11</td></tr>
<tr><td>2</td><td>CN1-9</td></tr>
<tr><td>3</td><td>CN1-10</td></tr>
<tr><td>4</td><td>CN1-12</td></tr>
</table>
</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
</table>

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="6">Expansion parameters 2</td><td>50</td><td></td><td>For manufacturer setting
Don't change this value by any means.</td><td>0000</td><td></td><td></td><td></td></tr>
<tr><td>51</td><td>*OP6</td><td>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</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
<tr><td>52</td><td></td><td>For manufacturer setting
Don't change this value by any means.</td><td>0000</td><td></td><td></td><td></td></tr>
<tr><td>53</td><td>*OP8</td><td>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</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
<tr><td>54</td><td>*OP9</td><td>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.
<table><tr><th rowspan="2">Set value</th><th colspan="2">Servo motor rotation direction</th></tr><tr><th>At forward rotation pulse input</th><th>At reverse rotation pulse input</th></tr><tr><td>0</td><td>CCW</td><td>CW</td></tr><tr><td>1</td><td>CW</td><td>CCW</td></tr></table>Encoder pulse output phase changing
Changes the phases of A/B-phase encoder pulses output .
<table><tr><th rowspan="2">Set value</th><th colspan="2">Servo motor rotation direction</th></tr><tr><th>CCW</th><th>CW</th></tr><tr><td>0</td><td>A phase
B phase</td><td>A phase
B phase</td></tr><tr><td>1</td><td>A phase
B phase</td><td>A phase
B phase</td></tr></table>Encoder output pulse setting selection (refer to parameter No. 27)
0: Output pulse setting
1: Division ratio setting</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
</table>

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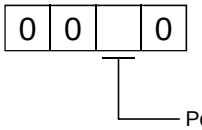
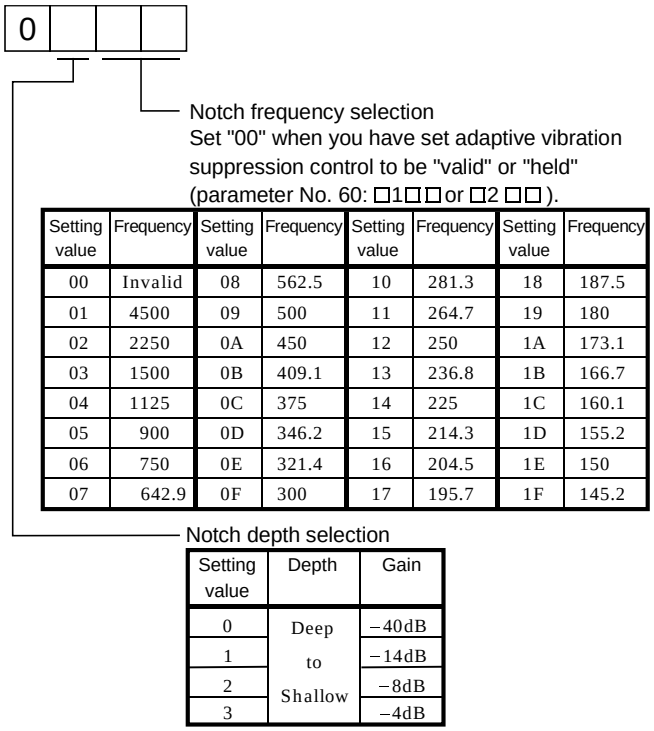
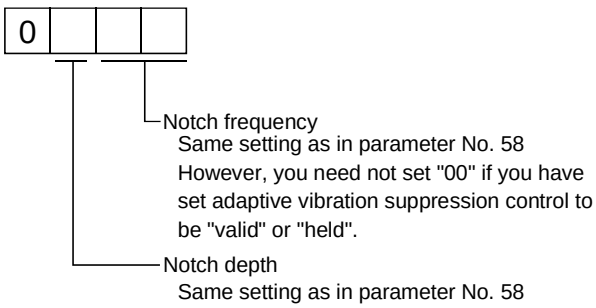
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="5">Expansion parameters 2</td><td>55</td><td>*OPA</td><td>Function selection A
Used to select the position command acceleration/deceleration time constant (parameter No. 7) control system.
 
</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P</td></tr>
<tr><td>56</td><td>SIC</td><td>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.</td><td>0</td><td>s</td><td>0
1 to 60</td><td>P•S</td></tr>
<tr><td>57</td><td></td><td>For manufacturer setting
Don't change this value by any means.</td><td>10</td><td></td><td></td><td></td></tr>
<tr><td>58</td><td>NH1</td><td>Machine resonance suppression filter 1
Used to selection the machine resonance suppression filter.
(Refer to Section 8.2.)
 

<table>
<tr><th>Setting value</th><th>Frequency</th><th>Setting value</th><th>Frequency</th><th>Setting value</th><th>Frequency</th><th>Setting value</th><th>Frequency</th></tr>
<tr><td>00</td><td>Invalid</td><td>08</td><td>562.5</td><td>10</td><td>281.3</td><td>18</td><td>187.5</td></tr>
<tr><td>01</td><td>4500</td><td>09</td><td>500</td><td>11</td><td>264.7</td><td>19</td><td>180</td></tr>
<tr><td>02</td><td>2250</td><td>0A</td><td>450</td><td>12</td><td>250</td><td>1A</td><td>173.1</td></tr>
<tr><td>03</td><td>1500</td><td>0B</td><td>409.1</td><td>13</td><td>236.8</td><td>1B</td><td>166.7</td></tr>
<tr><td>04</td><td>1125</td><td>0C</td><td>375</td><td>14</td><td>225</td><td>1C</td><td>160.1</td></tr>
<tr><td>05</td><td>900</td><td>0D</td><td>346.2</td><td>15</td><td>214.3</td><td>1D</td><td>155.2</td></tr>
<tr><td>06</td><td>750</td><td>0E</td><td>321.4</td><td>16</td><td>204.5</td><td>1E</td><td>150</td></tr>
<tr><td>07</td><td>642.9</td><td>0F</td><td>300</td><td>17</td><td>195.7</td><td>1F</td><td>145.2</td></tr>
</table>
<table>
<tr><th>Setting value</th><th>Depth</th><th>Gain</th></tr>
<tr><td>0</td><td rowspan="4">Deep
to
Shallow</td><td>−40dB</td></tr>
<tr><td>1</td><td>−14dB</td></tr>
<tr><td>2</td><td>−8dB</td></tr>
<tr><td>3</td><td>−4dB</td></tr>
</table></td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
<tr><td>59</td><td>NH2</td><td>Machine resonance suppression filter 2
Used to set the machine resonance suppression filter.
 
</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>P•S</td></tr>
</table>

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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.) Low-pass filter selection 0: Valid (Automatic adjustment) 1: Invalid When you choose "valid", $\frac{\text{VG2 setting}\times 10}{2\pi(1+\text{GD2 setting}\times 0.1)}$ [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 control 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	×0.1 times	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

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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 Don't 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 in-stanta-neous permi-ssible speed	S

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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 instantaneous permissible speed	S
	74	SC6	Internal speed command 6 Used to set speed 6 of internal speed commands.	500	r/min	0 to instantaneous permissible speed	S
	75	SC7	Internal speed command 7 Used to set speed 7 of internal speed commands.	800	r/min	0 to instantaneous permissible 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 Don't change this value by any means.	00			
	78			10000			
	79			10			
	80			10			
	81			100			
	82			100			
	83			100			
	84			0000			

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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.

▪ The following specification symbols are required to calculate the electronic gear.

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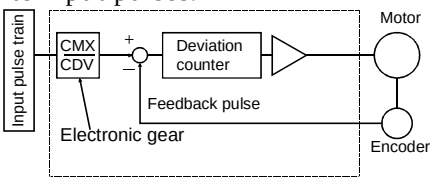
The machine can be moved at any multiplication factor to input pulses.

$$\frac{CMX}{CDV} = \frac{\text{Parameter No.3}}{\text{Parameter No.4}}$$



The following setting examples are used to explain how to calculate the electronic gear:

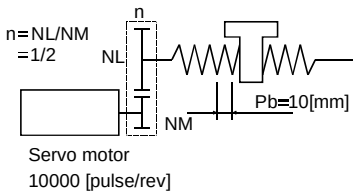
POINT

▪ The following specification symbols are required to calculate the electronic gear
Pb : Ballscrew lead [mm]
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

Ballscrew lead Pb =10 [mm]
Reduction ratio: n = 1/2
Servo motor resolution: Pt = 10000 [pulses/rev]



$$\frac{CMX}{CDV} = \Delta\ell_0 \cdot \frac{Pt}{\Delta S} = \Delta\ell_0 \cdot \frac{Pt}{n \cdot Pb} = 10 \times 10^{-3} \cdot \frac{10000}{1/2 \cdot 10} = \frac{20000}{1000} = \frac{20}{1}$$

Hence, set 20 to CMX and 1 to CDV.

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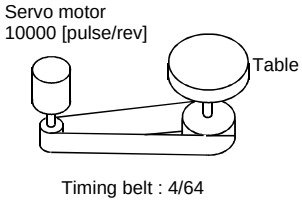
(2) Conveyor setting example

For rotation in increments of 0.01° per pulse



Machine specifications

Table : 360°/rev
Reduction ratio: n = 1/18
Servo motor resolution: Pt = 10000 [pulses/rev]

$$\frac{CMX}{CDV} = \Delta\theta^\circ \cdot \frac{Pt}{\Delta\theta} = 0.01 \cdot \frac{10000}{1/18 \cdot 360} = \frac{100}{20} = \frac{5}{1}$$

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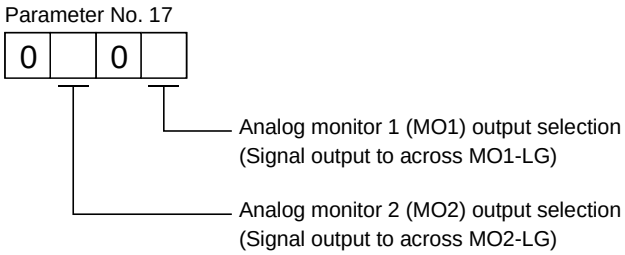
Hence, set 5 to CMX and 1 to CDV.

5.2.2 Analog monitor

The servo status can be output to two channels in terms of voltage. Use this function when using an ammeter to monitor the servo status or synchronizing the torque/speed with the other servo.

(1) Setting

Change the following digits of parameter No.17:



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.	

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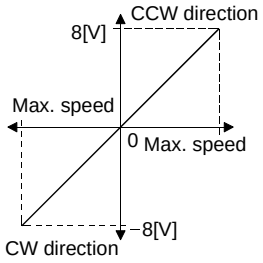
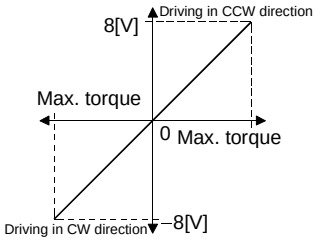
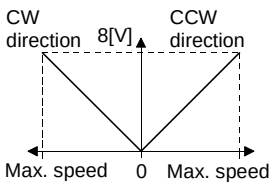
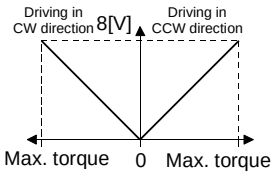
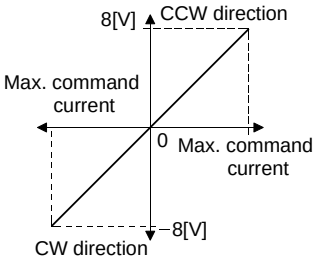
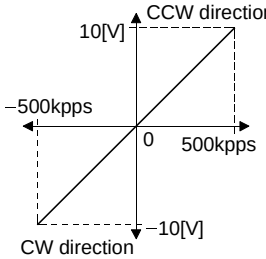
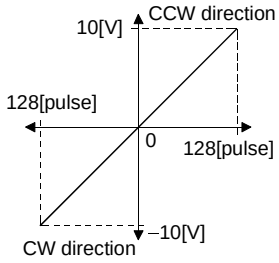
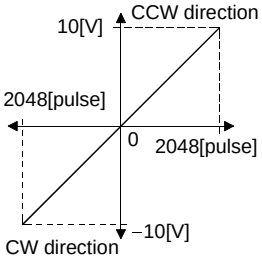
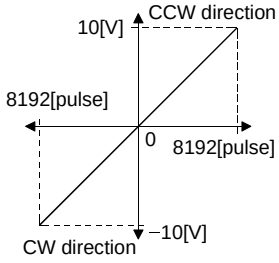
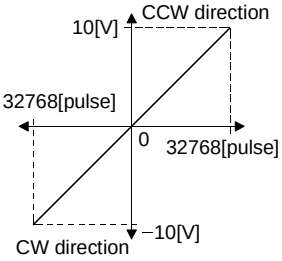
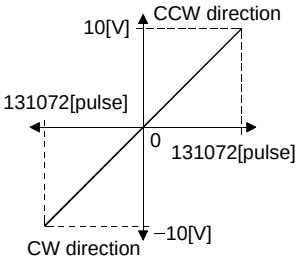
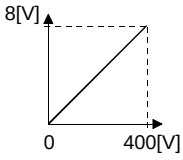
(2) Set content

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 Appendix 2 for the measurement point.

Setting	Output item	Description
0	Servo motor speed	
1	Torque	
2	Servo motor speed	
3	Torque	
4	Current command	
5	Command pulse frequency	

Setting	Output item	Description
6	Droop pulses (±10V/128pulse)	
7	Droop pulses (±10V/2048pulse)	
8	Droop pulses (±10V/8192pulse)	
9	Droop pulses (±10V/32768pulse)	
A	Droop pulses (±10V/131072pulse)	
B	Bus voltage	

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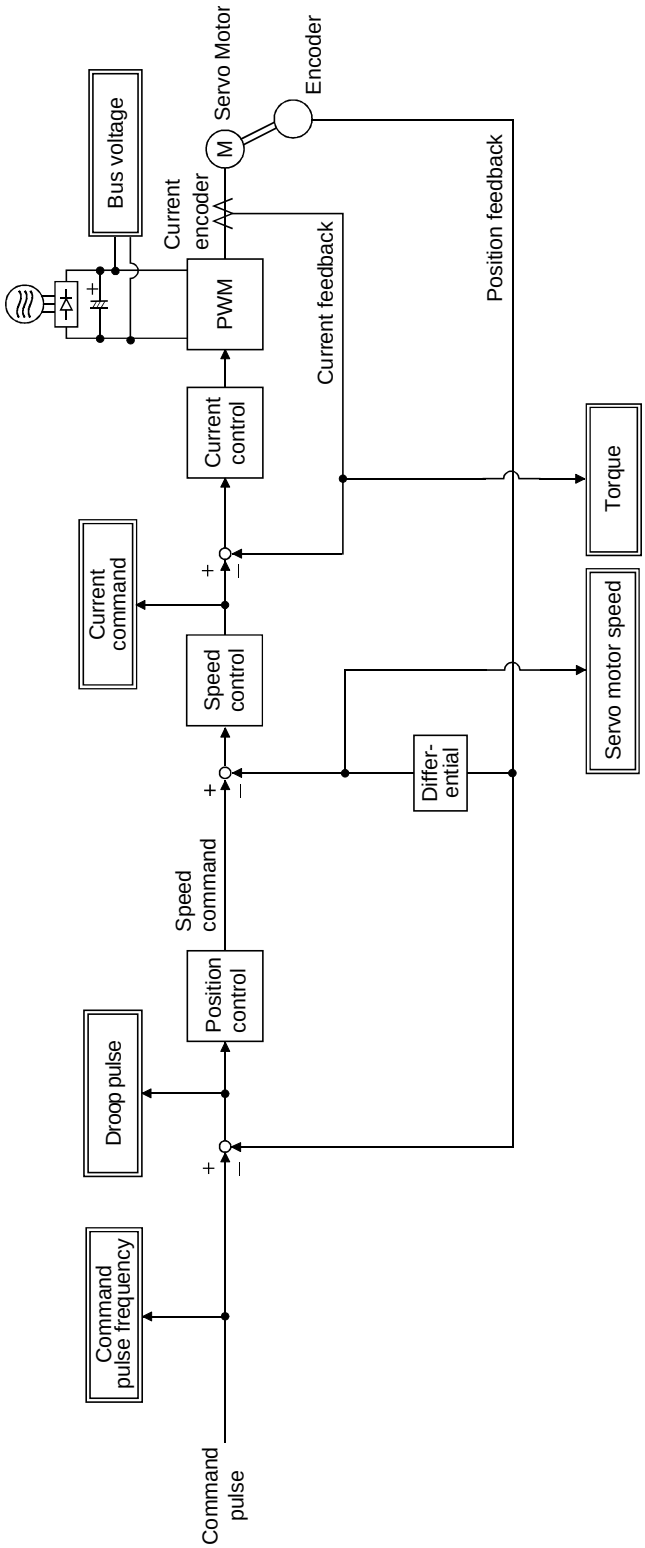
(3) Analog monitor block diagram



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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 made valid. 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.

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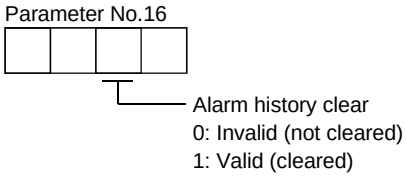
5.2.4 Alarm history clear

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.



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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

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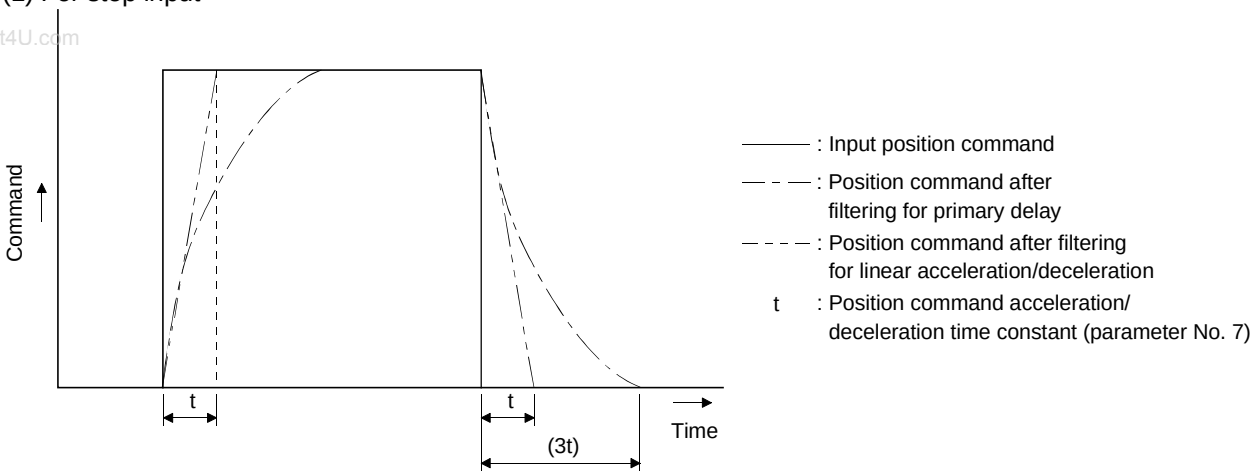
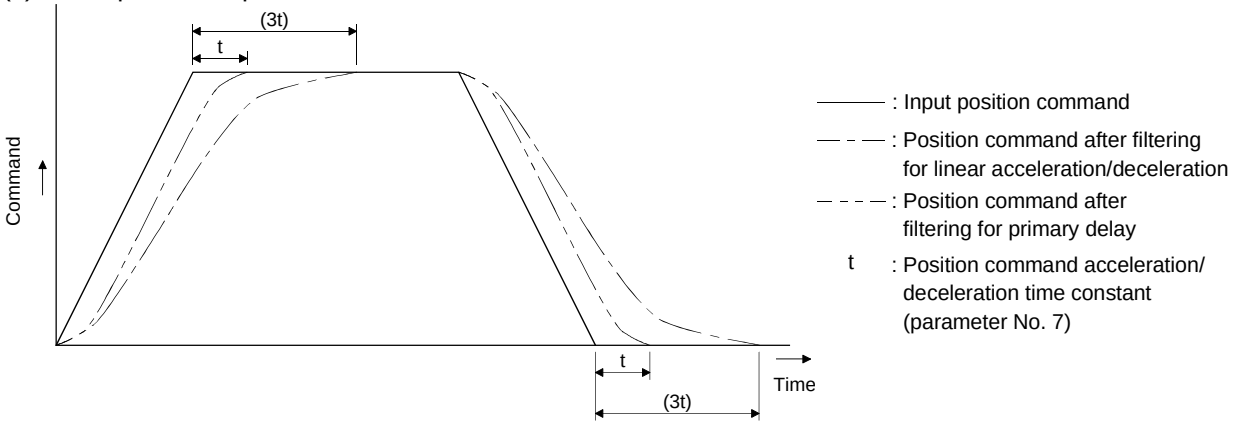


(2) For trapezoidal input



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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).

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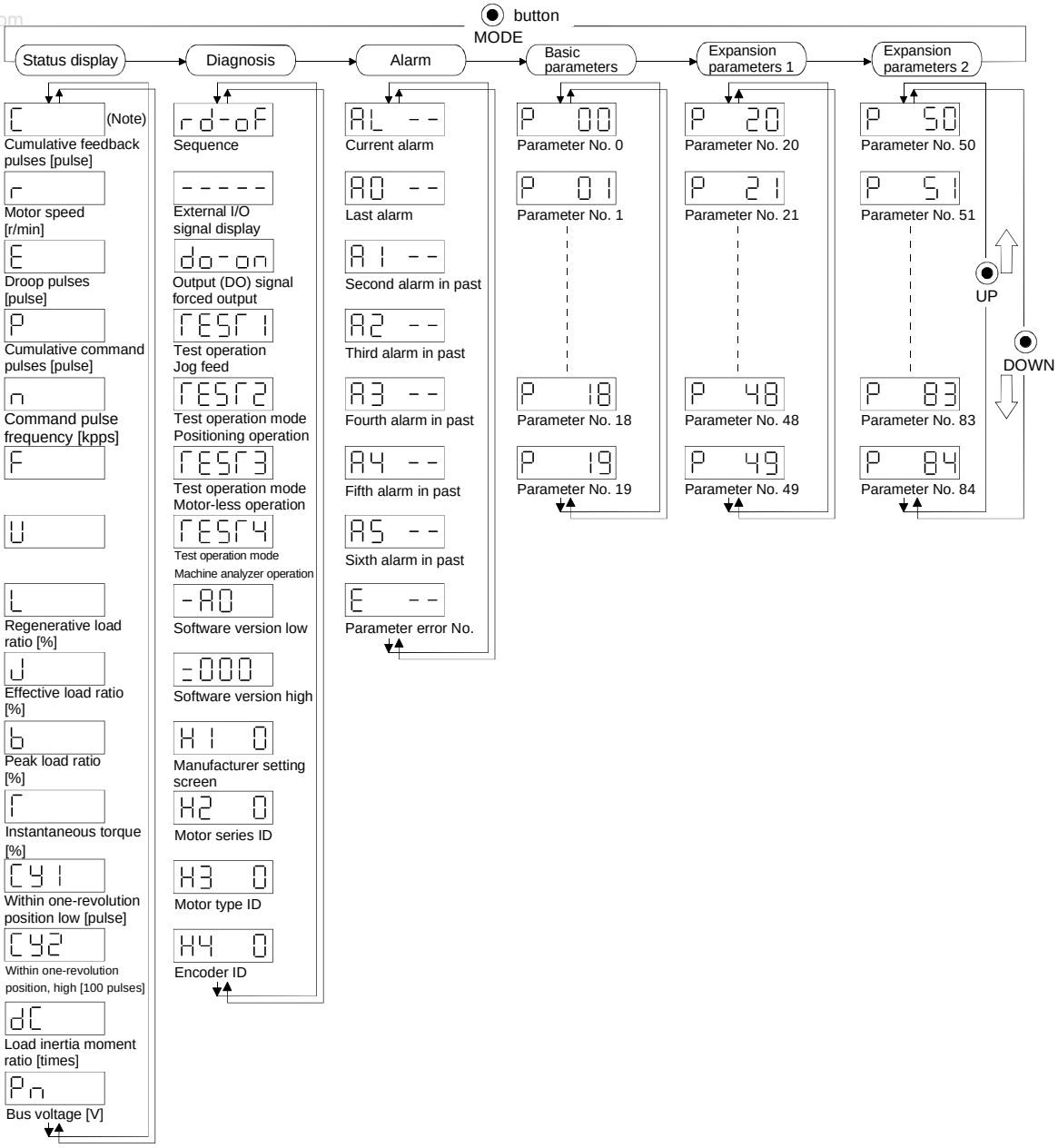

Note: The initial status display at power-on depends on the control mode.
Position control mode: Cumulative feedback pulses(C), Internal speed control mode: Servo motor speed(r)
Also, parameter No. 18 can be used to change the initial indication of the status display at power-on.

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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:

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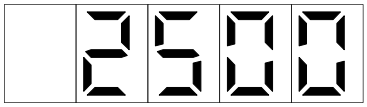
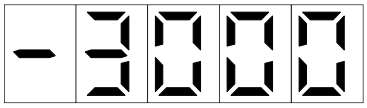
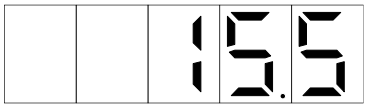
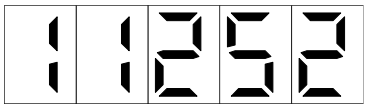
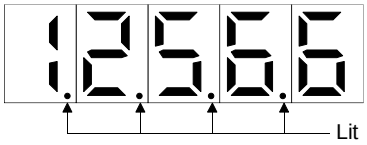
Item	Status	Displayed data Servo amplifier display
Servo motor speed	Forward rotation at 3000r/min	
	Reverse rotation at 3000r/min	 Reverse rotation is indicated by "−".
Load inertia moment	15.5 times	
Multi-revolution counter	11252pulse	
	−12566pulse	 Negative value is indicated by the lit decimal points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

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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

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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	0.1 Times	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

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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

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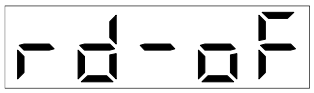
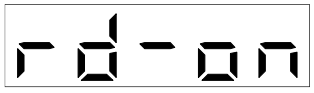
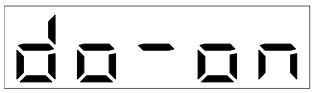
6.3 Diagnostic mode

Name		Display	Description
Sequence			Not ready. Indicates that the servo amplifier is being initialized or an alarm has occurred.
			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 signal (DO) forced output			The digital output signal can be forced on/off. For more information, refer to section 6.7.
Test operation mode	Jog feed		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		The servo configuration software (MRZJW3-SETUP154E) 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.
	Motorless operation		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		Merely connecting the servo amplifier allows the resonance point of the mechanical system to be measured. The servo configuration software (MRZJW3-SETUP154E or later) is required for machine analyzer operation.
Software version low			Indicates the version of the software.
Software version high			Indicates the system number of the software.
Manufacturer setting screen			Screen for manufacturer setting. When this screen is being displayed, do not press any other buttons than "UP" and "DOWN" button.
Motor series			Press the "SET" button to show the motor series ID of the servo motor currently connected.
Motor type			Press the "SET" button to show the motor type ID of the servo motor currently connected.
Encoder			Press the "SET" button to show the encoder ID of the servo motor currently connected.

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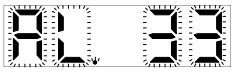
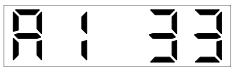
6.4 Alarm mode

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		Indicates no occurrence of an alarm.
		Indicates the occurrence of overvoltage (AL.33). Flickers at occurrence of the alarm.
Alarm history		Indicates that the last alarm is overload 1 (AL.50).
		Indicates that the second alarm in the past is overvoltage (AL.33).
		Indicates that the third alarm in the past is undervoltage (AL.10).
		Indicates that the fourth alarm in the past is overspeed (AL.31).
		Indicates that there is no fifth alarm in the past.
		Indicates that there is no sixth alarm in the past.
Parameter error No.		Indicates no occurrence of parameter error (AL.37).
		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 section. At this time, the decimal point in the fourth digit flickers.

(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 alarm 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.

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

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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.

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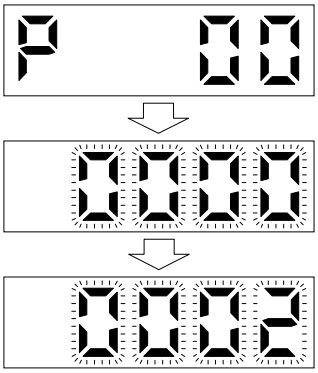

..... The parameter number is displayed.
Press UP or DOWN to change the number.
Press SET twice.
..... The set value of the specified parameter number flickers.
Press UP once.
..... During flickering, the set value can be changed.
Use UP or DOWN .
(□□□2: Internal speed control mode)
Press SET to enter.

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.

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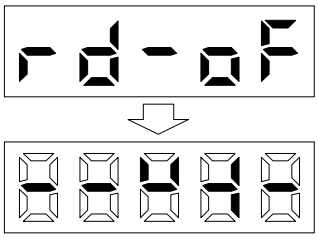
6.6 External I/O signal display

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.



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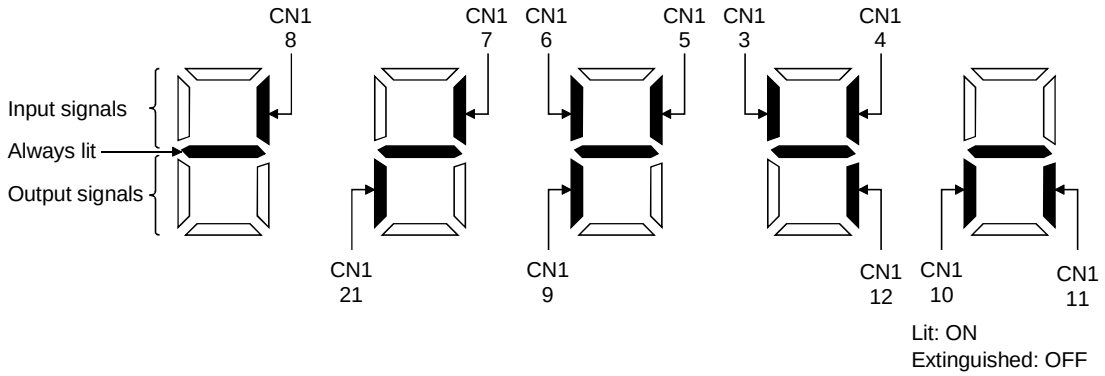
(2) Display definition



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. The signal of CN1A-18 is always output.

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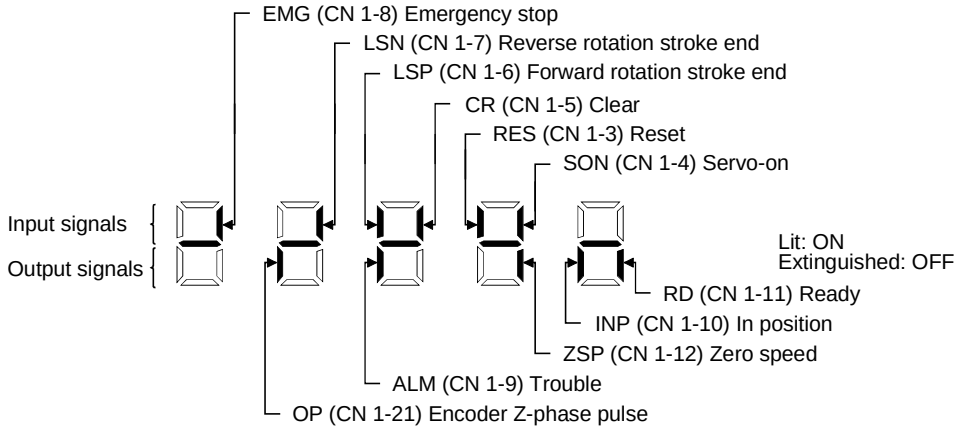
(3) Default signal indications

(a) Position control mode



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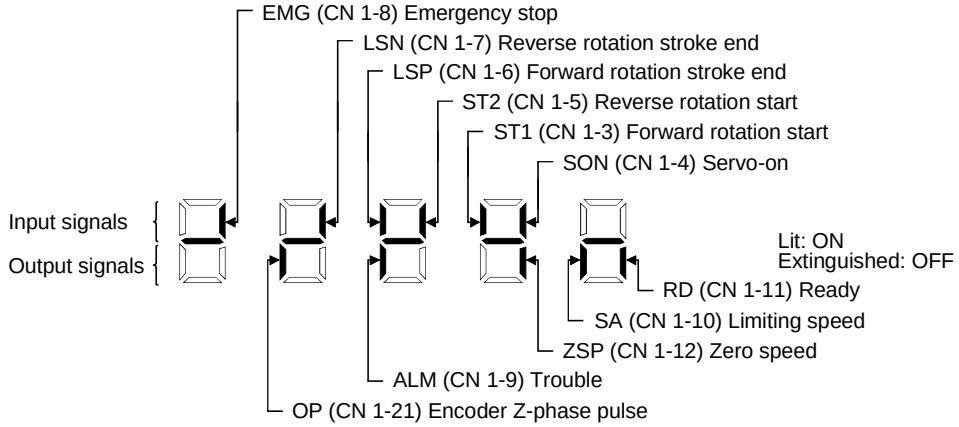
(b) Internal speed control mode



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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.

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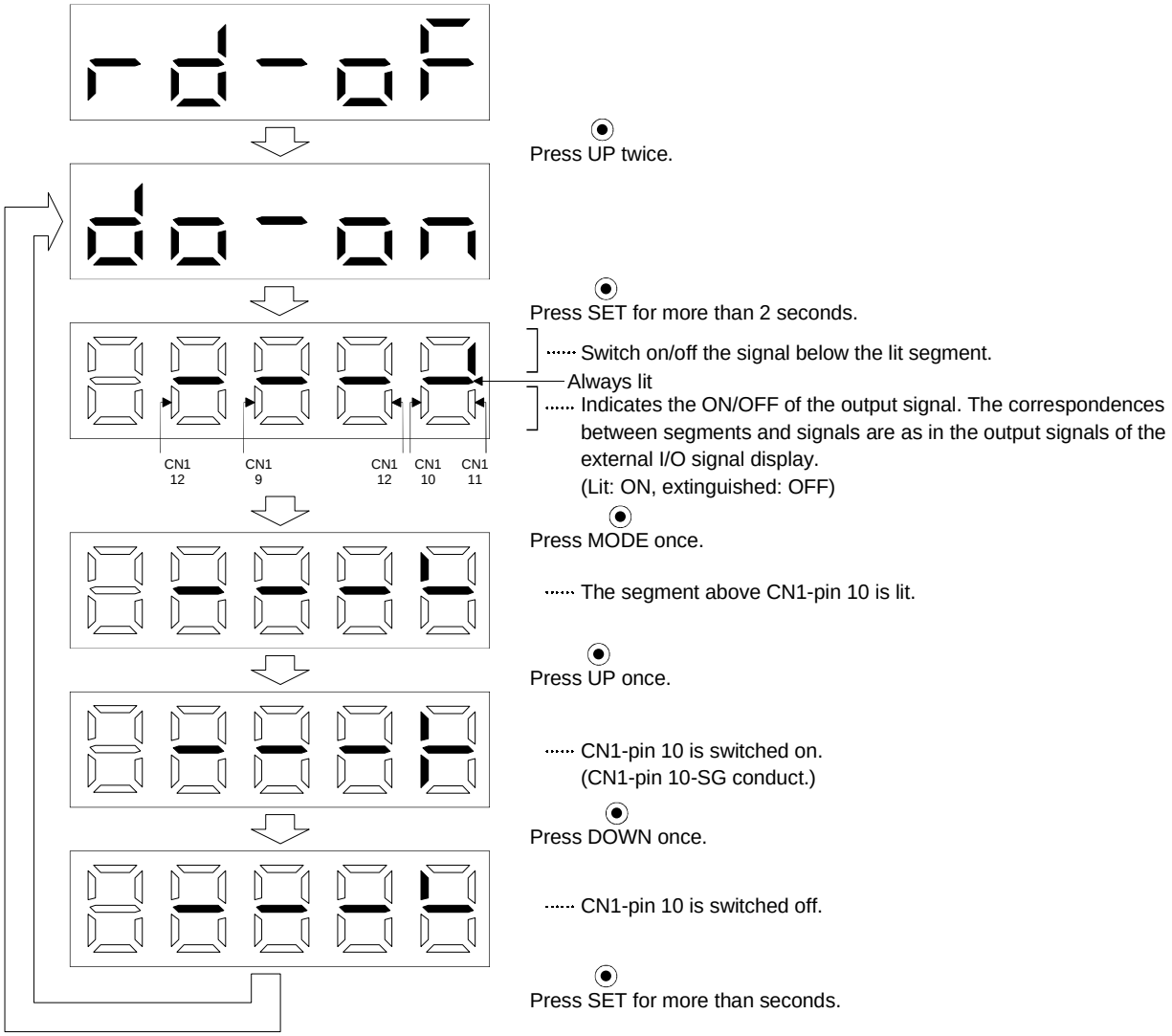
Operation
Call the display screen shown after power-on.
Using the "MODE" button, show the diagnostic screen.



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

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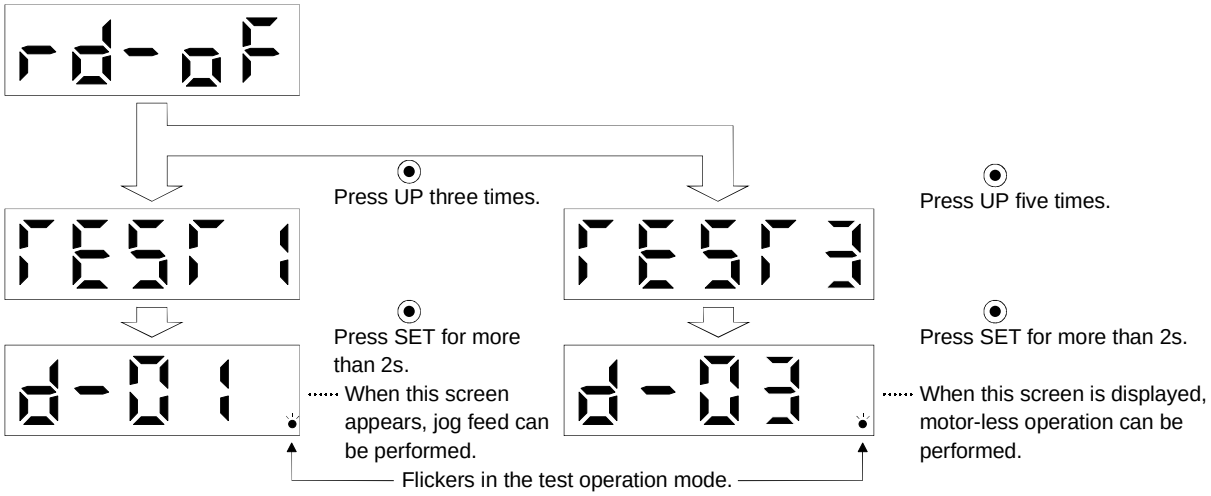
6.8.1 Mode change

Call the display screen shown after power-on. Choose jog operation/motor-less operation in the following procedure. Using the "MODE" button, show the diagnostic screen.



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6.8.2 Jog operation

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

(1) Operation

Connect EMG-SG 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 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

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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 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.

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6.8.3 Positioning operation

> POINT
> ▪ The 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

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

Click the "Forward" or "Reverse" button on the 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 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.

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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-SG, choose motor-less operation. After that, perform external operation as in ordinary operation.

(2) Status display

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

Pressing the "MODE" button in the motor-less operation-ready status calls the status display screen. With this screen being shown, perform motor-less operation. 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 motor-less 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 motor-less operation

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

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7. GENERAL GAIN ADJUSTMENT

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

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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)

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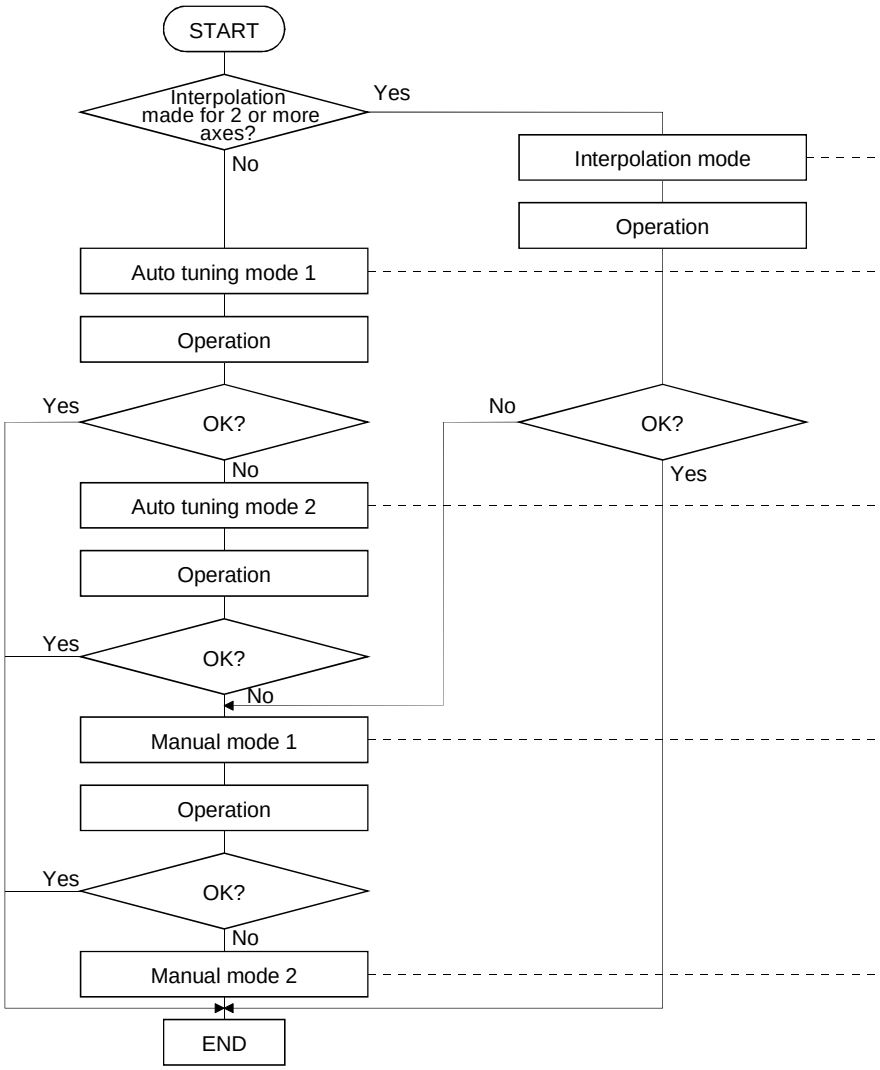
(2) Adjustment sequence and mode usage



Usage
Used when you want to match the position gain (PG1) between 2 or more axes. Normally not used for other purposes.
Allows adjustment by merely changing the response level setting. First use this mode to make adjustment.
Used when the conditions of auto tuning mode 1 are not met and the load inertia moment ratio could not be estimated properly, for example.
This mode permits adjustment easily with three gains if you were not satisfied with auto tuning results.
You can adjust all gains manually when you want to do fast settling or the like.

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7.1.2 Adjustment using servo configuration software

This section gives the functions and adjustment that may be performed by using the servo amplifier with the 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.

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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.

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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 ratio of load inertia moment to servo motor inertia moment is not more than 100 times.
  - 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

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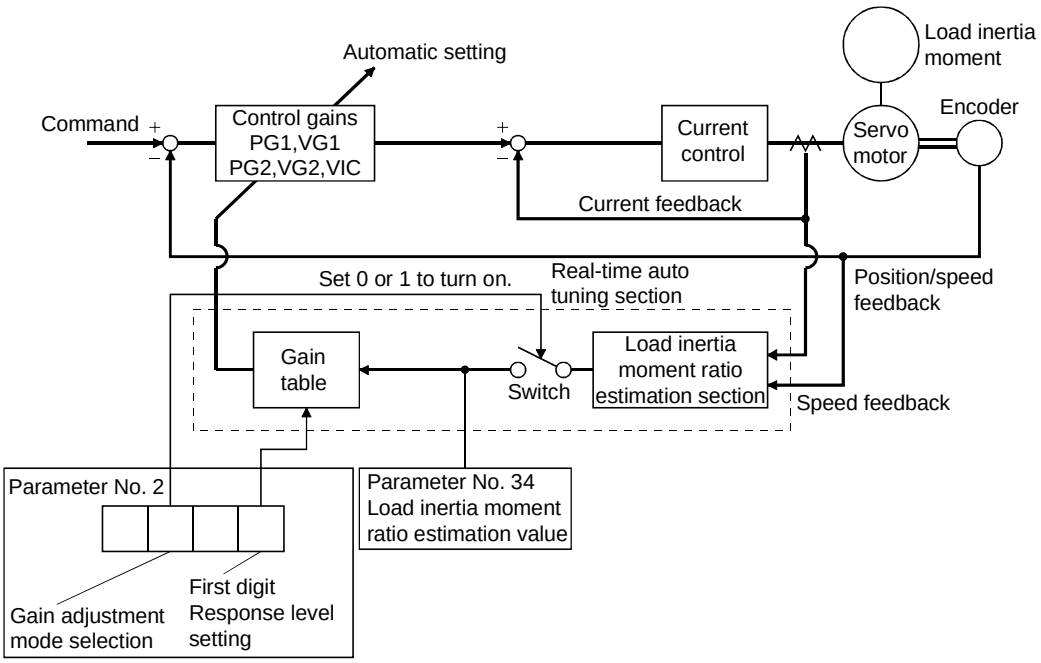
7.2.2 Auto tuning mode operation

The block diagram of real-time auto tuning is shown below.



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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 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.

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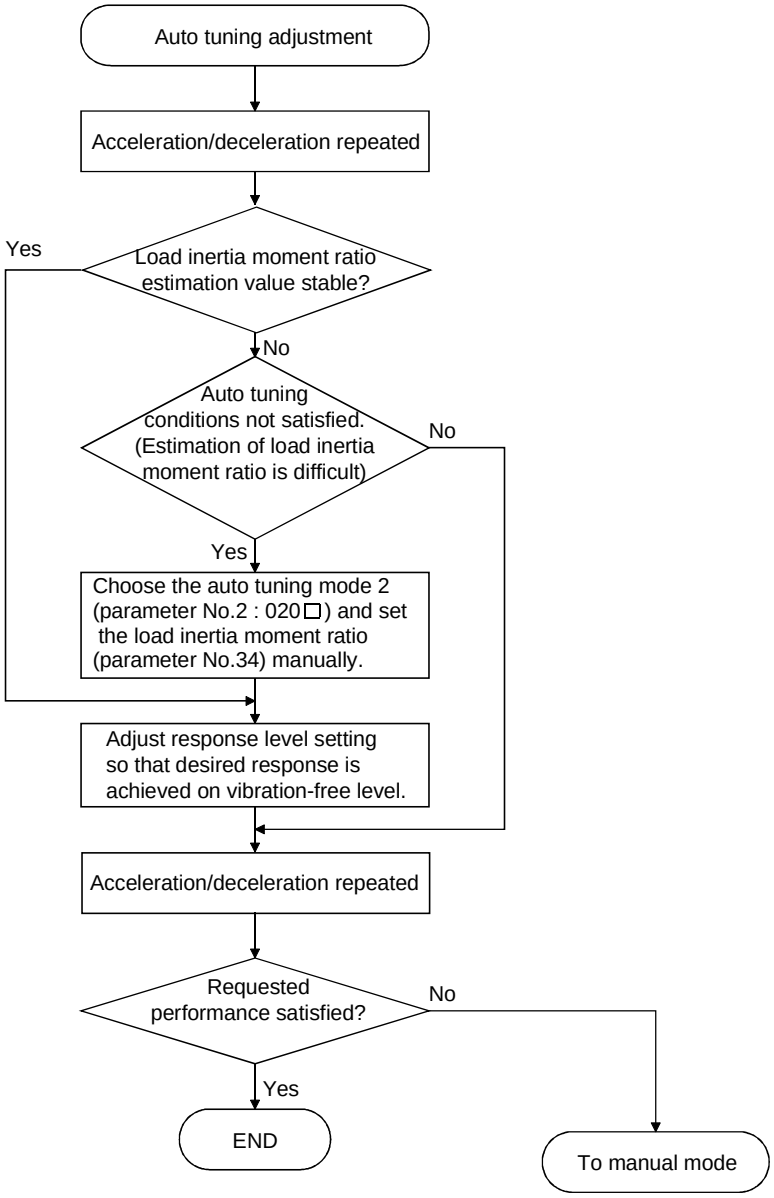
7.2.3 Adjustment procedure by auto tuning

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.



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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 trackability 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.

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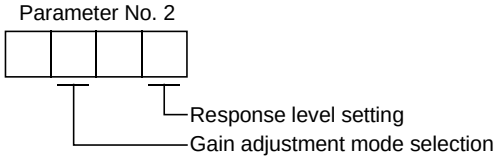
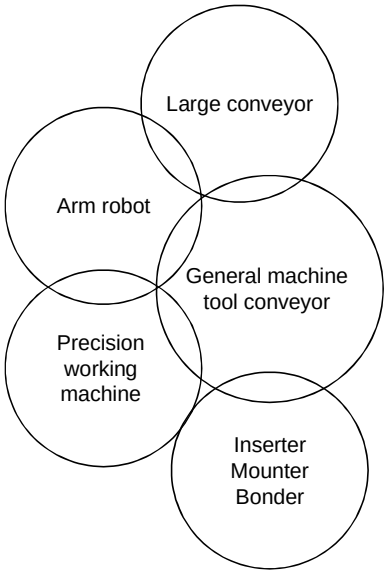


Response level setting	Machine characteristic		
	Machine rigidity	Machine resonance frequency guideline	Guideline of corresponding machine
1	Low	15Hz	
2		20Hz	
3		25Hz	
4	↑	30Hz	
5		35Hz	
6		45Hz	
7		55Hz	
8	Middle	70Hz	
9		85Hz	
A		105Hz	
B		130Hz	
C	↓	160Hz	
D		200Hz	
E		240Hz	
F	High	300Hz	



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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 Operation of manual mode 1

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.

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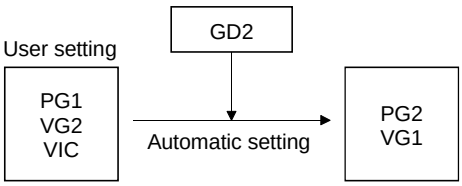

Therefore, you can adjust the model adaptive control system in the same image as the general PI control system (position gain, speed gain, speed integral time constant). Here, the position gain corresponds to PG1, the speed gain to VG2 and the speed integral time constant to VIC. When making gain adjustment 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.
5	While checking the settling characteristic and rotational status, fine-adjust each gain.	Fine adjustment

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(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)

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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

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(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 trackability 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)

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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:

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

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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 trackability 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.

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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 trackability 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.

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

(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 ≥ Position control gain 1 setting×3

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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.

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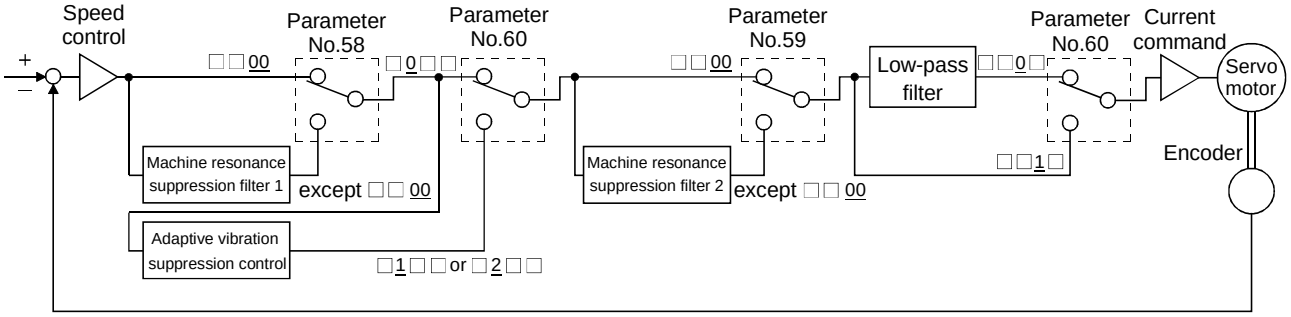
Using the machine resonance suppression filter and adaptive vibration suppression control functions can suppress the resonance of the mechanical system.

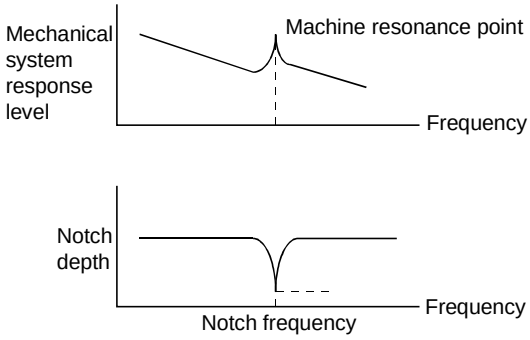
8.1 Function block diagram



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.



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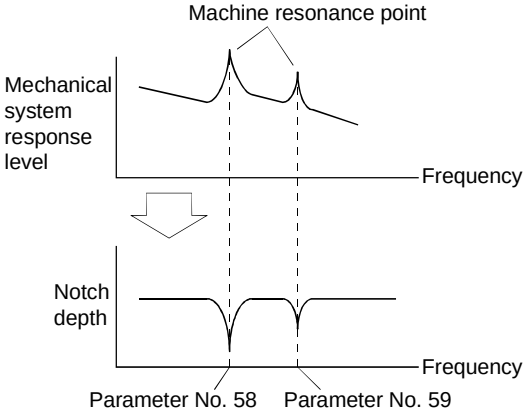
You can use the machine resonance suppression filter 1 (parameter No. 58) and machine resonance suppression filter 2 (parameter No. 59) to suppress the vibration of two resonance frequencies. Note that if adaptive vibration suppression control is made valid, the machine resonance suppression filter 1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



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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)
0	Deep (−40dB)
1	↑ (−14dB)
2	↓ (−8dB)
3	Shallow(−4dB)

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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 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.

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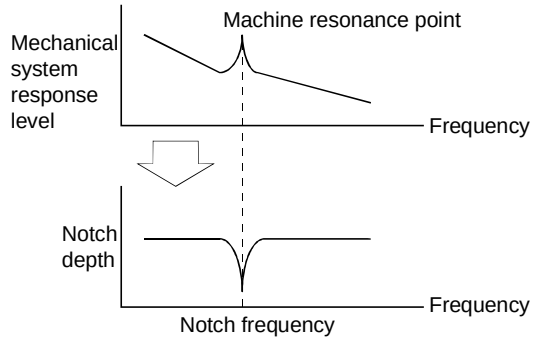
(b) Machine resonance suppression filter 2 (parameter No. 59)

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.

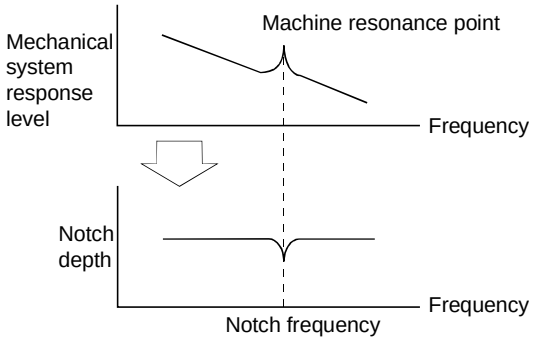
8.3 Adaptive vibration suppression control

(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.

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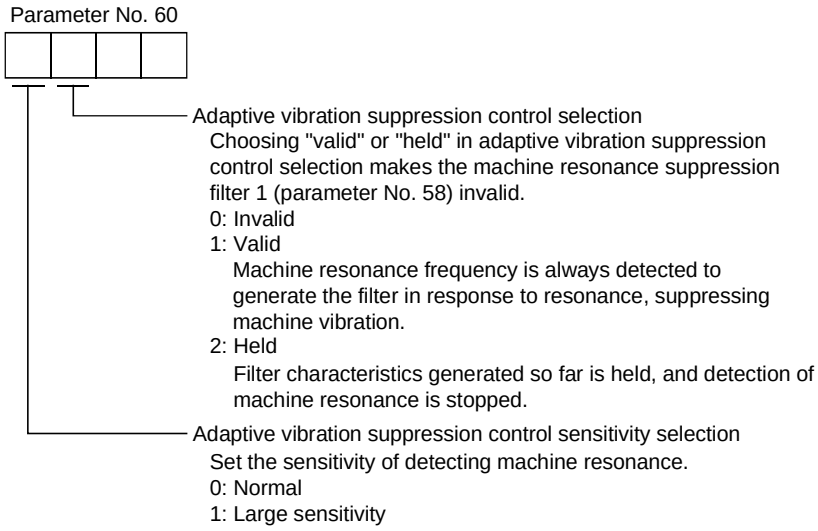
(2) Parameters

The operation of adaptive vibration suppression control selection (parameter No.60).



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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

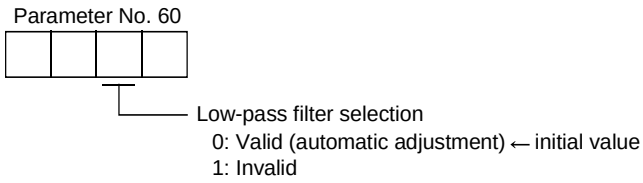
(1) Function

When a ballscrew 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 operation of the low-pass filter (parameter No. 60.)



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.

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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).

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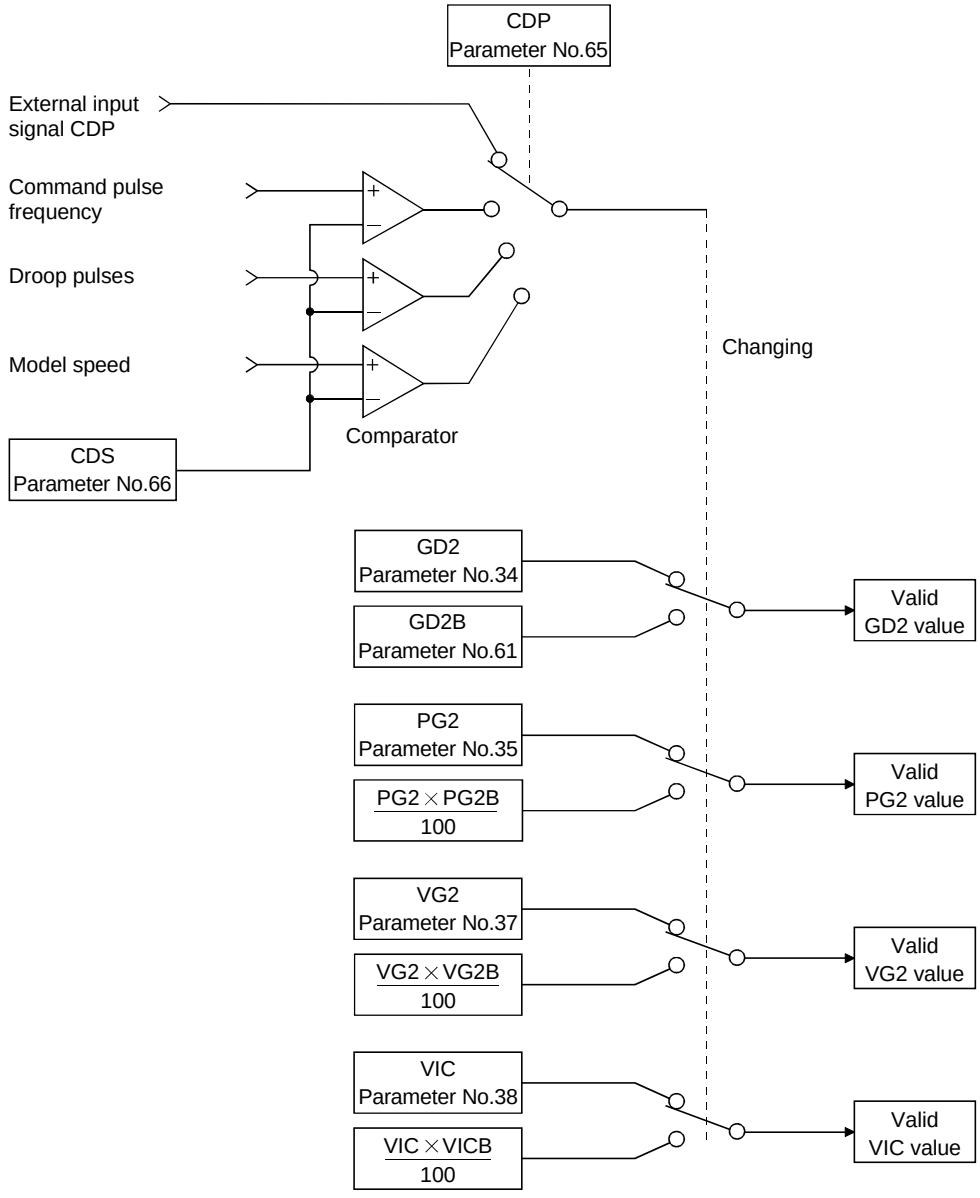
8.5.2 Function block diagram

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).



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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	0.1 times	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	0.1 times	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.

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(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).

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(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)

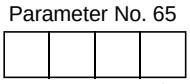
Set the values of after-changing position control gain 2, speed control gain 2 and speed integral compensation in ratio (%). 100% setting means no gain change.

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.



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.

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8.5.4 Gain changing operation

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	0.1 times
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	0.1 times
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

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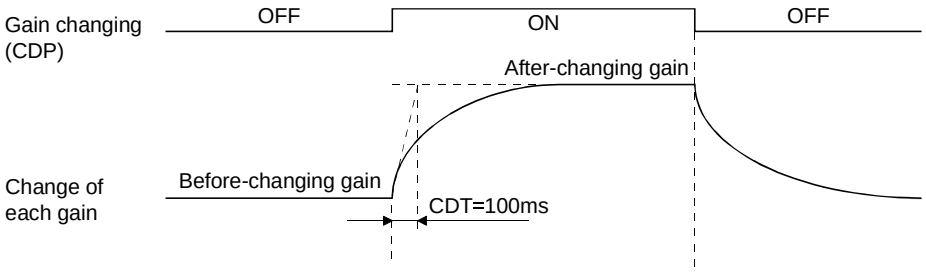
(b) Changing operation



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
Position control gain 2	120	→	84	→ 120
Speed control gain 2	3000	→	4000	→ 3000
Speed integral compensation	20	→	50	→ 20

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(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	0.1 times
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	0.1 times
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

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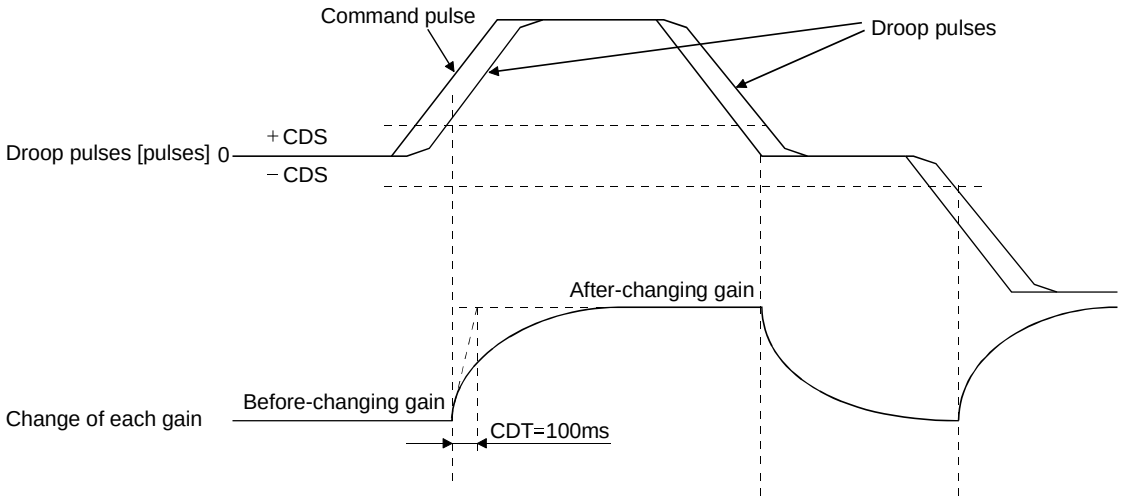
(b) Changing operation



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

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MEMO

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9. INSPECTION

⚠WARNING	・Before starting maintenance and/or inspection, make sure that the charge lamp is off more than 10 minutes after power-off. Then, confirm that the voltage is safe in the tester or the like. Otherwise, you may get an electric shock. ・Any person who is involved in inspection should be fully competent to do the work. Otherwise, you may get an electric shock. For repair and parts replacement, contact your safes representative.

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POINT

・Do not test the servo amplifier with a megger (measure insulation resistance), or it may become faulty.
・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 sales representative.

Part name	Life guideline
Smoothing capacitor	10 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.

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(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 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.

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(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.

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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 servo configuration software, you can refer to unrotated servo motor reasons, etc.

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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	Refer to
1	Power on (Note)	・LED is not lit. ・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-SG 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

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No.	Start-up sequence	Fault	Investigation	Possible cause	Refer to
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) in this section

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

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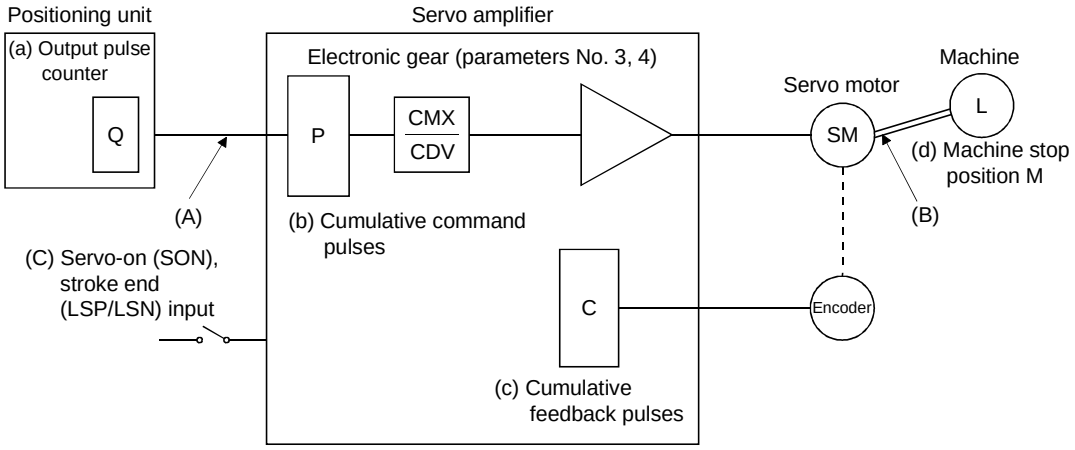
(2) How to find the cause of position shift



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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 mis-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) $P \cdot \frac{CMX(\text{parameter No.3})}{CDV(\text{parameter No.4})}$
   $= C$ (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 $P \cdot \frac{CMX}{CDV} \neq C$
   During operation, the servo-on signal (SON) or forward/reverse rotation stroke end 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)

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10.1.2 Internal speed control mode

No.	Start-up sequence	Fault	Investigation	Possible cause	Refer to
1	Power on (Note)	・LED is not lit. ・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.	(1), Section 5.1.2
			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.

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10.2 When alarm or warning has occurred

> 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.

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.

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Set "□□□1" in parameter No. 49 to output the alarm code in ON/OFF status across the corresponding pin and SG. 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.

	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.35	0	1	1	Command pulse frequency error	○	○	○
	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.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				Under voltage warning			

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

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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.

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.

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When an alarm occurs, the trouble signal (ALM) switches off and the dynamic brake is operated to stop the servomotor. 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. The optional servo configuration software may be used to refer to the cause.

Display	Name	Definition	Cause	Action
AL.10	Undervoltage	Power supply voltage dropped to 160VAC or less.	1. Power supply voltage is low.	Review 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. Power was restored after the bus voltage had 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	Faulty parts in the servo amplifier	Change the servo amplifier.
AL.19	Memory error 3	ROM memory fault		

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Display	Name	Definition	Cause	Action
AL.1A	Motor combination error	Wrong combination of servo anplifier 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 outputs (U,V and W phases) of the servo amplififer.	1. Power input wires and servo motor output wires are in contact at main circuit terminal block (TE1).	Connect correctly.
			2. Sheathes of servo motor power cables deteriorated, resulting in ground fault.	Change the cable.
			3. Main circuit of servo amplifier failed. Checking method 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 alarm	Permissible regenerative power of the built-in regenerative brake resistor or regenerative brake option is exceeded.	1. Wrong setting of parameter No. 0	Set correctly.
			2. Built-in regenerative brake resistor or regenerative brake option is not connected.	Connect correctly
			3. High-duty operation or continuous regenerative operation caused the permissible regenerative power of the regenerative brake 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 brake option of larger capacity. 3. Reduce the load.
			4. Power supply voltage is abnormal. MR-E-□A:260V or more	Review power supply
			5. Built-in regenerative brake resistor or regenerative brake option faulty.	Change servo amplifier or regenerative brake option.
		Regenerative transistor fault	6. Regenerative transistor faulty. Checking method 1) The regenerative brake option has overheated abnormally. 2) The alarm occurs even after removal of the built-in regenerative brake resistor or regenerative brake option.	Change the servo amplifier.

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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.	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. Lead of built-in regenerative brake resistor or regenerative brake option is open or disconnected.	1. Change lead. 2. Connect correctly.
			2. Regenerative transistor faulty.	Change servo amplifier
			3. Wire breakage of built-in regenerative brake resistor or regenerative brake option	1. For wire breakage of built-in regenerative brake resistor, change servo amplifier. 2. For wire breakage of regenerative brake option, change regenerative brake option.
			4. Capacity of built-in regenerative brake resistor or regenerative brake option is insufficient.	Add regenerative brake option or increase capacity.
			5. Power supply voltage high.	Review the power supply.
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.

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Display	Name	Definition	Cause	Action
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 brake 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 protector.	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 protector in encoder is faulty.	Change 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.

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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 droop pulse value of the deviation counter exceeded 2.5 rotations.	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 servo amplifier.

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10.2.3 Remedies for warnings

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 servo configuration software to refer to the cause of 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 brake resistor or regenerative brake option.	Regenerative power increased to 85% or more of permissible regenerative power of built-in regenerative brake resistor or regenerative brake option. Checking method Call the status display and check regenerative load ratio.	1. Reduce frequency of positioning. 2. Change regenerative brake 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-SG are open.	External emergency stop was made valid. (EMG-SG opened.)	Ensure safety and deactivate emergency stop.
AL.E9	Under voltage warning	This alarm occurs when the servo motor speed decreases to or below 50r/min with the bus voltage dropping.		Review the power supply.

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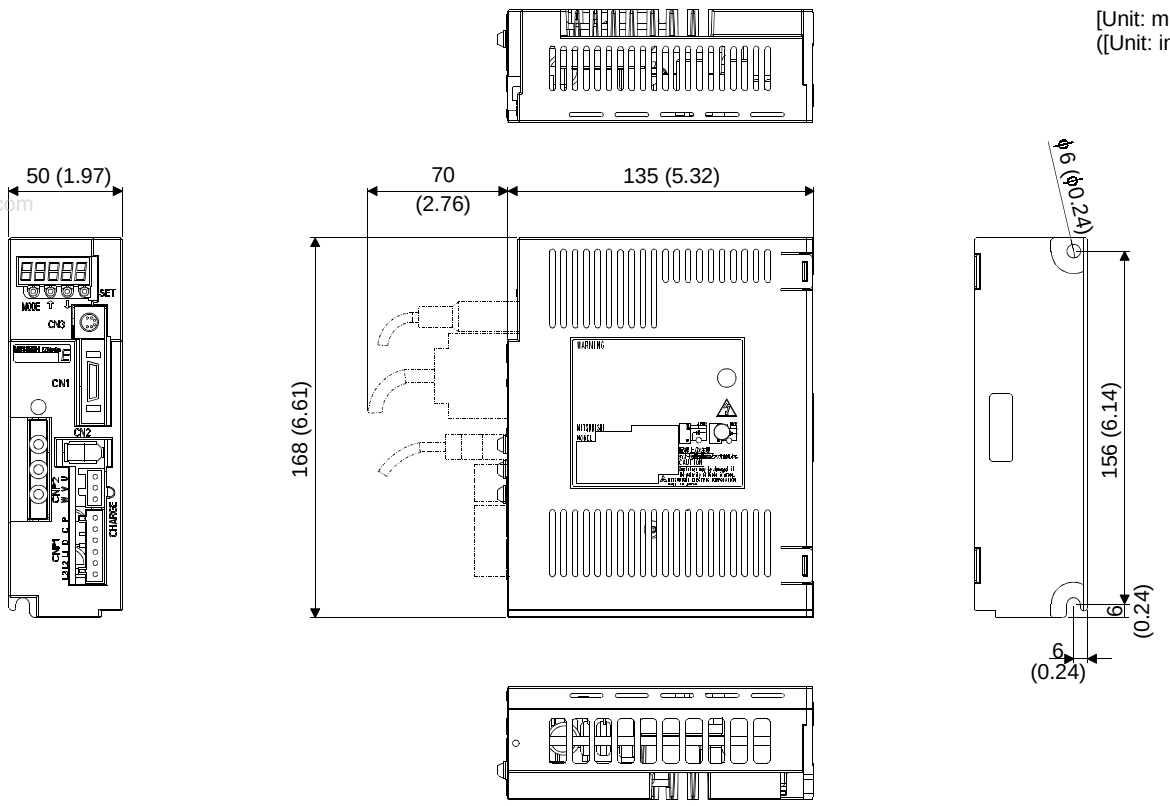
11. OUTLINE DIMENSION DRAWINGS

11.1 Servo amplifiers

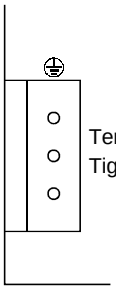
(1) MR-E-10A・MR-E-20A

[Unit: mm]
([Unit: in])



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

PE terminals



Terminal screw: M4
Tightening torque: 1.2 [N・m] (169.9 [oz・in])

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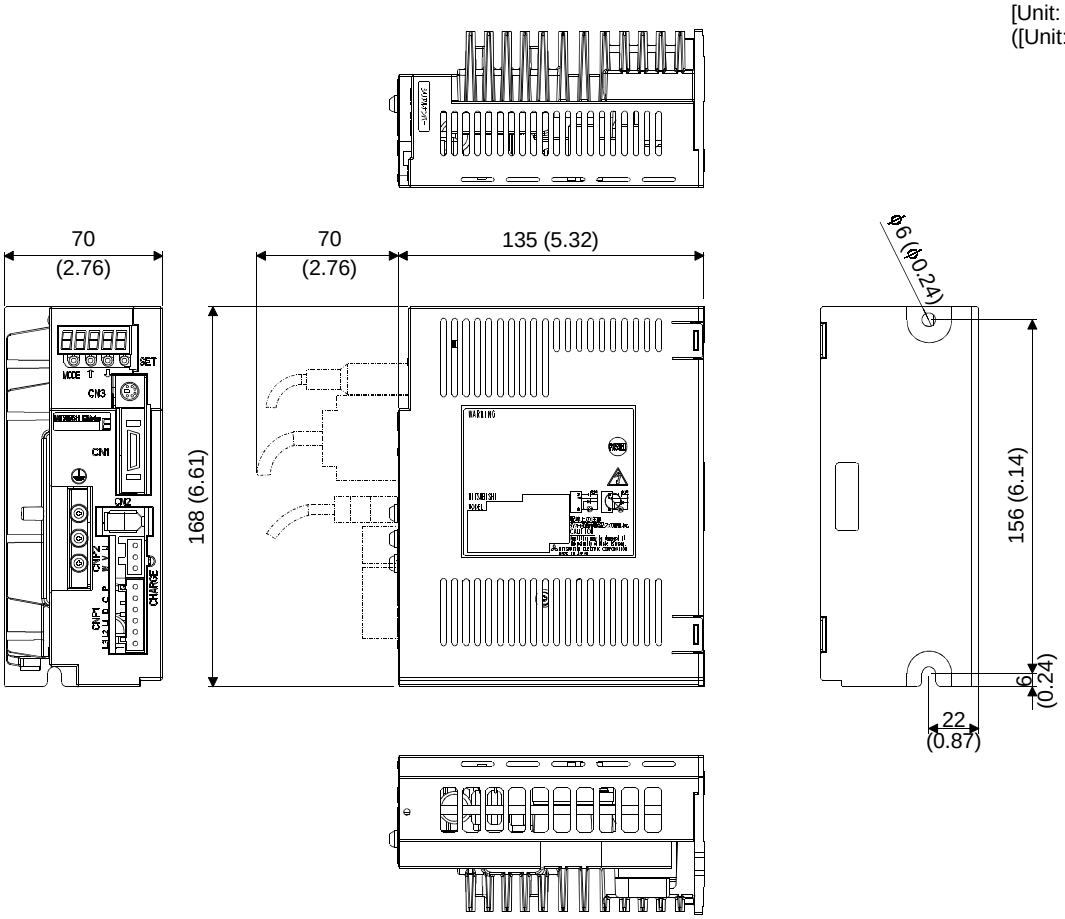
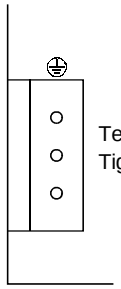
(2) MR-E-40A

[Unit: mm]
([Unit: in])



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

PE terminals



Terminal screw: M4
Tightening torque: 1.2 [N• m] (169.9 [oz• in])

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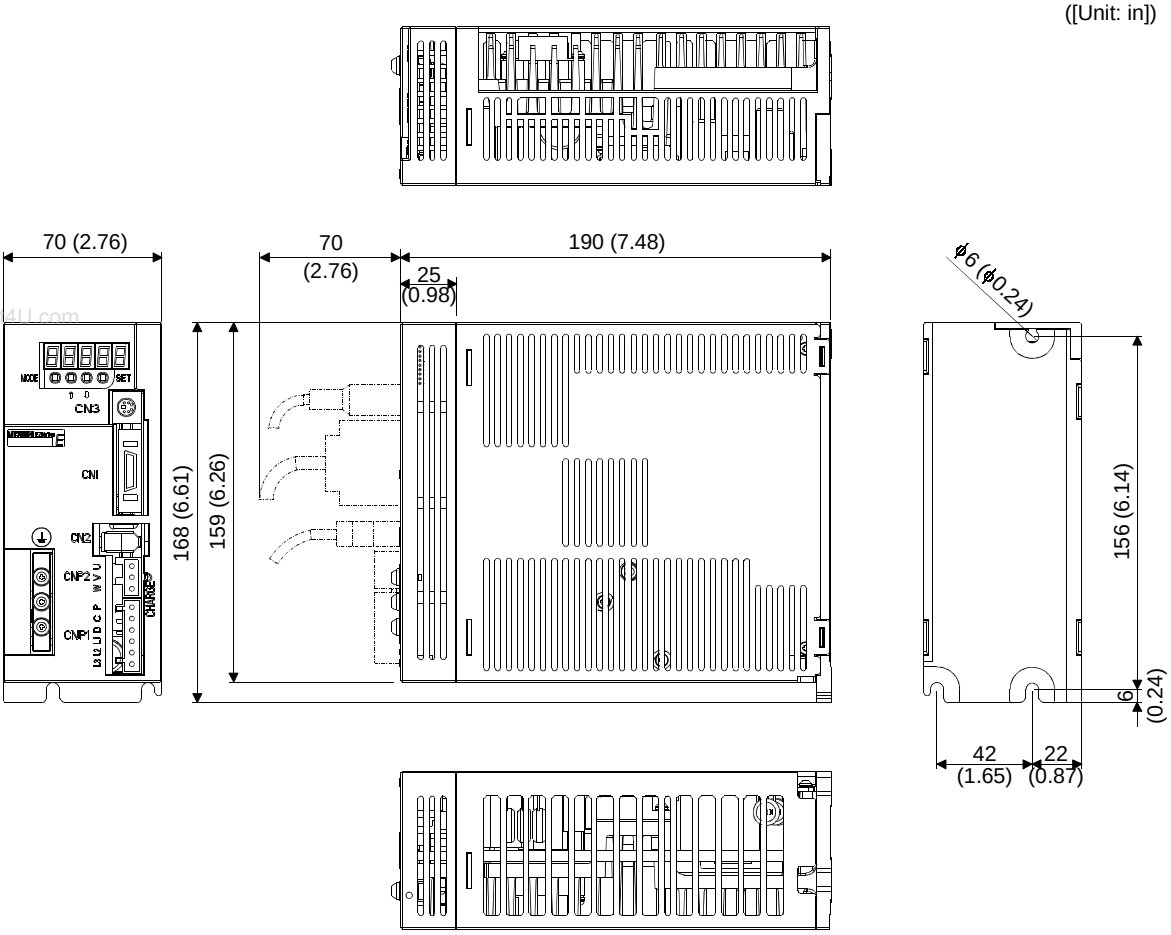
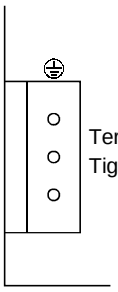
(3) MR-E-70A · MR-E-100A

[Unit: mm]
([Unit: in])



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

PE terminals



Terminal screw: M4
Tightening torque: 1.2 [N·m] (169.9 [oz·in])

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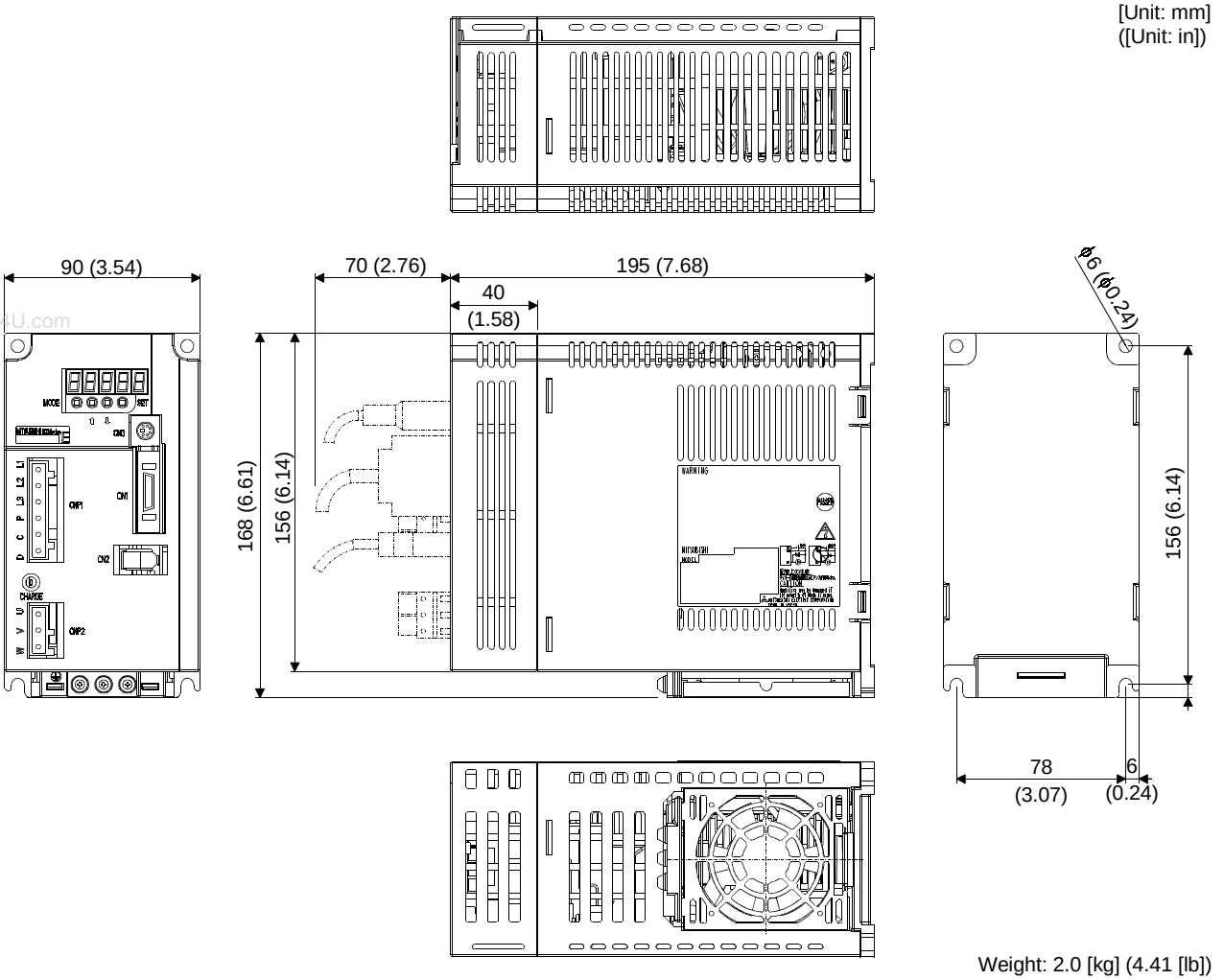
(4) MR-E-200A

[Unit: mm]
([Unit: in])



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

PE terminal

Terminal screw: M4
Tightening torque: 1.2 [N・m]

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11.2 Connectors

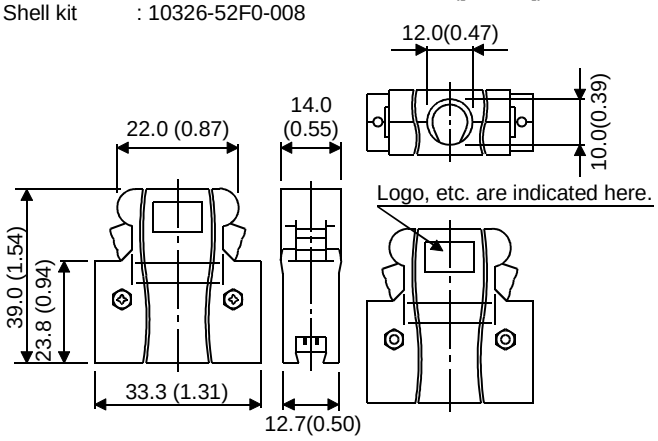
(1) Servo amplifier side

<3M >

(a) Soldered type

Model
Connector : 10126-3000VE
Shell kit : 10326-52F0-008

[Unit: mm]
([Unit: in])



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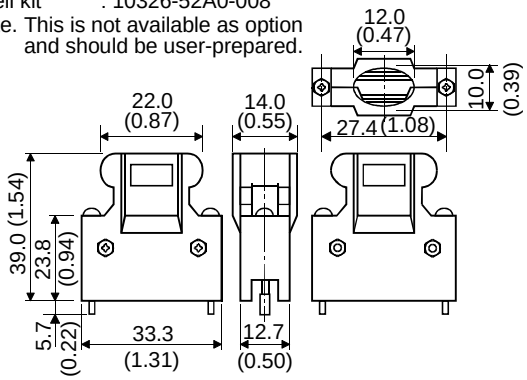
(b) Threaded type

Model
Connector : 10126-3000VE
Shell kit : 10326-52A0-008
Note. This is not available as option and should be user-prepared.

[Unit: mm]
([Unit: in])



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(2) CN2 Connector

Connector housing	: 54593-1011
Cover A	: 54594-1015
Cover B	: 54595-1005
Shell cover	: 58935-1000
Shell body	: 58934-1000
Cable clamp	: 58934-0000
Screw	: 58203-0010

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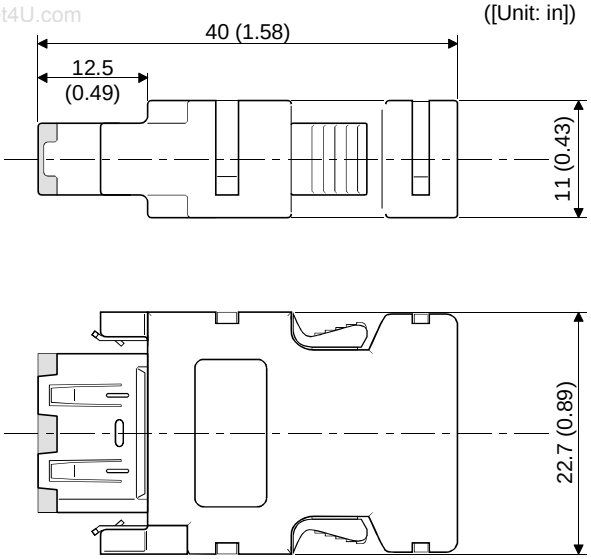
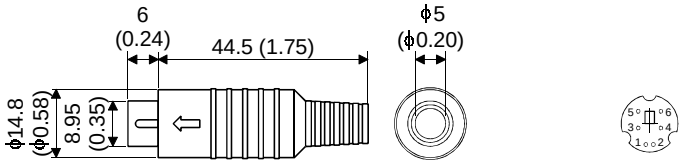
[Unit: mm]
([Unit: in])



(3) CN3 Connector (Marushin electric mfg)

Connector: MP371/6



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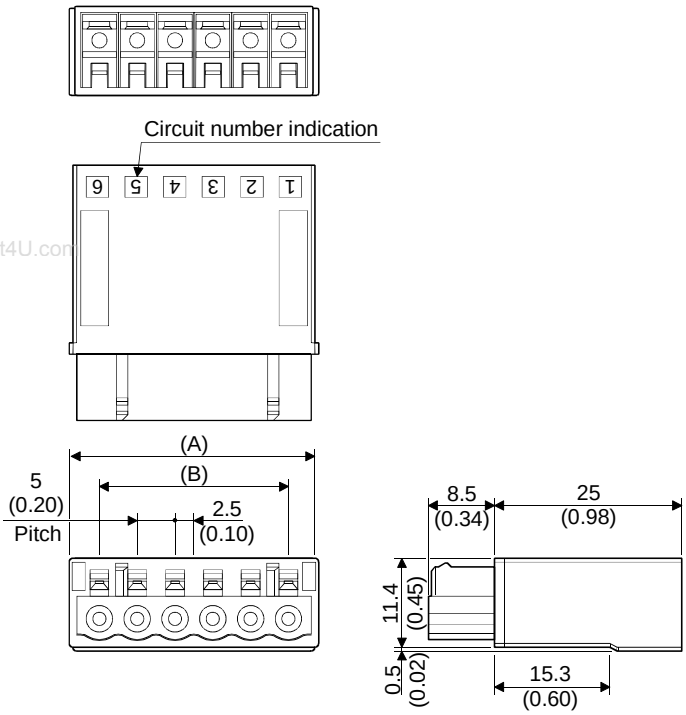
(4) CNP1 · CNP2 Connector (molex)

(a) Insulation displacement type

[Unit: mm]
([Unit: in])

Connector	Variable Dimensions [mm] ([in])		Number of Poles	Application
	A	B		
51240-0300	17.8 (0.70)	10 (0.39)	3	CNP2 (1kW or less)
51240-0600	32.8 (1.29)	25 (0.98)	6	CNP1 (1kW or less)

Crimping tool: 57349-5300 (molex)



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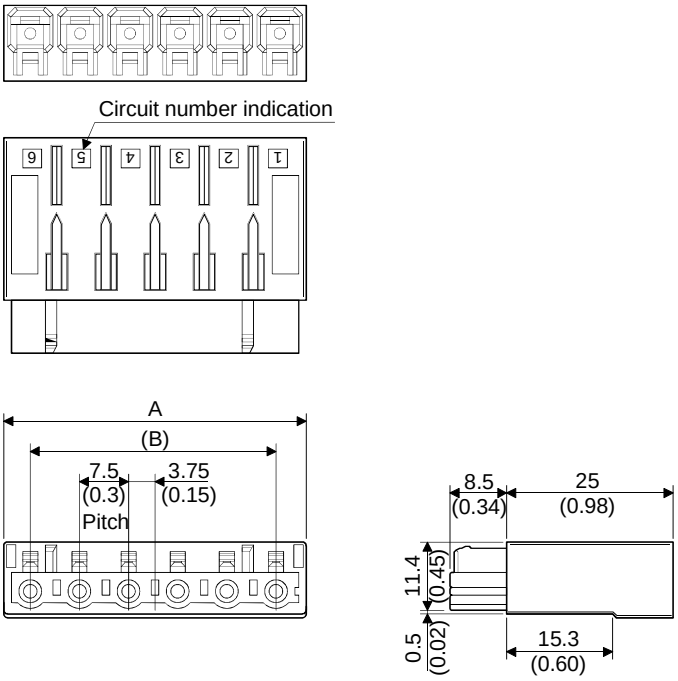
[Unit: mm]
([Unit: in])

Connector	Variable Dimensions [mm] ([in])		Number of Poles	Application
	A	B		
51241-0300	22.8 (0.9)	15 (0.59)	3	CNP2 (2kW)
51241-0600	45.3 (1.78)	37.5 (1.48)	6	CNP1 (2kW)

Crimping tool: 57349-5300 (molex)



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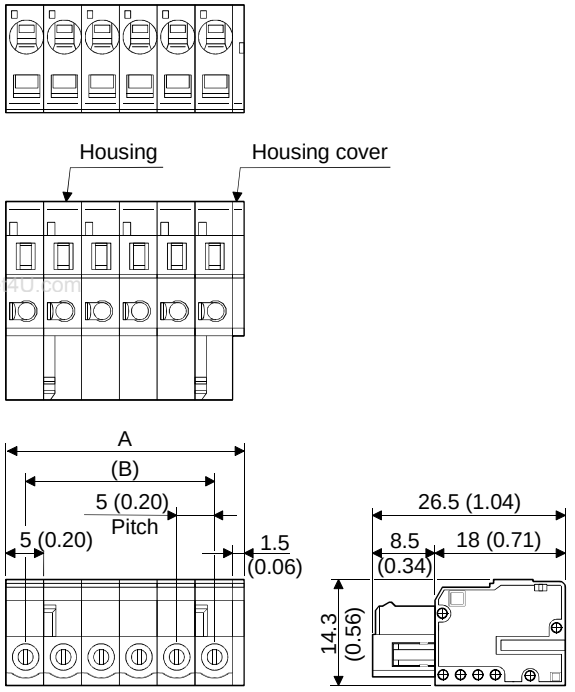
(b) Insertion type

[Unit: mm]
([Unit: in])

Connector	Variable Dimensions [mm] ([in])		Number of Poles	Application
	A	B		
55757-0310	16.5 (0.65)	10 (0.39)	3	CNP2 (1kW or less)
55755-0610	31.5 (1.24)	25 (0.98)	6	CNP1 (1kW or less)



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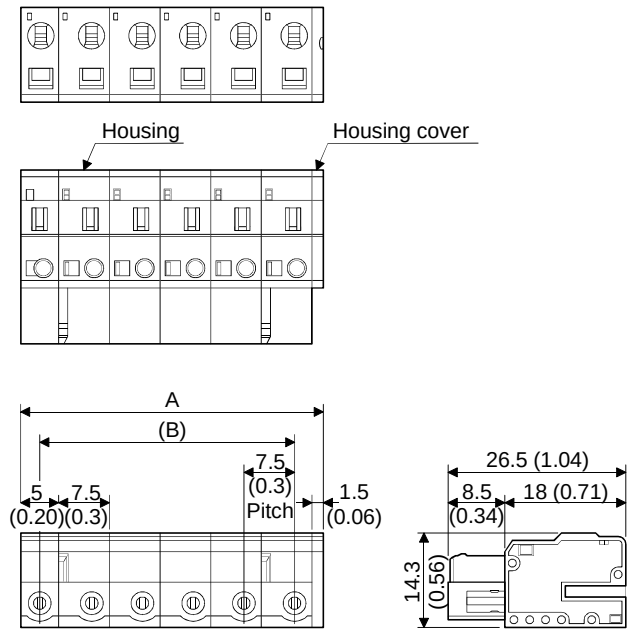
[Unit: mm]
([Unit: in])

Connector	Variable Dimensions [mm] ([in])		Number of Poles	Application
	A	B		
54927-0310	21.5 (0.85)	22.5 (0.89)	3	CNP2 (2kW)
54927-0610	44 (1.73)	37.5 (1.48)	6	CNP1 (2kW)



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12. CHARACTERISTICS

12.1 Overload protection characteristics

An electronic thermal relay is built in the servo amplifier to protect the servo motor and servo amplifier from overloads. Overload 1 alarm (AL.50) occurs if overload operation performed is above the electronic thermal relay protection curve shown in any of Figs 12.1, Overload 2 alarm (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.

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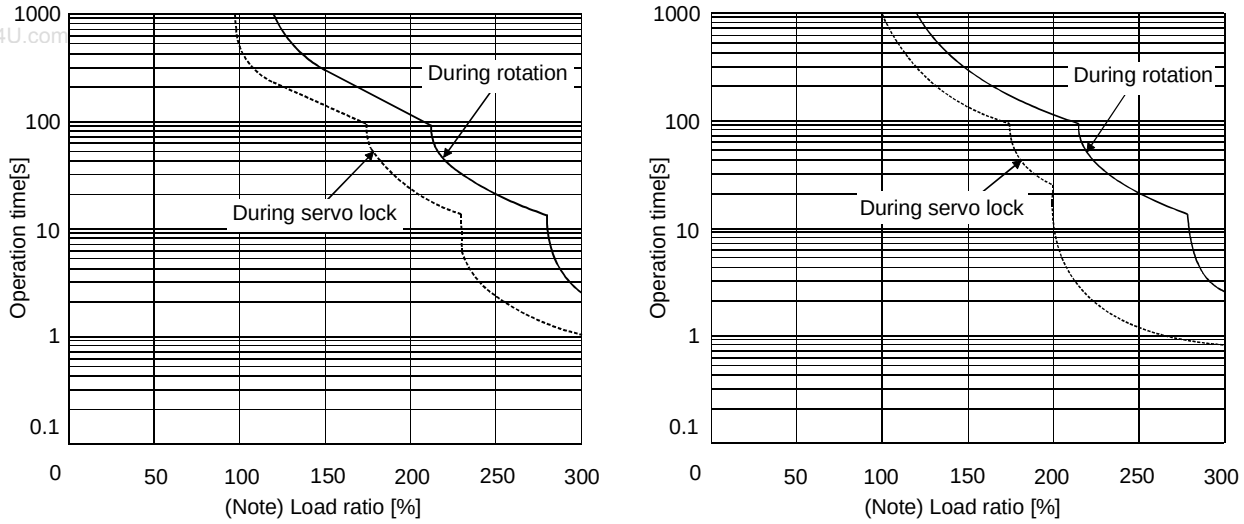

a. MR-E-10A to MR-E-100A b. MR-E-200A

Note: If the servo motor is stopped or low-speed (30r/min or less) operation is performed at an abnormally high duty with torque more than 100% of the rating being generated, the servo amplifier may fail even in a status where 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	
			At rated torque	With servo off	[m²]	[ft²]
MR-E-10A(1)	HC-KFE13	0.3	25	15	0.5	5.4
MR-E-20A(1)	HC-KFE23	0.5	25	15	0.5	5.4
MR-E-40A(1)	HC-KFE43	0.9	35	15	0.7	7.5
MR-E-60A	HC-SFE52	1.0	40	15	0.8	8.6
MR-E-70A	HC-KFE73	1.3	50	15	1.0	10.8
MR-E-100A	HC-SFE102	1.7	50	15	1.0	10.8
MR-E-200A	HC-SFE202	3.5	90	20	1.8	19.4

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 brake option, use Equation 13.1 in Section 13.1.1.

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(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]

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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 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.

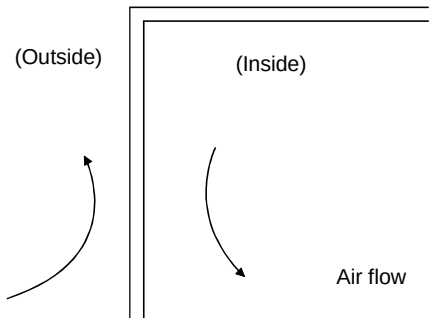

Fig. 12.2 Temperature distribution in enclosure

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.

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12.3 Dynamic brake characteristics

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)

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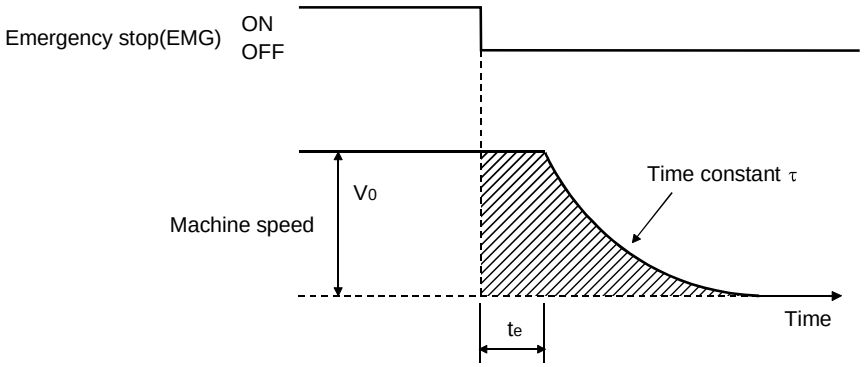
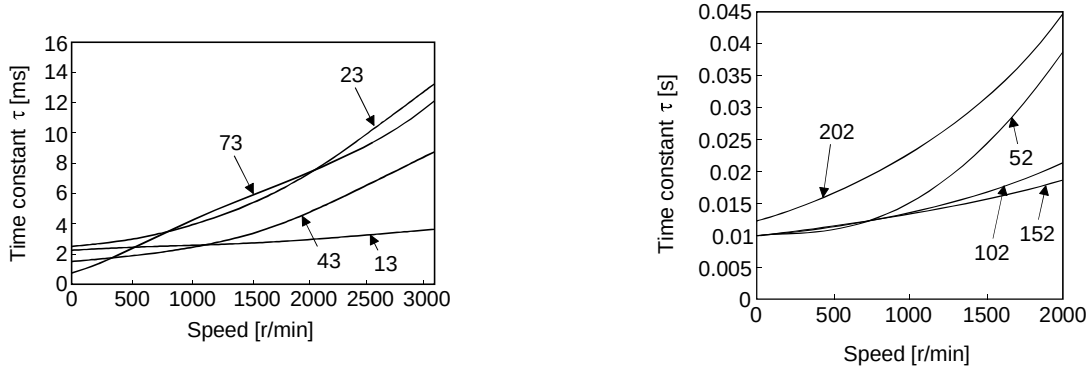


Fig. 12.3 Dynamic brake operation diagram

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

L_{max} : Maximum coasting distance [mm][in]
V_o : Machine rapid feedrate [mm/min][in/min]
J_M : Servo motor inertial moment [kg·cm²][oz·in²]
J_L : Load inertia moment converted into equivalent value on servo motor shaft [kg·cm²][oz·in²]
τ : Brake time constant [s]
t_e : Delay time of control section [s]
(There is internal relay delay time of about 30ms.)



a. HC-KFE series b. HC-SFE series

Fig. 12.4 Dynamic brake time constant

Use the dynamic brake at the load inertia moment 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 to MR-E-200A	30

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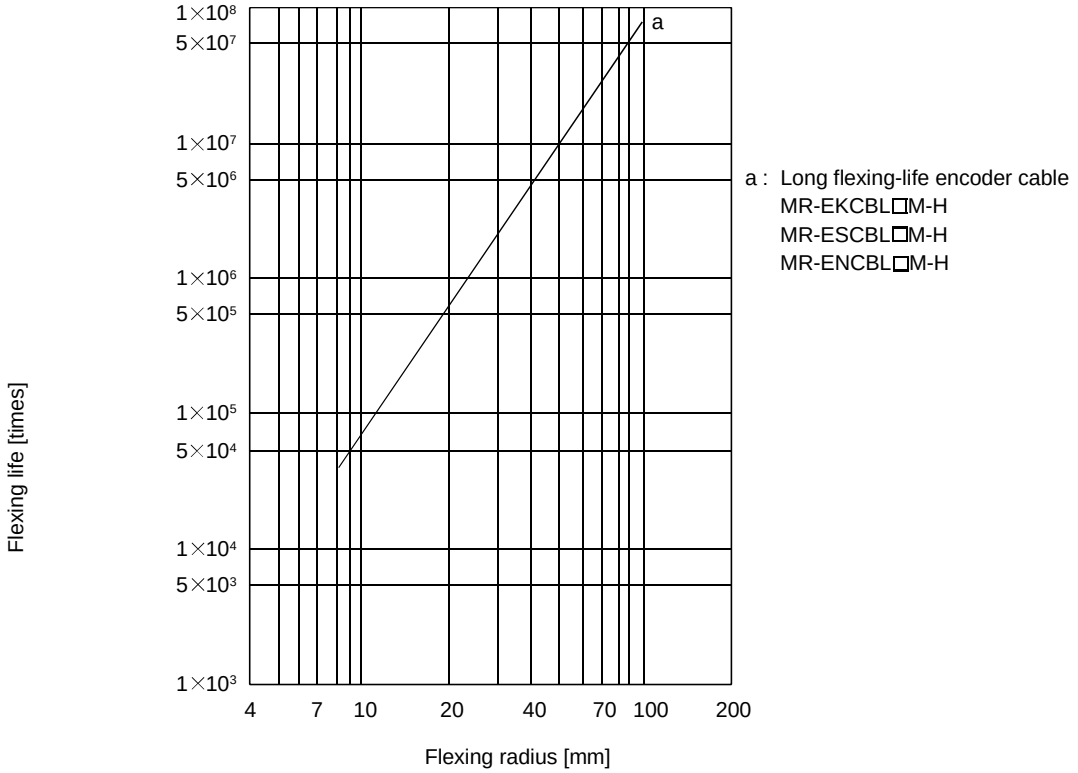
12.4 Encoder cable flexing life

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.



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13. OPTIONS AND AUXILIARY EQUIPMENT

⚠WARNING	· Before connecting any option or auxiliary equipment, make sure that the charge lamp is off more than 10 minutes after power-off, then confirm the voltage with a tester or the like. Otherwise, you may get an electric shock.

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

13.1 Options

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13.1.1 Regenerative brake options

⚠CAUTION	· The specified combinations of regenerative brake 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	Regenerative power[W]					
	Built-in regenerative brake resistor	MR-RB032 [40Ω]	MR-RB12 [40Ω]	MR-RB32 [40Ω]	MR-RB30 [13Ω]	(Note) MR-RB50 [13Ω]
MR-E-10A		30				
MR-E-20A		30	100			
MR-E-40A	10	30	100			
MR-E-70A	20	30	100	300		
MR-E-100A	20	30	100	300		
MR-E-200A	100				300	500

Note: Always install a cooling fan.

(2) Selection of the regenerative brake option

(a) Simple selection method

In horizontal motion applications, select the regenerative brake option as described below: When the servo motor is run without load in the regenerative mode from the running speed to a stop, the permissible duty is as indicated in Section 5.1 of the separately available Servo Motor Instruction Manual.

For the servo motor with a load, the permissible duty changes according to the inertia moment of the load and can be calculated by the following formula:

$$\text{Permissible duty} = \frac{\text{Permissible duty for servo motor with no load (value indication Section 5.1 in Servo Motor Instruction Manual)}}{(m+1)} \times \left(\frac{\text{ratedspeed}}{\text{running speed}}\right)^2 [\text{times/min}]$$

where m = load inertia moment/servo motor inertia moment

From the permissible duty, find whether the regenerative brake option is required or not.
Permissible duty < number of positioning times [times/min]
Select the regenerative brake option out of the combinations in (1) in this section.

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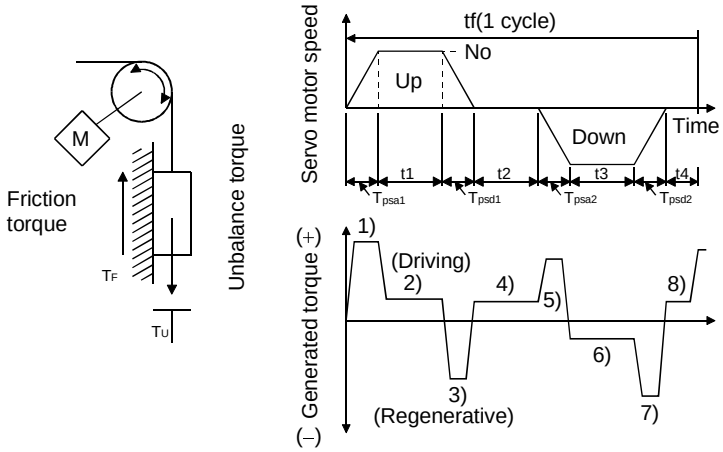
(b) To make selection according to regenerative energy

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 brake 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)	$T_1 = \frac{(J_L + J_M) \cdot N_0}{9.55 \times 10^4} \cdot \frac{1}{T_{psa1}} + T_U + T_F$	$E_1 = \frac{0.1047}{2} \cdot N_0 \cdot T_1 \cdot T_{psa1}$
2)	$T_2 = T_U + T_F$	$E_2 = 0.1047 \cdot N_0 \cdot T_2 \cdot t_1$
3)	$T_3 = \frac{(J_L + J_M) \cdot N_0}{9.55 \times 10^4} \cdot \frac{1}{T_{psd1}} + T_U + T_F$	$E_3 = \frac{0.1047}{2} \cdot N_0 \cdot T_3 \cdot T_{psd1}$
4), 8)	$T_4 = T_U$	$E_4 \geq 0$ (No regeneration)
5)	$T_5 = \frac{(J_L + J_M) \cdot N_0}{9.55 \times 10^4} \cdot \frac{1}{T_{psa2}} - T_U + T_F$	$E_5 = \frac{0.1047}{2} \cdot N_0 \cdot T_5 \cdot T_{psa2}$
6)	$T_6 = T_U + T_F$	$E_6 = 0.1047 \cdot N_0 \cdot T_6 \cdot t_3$
7)	$T_7 = \frac{(J_L + J_M) \cdot N_0}{9.55 \times 10^4} \cdot \frac{1}{T_{psd2}} - T_U + T_F$	$E_7 = \frac{0.1047}{2} \cdot N_0 \cdot T_7 \cdot T_{psd2}$

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(1)	55	9
MR-E-20A(1)	70	9
MR-E-40A(1)	85	11
MR-E-70A	80	18
MR-E-100A	80	18
MR-E-200A	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.

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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 brake option.

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

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

$$PR\ [W] = ER/tf \quad \text{.....(13.1)}$$

(3) Connection of the regenerative brake option

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

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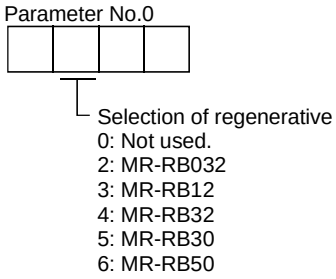
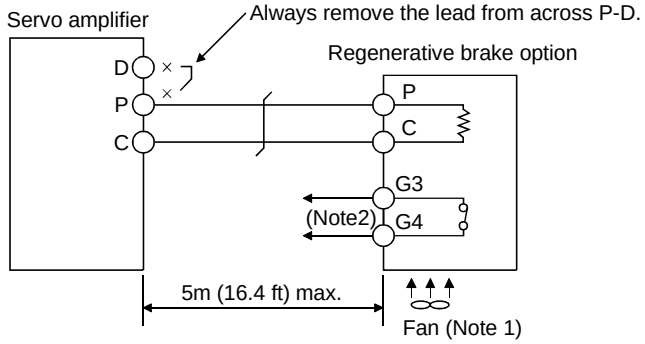


(4) Connection of the regenerative brake option

The regenerative brake option will generate heat of about 100℃. 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 brake option body. Always use twisted cables of max. 5m(16.4ft) length for connection with the servo amplifier.

Always remove the wiring from across P-D and fit the regenerative brake option across P-C.

The G3 and G4 terminals act as a thermal protector. G3-G4 are disconnected when the regenerative brake option overheats abnormally.



Note: 1. When using the MR-RB50, forcibly cool it with a cooling fan (1.0m³/min,□92 or so).
2. Make up a sequence which will switch off the magnetic contactor (MC) when abnormal heating occurs.
G3-G4 contact specifications
Maximum voltage: 120V AC/DC
Maximum current: 0.5A/4.8VDC
Maximum capacity: 2.4VA

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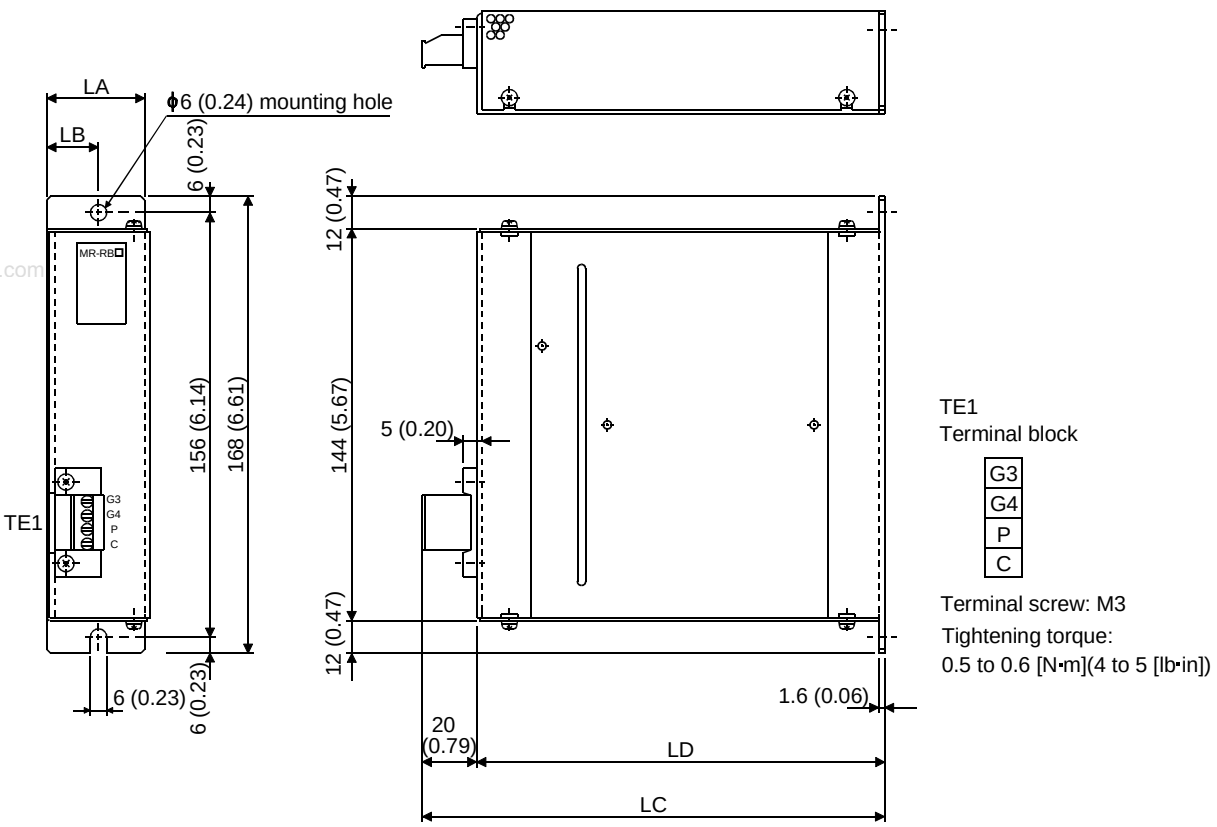
(5) Outline drawing

(a) MR-RB032 · MR-RB12

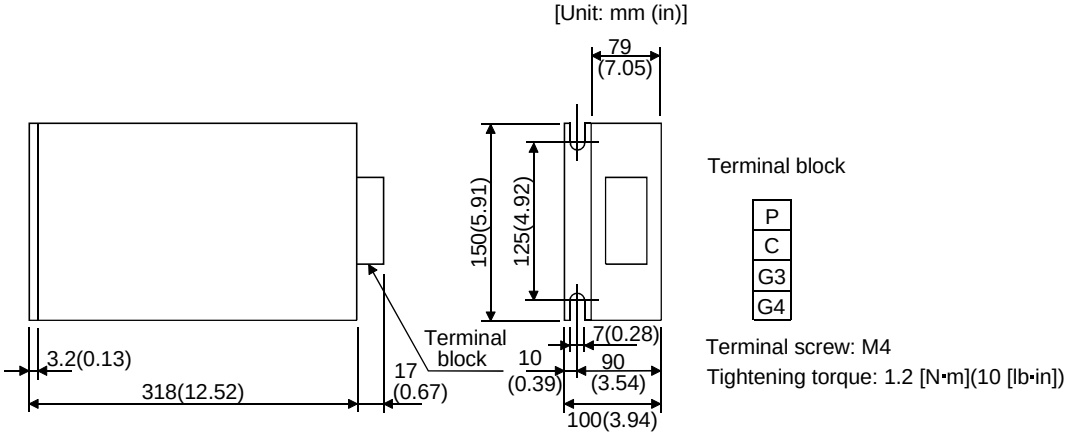
[Unit: mm (in)]



Regenerative brake option	Regenerative power[W]	Resistance [Ω]	Variable dimensions				Weight	
			LA	LB	LC	LD	[kg]	[lb]
MR-RB032	30	40	30 (1.18)	15 (0.59)	119 (4.69)	99 (3.9)	0.5	1.1
MR-RB12	100	40	40 (1.57)	15 (0.59)	169 (6.69)	149 (5.87)	1.1	2.4

(b) MR-RB32 · MR-RB30

[Unit: mm (in)]



Regenerative brake option	Regenerative power[W]	Resistance [Ω]	Weight	
			[kg]	[lb]
MR-RB32	300	40	2.9	6.4
MR-RB30	300	13	2.9	6.4

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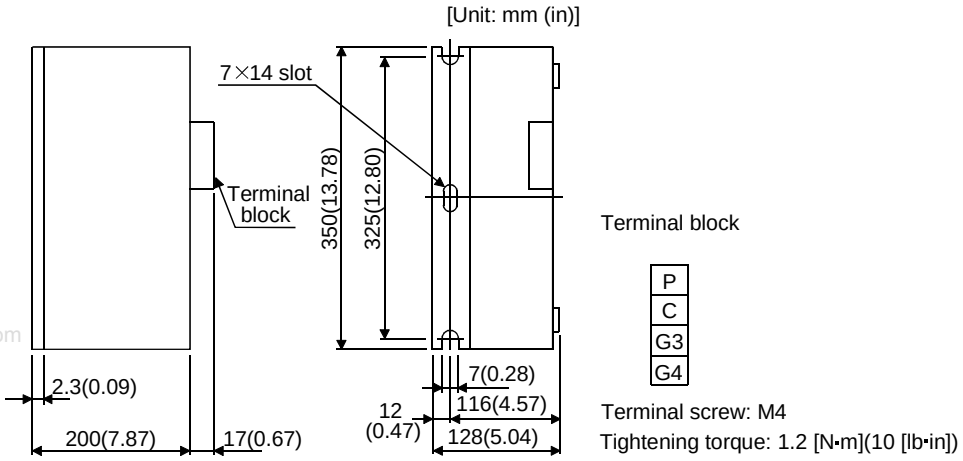
(c) MR-RB50



Regenerative brake option	Regenerative power [W]	Resistance [Ω]	Weight	
			[kg]	[lb]
MR-RB50	500	13	5.6	12.3

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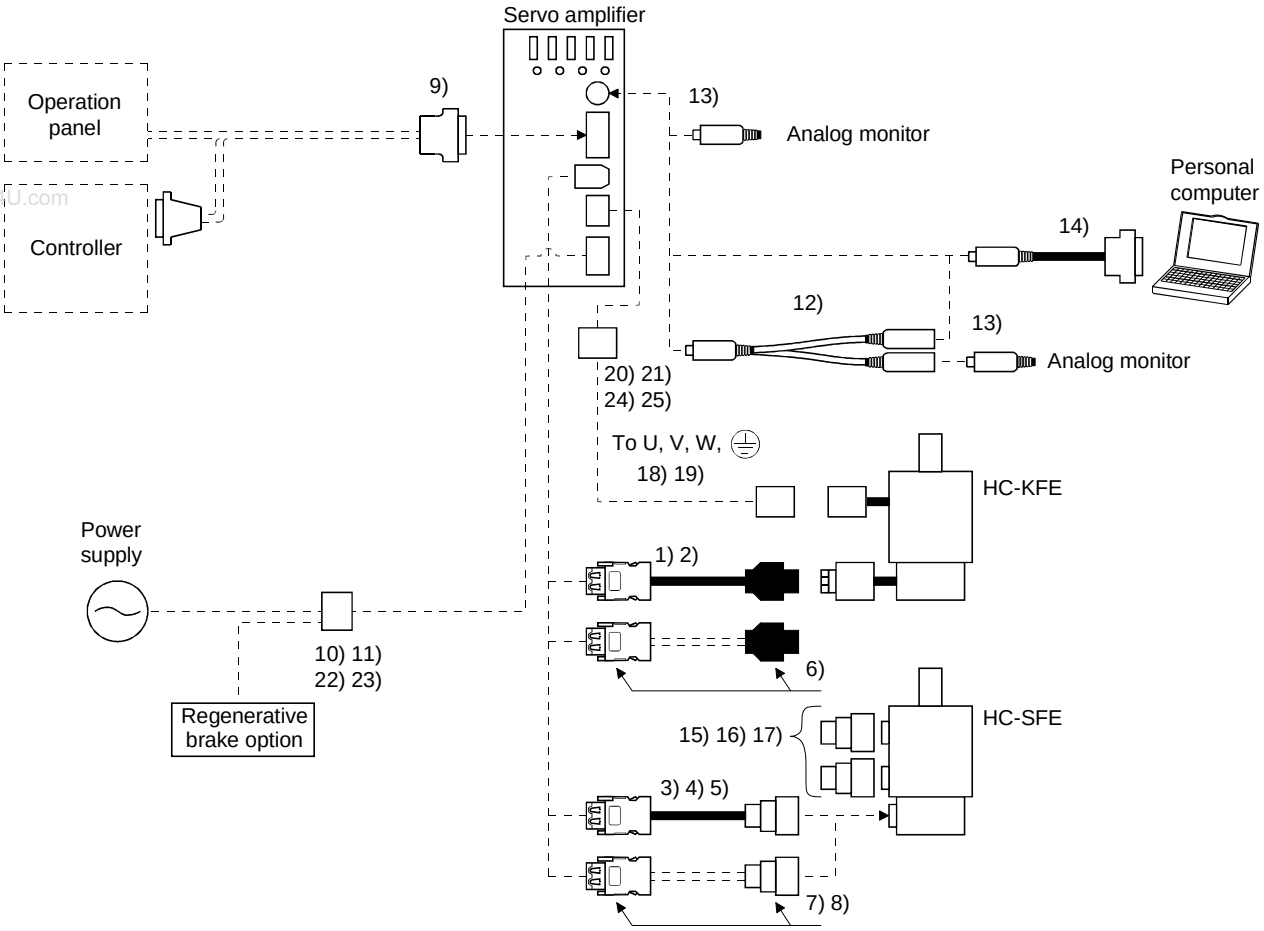
13.1.2 Cables and connectors

(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.



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No.	Product	Model	Description	Application
1)	Standard encoder cable	MR-EKCBL□M-L Refer to (2) (a) in this section.	(Note) (molex or equivalent) Housing: 1-172161-9 Connector pin: 170359-1 (AMP or equivalent)	Standard flexing life IP20
2)	Long flexing life encoder cable	MR-EKCBL□M-H Refer to (2) (b) in this section.		Long flexing life IP20
3)	Standard encoder cable	MR-ESCBL□M-L Refer to (2) (c) in this section.	(Note) (molex or equivalent) Plug: MS3106B20-29S Cable clamp: MS3057-12A (Japan Aviation Electronics)	Standard flexing life IP20
4)	Long flexing life encoder cable	MR-ESCBL□M-H Refer to (2) (d) in this section.		Long flexing life IP20
5)	IP65-compliant encoder cable	MR-ENECBL□M-H Refer to (2) (d) in this section.	(Note) (molex or equivalent) Plug: MS3106A20-29S (D190) Cable clamp : CE3057-12A-3 (D265) Back shell: CE02-20BS-S (DDK) 	Long flexing life IP65 IP67 Not oil-resistant.
6)	Encoder connector set	MR-ECNM	(Note) (molex or equivalent) Housing: 1-172161-9 Pin: 170359-1 Cable clamp: MTI-0002 (AMP or equivalent) 	IP20
7)	Encoder connector set	MR-ECNS	(Note) (molex or equivalent) Plug: MS3106B20-29S Cable clamp: MS3057-12A (JAE) 	IP20
8)	Encoder connector set	MR-ENECNS	(Note) (molex or equivalent) Plug: MS3106A20-29S (D190) Cable clamp : CE3057-12A-3 (D265) Back shell: CE02-20BS-S (DDK) 	IP65 IP67
9)	Control signal connector set	MR-ECN1 (In units of 20 pcs. /box)	Connector: 10126-3000VE Shell kit: 10326-52F0-008 (3M or equivalent) 	
10)	Amplifier power supply connector set (Insulation displacement type) MR-E-10A to 100A	MR-ECNP1-A (In units of 20 pcs. /box)	Connector: 51240-0600 (molex or equivalent) Terminal: 56125-0118 (molex or equivalent) 	Insulation displacement type
11)	Amplifier power supply connector set (Insertion type) MR-E-10A to 100A	MR-ECNP1-B (In units of 20 pcs. /box)	Connector: 54927-0610 (molex or equivalent) 	Insertion type

Note: The models of the soldering type are 54593-1011 (connector housing), 54594-1015 (cover A), 54595-1005 (cover B), 58935-1000 (shell cover), 58934-1000 (shell body), 58937-0000 (cable clamp) and 58203-0010 (screw).
The models of the insulation displacement type are 51209-1001 (connector housing), 54594-1015 (cover A), 54595-1005 (cover B), 58935-1000 (shell cover), 58934-1000 (shell body), 59351-8187 (terminal), 58937-0000 (cable clamp) and 58203-0010 (screw).

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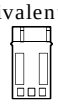
No.	Product	Model	Description	Application
12)	Analog monitor RS-232C branch cable	MR-E3CBL15-P	Connector: MP371/6 Connector: MJ372/6 (Marushin Musen Denki or equivalent)	Analog monitor RS-232C branch cable
13)	Analog monitor RS-232C connector	MR-ECN3 (In units of 20 pcs. /box)	 Connector: MP371/6 (Marushin Musen Denki or equivalent)	Analog monitor for RS-232C
14)	Communication cable	Refer to (3) in this section. 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
15)	Motor power supply connector set	MR-PWCNS1 Refer to Servo Motor Instruction Manual.	 Plug: CE05-6A22-23SD-B-BSS Cable clamp: CE3057-12A-2 (D265) (DDK)	Must be used for compliance with the EN Standard. IP65 IP67
16)	Motor power supply connector set	MR-PWCNS2 Refer to Servo Motor Instruction Manual.	 Plug: CE05-6A24-10SD-B-BSS Cable clamp: CE3057-16A-2 (D265) (DDK)	
17)	Brake connector set	MR-BKCN Refer to Servo Motor Instruction Manual.	 Plug: MS3106A10SL-4S (D190) (DDK) Cable connector: YS010-5-8 (Daiwa Dengyo)	EN Standard-compliant IP65 IP67
18)	Motor power supply connector set	MR-PWCNK1	 Plug: 5559-04P-210 Terminal: 5558PBT3L (for AWG16) (6 pcs.) (molex)	IP20
19)	Motor power supply connector set	MR-PWCNK2	 Plug: 5559-06P-210 Terminal: 5558PBT3L (for AWG16) (8 pcs.) (molex)	For motor with brake IP20
20)	Motor power supply connector (Insulation displacement type) MR-E-10A to 100A	MR-ECNP2-A (In units of 20 pcs. /box)	Connector: 51240-0300 (molex or equivalent) Terminal: 56125-0118 (molex or equivalent) 	Insulation displacement type
21)	Motor power supply connector (Insertion type) MR-E-10A to 100A	MR-ECNP2-B (In units of 20 pcs. /box)	Connector: 54927-0310 (molex or equivalent) 	Insertion type
22)	Amplifier power supply connector set (Insulation displacement type) MR-E-200A	MR-ECNP1-A1 (In units of 20 pcs. /box)	Connector: 54241-0600 (molex or equivalent) Terminal: 56125-0118 (molex or equivalent) 	Insulation displacement type
23)	Amplifier power supply connector set (Insertion type) MR-E-200A	MR-ECNP1-B1 (In units of 20 pcs. /box)	Connector: 54928-0610 (molex or equivalent) 	Insertion type
24)	Motor power supply connector (Insulation displacement type) MR-E-10A to 100A	MR-ECNP2-A1 (In units of 20 pcs. /box)	Connector: 54241-0300 (molex or equivalent)  Terminal: 56125-0118 (molex or equivalent) 	Insulation displacement type
25)	Motor power supply connector (Insertion type) MR-E-10A to 100A	MR-ECNP2-B1 (In units of 20 pcs. /box)	Connector: 54928-0310 (molex or equivalent) 	Insertion type

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(2) Encoder cable

CAUTION	▪ If you have fabricated the encoder cable, connect it correctly. Otherwise, misoperation or explosion may occur.

POINT

- The encoder cable is not oil resistant.
- Refer to Section 12.4 for the flexing life of the encoder cable.
- When the encoder cable is used, the sum of the resistance values of the cable used for P5 and the cable used for LG should be within 2.4Ω.
- When soldering the wire to the connector pin, insulate and protect the connection portion using heat-shrinkable tubing.
- When using the encoder cable of four-wire type communication system, set "1 □□□ " in parameter No. 20 to select the four-wire type.

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Generally use the encoder cable available as our options. If the required length is not found in the options, fabricate the cable on the customer side.
When fabricating an encoder cable, use the recommended wires given in Section 13.2.1 and the MR-ECNM connector set for encoder cable fabrication, and fabricate an encoder cable as shown in the wiring diagram.
Refer to section 14.5 and choose the encode side connector according to the servo motor installation environment.

(a) MR-EKCBL□M-L (standard flex life model)

These encoder cables are used with the HC-KFE series servo motors.

1) Model explanation

Model: MR-EKCBL□M-L

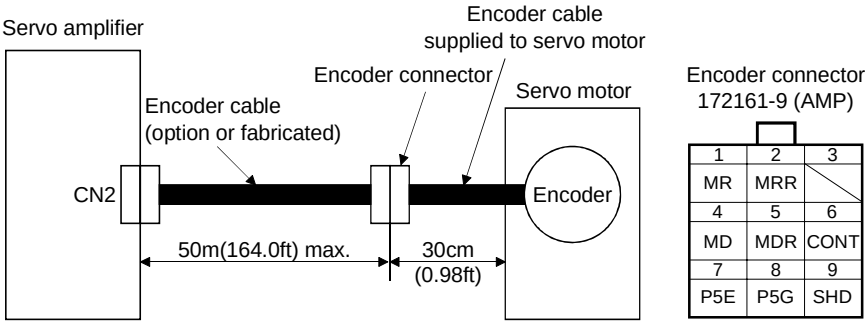
Standard flex life

Symbol	Cable Length [m(ft)]	Communication System
2	2 (6.56)	Two-wire type
5	5 (16.4)	
10	10 (32.8)	
20	20 (65.6)	
30	30 (98.4)	(Note) Four-wire type

Note: Set "1 □□□ " in parameter No. 20.

2) Connection diagram

For the pin assignment on the servo amplifier side, refer to Section 3.3.1.



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- Encoder cable of less than 30m

When fabricating an encoder cable, use the MR-ECNM connector set. Referring to the following wiring diagram, you can fabricate an encoder cable of up to less than 30m.

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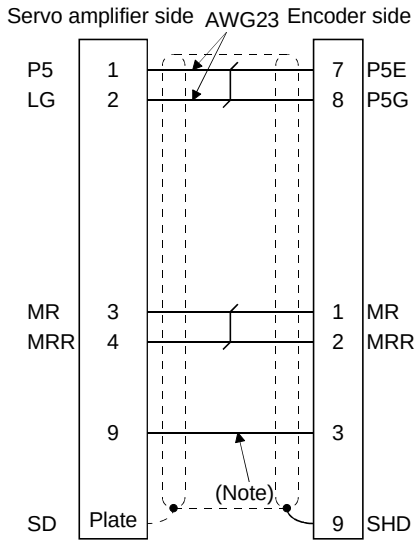
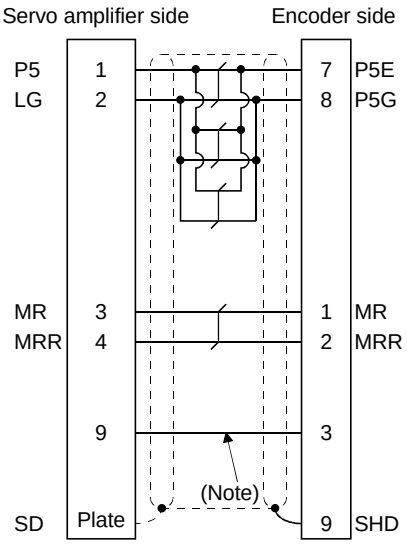
MR-EKCBL2M-L
MR-EKCBL5M-L
MR-EKCBL10M-L



MR-EKCBL20M-L



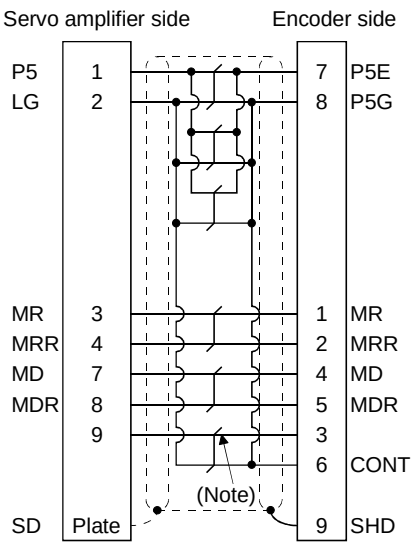
Note. When an encoder cable is fabricated, this wire is not required.

- Encoder cable of 30m or more

POINT
▪ The communication system of the encoder cable in this wiring diagram is the four-wire type. Set "1 □□□" in parameter No. 20.

When fabricating an encoder cable, use the MR-ECNM connector set. Referring to the following wiring diagram, you can fabricate an encoder cable of up to 50m.

MR-EKCBL30M-L



Note. When an encoder cable is fabricated, this wire is not required.

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(b) MR-EKCBL□M-H (long flex life model)

Use this encoder cable with the HC-KFE series servo motor.

1) Model explanation

Model: MR-EKCBL□M-H

Long flex life

Symbol	Cable Length [m(ft)]	Communication System
2	2 (6.56)	Two-wire type
5	5 (16.4)	
10	10 (32.8)	
20	20 (65.6)	
30	30 (98.4)	(Note) Four-wire type
40	40 (131.2)	
50	50 (164.0)	

Note: Set "1 □□□" in parameter No. 20.

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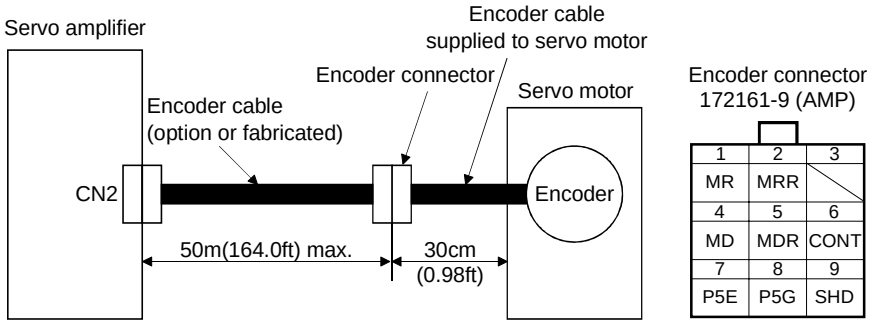
2) Connection diagram

For the pin assignment on the servo amplifier side, refer to Section 3.3.1.



- Encoder cable of less than 30m

When fabricating an encoder cable, use the MR-ECNM connector set. Referring to the following wiring diagram, you can fabricate an encoder cable of up to less than 30m.

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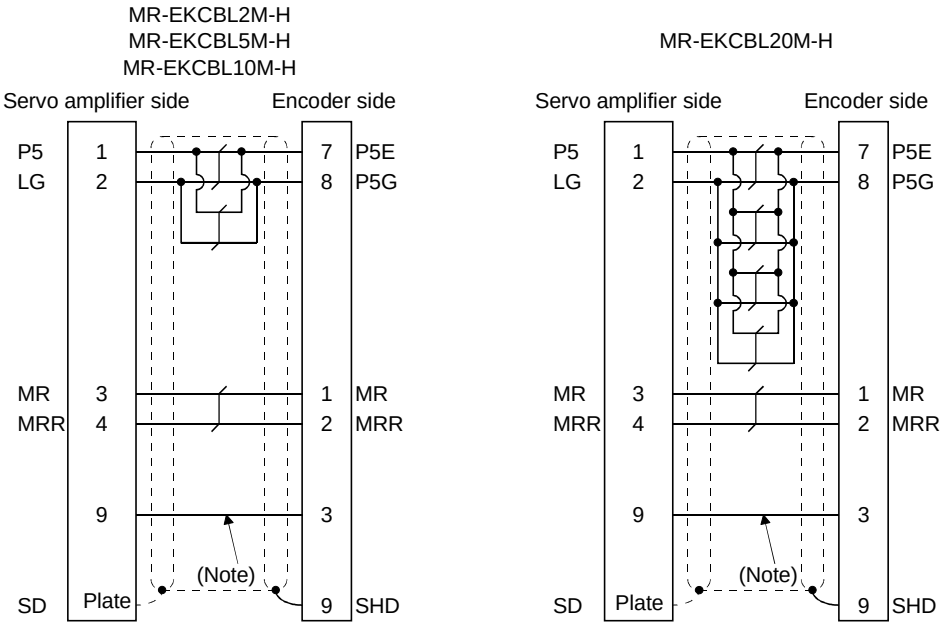


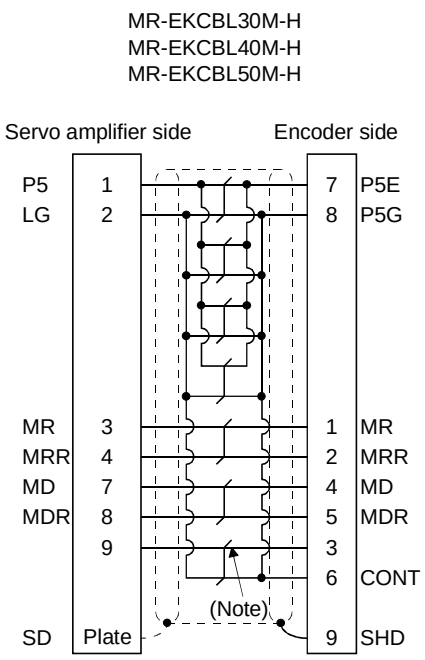
Note. When an encoder cable is fabricated, this wire is not required.

- Encoder cable of 30m or more

POINT

- The communication system of the encoder cable in this wiring diagram is the four-wire type. Set "1 □□□" in parameter No. 20.

When fabricating an encoder cable, use the MR-ECNM connector set. Referring to the following wiring diagram, you can fabricate an encoder cable of up to 50m.



Note. When an encoder cable is fabricated, this wire is not required.

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(c) MR-ESCBL□M-L (standard flex life model)

These encoder cables are used with the HC-SFE series servo motors.

1) Model explanation

Model: MR-ESCBL□M-L

Standard flex life

Symbol	Cable Length [m(ft)]	Communication System
2	2 (6.56)	Two-wire type
5	5 (16.4)	
10	10 (32.8)	
20	20 (65.6)	
30	30 (98.4)	(Note) Four-wire type

Note: Set "1 □□□" in parameter No. 20.

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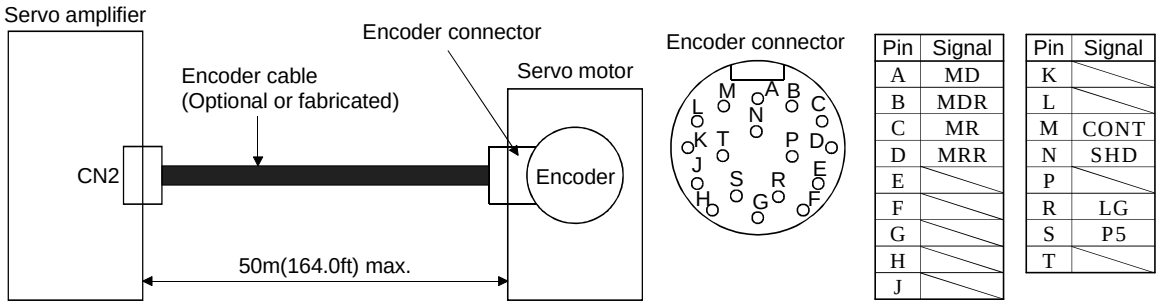
2) Connection diagram

For the pin assignment on the servo amplifier side, refer to Section 3.3.1.



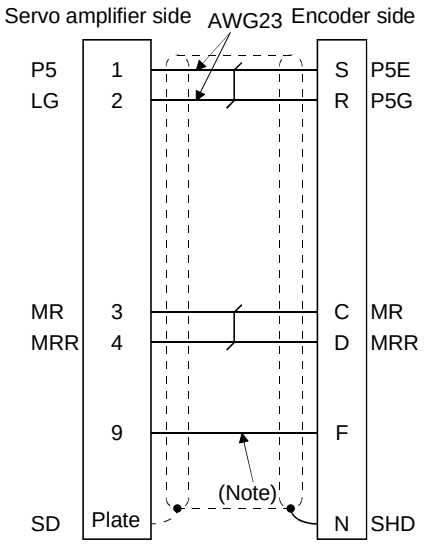
Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	
G	
H	
J	

Pin	Signal
K	
L	
M	CONT
N	SHD
P	
R	LG
S	P5
T	

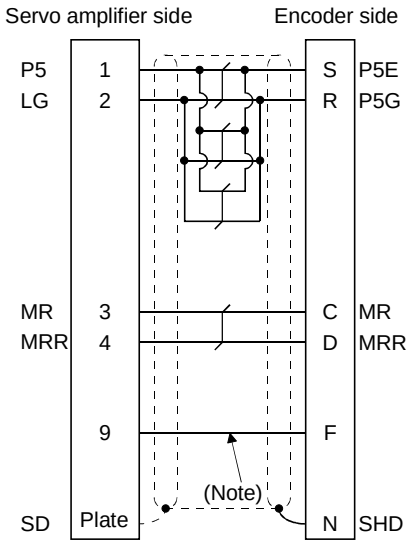
・Encoder cable of less than 30m

When fabricating an encoder cable, use the MR-ECNS connector set. Referring to the following wiring diagram, you can fabricate an encoder cable of up to less than 30m.

MR-ESCBL2M-L
MR-ESCBL5M-L
MR-ESCBL10M-L



MR-ESCBL20M-L



Note. When an encoder cable is fabricated, this wire is not required.

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・Encoder cable of 30m or more

POINT
・The communication system of the encoder cable in this wiring diagram is the four-wire type. Set "1 □□□ " in parameter No. 20.

When fabricating an encoder cable, use the MR-ECNS connector set. Referring to the following wiring diagram, you can fabricate an encoder cable of up to 50m.

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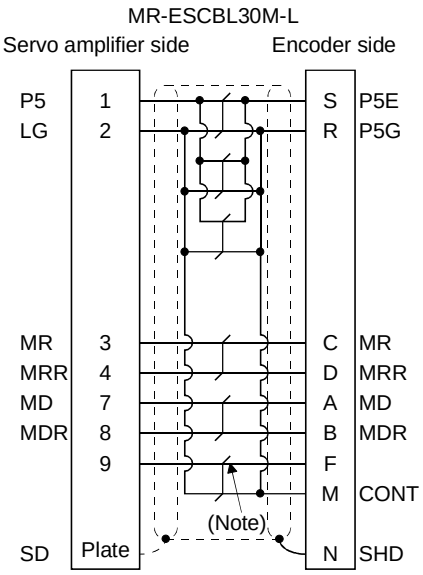

Note. When an encoder cable is fabricated, this wire is not required.

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(d) MR-ESCBL□M-H (long flex life model) · MR-ENECBL□M-H (IP65/IP67-compatible, long flex life model)

These encoder cables are used with the HC-SFE series servo motors.

1) Model explanation

Model: MR-ESCBL□M-H

Long flex life

Symbol	Cable Length [m(ft)]	Communication System
2	2 (6.56)	Two-wire type
5	5 (16.4)	
10	10 (32.8)	
20	20 (65.6)	
30	30 (98.4)	(Note) Four-wire type
40	40 (131.2)	
50	50 (164.0)	

Note: Set "1 □□□" in parameter No. 20.

Model: MR-ENECBL□M-H

Long flex life

Symbol	Cable Length [m(ft)]	Communication System
2	2 (6.56)	Two-wire type
5	5 (16.4)	
10	10 (32.8)	
20	20 (65.6)	
30	30 (98.4)	(Note) Four-wire type
40	40 (131.2)	
50	50 (164.0)	

Note: Set "1 □□□" in parameter No. 20.

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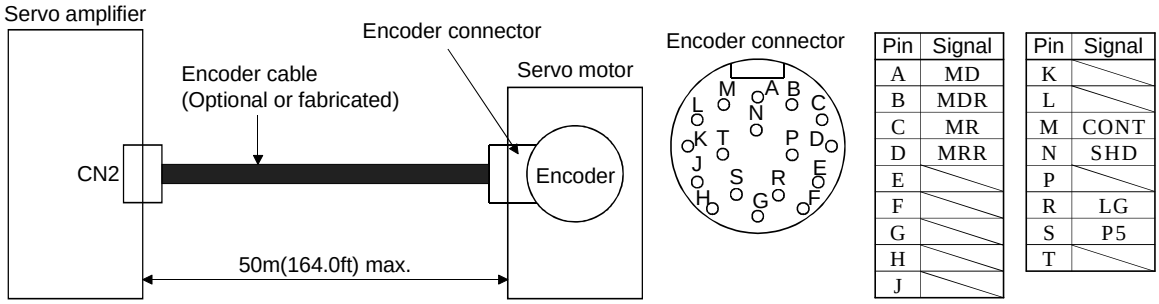
2) Connection diagram

For the pin assignment on the servo amplifier side, refer to Section 3.3.1.



Pin	Signal
A	MD
B	MDR
C	MR
D	MRR
E	
F	
G	
H	
J	

Pin	Signal
K	
L	
M	CONT
N	SHD
P	
R	LG
S	P5
T	

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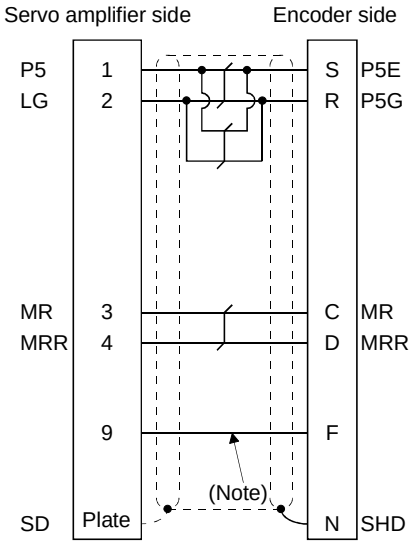
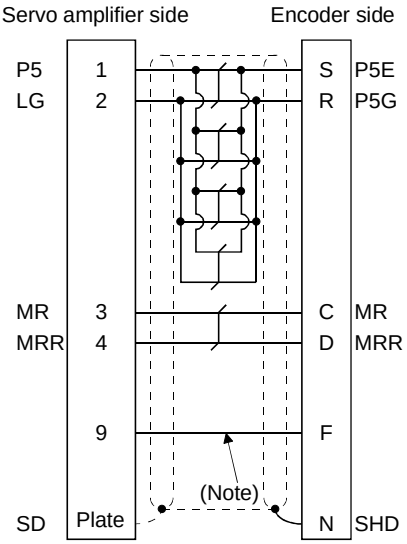
- Encoder cable of less than 30m

When fabricating an encoder cable, use the MR-ECNS (IP20-compatible model) or MR-ENECNS (IP65/IP67-compatible model) connector set. Referring to the following wiring diagram, you can fabricate an encoder cable of up to less than 30m.

MR-ESCBL2M-H
MR-ESCBL5M-H
MR-ESCBL10M-H
MR-ENECBL2M-H
MR-ENECBL5M-H
MR-ENECBL10M-H



MR-ESCBL20M-H
MR-ENECBL20M-H



Note. When an encoder cable is fabricated, this wire is not required.

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・Encoder cable of 30m or more

POINT
・The communication system of the encoder cable in this wiring diagram is the four-wire type. Set "1 □□□ " in parameter No. 20.

When fabricating an encoder cable, use the MR-ECNS (IP20-compatible model) or MR-ENECNS (IP65/IP67-compatible model) connector set. Referring to the following wiring diagram, you can fabricate an encoder cable of up to 50m.

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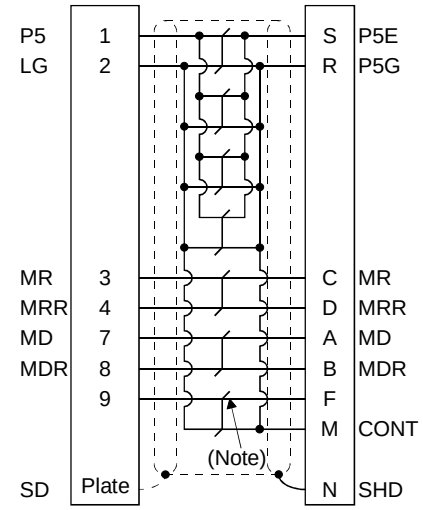
MR-ESCBL30M-H
MR-ESCBL40M-H
MR-ESCBL50M-H
MR-ENECBL30M-H
MR-ENECBL40M-H
MR-ENECBL50M-H



Note. When an encoder cable is fabricated, this wire is not required.

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(3) 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](10[ft]))

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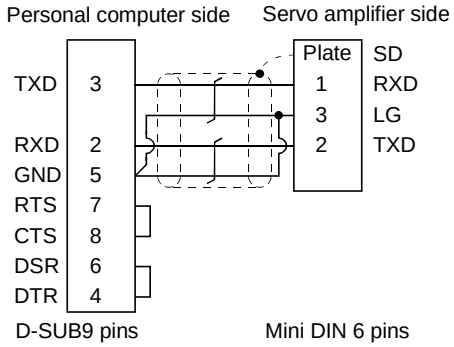
(b) Connection diagram for fabrication

▪ MR-CPCATCBL3M



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(10ft) long. When the cable is fabricated, its maximum length is 15m(49ft) in offices of good environment with minimal noise.

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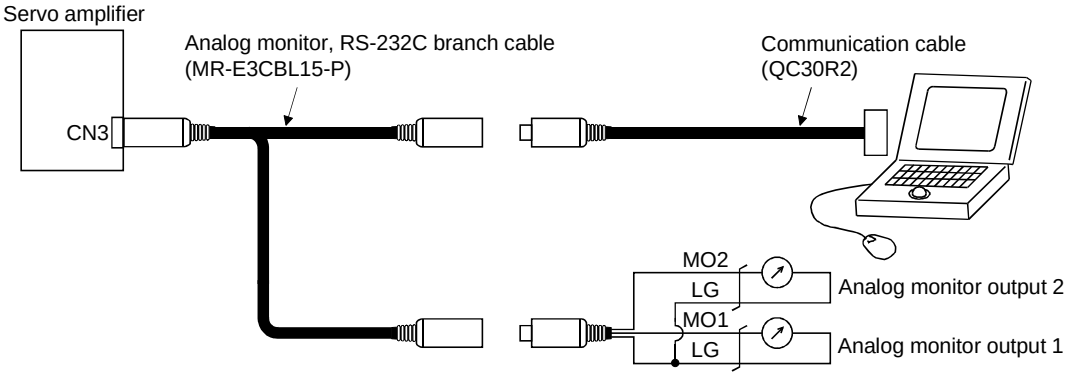
13.1.3 Analog monitor, RS-232C branch cable (MR-E3CBL15-P)

(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.



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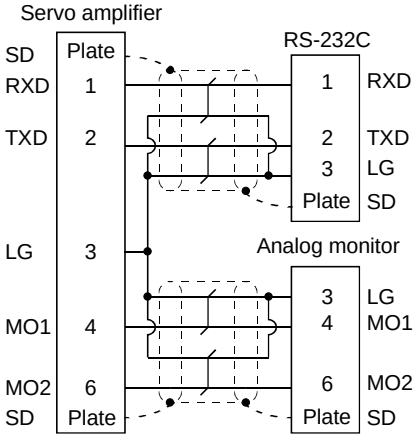
(2) Connection diagram



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13.1.4 Servo configurations software

The servo configuration software (MRZJW3-SETUP154E) 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
Communication signal	Conforms to RS-232C.
Baudrate [bps]	57600, 38400, 19200, 9600
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, absolute encoder data, automatic voltage control, Axis name setting.
Parameters	Parameter list, turning, change list, detailed information
Test operation	Jog operation, positioning operation, motor-less operation, Do forced output, program operation.
Advanced function	Machine analyzer, gain search, machine simulation.
File operation	Data read, save, print
Others	Automatic demo, help display

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(2) System configuration

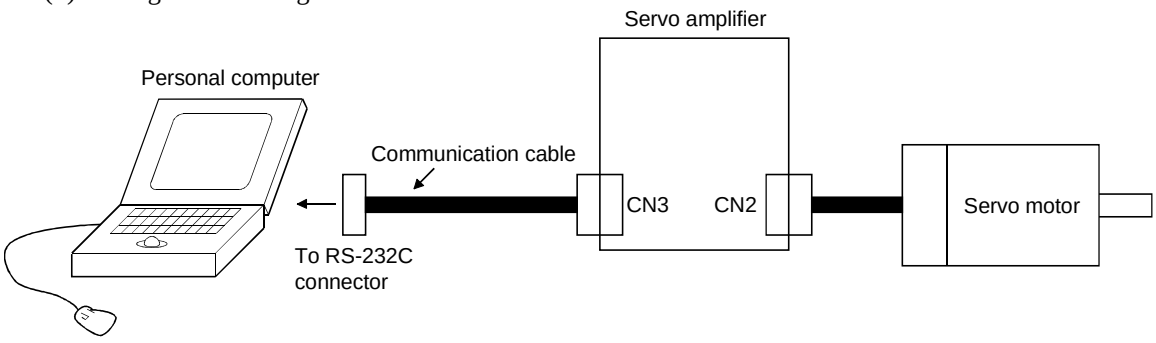
(a) Components

To use this 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 of Windows 95, Windows 98, Windows Me, Windows NT Workstation 4.0 or Windows 2000 Professional operates Processor: Pentium 133MHz or more (Windows 95, Windows 98, Windows NT Workstation 4.0, Windows 2000 Professional) Pentium 150MHz or more (Windows Me) Memory: 16MB or more (Windows 95), 24MB or more (Windows 98) 32MB or more (Windows Me, Windows NT Workstation 4.0, Windows 2000 Professional) Free hard disk space: 30MB or more Serial port used
OS	Windows 95, Windows 98, Windows Me, Windows NT Workstation 4.0, Windows 2000 Professional (English 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 (3) Section 13.1.2 and fabricate.

Note: 1. Windows and Windows NT are the registered trademarks of Microsoft Corporation in the United State and other countries.
2. On some personal computers, this software may not run properly.

(b) Configuration diagram



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13.2 Auxiliary equipment

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

13.2.1 Recommended 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.

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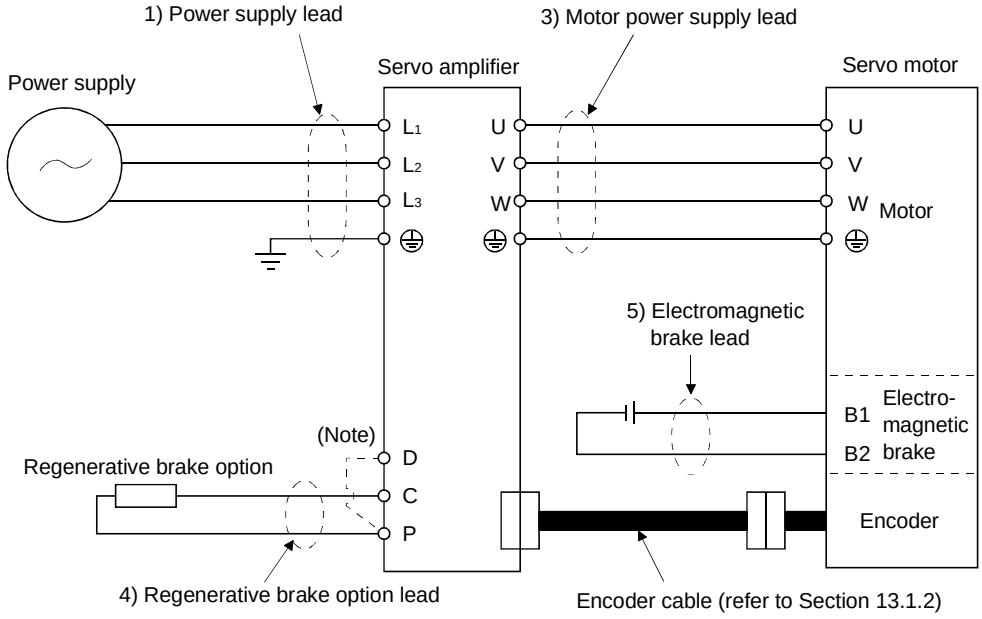

Note: When using the regenerative brake option, always remove the wiring across D-P.

The following table lists wire sizes. The wires used assume that they are 600V vinyl wires and the wiring distance is 30m(98.4ft) max. If the wiring distance is over 30m(98.4ft), 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 Section 3.8.

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/C-UL (CSA) Standard, use UL-recognized copper wires rated at 60℃ (140℉) or more for wiring.

Table 13.1 Recommended wires

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

Note: Use the heat-resistant PVC coble (more than 105℃), if AWG14 cable is used in ambient temperature more than 40℃.

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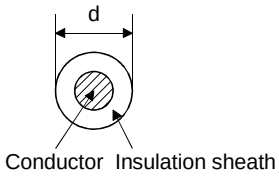
(2) Wires for cables

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 [m(ft)]	Core size [mm²]	Number of Cores	Characteristics of one core			(Note 3) Finishing OD [mm]	Wire model
					Structure [Wires/mm]	Conductor resistance[Ω/mm]	Insulation coating ODd[mm] (Note 1)		
Encoder cable	MR-EKCBL□M-L MR-ESCBL□M-L	2 to 10 (6.56 to 32.8)	0.3	4 (2 pairs)	12/0.18	65.7	1.3	7.3	(Note 4) 20276 composite 4-pair shielded cable (A-TYPE)
			0.08	4 (2 pairs)	7/0.127	234	0.67		
		20 • 30 (65.6 • 98.4)	0.3	12 (6 pairs)	7/0.18	63.6	1.2	8.2	UL20276AWG#23 6 pair (BLACK)
	MR-EKCBL□M-H MR-ESCBL□M-H MR-ENECBL□M-H	2 to 10 (6.56 to 32.8)	0.2	12 (6 pairs)	40/0.08	105	0.88	7.2	(Note 2) A14B2339 4P
		20 (65.6)	0.2	12 (6 pairs)	40/0.08	105	0.88	7.2	(Note 2) A14B2343 6P
		30 to 50 (98.4 to 164)	0.2	14 (7 pairs)	40/0.08	105	0.88	8.0	(Note 3) J14B0238 (0.2 * 7P)
Communication cable	QC30R2	3 (9.84)	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:



2: Purchased from Toa Electric Industry

3: Standard OD. Max. OD is about 10% greater.

4: BANDO ELECTRIC WIRE

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13.2.2 No-fuse breakers, fuses, magnetic contactors

Always use one no-fuse breaker and one magnetic contactor with one servo amplifier. When using a fuse instead of the no-fuse breaker, use the one having the specifications given in this section.

Servo amplifier	No-fuse breaker	Fuse			Magnetic contactor
		Class	Current [A]	Voltage [V]	
MR-E-10A	30A frame 5A	K5	10	AC250	S-N10
MR-E-20A	30A frame 5A	K5	10		
MR-E-40A	30A frame 10A	K5	15		
MR-E-70A	30A frame 15A	K5	15		
MR-E-100A	30A frame 15A	K5	15		
MR-E-200A	30A frame 20A	K5	15		S-N18

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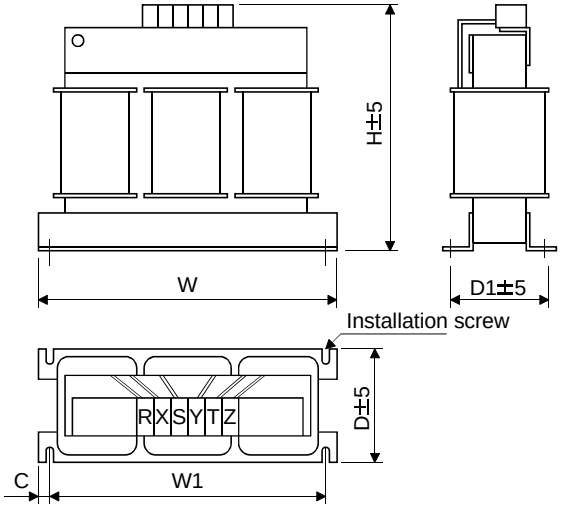
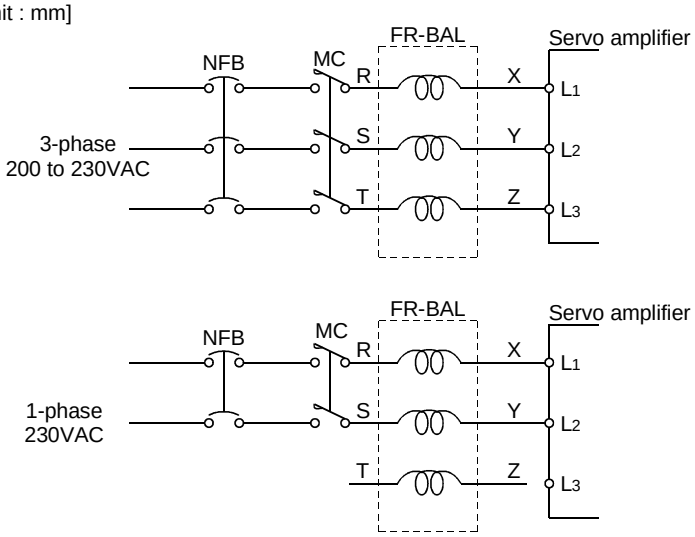
13.2.3 Power factor improving reactors

The input power factor is improved to be about 90%. For use with a 1-phase power supply, it may be slightly lower than 90%.

[Unit : mm]





Servo amplifier	Model	Dimensions [mm (in)]						Mounting screw size	Terminal screw size	Weight [kg (lb)]
		W	W1	H	D	D1	C			
MR-E-10A/20A	FR-BAL-0.4K	135 (5.31)	120 (4.72)	115 (4.53)	59 (2.32)	45 (1.77)	7.5 (0.29)	M4	M3.5	2.0 (4.4)
MR-E-40A	FR-BAL-0.75K	135 (5.31)	120 (4.72)	115 (4.53)	69 (2.72)	57 (2.24)	7.5 (0.29)	M4	M3.5	2.8 (6.17)
MR-E-70A	FR-BAL-1.5K	160 (6.30)	145 (5.71)	140 (5.51)	71 (2.79)	55 (2.17)	7.5 (0.29)	M4	M3.5	3.7 (8.16)
MR-E-100A	FR-BAL-2.2K	160 (6.30)	145 (5.71)	140 (5.51)	91 (3.58)	75 (2.95)	7.5 (0.29)	M4	M3.5	5.6 (12.35)
MR-E-200A	FR-BAL-3.7K	220 (8.66)	200 (7.87)	192 (7.56)	90 (3.54)	70 (2.76)	10 (0.39)	M5	M4	8.5 (18.74)

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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 40mA or less (Ex.) Omron : type MY

13.2.5 Surge absorbers

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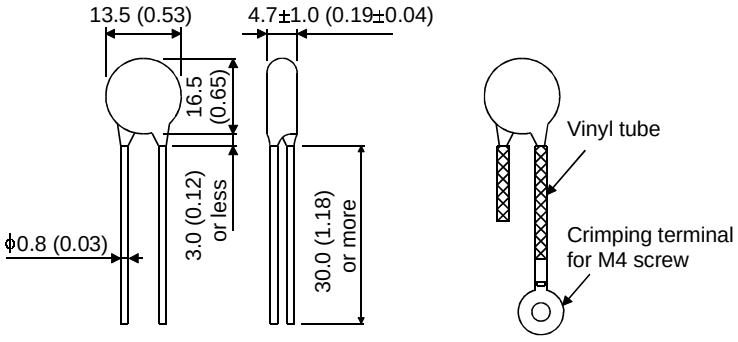
A surge absorber is required for the electromagnetic brake. Use the following surge absorber or equivalent. Insulate the wiring as shown in the diagram.

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 (Matsushita Electric Industry)
TNR-10V221K (Nippon chemi-con)
Outline drawing [mm] ([in]) (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 3.10).

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(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.

(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.

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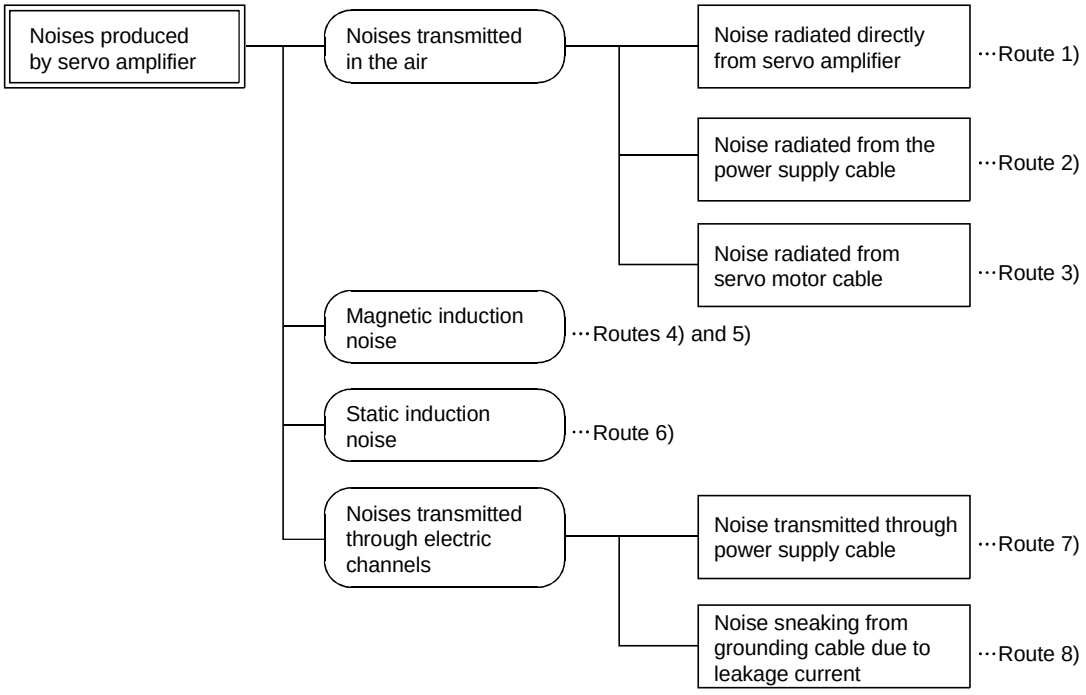

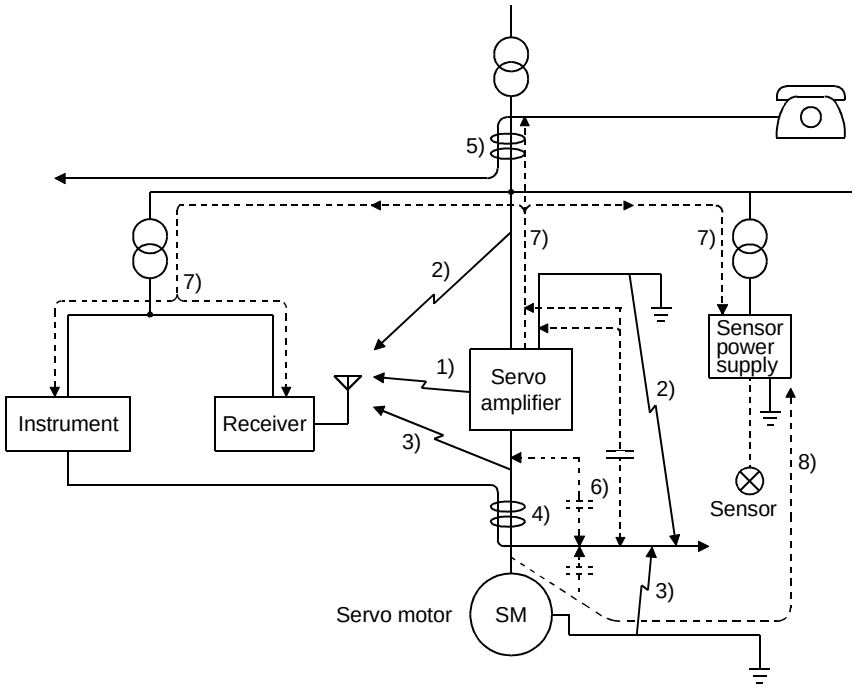

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Noise transmission route	Suppression techniques
1) 2) 3)	When measuring instruments, receivers, sensors, etc. which handle weak signals and may malfunction due to noise and/or their signal cables are contained in a control box together with the servo 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.

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(2) Noise reduction products

(a) Data line filter

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

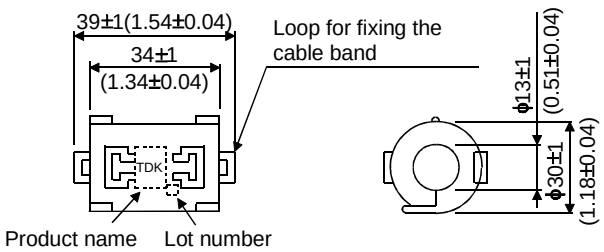
For example, the ZCAT3035-1330 of TDK and the ESD-SR-25 of Tokin make are available as data line filters.

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]([Unit: in.])



Outline drawing (ZCAT3035-1330)

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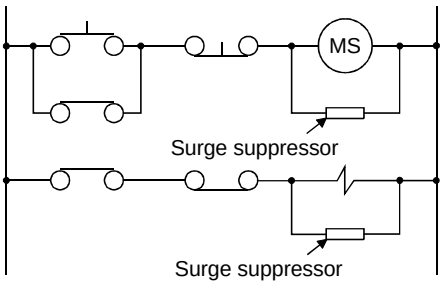
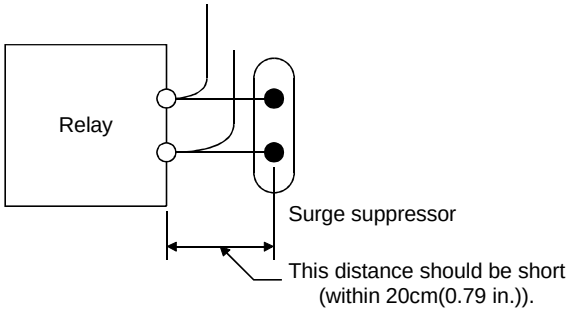
(b) Surge suppressor

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





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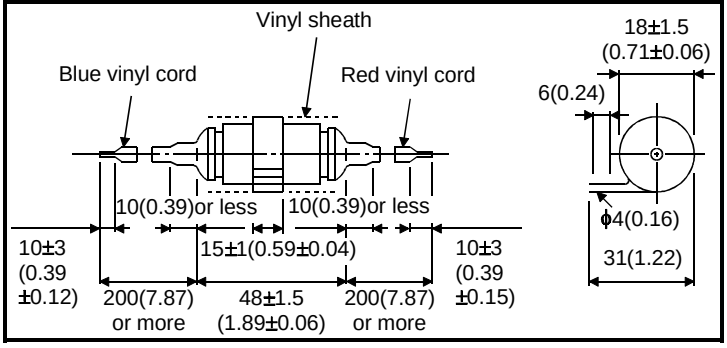
(Ex.) 972A.2003 50411
(Matsuo Electric Co.,Ltd.—200VAC rating)

Rated voltage AC[V]	C [μF]	R [Ω]	Test voltage AC[V]
200	0.5	50 (1W)	Across T-C 1000(1 to 5s)

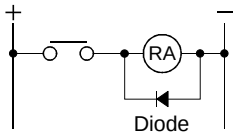
Outline drawing [Unit: mm] ([Unit: in.])



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

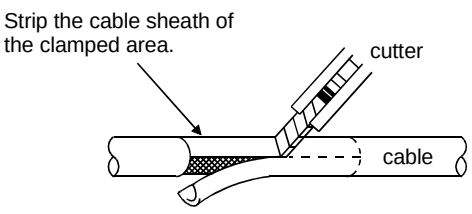


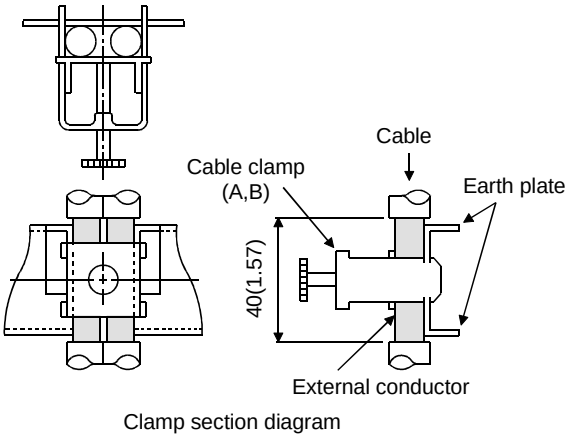
(c) Cable clamp fitting (AERSBAN□-SET)

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 sheath 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.





Clamp section diagram

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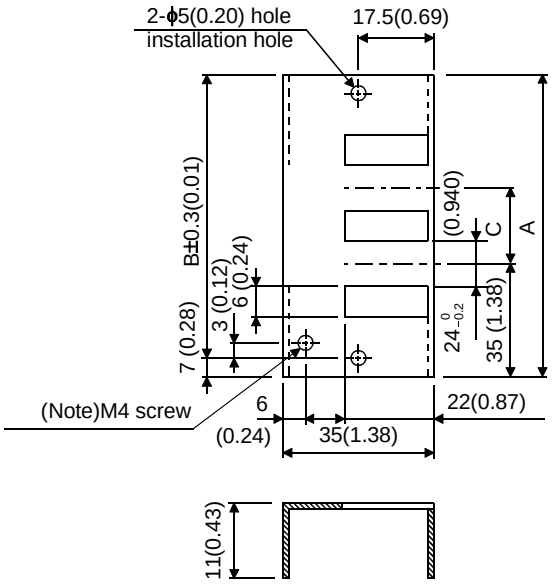
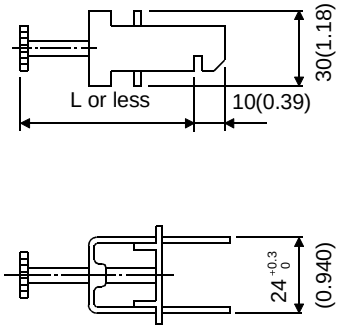
- Outline drawing

[Unit: mm]
([Unit: in.])

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 (3.94)	86 (3.39)	30 (1.18)	clamp A: 2pcs.
AERSBAN-ESET	70 (2.76)	56 (2.20)		clamp B: 1pc.

Clamp fitting	L
A	70 (2.76)
B	45 (1.77)

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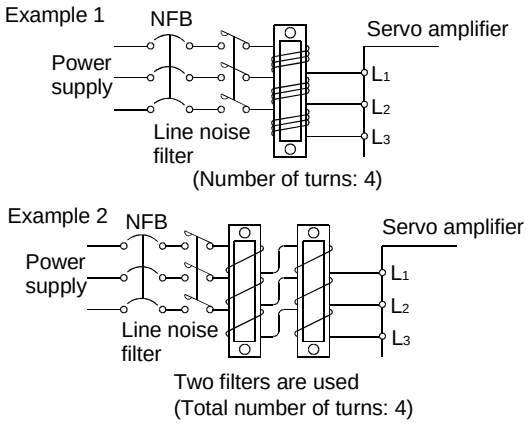
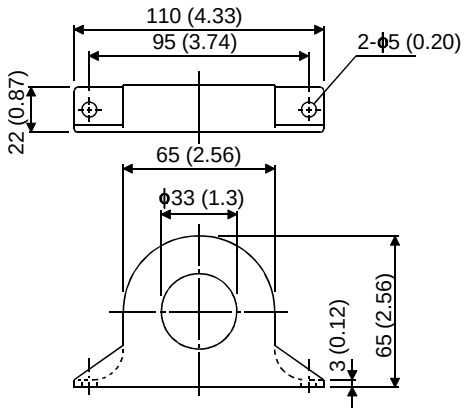
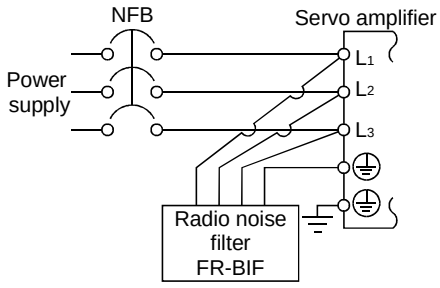
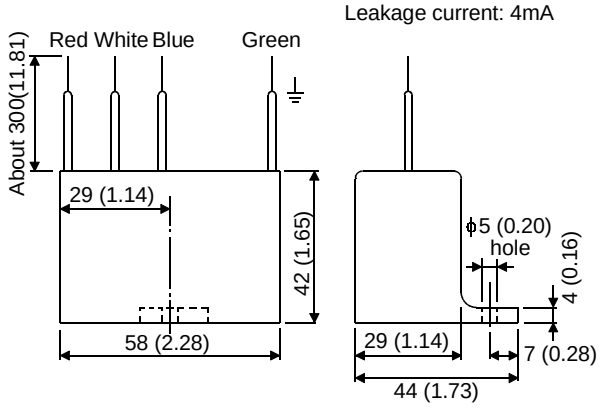
(d) Line noise filter (FR-BSF01)

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] ([Unit: in.])
Wind the 3-phase wires by the equal number of times in the same direction, and connect the filter to the power supply side and output side of the servo amplifier. The effect of the filter on the power supply side is higher as the number of winds is larger. The number of turns is generally four. If the wires are too thick to be wound, use two or more filters and make the total number of turns as mentioned above. On the output side, the number of turns must be four or less. Do not wind the grounding wire together with the 3-phase wires. The filter effect will decrease. Use a separate wire for grounding. 	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) ([Unit: in.])
Make the connection cables as short as possible. Grounding is always required. 	Leakage current: 4mA 

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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 (11.8 in)) to minimize leakage currents.

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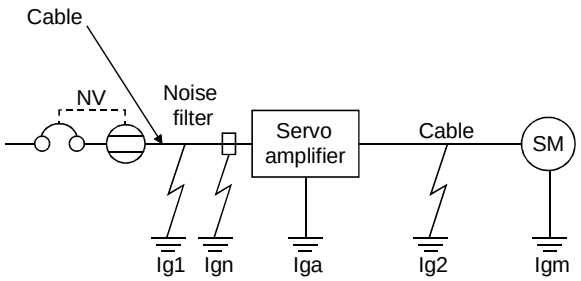
Rated sensitivity current ≥ 10 · {Ig1+Ign+Iga+K · (Ig2+Igm)} [mA] .....(13.2)



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.)

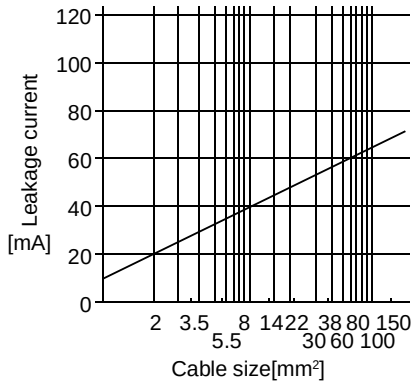


Fig. 13.1 Leakage current example (Ig1, Ig2) for CV cable run in metal conduit

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 to MR-E-200A	15

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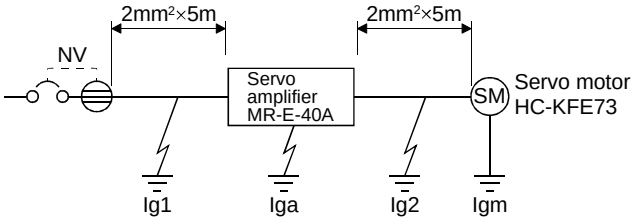
(2) Selection example

Indicated below is an example of selecting a leakage current breaker under the following conditions:



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Use a leakage current breaker generally available.

Find the terms of Equation (13.2) 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 (not used)

Iga = 0.1 [mA]

Igm = 0.1 [mA]

Insert these values in Equation (13.2):

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

$$\geq 4.0 \text{ [mA]}$$

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.

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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		Weight [kg]([lb])
	Model	Leakage current [mA]	
MR-E-10A to MR-E-100A	SF1252	38	0.75 (1.65)
MR-E-200A	SF1253	57	1.37 (1.65)

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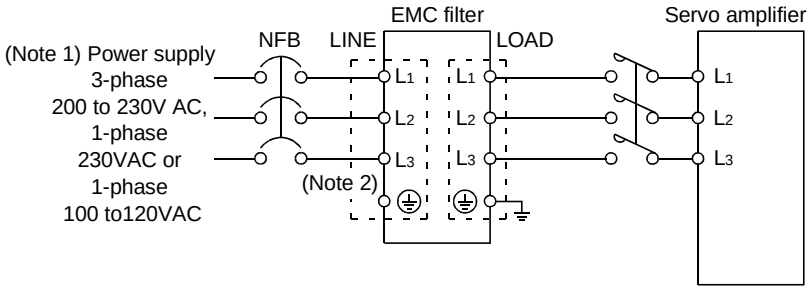
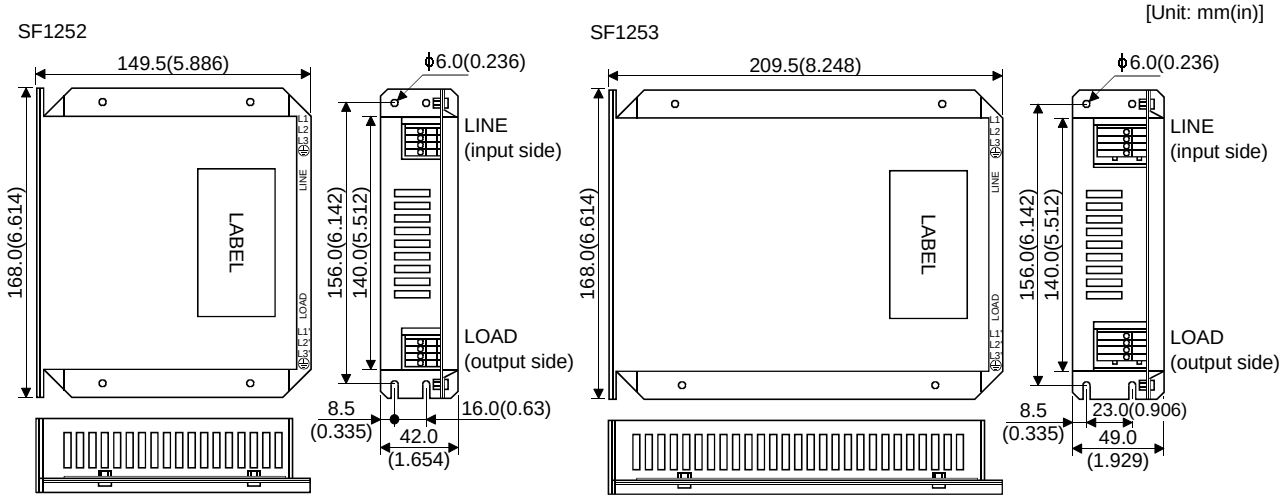
(2) Connection example



Note: 1. For 1-phase 230VAC power supply, connect the power supply to L1,L2 and leave L3 open.
2. Connect when the power supply has earth.

(3) Outline drawing

[Unit: mm(in)]



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14. SERVO MOTOR

14.1 Compliance with the overseas standards

14.1.1 Compliance with EC directives

Use the servo motor compatible with the EN Standard.
Unless otherwise specified, the handling, performance, specifications and others of the EN Standard-compatible models are the same as those of the standard models.
To comply with the EN Standard, also observe the following items strictly.

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(1) Wiring

Use the servo motor side power connector which complies with the EN Standard.
The EN Standard-compliant power connector sets are available from us as options.

Power Connector Set Model	Servo Motor Model
MR-PWCNS1	HC-SFE52 (B) to 152 (B)
MR-PWCNS2	HC-SFE202 (B)

(2) Installation

The flange of the machine mounted with the HC-KFE must be connected to the earth.

14.1.2 Conformance with UL/C-UL standard

Mount the servo motor on a flange which has the following size or produces an equivalent or higher heat dissipation effect: Note that if the servo motor used is the same, the flange size depends on the servo amplifier combined.

Flange size [mm]	Servo motor	
	HC-KFE	HC-SFE
150×150×6	13	
250×250×6	23	
250×250×12	43	52 to 152
300×300×12	73	
300×300×20		202

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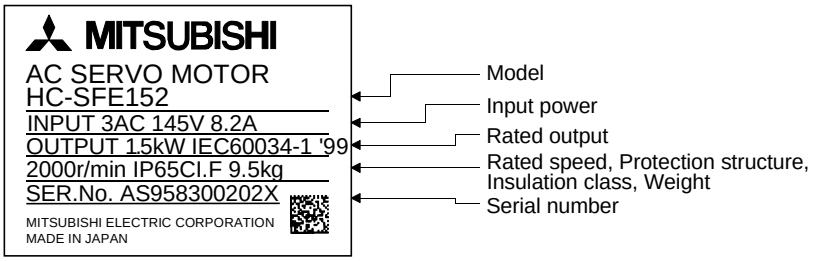
14.2 Model name make-up

(1) Name plate



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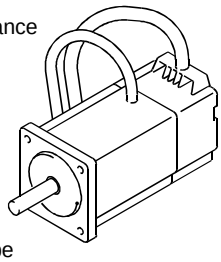
(2) Model

(a) HC-KFE series (low inertia, small capacity)

HC-KFE □ □ 3 □ □

Series name

Appearance



Shaft type

Symbol	Shaft Shape
None	Standard (Straight shaft)
K	(Note) With keyway

Note: With key

Reduction gear

Symbol	Reduction Gear
None	Without
G1	For general industrial machine
G2	For precision application

Electromagnetic brake

Symbol	Electromagnetic Brake
None	Without
B	With

Rated speed
3000[r/min]

Rated output

Symbol	Rated Output [W]
1	100
2	200
4	400
7	750

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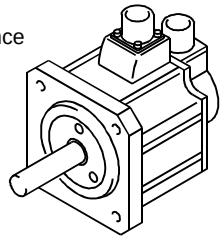
(b) HC-SFE series (middle inertia, middle capacity)

HC-SFE □ 2 □ □ □

Series name

Appearance



Shaft type

Symbol	Shaft Shape
None	Standard (Straight shaft)
K	With keyway

Note: Without key

Reduction gear

Symbol	(Note) Reduction Gear
None	Without
G1	For general industrial machine (flange type)
G1H	For general industrial machine (leg type)
G2	For precision application

Electromagnetic brake

Symbol	Electromagnetic Brake
None	Without
B	With

Rated speed
2000 [r/min]

Rated output

Symbol	Rated Output [W]
5	500
10	1000
15	1500
20	2000

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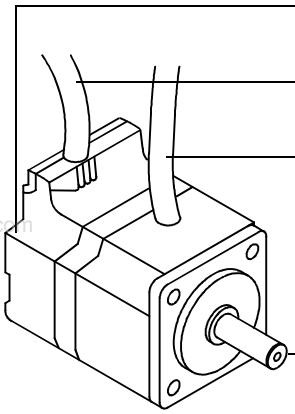
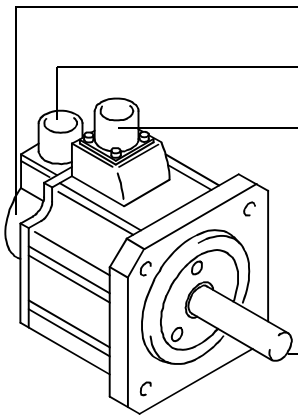
14.3 Parts identification

Lead type



Name/Application	Refer To
Encoder	Section 14.7.1
Encoder cable with encoder connector	Section 14.5
Power cable • Power lead (U, V, W) • Earth lead • Brake lead (for motor with electromagnetic brake)	Section 14.5
Servo motor shaft	Section 14.7.4

Connector type



Name/Application	Refer To
Encoder	Section 14.7.1
Encoder connector	Section 14.5
Power connector • Power supply (U, V, W) • Earth • Brake (for motor with electromagnetic brake) Some motors with electromagnetic brakes have brake connectors separately.	Section 14.5
Servo motor shaft	Section 14.7.4

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14.4 Installation

⚠ CAUTION	・Stacking in excess of the limited number of products is not allowed. ・Install the equipment to incombustibles. Installing them directly or close to combustibles will led 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. ・Do not subject the servo motor to drop impact or shock loads as they are precision equipment. ・Do not install or operate a faulty servo amplifier. ・Do not hold the cable, shaft or encoder to carry the servo motor. Otherwise, a fault or injury may occur. ・The lifting eyebolts of the servo motor may only be used to transport the servo motor. They must not be used to transport the servo motor when it is mounted on a machine. ・The servo motor with reduction gear must be installed in the specified direction. Otherwise, it can leak oil, leading to a fire or fault. ・Securely fix the servo motor to the machine. If fixed insecurely, the servo motor will come off during operation, leading to injury. ・When coupling the shaft end of the servo motor, do not subject the shaft end to impact, such as hammering. The encoder may become faulty. ・Cover the shaft of the servo motor to make its rotary part completely inaccessible during operation. ・Do not subject the servo motor shaft to more than the permissible load. Otherwise, the shaft may break, leading to injury. ・When the product has been stored for an extended period of time, consult Mitsubishi.

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14.4.1 Environmental conditions

Environment		Conditions	
Ambient temperature	[℃]	0 to +40 (non-freezing)	
	[℉]	32 to +104 (non-freezing)	
Ambient humidity		80%RH or less (non-condensing)	
Storage temperature	[℃]	−15 to +70 (non-freezing)	
	[℉]	5 to 158 (non-freezing)	
Storage humidity		90%RH or less (non-condensing)	
Ambient		Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt	
Altitude		Max. 1000m (3280ft) above sea level	
(Note) Vibration	[m/s²]	HC-KFE series	X,Y:49
		HC-SFE52 to 152	X,Y:24.5
		HC-SFE202	X:24.5 Y:49
	[ft/s²]	HC-KFE series	X,Y:161
		HC-SFE52 to 152	X,Y:80
		HC-SFE202	X:80 Y:161

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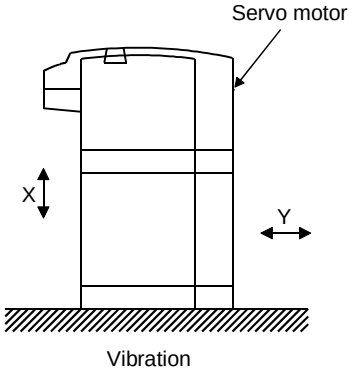
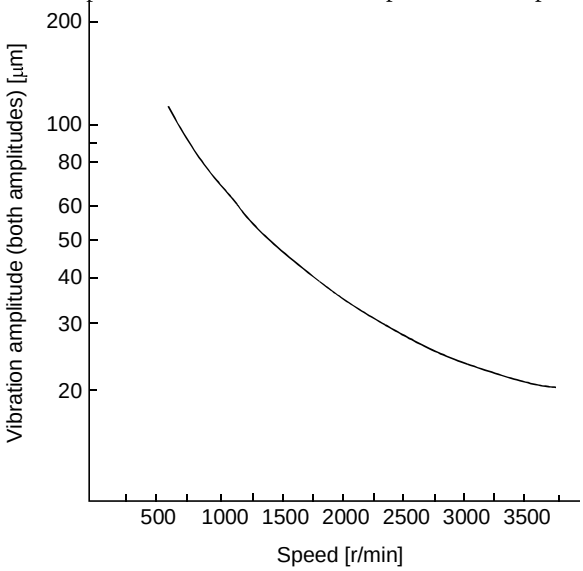
Note: Except the servo motor with reduction gear.

Vibration occurs in the directions shown below. The values were measured at the portion which indicates the maximum value (normally the bracket opposite to load side). When the servo motor is at a stop, the bearings are likely to fret and vibration should therefore be suppressed to about half of the permissible value.



Graph of vibration servo amplitude vs. speed



14.4.2 Installation orientation

The following table lists directions of installation:

Servo Motor Series	Direction of Installation	Remarks
HC-KFE HC-SFE	May be installed in any direction.	For installation in the horizontal direction, it is recommended to set the connector section downward.

When the servo motor with electromagnetic brake is installed with the shaft end at top, the brake plate may generate sliding sound but it is not a fault. Refer to Section 14.6.3 for the installation orientation of the servo motor with reduction gear.

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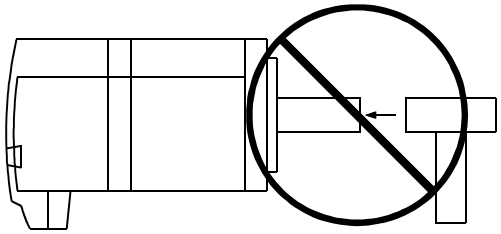
14.4.3 Load mounting precautions

POINT

During assembling, the shaft end must not be hammered.

Doing so can cause the encoder to fail.



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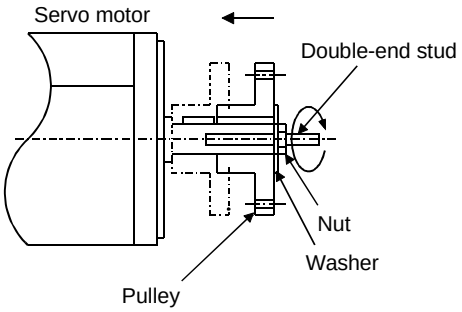
(1) When mounting a pulley to the servo motor shaft provided with a keyway, use the screw hole in the shaft end. To fit the pulley, first insert a double-end stud into the screw hole of the shaft, put a washer against the end face of the coupling, and insert and tighten a nut to force the pulley in.



(2) For the servo motor shaft with a keyway, use the screw hole in the shaft end. For the shaft without a keyway, use a friction coupling or the like.

(3) When removing the pulley, use a pulley remover to protect the shaft from impact.

(4) To ensure safety, fit a protective cover or the like on the rotary area, such as the pulley, mounted to the shaft.

(5) When a threaded shaft end part is needed to mount a pulley on the shaft, please contact us.

(6) The orientation of the encoder on the servo motor cannot be changed.

(7) For installation of the servo motor, use spring washers, etc. and fully tighten the bolts so that they do not become loose due to vibration.

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14.4.4 Permissible load for the shaft

POINT
▪ Do not use a rigid coupling as it may apply excessive bending load to the shaft, leading to shaft breakage.

(a) Use a flexible coupling and make sure that the misalignment of the shaft is less than the permissible radial load.
(b) When using a pulley, sprocket or timing belt, select a diameter that will fit into the permissible radial load.
(c) Excess of the permissible load can cause the bearing life to reduce and the shaft to break.
(d) The load indicated in this section is static load in a single direction and does not include eccentric load. Make eccentric load as small as possible. Not doing so can cause the servo motor to be damaged.

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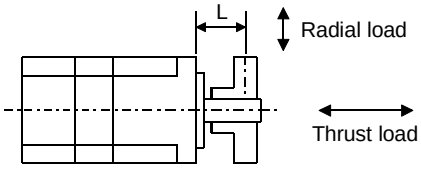
(1) Without reduction gear

Servo Motor		(Note) L		Permissible Radial Load		Permissible Thrust Load	
		[mm]	[in]	[N]	[lb]	[N]	[lb]
HC-KFE	053 / 13	25	0.98	88	20	59	13
	23 / 43	30	1.18	245	55	98	22
	73	40	1.57	392	88	147	33
HC-SFE	52 to 152	55	2.17	980	220	490	110
	202	79	3.11	2058	463	980	220

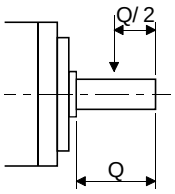
Note : For the symbols in the table, refer to the following diagram:



L: Distance from flange mounting surface to load center

(2) With reduction gear

The permissible radial loads in the table are the values at the center of the reduction gear output shaft.



(a) HC-KFE series

1) General industrial machine-compliant

Item		Gear ratio	HC-KFE13(B) G1	HC-KFE23(B) G1	HC-KFE43(B) G1	HC-KFE73(B) G1
Permissible Radial Load	[N]	1/5	150	330		430
		1/12	240	710		620
		1/20	370	780	760	970
	[lb]	1/5	34	74		97
		1/12	54	160		139
		1/20	83	175	171	218
Permissible Thrust Load	[N]	1/5	200	350		430
		1/12	320	720		620
		1/20	450	780	760	960
	[lb]	1/5	45	79		97
		1/12	72	162		139
		1/20	101	175	171	216

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2) Precision application-compliant

Item		Gear ratio	HC-KFE13(B) G2	HC-KFE23(B) G2	HC-KFE43(B) G2	HC-KFE73(B) G2
Permissible Radial Load	[N]	1/5	160	160	340	390
		1/9	200	420	480	600
		1/20	540	610	790	1040
		1/29	610	700	900	1190
	[lb]	1/5	36	36	76	88
		1/9	45	94	108	135
		1/20	121	137	178	234
		1/29	137	157	202	268
Permissible Thrust Load	[N]	1/5	220	220	370	390
		1/9	270	450	490	600
		1/20	660	640	790	1140
		1/29	750	830	1010	1290
	[lb]	1/5	49	49	83	87
		1/9	61	101	110	135
		1/20	148	144	178	256
		1/29	167	187	227	290

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(b) HC-SFE (2000r/min) series

1) General industrial machine-compliant

Item		Gear ratio	HC-SFE52(B) G1	HC-SFE102(B) G1	HC-SFE152(B) G1	HC-SFE202(B) G1
Permissible Radial Load	[N]	1/6	2058	2842	2842	2842
		1/11	2391	3273	3273	3273
		1/17	2832	3646	3646	3646
		1/29	3273	4410	5135	7291
		1/35	5253	5253	6047	8555
		1/43	5253	6047	8555	8555
		1/59	5800	9741	9741	9741
	[lb]	1/6	463	639	639	639
		1/11	538	728	728	728
		1/17	637	820	820	820
		1/29	728	991	1154	1639
		1/35	1181	1181	1359	1923
		1/43	1181	1359	1923	1923
		1/59	1304	2190	2190	2190
Permissible Thrust Load	[N]	1/6	1470	2352	2352	2352
		1/11	1470	2764	2764	2764
		1/17	1470	2940	2940	2940
		1/29	1470	2940	3920	6860
		1/35	2940	2940	3920	6860
		1/43	2940	3920	6860	6860
		1/59	2940	6860	6860	6860
	[lb]	1/6	330	529	529	529
		1/11	330	621	621	621
		1/17	330	661	661	661
		1/29	330	661	881	1542
		1/35	661	661	881	1542
		1/43	661	881	1542	1542
		1/59	661	1542	1542	1542

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2) Precision application-compliant

Item		Gear ratio	HC-SFE52(B) G2	HC-SFE102(B) G2	HC-SFE152(B) G2	HC-SFE202(B) G2
Permissible Radial Load	[N]	1/5	833	833	833	1666
		1/9	980	980	1960	1960
		1/20	1274	2646	2646	6076
		1/29	2940	2940	6860	6860
		1/45	3430	8036	8036	8036
	[lb]	1/5	187	187	187	375
		1/9	220	220	441	441
		1/20	286	595	595	1366
		1/29	661	661	1542	1542
		1/45	771	1807	1807	1807
Permissible Thrust Load	[N]	1/5	1176	1176	1176	2156
		1/9	1568	1568	2646	2646
		1/20	2254	3724	3724	9506
		1/29	4704	4704	11760	11760
		1/45	5390	14700	14700	14700
	[lb]	1/5	264	264	264	485
		1/9	353	353	595	595
		1/20	507	837	837	2137
		1/29	1058	1058	2644	2644
		1/45	1212	3305	3305	3305

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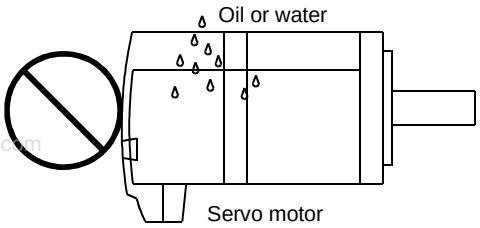
14.4.5 Protection from oil and water

(1) Next, the servo motor is not waterproof (IP44). Do not subject the servo motor to oil and water. Especially for the HC-KFE series, do not subject the shaft-through portion to oil.

Servo Motor Series	Protection
HC-KFE	IP55



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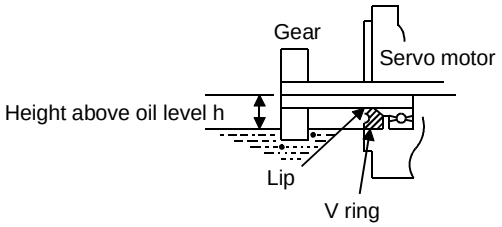
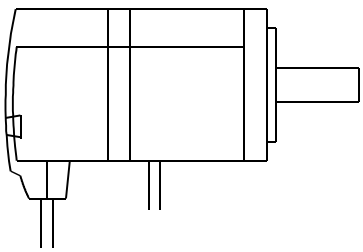
(2) When the gear box is mounted horizontally, the oil level in the gear box should always be lower than the oil seal lip on the servo motor shaft. If it is higher than the oil seal lip, oil will enter the servo motor, leading to a fault. Also, provide a breathing hole in the gear box to hold the internal pressure low.

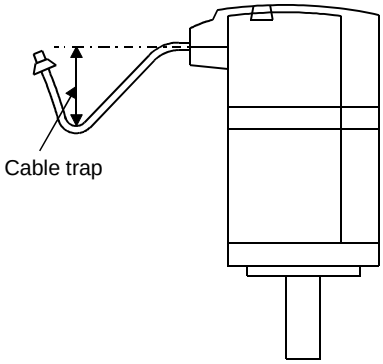
The HC-KFE series servo motor is not equipped with a V ring or an oil seal and cannot be used with the gear box as described above. Oil should be shut off on the gear box side.



Servo Motor		Height above Oil Level h	
		[mm]	[in]
HC-SFE	52 to 152	20	0.79
	202 to 702	25	0.98

(3) When installing the servo motor horizontally, face the power cable and encoder cable downward. When installing the servo motor vertically or obliquely, provide a trap for the cable.





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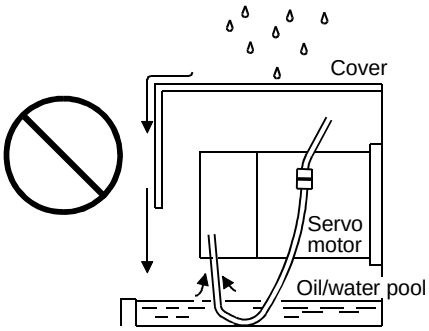
(4) Do not use the servo motor with its cable soaked in oil or water. (Figure on the right)



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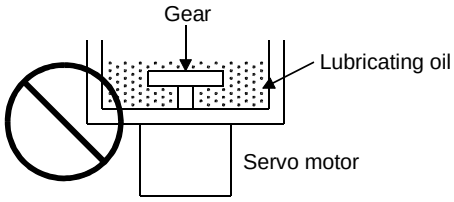
<Incorrect> Capillary phenomenon

(5) When the servo motor is to be installed with the shaft end at top, provide measures so that it is not exposed to oil and water entering from the machine side, gear box, etc.



(6) If the servo motor is exposed to oil such as coolant, the sealant, packing, cable and others may be affected depending on the oil type.

(7) In the environment where the servo motor is exposed to oil mist, oil, water and/or like, the servo motor of the standard specifications may not be usable. Contact us.

(8) In the case of the servo motor with oil seal, the oil seal may sound during operation. It poses no problems in function.

14.4.6 Cable

The power supply and encoder cables routed from the servo motor should be fixed to the servo motor to keep them unmovable. Otherwise, cable breaks may occur. In addition, do not modify the connectors, terminals and others at the ends of the cables.

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14.5. Connectors used for servo motor wiring

This section gives connector makeups on an operating environment basis. Use the models of the manufacturers given or equivalent.

14.5.1 HC-KFE series

Use the connectors indicated in this section or equivalent for connection of the power supply, electromagnetic brake and encoder. These connectors may be used for the EN Standard and UL/C-UL Standard but are not waterproof.

1) For connection of power supply and brake

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Servo Motor	Connector Supplied for Servo Motor (molex)	Cable Side Connector		Manual crimping tool
		Plug (molex)	Terminal (molex)	
HC-KFE□	5557-04R-210	5559-04P-210	5558PBT3L	57022-5300

Servo Motor	Connector Supplied for Servo Motor (molex)	Cable Side Connector		Manual crimping tool
		Plug (molex)	Terminal (molex)	
HC-KFE□B	5557-06R-210	5559-06P-210	5558PBT3L	57022-5300

2) For connection of encoder

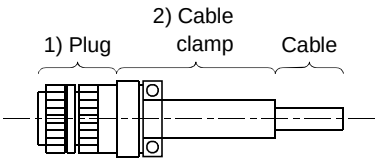
Servo Motor	Connector Supplied for Servo Motor (AMP)	Cable Side Connector		
		Housing (AMP)	Connector pin (AMP)	Cable clamp (Toa Electric Industry)
HC-KFE□(B)	1-172169-9	1-172161-9	170359-1 170363-1 (loose piece)	MTI-0002

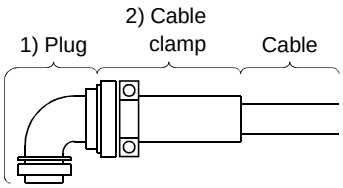
14.5.2 HC-SFE series

(1) Non-waterproof, UL/C-UL Standard-compliant

(a) When using cabtyre cables

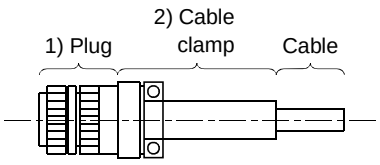
1) For connection of power supply

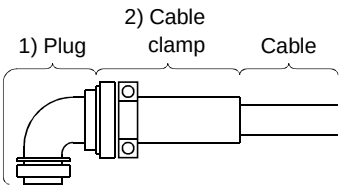




Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)		2) Cable clamp (DDK)
		Type	Model	
HC-SFE52(B) to 152(B)	CE05-2A22-23PD-B	Straight	MS3106B22-23S	MS3057-12A
		Angle	MS3108B22-23S	
HC-SFE202(B)	CE05-2A24-10PD-B	Straight	MS3106B24-10S	MS3057-16A
		Angle	MS3108B24-10S	

2) For connection of encoder





Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)		2) Cable clamp (DDK)
		Type	Model	
HC-SFE52(B) to 202(B)	MS3102A20-29P	Straight	MS3106B20-29S	MS3057-12A
		Angle	MS3108B20-29S	

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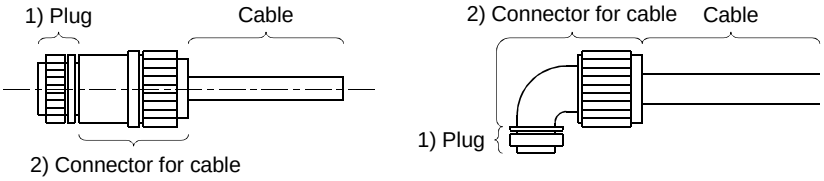
3) For connection of brake



Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Connector for Cable			
			Type	Maker	Cable OD	Model
HC-SFE202B	MS3102A10SL-4P	MS3106A10SL-4S	Straight	Nippon flex	4 to 8	ACS-08RL-MS10F
					8 to 12	ACS-12RL-MS10F
			Angle	Daiwa Dengyo	5 to 8.3	YSO10-5 to 8
			Straight	Nippon flex	4 to 8	ACA-08RL-MS10F
					8 to 12	ACA-12RL-MS10F
			Angle	Daiwa Dengyo	5 to 8.3	YLO10-5 to 8

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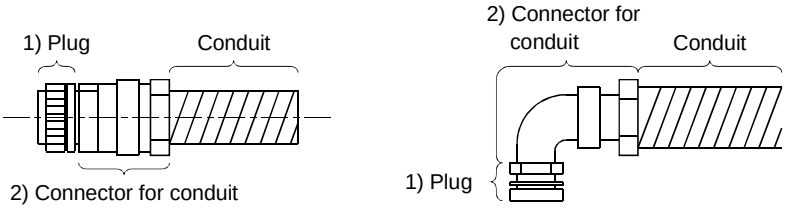
(b) When using flexible conduits

1) For connection of power supply



Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Connector for conduit				Conduit	
			Type	Maker	Size	Model	Model	ID
HC-SFE52(B) to 152(B)	CE05-2A22-23PD-B	MS3106A22-23S(D190)	Straight	Nippon flex	1/2	RCC-104RL-MS22F	VF-04	14.0
					3/4	RCC-106RL-MS22F	VF-06	19.0
					1	RCC-108RL-MS22F	VF-08	24.4
				Daiwa Dengyo	16	MSA-16-22	FCV16	15.8
					22	MSA-22-22	FCV22	20.8
					28	MSA-28-22	FCV28	26.4
			Angle	Nippon flex	1/2	RCC-304RL-MS22F	VF-04	14.0
					3/4	RCC-306RL-MS22F	VF-06	19.0
					1	RCC-308RL-MS22F	VF-08	24.4
				Daiwa Dengyo	16	MAA-16-22	FCV16	15.8
					22	MAA-22-22	FCV22	20.8
					28	MAA-28-22	FCV28	26.4
HC-SFE202(B)	CE05-2A24-10PD-B	MS3106A24-10S(D190)	Straight	Nippon flex	1/2	RCC-104RL-MS24F	VF-04	14.0
					3/4	RCC-106RL-MS24F	VF-06	19.0
					1	RCC-108RL-MS24F	VF-08	24.4
				Daiwa Dengyo	16	MSA-16-24	FCV16	15.8
					22	MSA-22-24	FCV22	20.8
					28	MSA-28-24	FCV28	26.4
			Angle	Nippon flex	1/2	RCC-304RL-MS24F	VF-04	14.0
					3/4	RCC-306RL-MS24F	VF-06	19.0
					1	RCC-308RL-MS24F	VF-08	24.4
				Daiwa Dengyo	16	MAA-16-24	FCV16	15.8
					22	MAA-22-24	FCV22	20.8
					28	MAA-28-24	FCV28	26.4

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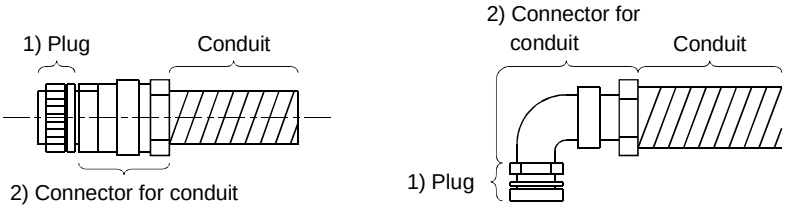
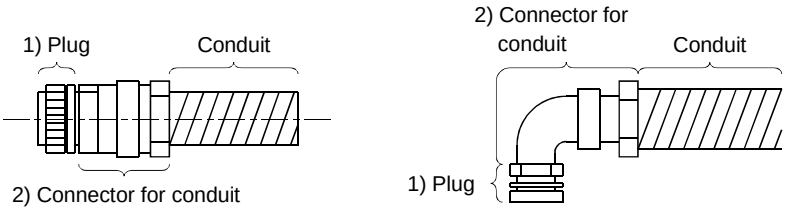
2) For connection of encoder



Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Connector for conduit				Conduit	
			Type	Maker	Size	Model	Model	ID
HC-SFE52(B) to 202(B)	MS3102A20-29P	MS3106A20-29S(D190)	Straight	Nippon flex	1/2	RCC-104RL-MS20F	VF-04	14.0
					3/4	RCC-106RL-MS20F	VF-06	19.0
				Daiwa Dengyo	16	MSA-16-20	FCV16	15.8
					22	MSA-22-20	FCV22	20.8
			Angle	Nippon flex	1/2	RCC-304RL-MS20F	VF-04	14.0
					3/4	RCC-306RL-MS20F	VF-06	19.0
				Daiwa Dengyo	16	MAA-16-20	FCV16	15.8
					22	MAA-22-20	FCV22	20.8

3) For connection of brake



Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Connector for conduit				Conduit	
			Type	Maker	Size	Model	Model	ID
HC-SFE203B	MS3102A 10SL-4P	MS3106A10-SL-4S(D190)	Straight	Nippon flex	1/4	RCC-102RL-MS10F	VF-02	8.3
				Daiwa Dengyo	10	MSA-10-10	FCV10	10
			Angle	Nippon flex	1/4	RCC-302RL-MS10F	VF-02	8.3
				Daiwa Dengyo	10	MAA-10-10	FCV10	10

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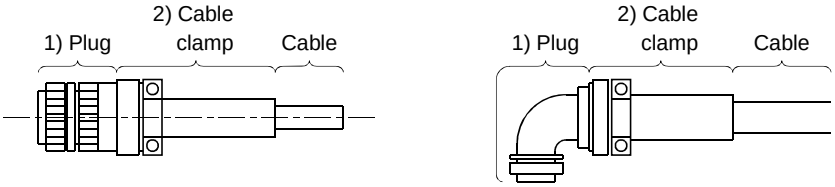
(2) Waterproof (IP65), EN Standard, UL/C-UL Standard-compliant

(a) When using cabtyre cables

1) For connection of power supply



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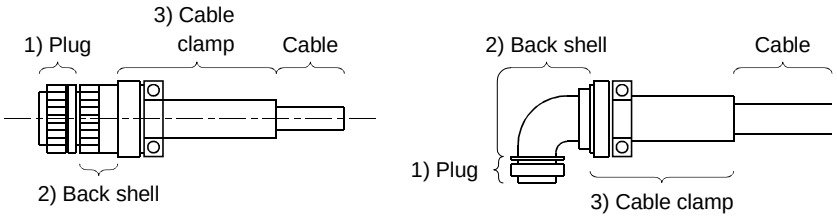
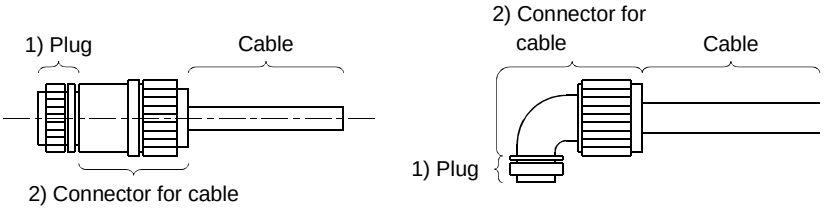
Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)		2) Cable clamp (DDK)	
		Type	Model	Cable OD	Model
HC-SFE52(B) to 152(B)	CE05-2A22-23PD-B	Straight	CE05-6A22-23SD-B-BSS	9.5 to 13	CE3057-12A-2(D265)
		Angle	CE05-8A22-23SD-B-BAS	12.5 to 16	CE3057-12A-1(D265)
HC-SFE202(B)	CE05-2A24-10PD-B	Straight	CE05-6A24-10SD-B-BSS	13 to 15.5	CE3057-16A-2(D265)
		Angle	CE05-8A24-10SD-B-BAS	15 to 19.1	CE3057-16A-1(D265)

2) For connection of encoder



Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Back shell		3) Cable clamp (DDK)	
			Type	Model	Cable OD	Model
HC-SFE52(B) to 202(B)	MS3102A20-29P	MS3106A20-29S(D190)	Straight	CE02-20BS-S	6.8 to 10	CE3057-12A-3(D265)
			Angle	CE-20BA-S		

3) For connection of brake



Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Connector for Cable			
			Type	Maker	Cable OD	Model
HC-SFE202B	MS3102A10SL-4P	MS3106A10SL-4S(D190)	Straight	Nippon flex	4 to 8	ACS-08RL-MS10F
					8 to 12	ACS-12RL-MS10F
				Daiwa Dengyo	5 to 8.3	YSO-10-5 to 8
			Angle	Nippon flex	4 to 8	ACA-08RL-MS10F
					8 to 12	ACA-12RL-MS10F
				Daiwa Dengyo	5 to 8.3	YLO-10-5 to 8

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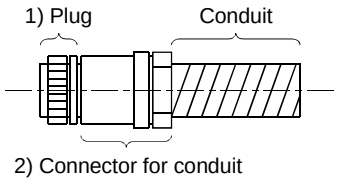
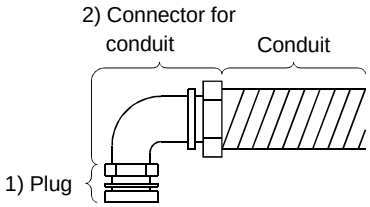
(b) When using flexible conduits

1) For connection of power supply





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Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Connector for conduit				Conduit	
			Type	Maker	Size	Model	Model	ID
HC-SFE52(B) to 152(B)	CE05-2A22-23PD-B	CE05-6A22-23SD-B	Straight	Nippon flex	1/2	RCC-104RL-MS22F	VF-04	14.0
					3/4	RCC-106RL-MS22F	VF-06	19.0
					1	RCC-108RL-MS22F	VF-08	24.4
				Daiwa Dengyo	16	MSA-16-22	FCV16	15.8
					22	MSA-22-22	FCV22	20.8
					28	MSA-28-22	FCV28	26.4
			Angle	Nippon flex	1/2	RCC-304RL-MS22F	VF-04	14.0
					3/4	RCC-306RL-MS22F	VF-06	19.0
					1	RCC-308RL-MS22F	VF-08	24.4
				Daiwa Dengyo	16	MAA-16-22	FCV16	15.8
					22	MAA-22-22	FCV22	20.8
					28	MAA-28-22	FCV28	26.4
HC-SFE202(B)	CE05-2A24-10PD-B	CE05-6A24-10SD-B	Straight	Nippon flex	1/2	RCC-104RL-MS24F	VF-04	14.0
					3/4	RCC-106RL-MS24F	VF-06	19.0
					1	RCC-108RL-MS24F	VF-08	24.4
				Daiwa Dengyo	16	MSA-16-24	FCV16	15.8
					22	MSA-22-24	FCV22	20.8
					28	MSA-28-24	FCV28	26.4
			Angle	Nippon flex	1/2	RCC-304RL-MS24F	VF-04	14.0
					3/4	RCC-306RL-MS24F	VF-06	19.0
					1	RCC-308RL-MS24F	VF-08	24.4
				Daiwa Dengyo	16	MAA-16-24	FCV16	15.8
					22	MAA-22-24	FCV22	20.8
					28	MAA-28-24	FCV28	26.4

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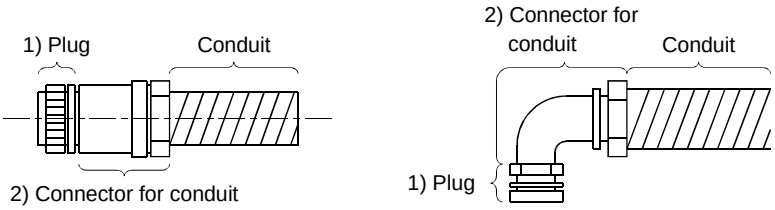
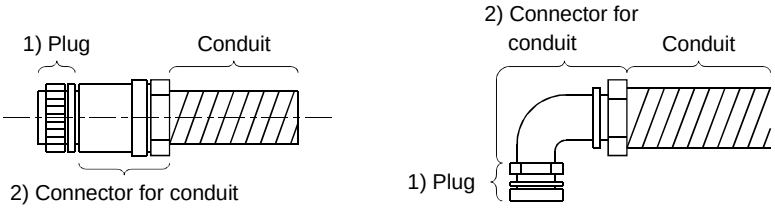
2) For connection of encoder



Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Connector for conduit				Conduit	
			Type	Maker	Size	Model	Model	ID
HC-SFE52(B) to 202(B)	MS3102A20-29P	MS3106A20-29S(D190)	Straight	Nippon flex	1/2	RCC-104RL-MS20F	VF-04	14.0
					3/4	RCC-106RL-MS20F	VF-06	19.0
				Daiwa Dengyo	16	MSA-16-20	FCV16	15.8
					22	MSA-22-20	FCV22	20.8
			Angle	Nippon flex	1/2	RCC-304RL-MS20F	VF-04	14.0
					3/4	RCC-306RL-MS20F	VF-06	19.0
				Daiwa Dengyo	16	MAA-16-20	FCV16	15.8
					22	MAA-22-20	FCV22	20.8

3) For connection of brake



Servo Motor	Connector Supplied for Servo Motor	1) Plug (DDK)	2) Connector for conduit				Conduit	
			Type	Maker	Size	Model	Model	ID
HC-SFE202B	MS3102A10SL-4P	MS3106A10SL-4S(D190)	Straight	Nippon flex	1/4	RCC-102RL-MS10F	VF-02	8.3
				Daiwa Dengyo	10	MSA-10-10	FCV10	10
			Angle	Nippon flex	1/4	RCC-302RL-MS10F	VF-02	8.3
				Daiwa Dengyo	10	MAA-10-10	FCV10	10

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14.6 Specifications

14.6.1 Standard specifications

Item \ Servo Motor			HA-KFE Series (Low inertia, small capacity)			
			13	23	43	73
Applicable servo amplifier/drive unit	MR-E-□A		10	20	40	70
(Note 1,11) Continuous duty	Rated output [kW]		0.1	0.2	0.4	0.75
	Rated torque	[N・m]	(Note 14) 0.32	(Note 14) 0.64	(Note 14) 1.3	2.4
		[oz・in]	(Note 14) 45.3	(Note 14) 90.7	(Note 14) 184	340
(Note 1) Rated speed		[r/min]	3000			
Maximum speed		[r/min]	4500			
Permissible instantaneous speed		[r/min]	5175			
Maximum torque		[N・m]	0.95	1.9	3.8	7.2
		[oz・in]	135	269	538	1020
Power rate at continuous rated torque		[kW/s]	12.1	9.65	24.2	37.7
(Note 3) Inertia moment	J	[×10^{-4}kg・m^2]	0.084	0.42	0.67	1.51
	WK^2	[oz・in^2]	0.459	2.296	3.663	8.26
(Note 2) Recommended ratio of load inertia moment to servo motor shaft inertia moment			10 times or less			
(Note4,10) Regenerative brake duty [times/min]	Servo amplifier' built-in regenerative brake resistor		(Note 5)	(Note 9)	220	190
	MR-RB032(30W)		(Note 5)	(Note 5)	660	280
	MR-RB12(100W)		(Note 5)	(Note 5)	2200	940
Power supply capacity			Refer to "Power supply equipment capacity and generated loss of servo amplifiers" in Servo Amplifier Instruction Manual.			
Rated current		[A]	0.83	1.1	2.3	5.8
Maximum current		[A]	2.5	3.4	6.9	18.6
Speed/position detector			Encoder (resolution : 10000 pulse/rev)			
Accessories			Encoder, V ring			
Insulation class			Class B			
Structure			Totally-enclosed, self-cooled (protection type: IP44 (Note 3,6,8))			
(Note 7) Environmental conditions			Refer to section 14.4.1			
(Note 3) Weight		[kg]	0.53	0.99	1.45	3.0
		[lb]	1.168	2.18	3.20	6.61

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Item \ Servo Motor			HC-SFE Series (Middle inertia, middle capacity)			
			52	102	152	202
Applicable servo amplifier/drive unit	MR-E-□A		70	100	200	200
(Note 1,11) Continuous duty	Rated output	[kW]	0.5	1.0	1.5	2.0
	Rated torque	[N・m]	2.39	4.78	7.16	9.55
		[oz・in]	339	677	1015	1353
(Note 1) Rated speed		[r/min]	2000			
Maximum speed		[r/min]	3000			2500
Permissible instantaneous speed		[r/min]	345			2850
Maximum torque		[N・m]	7.16	14.4	21.6	28.5
		[oz・in]	1015	2041	3061	4039
Power rate at continuous rated torque		[kW/s]	8.7	16.7	25.6	21.5
(Note 3) Inertia moment	J	[×10^{-4}kg・m^2]	6.6	13.7	20.0	4.5
	WK^2	[oz・in^2]	36.1	74.9	109	232
(Note 2) Recommended ratio of load inertia moment to servo motor shaft inertia moment			15 times or less			
(Note4) Regenerative brake duty [times/min]	MR-E series	Servo amplifier' built-in regenerative brake resistor	56	54	136	64
		MR-RB032(30W)	165	80		
		MR-RB12(100W)	560	270		
		MR-RB32(300W)		810		
		MR-RB30(300W)			408	192
		MR-RB50(500W)			680	320
Power supply capacity			Refer to "Power supply equipment capacity and generated loss of servo amplifiers" in Servo Amplifier Instruction Manual.			
Rated current		[A]	3.2	6	9	11
Maximum current		[A]	9.6	18	27	33
Speed/position detector			Encoder (resolution: 10000 pulse/rev)			
Accessories			Encoder・Oil seal			
Insulation class			Class F			
Structure			Totally-enclosed, self-cooled (protection type: IP65(Note 8))			
(Note 7) Environmental conditions			Refer to section 2.1			
(Note 3) Weight		[kg]	5.0	7.0	9.0	12.0
		[lb]	11.0	15.4	19.8	26.5

Note: 1. When the power supply voltage drops, we cannot guarantee the output and rated speed.

2. If the load inertia moment ratio exceeds the indicated value, please consult us.
3. When the servo motor is equipped with electromagnetic brake, refer to section 14.8.When the servo motor is equipped with reduction gear, please consult us.
4. The regenerative brake duty indicated is the permissible duty when the servo motor running without load at the rated speed is decelerated to a stop. When a load is connected, the value in the table is multiplied by 1/(m + 1), where m = load inertia moment/motor inertia moment. At the speed higher than the rated, the permissible number of times is in inverse proportion to the square of (running speed/rated speed). When the running speed varies frequently or when the regenerative mode continues as in vertical feed, calculate regenerative heat generated during operation. Provisions must be made to keep this generated heat below the permissible value.
5. If the effective torque is within the rated torque range, there are no restrictions on the regenerative duty. Note that the recommended load inertia moment ratio is 15 times or less.
6. Except for the shaft-through portion and connector end.
7. When the equipment is to be used in places where it is subjected to oil and/or water, such as on machine field sites, optional features apply to the equipment. Please contact.
8. When the servo motor is provided with the reduction gear, the protection type of the reduction gear section is IP44.
9. At the load inertia moment ratio of 5 times or less, there are no restrictions on the regenerative duty if the effective torque is within the rated torque range.
10. The regenerative brake duty of the 400W or less servo amplifier may vary under the influence of the power supply voltage because of the large ratio of the energy for charging the electrolytic capacitor in the servo amplifier.

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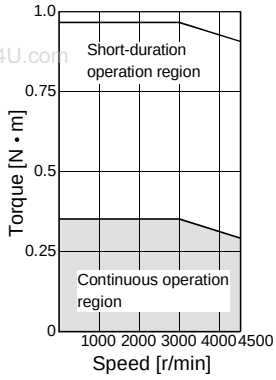
14.6.2 Torque characteristics

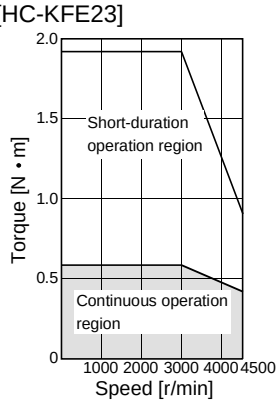
> **POINT**
>
> ▪ For machines which produce unbalance torque, e.g. vertical lift applications, it is recommended to use the servo motor so that the unbalance torque will be within 70% of the rated torque.

(1) HC-KFE series

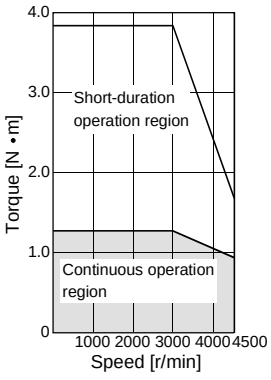
[HC-KFE13]



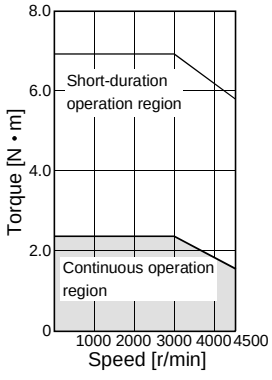
[HC-KFE23]



[HC-KFE43]

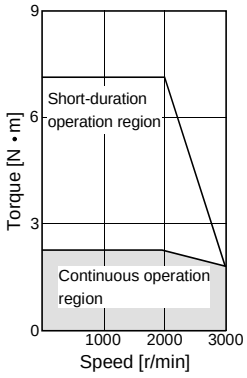


[HC-KFE73]

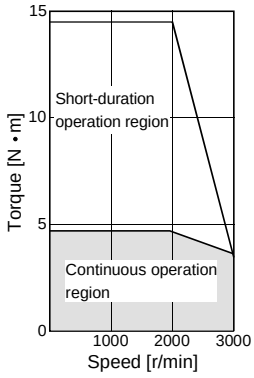


(2) HC-SFE series

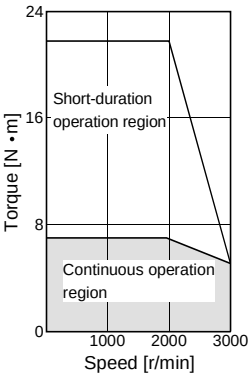
[HC-SFE52]



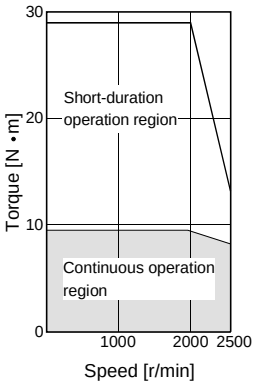
[HC-SFE102]



[HC-SFE152]



[HC-SFE202]



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14.6.3 Servo motors with reduction gears

> **CAUTION**
> - The servo motor with reduction gear must be installed in the specified direction. Otherwise , it can leak oil, leading to a fire or fault.
> - For the servo motor with reduction gear, transport it in the same status as in the installation method. Tipping it over can cause oil leakage.

Servo motors are available with reduction gears designed for: general industrial machines and precision applications.
Servo motors with electromagnetic brakes are also available.

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(1) Manufacturing range of servo motor with reduction gear

Servo motors with reduction gears that may be manufactured are indicated by symbols (G1(H), G2) in the following table. G1 (H) and G2 are symbols appended to the servo motor models.

Reduction Gear Series / Reduction ratio / Servo Motor	For General Industrial Machines									For Precision Applications					
	(Note) 1/5	1/6	1/11	(Note) 1/12	1/17	(Note) 1/20	1/29	1/35	1/43	1/59	1/5	1/9	1/20	1/29	1/45
HC-KFE13□ to 73□	G1			G1		G1					G2	G2	G2	G2	
HC-SFE52□ to 202□		G1 (H)	G1 (H)		G1 (H)		G1 (H)	G1 (H)	G1 (H)	G1 (H)	G2	G2	G2	G2	G2

Note : Reduction ratios for general industrial machines are nominal values. For actual reduction ratios, refer to (2) and (3) in this section.

(2) HC-KFE series

Reduction Gear Series		For General Industrial Machines HC-KFE□G1				For Precision Applications HC-KFE□G2
Mounting method		Flange mounting				
Mounting direction		In any directions				
Lubrication method		Grease lubrication (Already packed)				Grease lubrication (Already packed)
	Packed grease	100W	200W • 400W 1/12 • 1/20	1/5	750W	LDR101BV American Oil Center Research
		Mobilplex 46 Mobil Oil	New Molynoc No.2 Nisseki Mitsubishi	Mobil Grease SP Mobil Oil		
Output shaft rotating direction		Same as the servo motor output shaft direction.				
With electromagnetic brake		Available				
Backlash		60 minutes or less at reduction gear output shaft				3 minutes or less at reduction gear output shaft
Permissible load inertia moment ratio (when converting into the servo motor shaft)		10 times or less				
Permissible speed (at servo motor shaft)		4500 r/min				

The actual reduction ratios of the servo motors with reduction gears designed for general industrial machines are as listed below:

Servo Motor / Nominal Reduction Ratio	HC-KFE13(B)G1	HC-KFE23(B)G1	HC-KFE43(B)G1	HC-KFE73(B)G1
1/5	9/44	19/96		1/5
1/12	49/576	25/288		525/6048
1/20	25/484	253/5000		625/12544

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(3) HC-SFE series

Reduction Gear Series		For General Industrial Machines HC-SFE□G1(H)	For Precision Applications HC-SFE□G2
Mounting method		As in (a) in this section	Flange mounting
Mounting direction		As in (a) in this section	In any directions
Lubrication method		As in (a)(b) in this section	Grease lubrication (Already packed)
	(Note2) Recommended products	As in (b) in this section	LDR101BJ of American Oil Center Research make
Output shaft rotating direction		Opposite direction to the servo motor shaft	Same direction as the servo motor shaft
With electromagnetic brake		Available	
Backlash		40 minutes to 2*at reduction gear output shaft (Note1)	3 minutes or less at reduction gear output shaft
Permissible load inertia moment ratio (when converting into the servo motor shaft)		4 times or less	5 times or less
Permissible speed (at servo motor shaft)		2000[r/min]	0.5 to 1.5kW:3000[r/min] 2kW:2500[r/min]

Note1. The above values are typical values and not guaranteed values.
2. For grease lubrication, the reduction gear is already grease-packed.

(a) Lubrication of reduction gears for general industrial machines

Oil lubrication cannot be used in applications where the servo motor will move. Specify grease lubrication.

For grease lubrication, the reduction gear is already grease-packed.

For oil lubrication, pack the reduction gear with oil on the customer side.

Mounting Direction / Reduction gear model / Reduction gear frame No.	Shaft in Any Direction		Shaft Horizontal		Shaft Downward		Shaft Upward	
	CNHM (leg type)	CNVM (flange type)	CHHM (leg type)	CHVM (flange type)	CVHM (leg type)	CVVM (flange type)	CWHM (leg type)	CWVM (flange type)
4105	Grease	Grease						
4115	Grease	Grease						
4135			(Note) Oil	(Note) Oil	(Note) Oil	(Note) Oil	Grease	Grease
4165			(Note) Oil	(Note) Oil	(Note) Oil	(Note) Oil	Grease	Grease

Note: Grease-lubricated type is also available.

The reduction gear frame numbers are as follows:

Servo Motor	Reduction Ratio						
	1/6	1/11	1/17	1/29	1/35	1/43	1/59
HC-SFE52(B)G1 (H)	4105				4115		
HC-SFE102(B)G1 (H)	4115					4135	4165
HC-SFE152(B)G1 (H)	4115			4135		4165	
HC-SFE202(B)G1 (H)	4115			4165			

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(b) Recommended lubricants

1) Grease

Albania Grease/Shell OIL

2) Lubricating oil

Ambient Temperature ℃	COSMO OIL	NISSEKI MITSUBISHI OIL	IDEMITSU KOSAN CO., LTD	GENERAL OIL	Shell OIL	ESSO OIL	Mobil OIL	Japan Energy
−10 to 5	COSMO GEAR SE 68	BONNOC SP 68 DIAMOND GEAR LUBE SP 68	DAPHNE CE 68S DAPHNE SUPER GEAR OIL 68		Omala Oils 68	SPARTANEP 68	Mobilgear 626 (ISO VG68)	JOMO. Reductus 68
0 to 35	COSMO GEAR SE 100, 150	BONNOC SP 100, 150 DIAMOND GEAR LUBE SP 100, 150	DAPHNE CE 100S,150S DAPHNE SUPER GEAR OIL 100, 150	GENERAL SP GEAROL 100, 150	Omala Oils 100, 150	SPARTANEP 150	Mobilgear 629 (ISO VG150)	JOMO. Reductus 100, 150
30 to 50	COSMO GEAR SE 200,320,460	BONNOC SP 200 to 460 DIAMOND GEAR LUBE SP 220 to 460	DAPHNE CE 220S to 460S	GENERAL SP GEAROL 200 to 260	Omala Oils 200 to 460	SPARTANEP 220 to 460	Mobilgear 630 to 634 (ISO VG 220 to 460)	JOMO. Reductus 200 to 460

Lubricating oil fill amount (ℓ)

Reduction gear frame No.	Fill amount [ℓ]	
	Horizontal type	Vertical type
4135	0.7	1.1
4165	1.4	1.0

(c) Lubricating product changing intervals

1) Grease:

20000 hours or 4 to 5 years

2) Lubricant

Changing intervals	Operation hours per day	
	Less than 10 hours	10 to 24 hours
First time	500 hours	
Second time and later	Half year	2500 hours

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14.6.4 Servo motors with special shafts

The standard shaft of the servo motor is straight without a keyway. Shafts with keyway and D cut are also available. Except for the servo motor with reduction gear.
These shafts are not appropriate for applications where the servo motor is started and stopped frequently. Use a friction coupling or the like with such keys since we cannot guarantee such trouble as broken shafts due to loose keys.

Servo Motor	Shaft Shape		
	Keyway	D cut	Straight
HC-SFE52 to 202	(Note 2)○		(Note 3) ○
HC-KFE13		○	(Note 3) ○
HC-KFE23 to 73	(Note 1)○		(Note 3) ○

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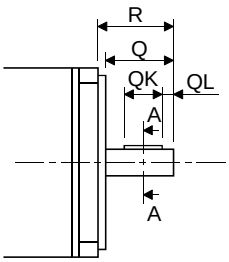
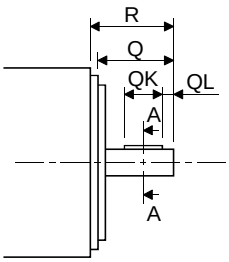
Note: 1. With a key.
2. Without a key.
3. This is a standard. For shape, refer to Section 14.9.

(1) Keyway

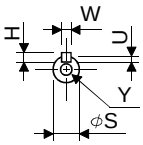
(a) With key



HC-MF23K to 73K



HC-UF23K to 73K



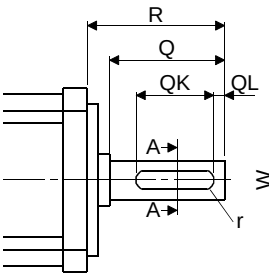
Section A-A

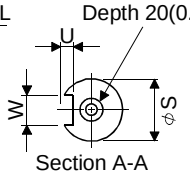
[Unit: mm]
([Unit: in])

Servo Motor Model	Variable Dimensions								
	S	R	Q	W	QK	QL	U	H	Y
HC-KFE23K・43K	14h6 (14)	30 (1.18)	27 (1.06)	5 (0.20)	20 (0.79)	3 (0.12)	3 (0.12)	5 (0.20)	M4 Depth 15 (0.59)
HC-KFE73K	19h6 (19)	40 (1.57)	37 (1.46)	6 (0.24)	25 (0.98)	5 (0.20)	3.5 (0.14)	6 (0.24)	M5 Depth 20 (0.79)

(b) Without key

[Unit: mm]
([Unit: in])



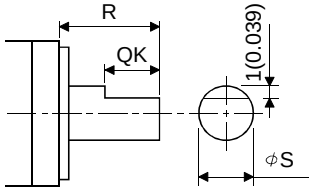


Section A-A

Servo motor	Variable Dimensions							
	S	R	Q	W	QK	QL	U	r
HC-SFE52K to 152K	24h6 (0.94)	55 (2.17)	50 (1.97)	$8^{0}_{-0.036}$ (0.31)	36 (1.42)	5 (0.20)	$4^{+0.2}_{0}$ (0.16)	4 (0.16)
HC-SFE202K	35 (1.38)	79 (3.11)	-	$10^{0}_{-0.036}$ (0.39)	55 (2.17)	5 (0.20)	$5^{+0.2}_{0}$ (0.20)	5 (0.20)

14.6.5 D cut

[Unit: mm]
([Unit: in])



Servo Motor Model	Variable Dimensions		
	R	QK	S
HC-KFE053D・13D	25(0.98)	20.5(0.81)	8h(0.32)

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14.7 Characteristics

14.7.1 Electromagnetic brake characteristics

> **CAUTION**
> - Configure the electromagnetic brake operation circuit so that it is activated not only by the servo amplifier signals but also by an external emergency stop signal. Refer to Section 3.9 for details.
> - The electromagnetic brake is designed to hold a load. Do not use it for braking.

(1) Characteristics

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Though the brake lining may rattle during operation, it poses no functional problem.
A leakage magnetic flux will occur at the shaft end of the servo motor equipped with electromagnetic brake.

Item \ (Note 5) Servo Motor			HC-SFE Series		HC-KFE Series		
			52B to 152B	202B	13B	23B・43B	73B
(Note 1) Type			Spring-loaded safety brake				
(Note 4) Rated voltage			$24V^{0}_{-10\%}$ DC				
Rated current at 20℃(68°F)		[A]	0.8	1.4	0.26	0.33	0.42
Excitation coil resistance at 20℃(68°F)		[Ω]	29	16.8	9.1	73	57
Capacity		[W]	19	34	6.3	7.9	9
Static friction torque		[N・m]	8.3	43.1	0.32	43.1	2.4
		[oz・in]	1176	6103	45	6108	340
(Note 2) Release delay time		[S]	0.04	0.1	0.03	0.1	0.03
Braking delay time (Note 2) [s]	AC off	(Fig. a)	0.12	0.12	0.08	0.12	0.12
	DC off	(Fig.s b, c)	0.03	0.03	0.01	0.03	0.03
Permissible braking work	Per braking	[J]	400	4500	5.6	22.0	64.0
		[oz・in]	56683.3	637687.1	793.6	3117.6	9069.3
	Per hour	[J]	4000	45000	56	220	640
		[oz・in]	566833	6376871	7936	31176	90693
Brake looseness at servo motor shaft (Note 5)		[degrees]	0.2 to 0.6	0.2 to 0.6	0.19 to 2.5	0.12 to 1.2	0.1 to 0.9
Brake life (Note 3)	Number of braking cycles	[times]	20000	20000	20000	20000	20000
	Work per braking	[J]	200	1000	4	15	32
		[oz・in]	28342	141708	567	2124.18	4535

Note: 1. There is no manual release mechanism. When it is necessary to hand-turn the servo motor shaft for machine centering, etc., use a separate 24VDC power supply to release the brake electrically.
2. The value for initial ON gap at 20℃ (68°F).
3. The brake gap will increase as the brake lining wears, but the gap is not adjustable. The brake life indicated is the number of braking cycles after which adjustment will be required.
4. 24VDC of the power output for interface (VDD) cannot be used. Always use a separate power supply.
5. The above values are typical initial values and not guaranteed values.

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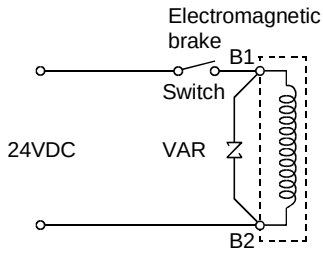
(2) Electromagnetic brake power supply

Prepare the following power supply for use with the electromagnetic brake only.



VAR : Surge absorber

The surge absorber must be installed across B1-B2. For the selection of the surge absorber, refer to section 13.2.5.

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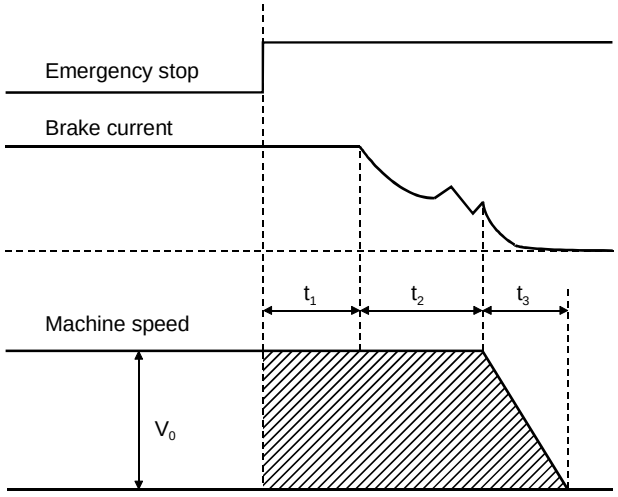
The electromagnetic brake terminals (B1, B2) have no polarity.

(3) Coasting distance

At an emergency stop, the servo motor will decelerate to a stop in the pattern shown in the following diagram. Here, the maximum coasting distance (during fast feed), Lmax, will be the area shown with the diagonal line in the figure and can be calculated approximately with Equation 6.1. The effect of the load torque is greater near the stopping area. When the load torque is large, the servo motor will stop faster than the value obtained in the equation.



$$L\,max = \frac{Vo}{60} \cdot \left(t1 + t2 + \frac{t3}{2} \right) \quad \text{..... (6.1)}$$

Where,

L max :	Maximum coasting distance	[mm]
Vo:	Machine's fast feed speed	[mm/min]
t_1:	Delay time of control section	[s]
t_2:	Braking delay time of brake (Note)	[s]
t_3:	Braking time	[s]
	$t_3 = \frac{(J_L + J_L) \cdot No}{9.55 \times 10^4 \cdot (T_L + 0.8T_B)}$	
J_L	: Load inertia moment converted into equivalent value on servo motor shaft (Note)	[kg·cm²]
JM	: Servo motor inertia moment	[kg·cm²]
No	: Servomotor speed during fast feed	[r/min]
T_L	: Load torque converted into equivalent value on servo motor shaft	[N·m]
T_B	: Brake static friction torque (Note)	[N·m]

Note: t_2 and TB are the values noted in this section Characteristics. JL is the machine's inertia moment at the servo motor shaft.

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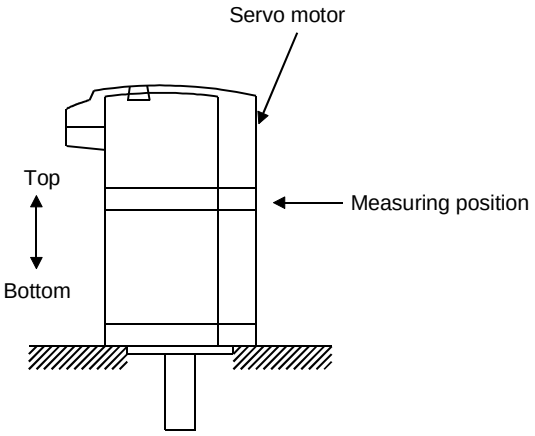
14.7.2 Vibration rank

The vibration rank of the servo motor is V-10 at the rated speed. Measure vibration in the following position with the servo motor installed as shown below.



Servo Motor Vibration
Measuring Conditions

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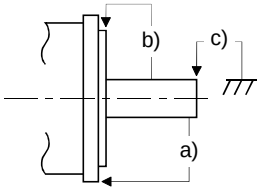
14.7.3 Machine Accuracies

The following table indicates the machine accuracies of the servo motor around the output shaft and mounting. (except the optional products)

Accuracy [mm]	Measuring Position	Flange Size		
		Less than □100	□100 · □130	□176
Runout of flange surface to output shaft	a)	0.05	0.06	0.08
Runout of fitting OD of flange surface	b)	0.04	0.04	0.06
Runout of output shaft end	c)	0.02	0.02	0.03

Reference diagram



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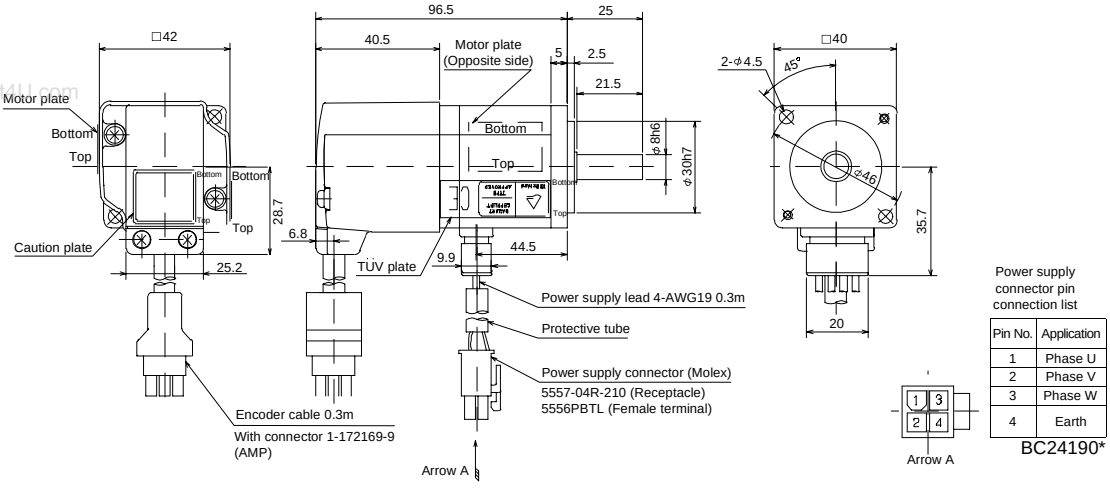
14.8 Outline dimension drawing

14.8.1 HC-KFE series

(1) Standard (without electromagnetic brake, without reduction gear)

Model	Output [W]	Inertia Moment J[×10^{-4}kg・m^2]	Weight [kg]
HC-KFE13	100	0.084	0.53

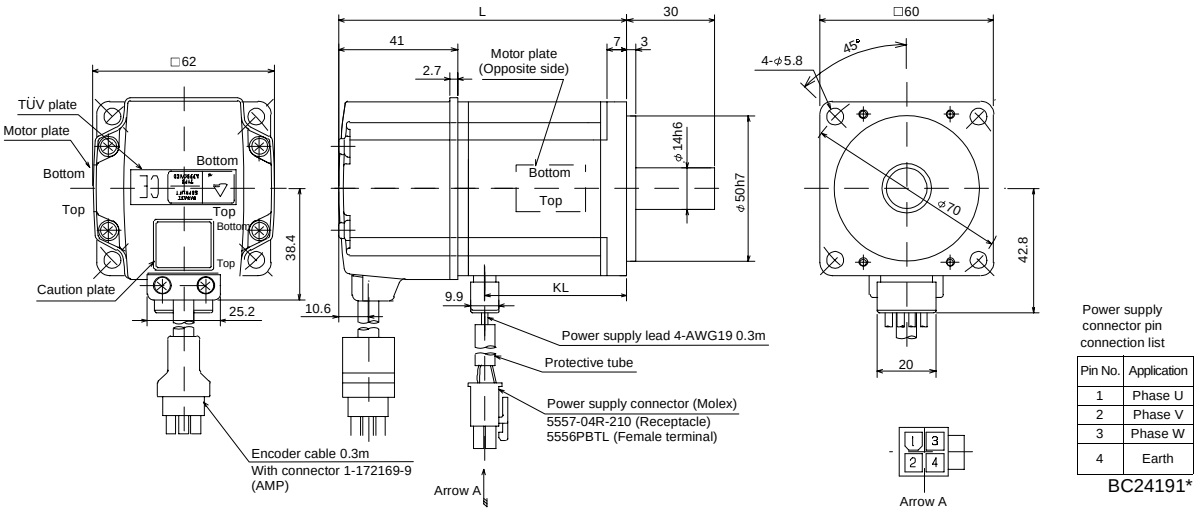
(Note)[Unit: mm]



Note: The dimensions without tolerances are reference dimensions.

Model	Output [W]	Variable Dimensions L	Variable Dimensions KL	Inertia Moment J[×10^{-4}kg・m^2]	Weight [kg]
HC-KFE23	200	99.5	49.1	0.42	0.99
HC- KFE 43	400	124.5	72.1	0.67	1.45

(Note)[Unit: mm]



Note: The dimensions without tolerances are reference dimensions.

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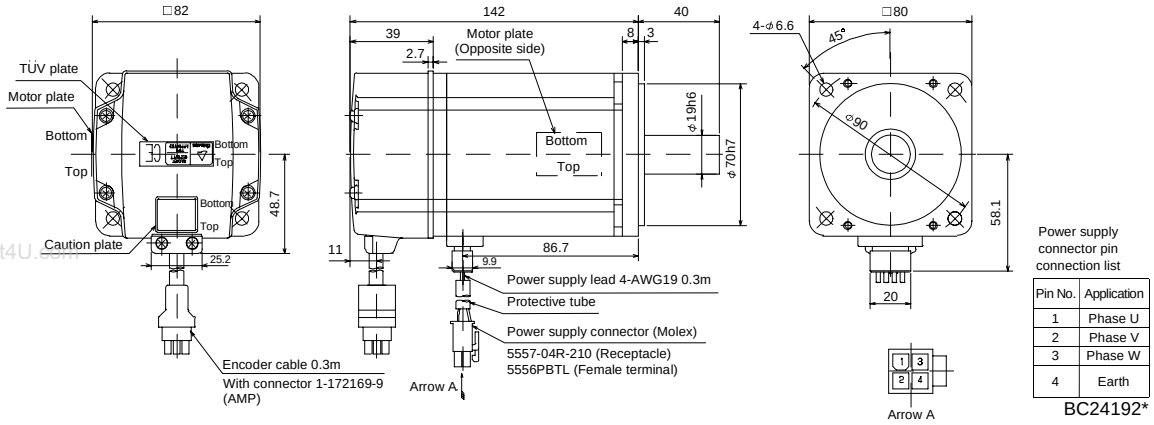
Model	Output [W]	Inertia Moment J[×10^{-4}kg・m^2]	Weight [kg]
HC-KFE73	750	1.51	3

(Note)[Unit: mm]



Power supply connector pin connection list

Pin No.	Application
1	Phase U
2	Phase V
3	Phase W
4	Earth

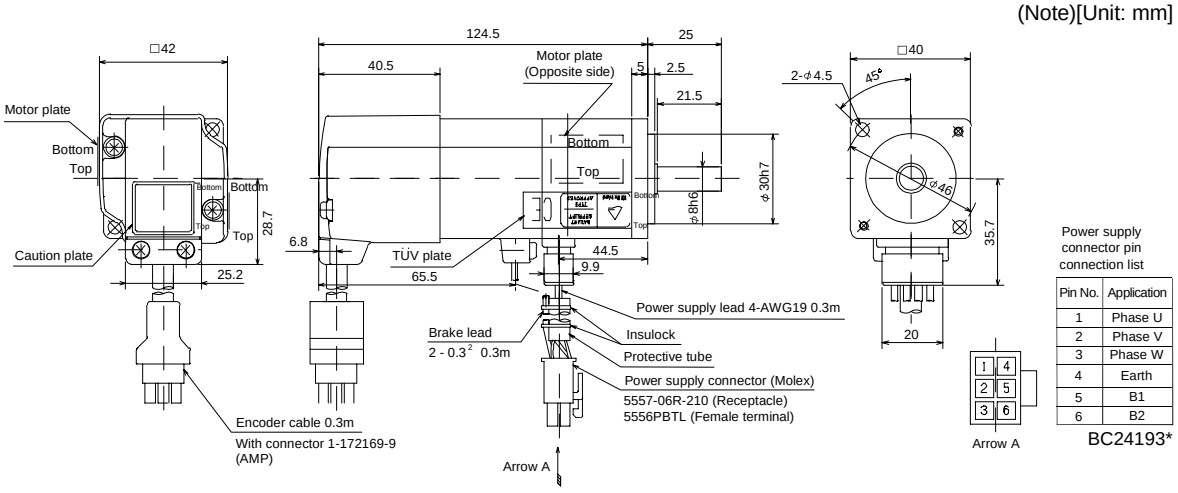
BC24192*

Note: The dimensions without tolerances are reference dimensions.

(2) With electromagnetic brake

Model	Output [W]	Braking Force [N・m]	Inertia Moment J[×10^{-4}kg・m^2]	Weight [kg]
HC-KFE13B	100	0.32	0.087	0.89

(Note)[Unit: mm]



Power supply connector pin connection list

Pin No.	Application
1	Phase U
2	Phase V
3	Phase W
4	Earth
5	B1
6	B2

BC24193*

Note: The dimensions without tolerances are reference dimensions.

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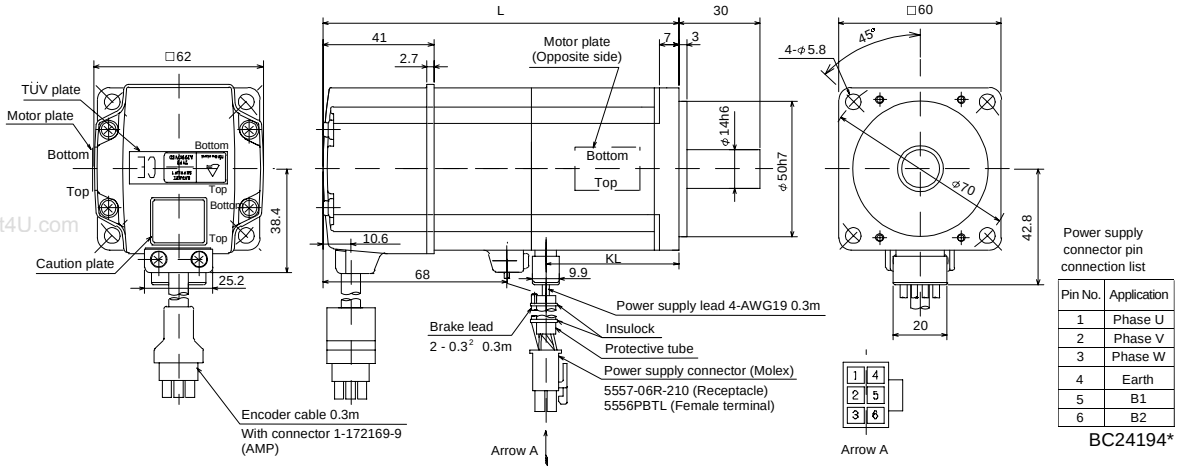
Model	Output [W]	Variable Dimensions		Braking Force [N・m]	Inertia Moment J[×10^{-4}kg・m^2]	Weight [kg]
		L	KL			
HC-KFE23B	200	131.5	49.1	1.3	0.47	1.6
HC- KFE43B	400	156.5	72.1	1.3	0.72	2.1

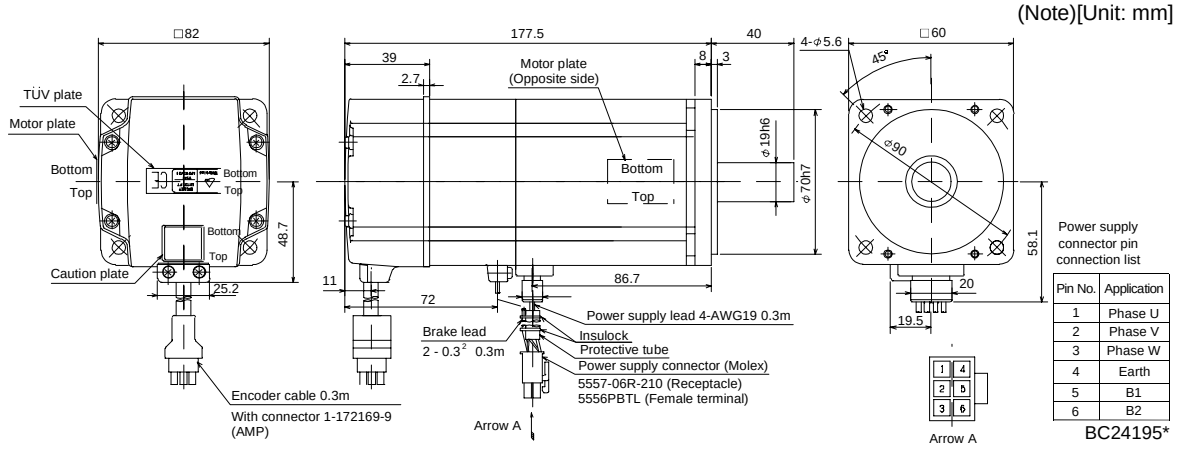
(Note)[Unit: mm]



Note: The dimensions without tolerances are reference dimensions.

Model	Output [W]	Braking Force [N・m]	Inertia Moment J[×10^{-4}kg・m^2]	Weight [kg]
HC-KFE73B	750	2.4	1.635	4.0

(Note)[Unit: mm]



Note: The dimensions without tolerances are reference dimensions.

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14.8.2 HC-SFE series

(1) Standard (without electromagnetic brake, without reduction gear)

Model	Output [kW]	Variable dimensions L	Variable dimensions KL	Inertia Moment J[×10^{-4}kg·m^2]	Weight [kg]
HC-SFE52	0.5	150.5	51.5	6.7	5.5
HC-SFE102	1.0	175.5	76.5	13.8	7.5
HC-SFE152	1.5	200.5	101.5	20.1	9.5

(Note)[Unit: mm]

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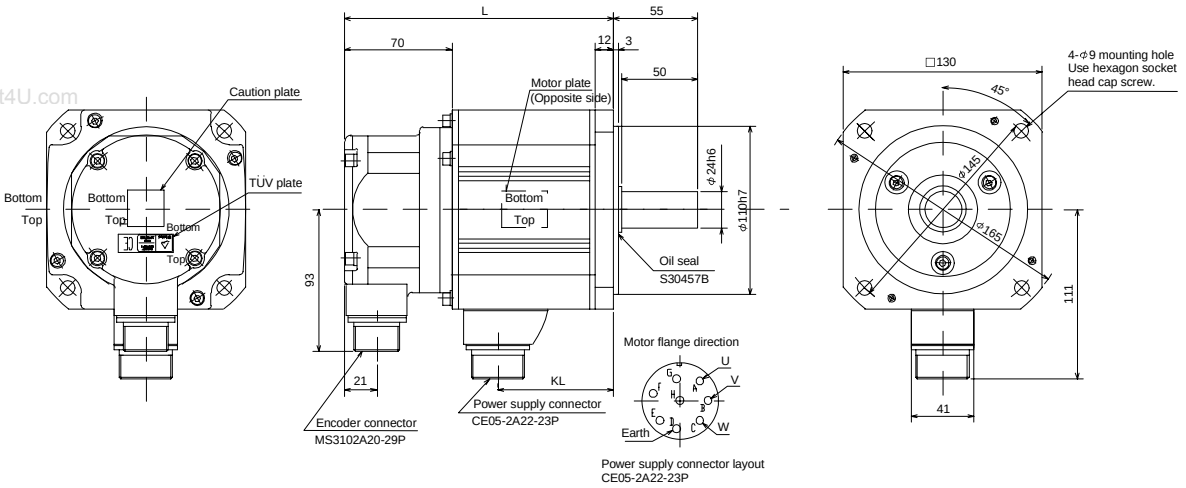
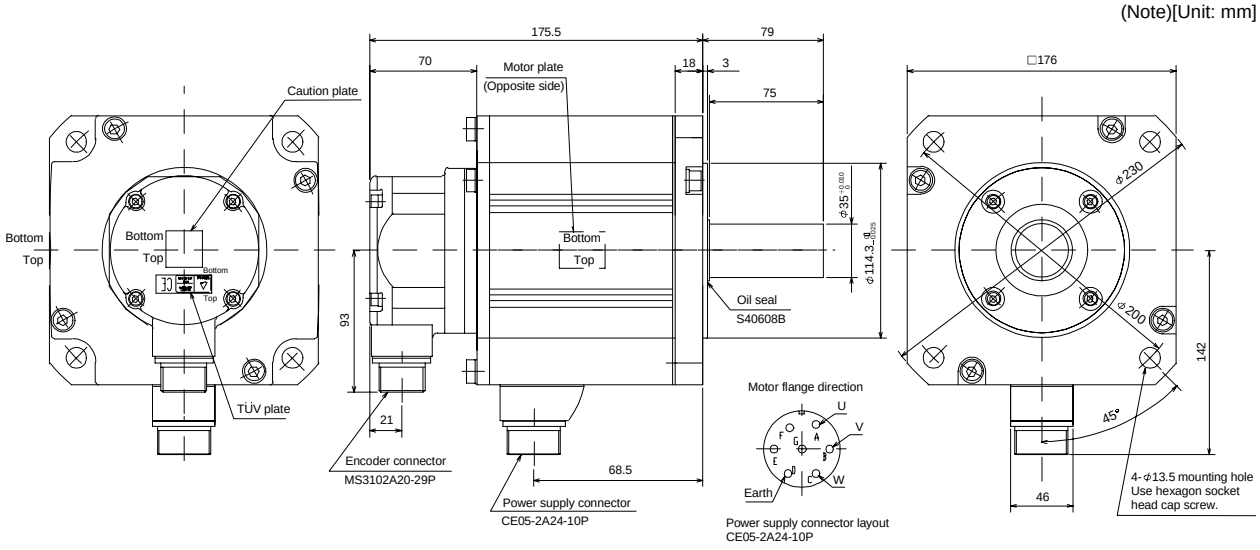


BC25010*

Note: The dimensions without tolerances are reference dimensions.

Model	Output [kW]	Inertia Moment J[×10^{-4}kg·m^2]	Weight [kg]
HC-SFE202	2.0	42.6	12.5

(Note)[Unit: mm]



BC25012*

Note: The dimensions without tolerances are reference dimensions.

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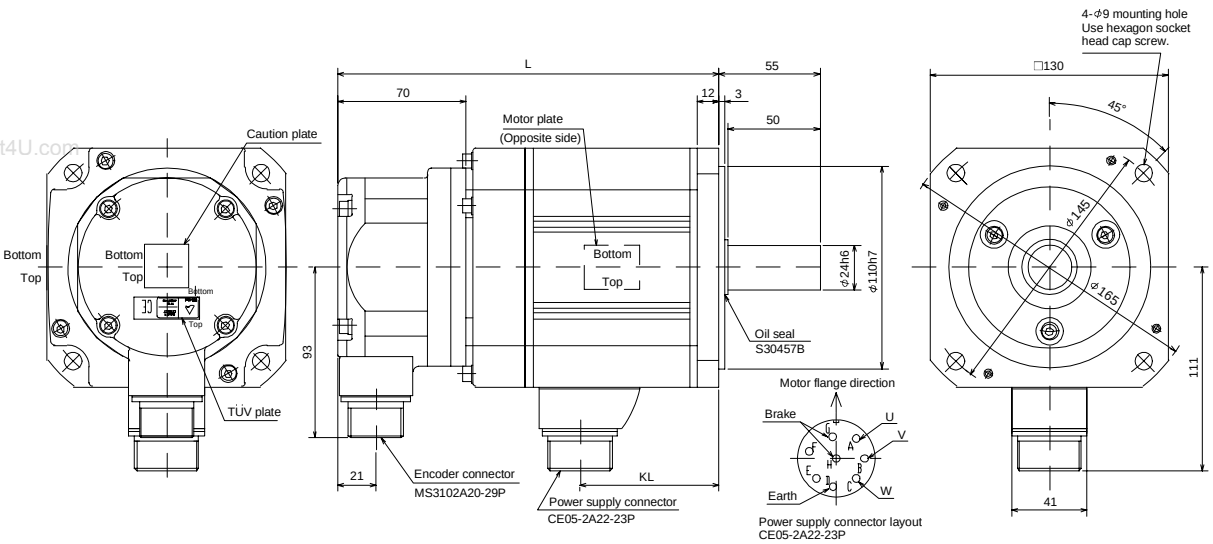
(2) With electromagnetic brake

Model	Output [kW]	Variable dimensions		Braking Force [N・m]	Inertia Moment J[×10^{-4}kg・m^2]	Weight [kg]
		L	KL			
HC-SFE52B	0.5	183.5	51.5	8.3	8.7	7.5
HC-SFE102B	1.0	208.5	76.5	8.3	15.8	9.5
HC-SFE152B	1.5	233.5	101.5	8.3	22.1	11.5

(Note)[Unit: mm]

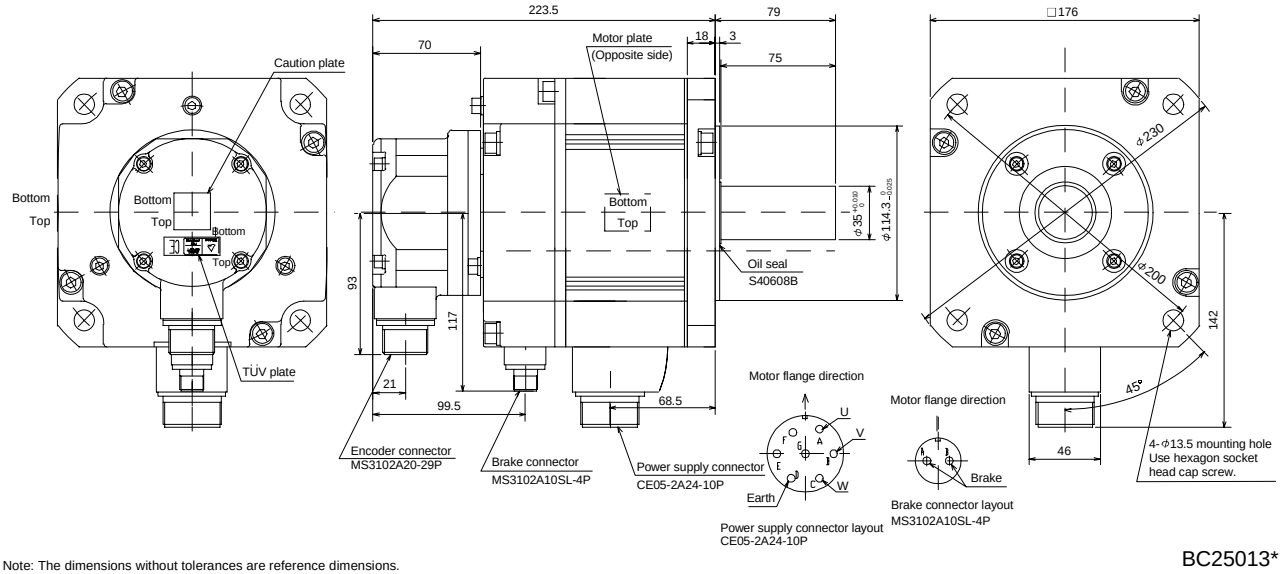


BC25011*

Note: The dimensions without tolerances are reference dimensions.

Model	Output [kW]	Braking Force [N・m]	Inertia Moment J[×10^{-4}kg・m^2]	Weight [kg]
HC-SFE202B	2.0	43.1	52.6	18.5

(Note)[Unit: mm]



BC25013*

Note: The dimensions without tolerances are reference dimensions.

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14.9 Outline dimension drawing (in inches)

POINT
The values in yards/pounds are reference values.

14.9.1 HC-KFE series

(1) Standard (without electromagnetic brake, without reduction gear)

Model	Output [W]	Inertia Moment WK^2[oz ▪ in^2]	Weight [lb]
HC-KFE13	100	0.459	1.17

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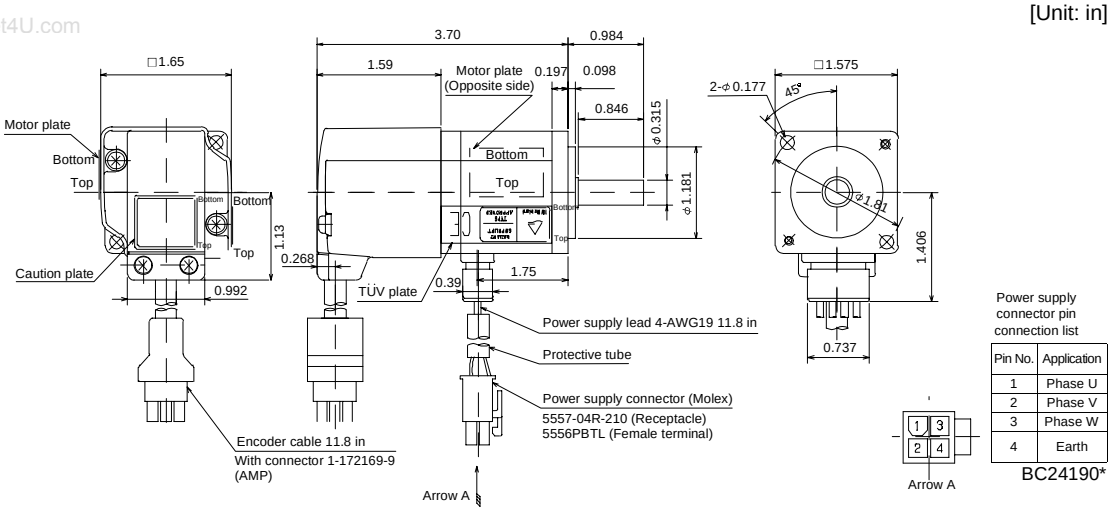
[Unit: in]



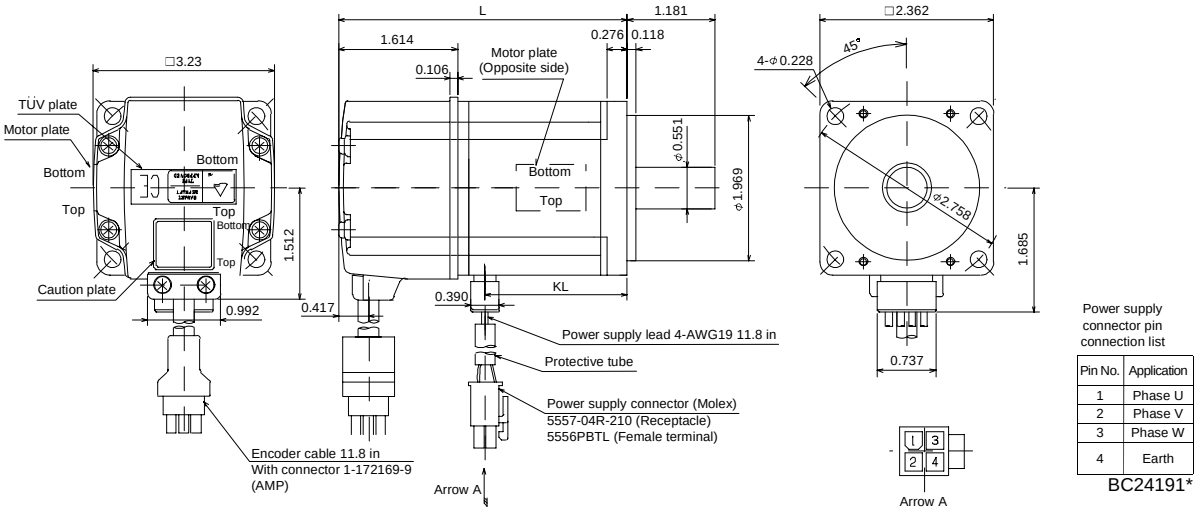
Power supply connector pin connection list

Pin No.	Application
1	Phase U
2	Phase V
3	Phase W
4	Earth

BC24190*

Model	Output [W]	Variable Dimensions [in]		Inertia Moment WK^2[oz ▪ in^2]	Weight [lb]
		L	KL		
HC-KFE23	200	3.92	1.93	2.296	2.183
HC-KFE43	400	4.90	2.84	3.663	3.197

[Unit: in]



Power supply connector pin connection list

Pin No.	Application
1	Phase U
2	Phase V
3	Phase W
4	Earth

BC24191*

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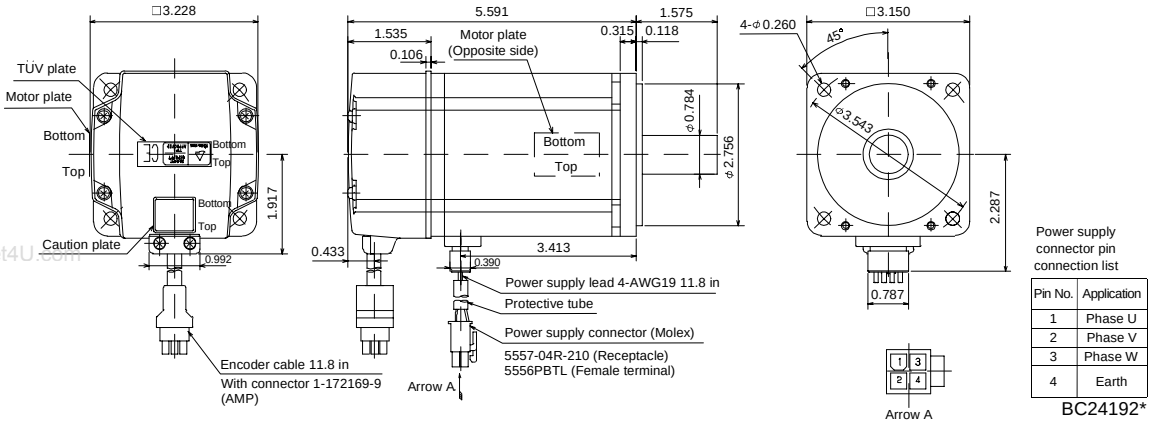
Model	Output [W]	Inertia Moment WK^2[oz ▪ in^2]	Weight [lb]
HC-KFE73	750	8.256	6.614

[Unit: in]



Power supply connector pin connection list

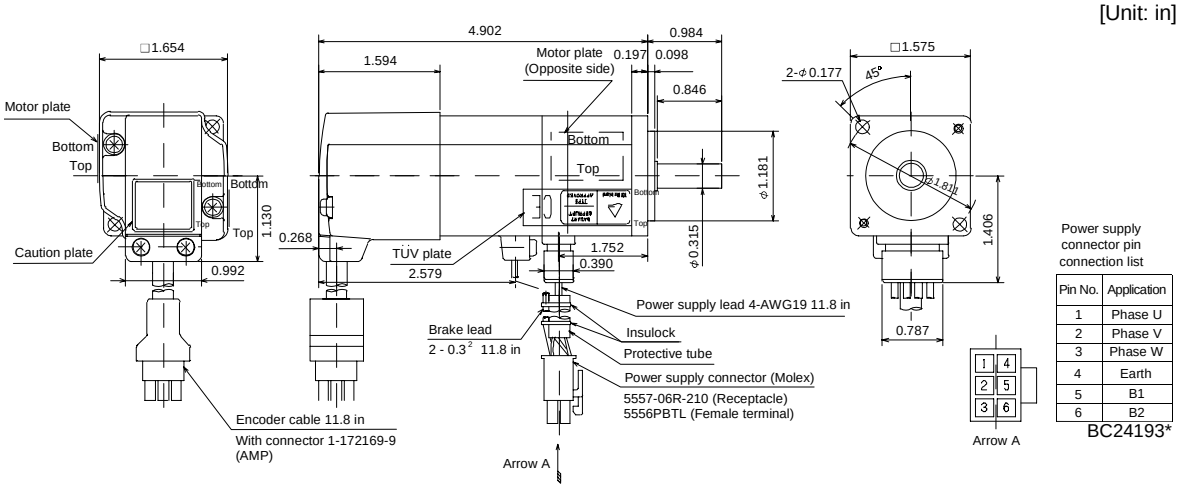
Pin No.	Application
1	Phase U
2	Phase V
3	Phase W
4	Earth

BC24192*

(2) With electromagnetic brake

Model	Output [W]	Braking Force [oz ▪ in]	Inertia Moment WK^2[oz ▪ in^2]	Weight [lb]
HC-KFE13B	100	45.316	0.476	1.962

[Unit: in]



Power supply connector pin connection list

Pin No.	Application
1	Phase U
2	Phase V
3	Phase W
4	Earth
5	B1
6	B2

BC24193*

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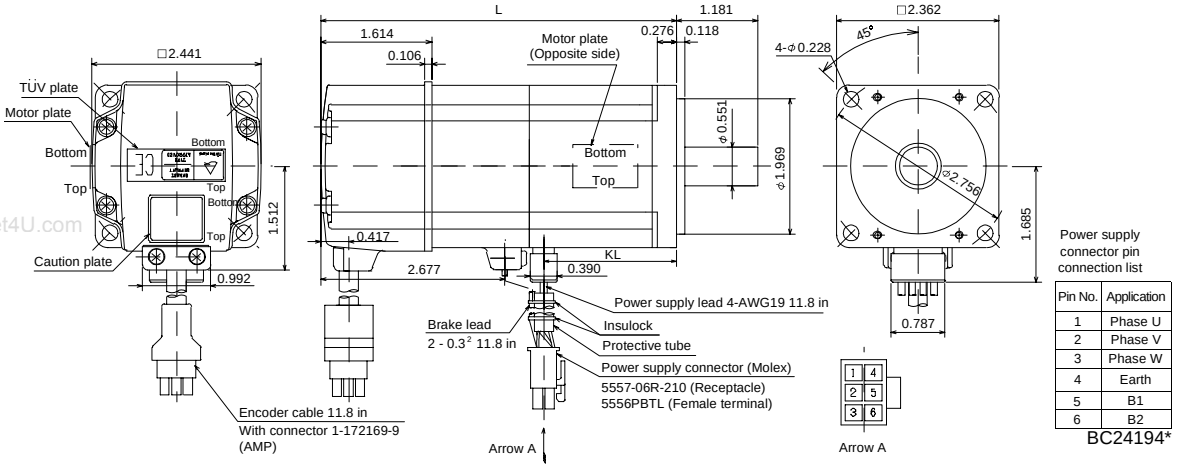
Model	Output [W]	Variable Dimensions [in]		Braking Force [oz ▪ in]	Inertia Moment WK^2 [oz ▪ in^2]	Weight [lb]
		L	KL			
HC-KFE23B	200	5.177	1.933	184.096	2.57	3.527
HC-KFE43B	400	6.161	2.839	184.096	3.937	4.63

[Unit: in]



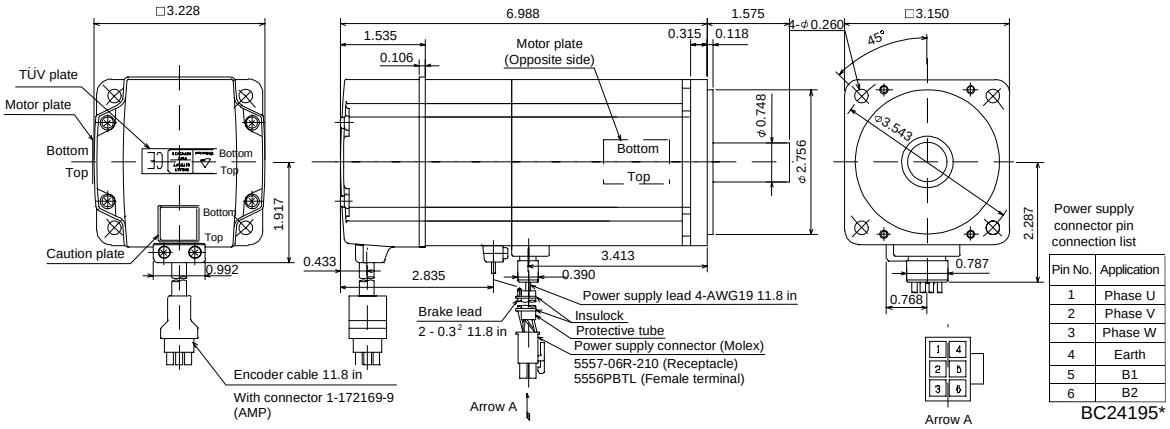
Power supply connector pin connection list

Pin No.	Application
1	Phase U
2	Phase V
3	Phase W
4	Earth
5	B1
6	B2

BC24194*

Model	Output [W]	Braking Force [oz ▪ in]	Inertia Moment WK^2 [oz ▪ in^2]	Weight [lb]
HC-KFE73B	750	339.869	8.939	8.818

[Unit: in]



Power supply connector pin connection list

Pin No.	Application
1	Phase U
2	Phase V
3	Phase W
4	Earth
5	B1
6	B2

BC24195*

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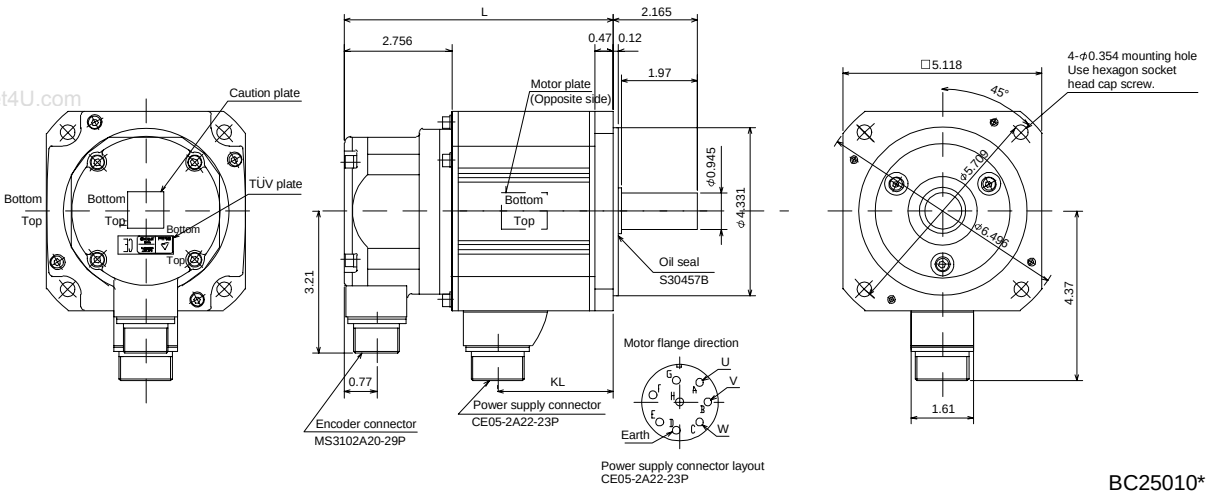
14.9.2 HC-SFE series

(1) Standard (without electromagnetic brake, without reduction gear)

Model	Output [kW]	Variable Dimensions [in]		Inertia Moment WK^2[oz·in^2]	Weight [lb]
		L	KL		
HC-SFE52	0.5	5.925	2.028	36.632	12.125
HC-SFE102	1.0	6.909	3.012	75.451	16.535
HC-SFE152	1.5	7.894	3.996	109.896	20.944

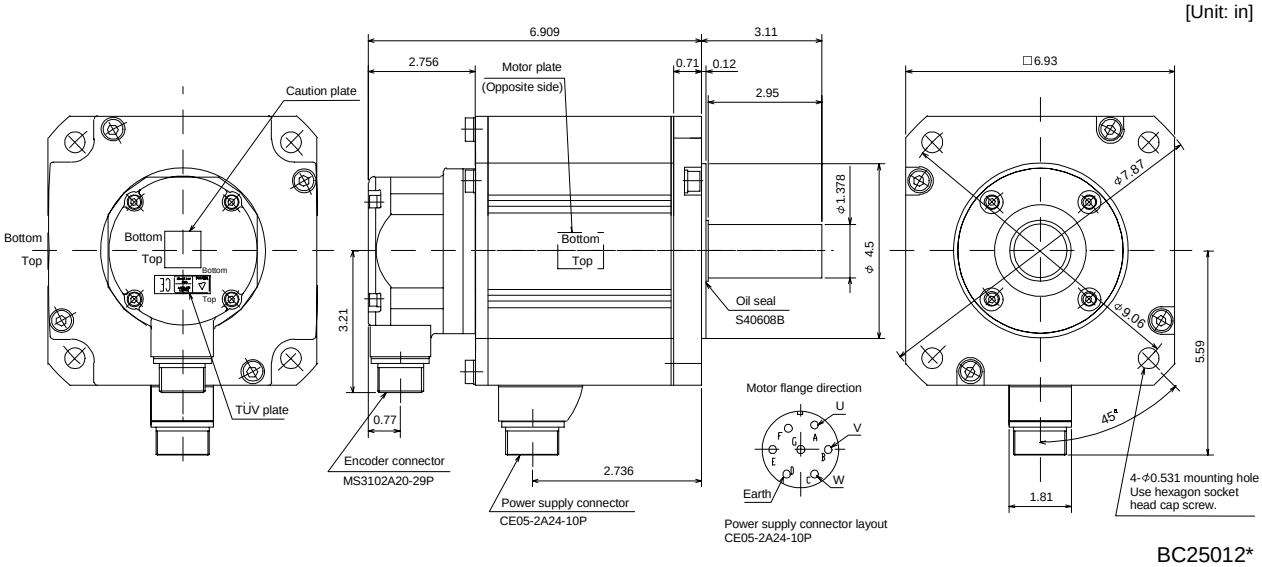
[Unit: in]



BC25010*

Model	Output [kW]	Inertia Moment WK^2[oz·in^2]	Weight [lb]
HC-SFE202	2.0	232.913	27.558

[Unit: in]



BC25012*

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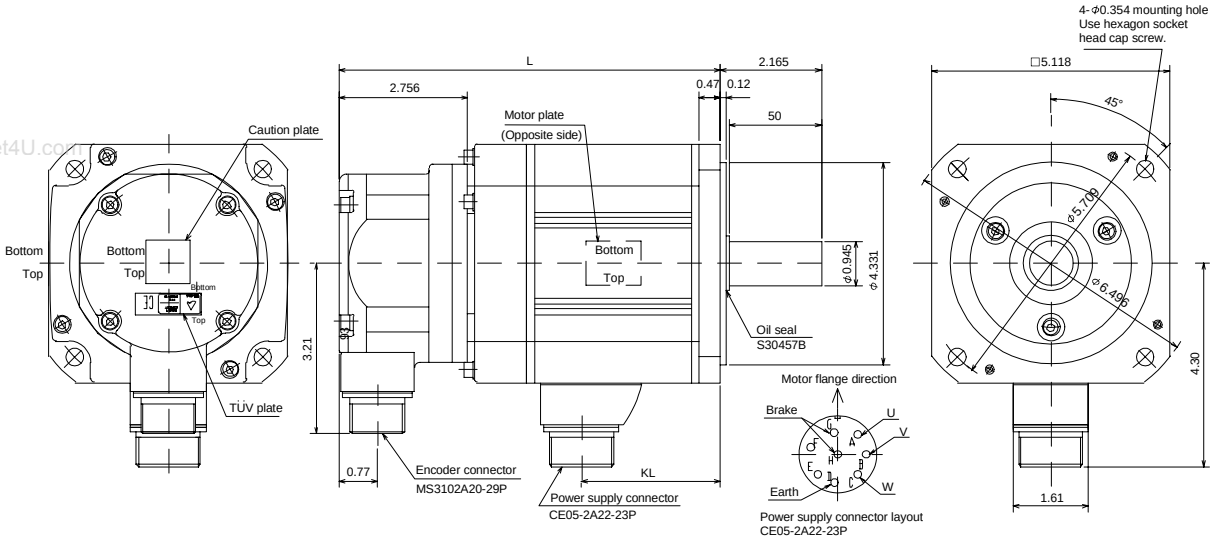
(2) With electromagnetic brake

Model	Output [kW]	Variable dimensions [in]		Braking Force [oz ▪ in]	Inertia Moment WK^2[oz ▪ in^2]	Weight [lb]
		L	KL			
HC-SFE52B	0.5	7.224	2.028	1175.382	47.567	16.535
HC-SFE102B	1.0	8.209	3.012	1175.382	86.386	20.944
HC-SFE152B	1.5	9.193	3.996	1175.382	120.831	25.353

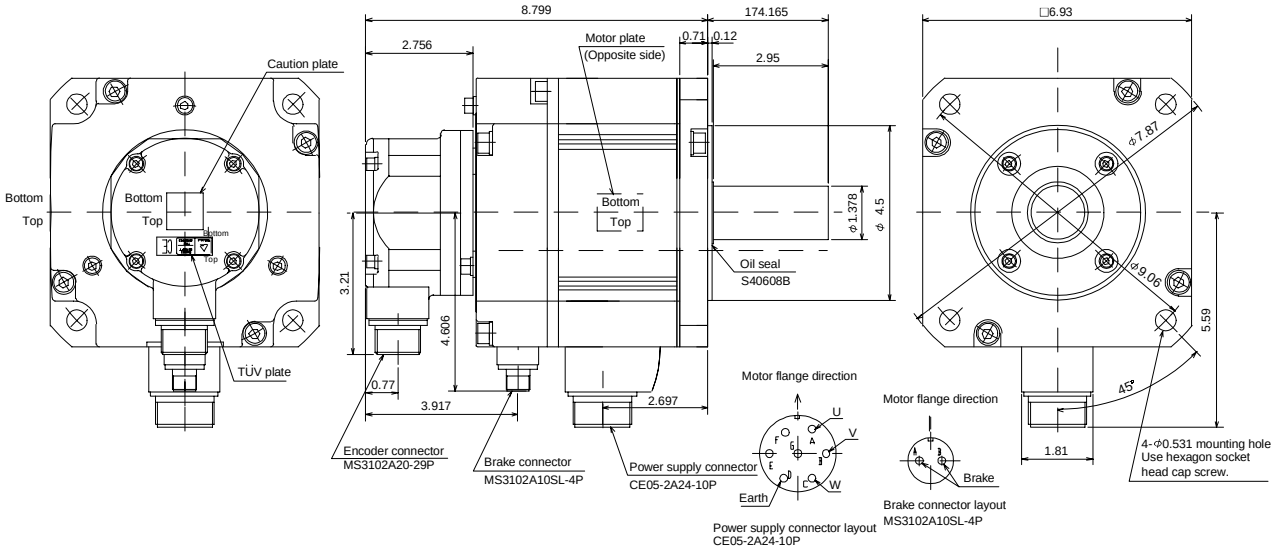
[Unit: in]



BC25011*

Model	Output [kW]	Braking Force [oz ▪ in]	Inertia Moment WK^2[oz ▪ in^2]	Weight [lb]
HC-SFE202B	2.0	6103.49	287.588	40.785

[Unit: in]



BC25013*

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15. MR-E-□ AG SERVO AMPLIFIER COMPATIBLE WITH ANALOG INPUT

POINT
・In this chapter, difference of the operation of MR-E- □ AG from that of MR-E- □ A is described. For description not given in this Chapter, refer to Chapters 1 through 14.

15.1. Functions and configuration

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15.1.1 Introduction

The analog input MR-E- □ AG Servo Amplifier is based on the MR-E- □ A 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 protect misoperation under no load, the speed limit function (external or internal setting) is also available for application to tension control, etc.

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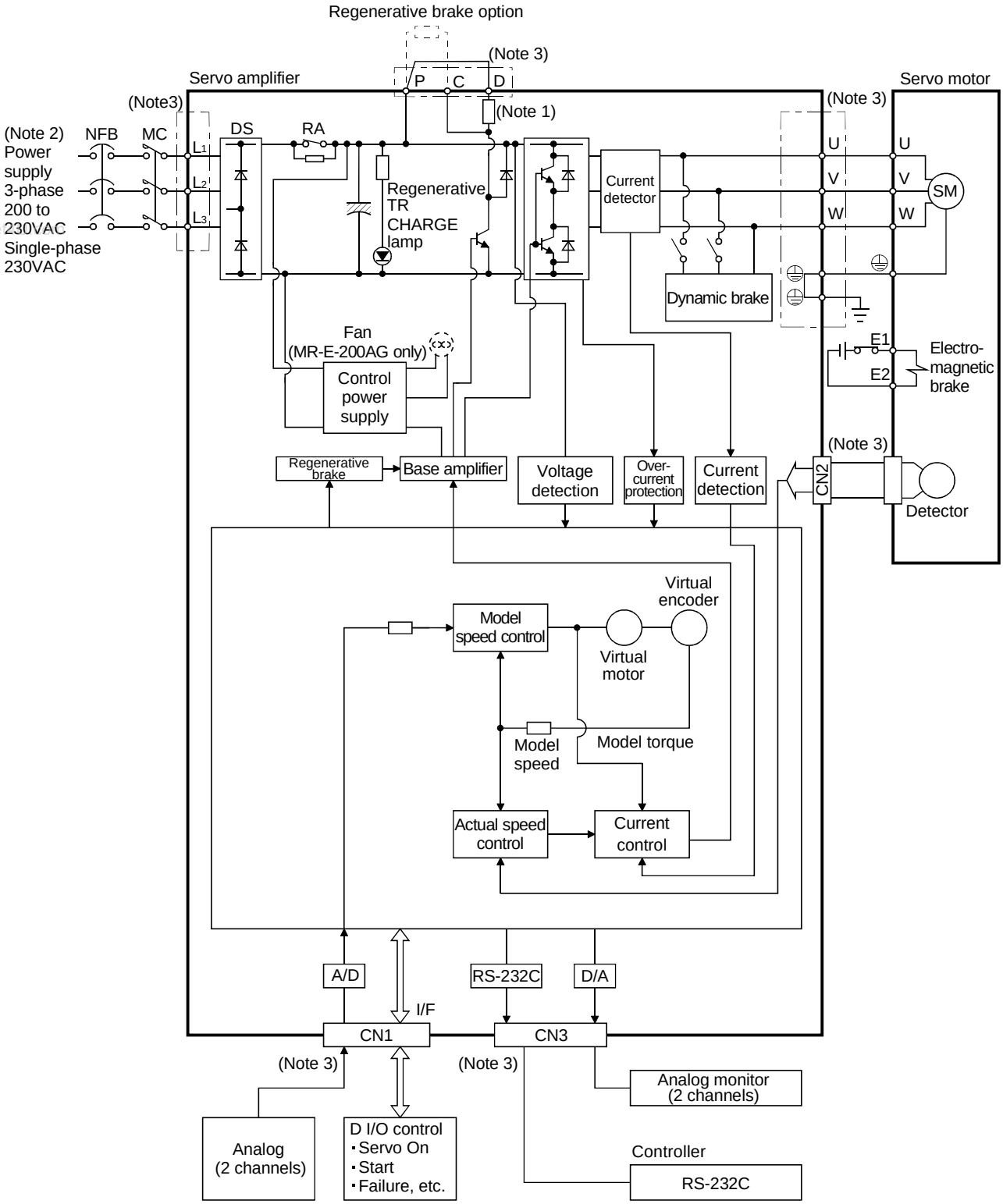
15.1.2 Function block diagram

The function block diagram of this servo is shown below.



Note: 1. The built-in regenerative brake resistor is not provided for the MR-E-10AG/20AG.
2. Single-phase 230VAC power supply can be used for MR-E-70AG or servo amplifiers with smaller capacities. Connect the power cables to L_1 and L_2 while leaving L_3 open.
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).

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15.1.3 Servo amplifier standard specifications

Item \ Servo Amplifier MR-E-□				10AG	20AG	40AG	70AG	100AG	200AG
Power supply	Voltage/frequency			3-phase 200 to 230VAC, 50/60Hz or 1-phase 230VAC, 50/60Hz				3-phase 200 to 230VAC, 50/60Hz	
	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 Section12.2					
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 brake error protection, undervoltage, instantaneous power failure protection, overspeed 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% or less (power fluctuation ±10%) ±0.2% max.(ambient temperature 25±10℃) for external speed setting only					
	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 (3280ft) above sea level					
	Vibration			5.9 [m/s^2] or less					
				19.4 [ft/s^2] or less					
Weight			[kg]	0.8	0.8	1.2	1.8	1.8	2.0
			[lb]	1.8	1.8	2.6	4.0	4.0	4.4

Note. The MR-E-200A is scheduled for release.

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15.1.4 Model code definition

MR - E - □ AG

Series

Analog input

Rated output

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

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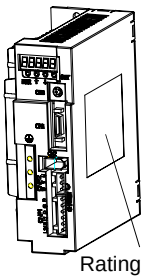
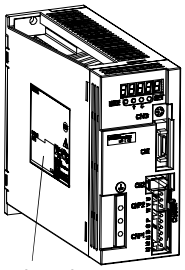
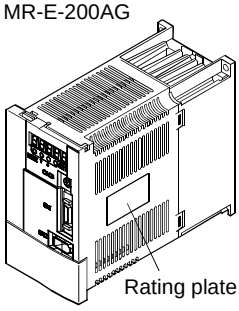
MR-E-40AG or less



MR-E-70AG, 100AG

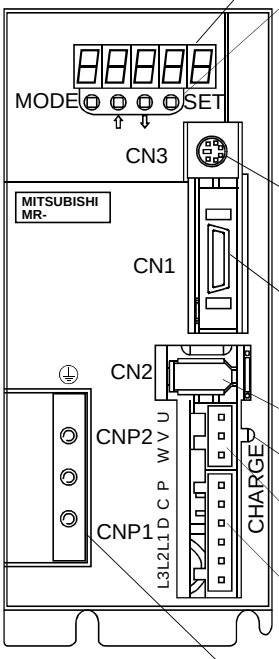


MR-E-200AG



15.1.5 Parts identification

(1) MR-E-100AG or less



Name/Application	Refer to
Display The 5-digit, seven-segment LED shows the servo status and alarm number.	Chapter6
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.	Chapter6
Communication connector (CN3) Used to connect a command device (RS-232C) and output analog monitor data.	Section3.3 Section13.1.2 Chapter14
I/O signal connector (CN1) Used to connect digital I/O signals.	Section3.3
Encoder connector (CN2) Connector for connection of the servo motor encoder.	Section3.3 Section13.1.2
Charge lamp Lit to indicate that the main circuit is charged. While this lamp is lit, do not reconnect the cables.	
Motor power supply connector (CNP2) Used to connect the servo motor.	Section3.7 Section11.1
Power supply/regenerative connector (CNP1) Used to connect the input power supply and regenerative brake option.	Section3.7 Section11.1 Section13.1.1
Protective earth (PE) terminal (⏚) Ground terminal.	Section3.10 Section11.1

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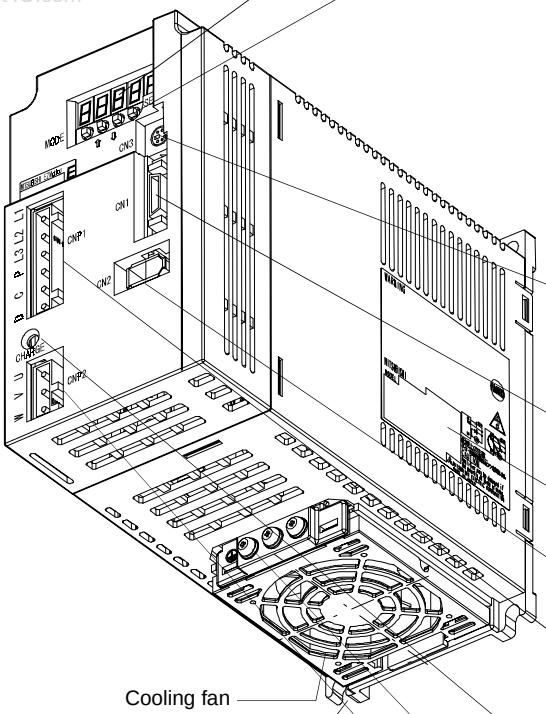
(2) MR-E-200AG



Name/Application	Refer to
Display The 5-digit, seven-segment LED shows the servo status and alarm number.	Section15.5
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.	Section15.5
Communication connector (CN3) Used to connect a command device (RS232C) and output analog monitor data.	Section3.3 Section13.1.2 Chapter14
I/O signal connector (CN1) Used to connect digital I/O signals.	Section15.2
Name plate	Section1.5
Encoder connector (CN2) Connector for connection of the servo motor encoder.	Section3.3 Section13.1.2
Power supply/regenerative connector (CNP1) Used to connect the input power supply and regenerative brake option.	Section3.7 Section11.1 Section13.1.1
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.	Section3.10 Section11.1
Motor power supply connector (CNP2) Used to connect the servo motor.	Section3.7 Section11.1

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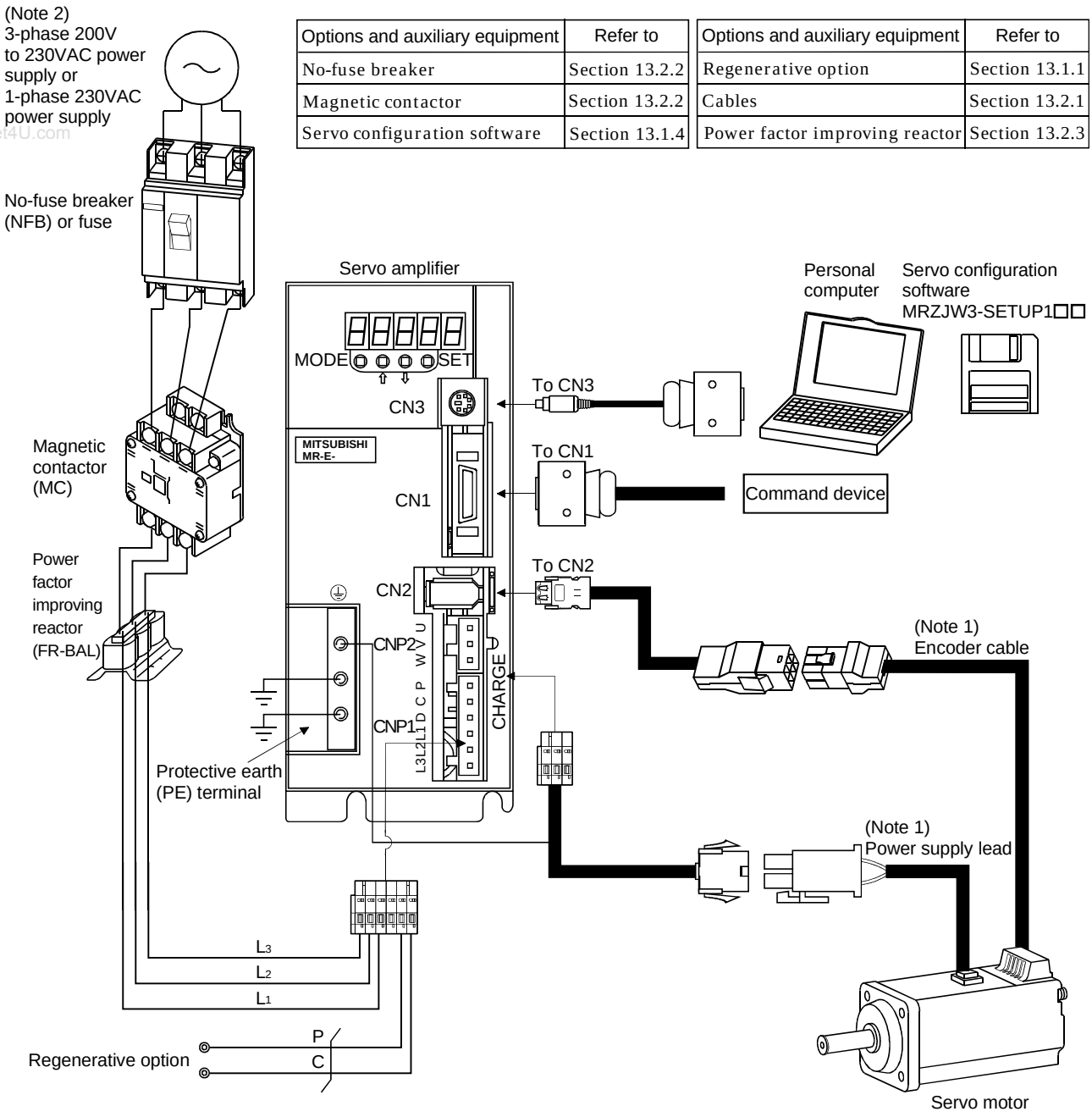
15.1.6 Servo system with auxiliary equipment

> **⚠ 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 or less

Options and auxiliary equipment	Refer to
No-fuse breaker	Section 13.2.2
Magnetic contactor	Section 13.2.2
Servo configuration software	Section 13.1.4

Options and auxiliary equipment	Refer to
Regenerative option	Section 13.1.1
Cables	Section 13.2.1
Power factor improving reactor	Section 13.2.3



Note: 1. The HC-SFE series have cannon connectors.
2. A 1-phase 230VAC power supply may be used with the servo amplifier of MR-E-70AG or less. Connect the power supply to L_1 and L_2 terminals and leave L_3 open.

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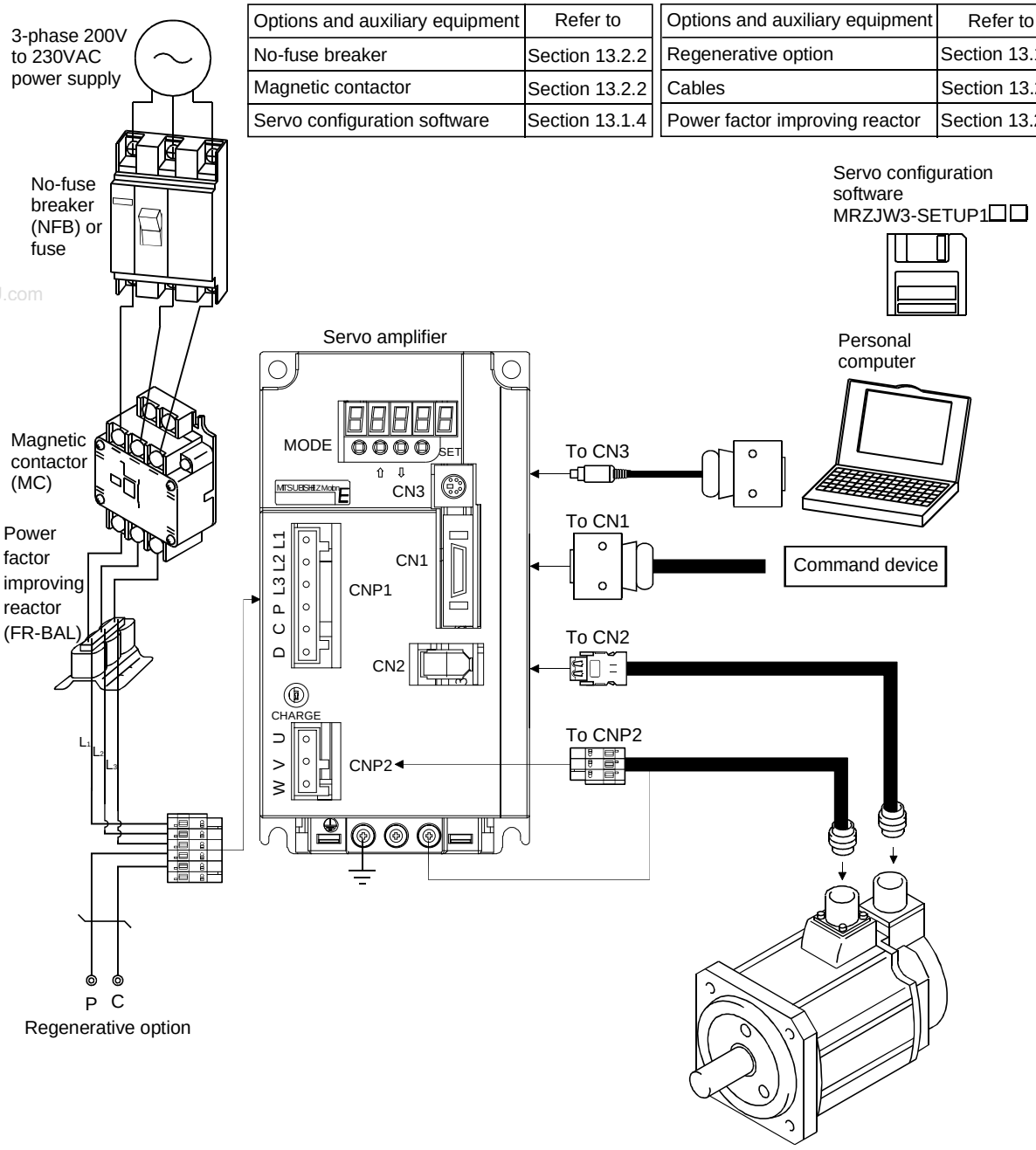
(2) MR-E-200AG

Options and auxiliary equipment	Refer to
No-fuse breaker	Section 13.2.2
Magnetic contactor	Section 13.2.2
Servo configuration software	Section 13.1.4

Options and auxiliary equipment	Refer to
Regenerative option	Section 13.1.1
Cables	Section 13.2.1
Power factor improving reactor	Section 13.2.3



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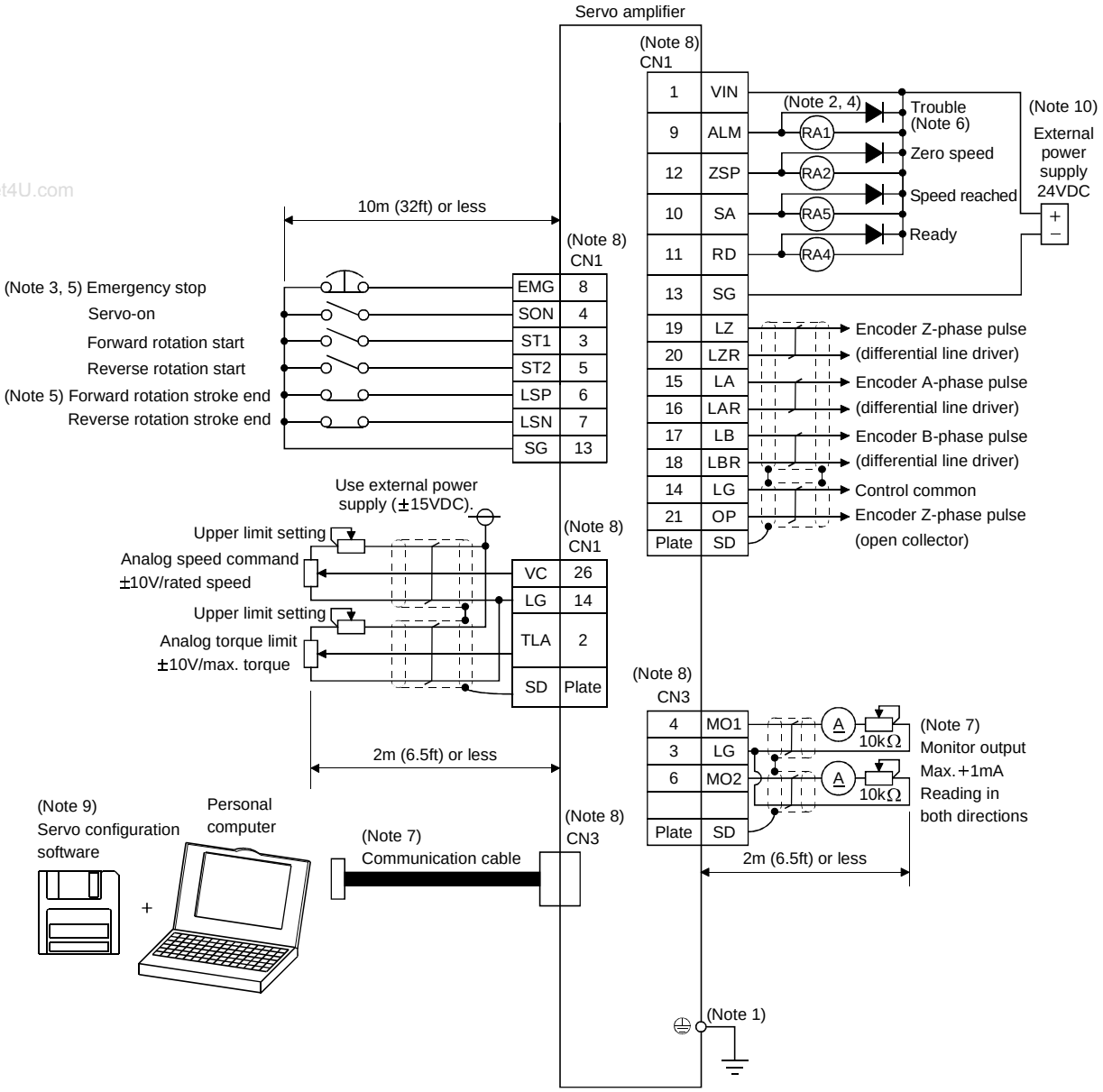
15.2. Signals and wiring

15.2.1 Standard connection example

(1) Speed control mode



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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. The sum of currents that flow in the external relays should be 80mA max. If it exceeds 80mA, supply interface power from external.(Refer to Section 3.6.2)
5. When starting operation, always connect the emergency stop signal (EMG) and forward/ reverse rotation stroke end signal (LSN/LSP) with SG. (Normally closed contacts)
6. Trouble (ALM) is connected with COM in normal alarm-free condition.
7. When connecting the personal computer together with monitor outputs 1, 2, use the branch cable (MR-E3CBL15-P). (Refer to Section 13.1.3)
8. The pins with the same signal name are connected in the servo amplifier.
9. Use MRZJW3-SETUP 154E.
10. Connect the external 24VDC power supply if the output signals are not used.

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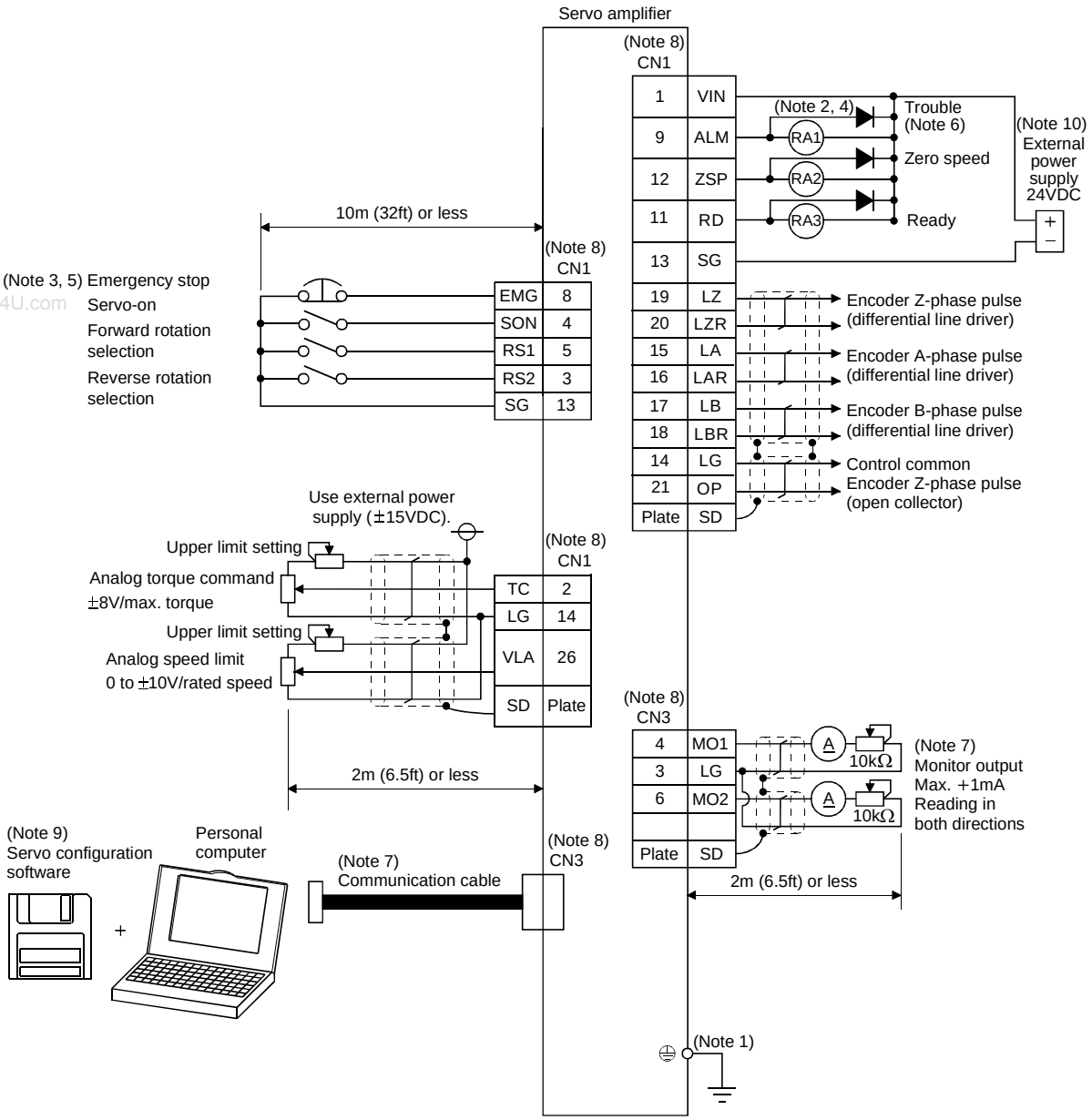
(2) Torque control mode



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. The sum of currents that flow in the external relays should be 80mA max. If it exceeds 80mA, supply interface power from external.(Refer to Section 3.6.2)

5. When starting operation, always connect the emergency stop signal (EMG) with SG. (Normally closed contacts)

6. Trouble (ALM) is connected with COM in normal alarm-free condition.

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

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

9. Use MRZJW3-SETUP 154E.

10. Connect the external 24VDC power supply if the output signals are not used.

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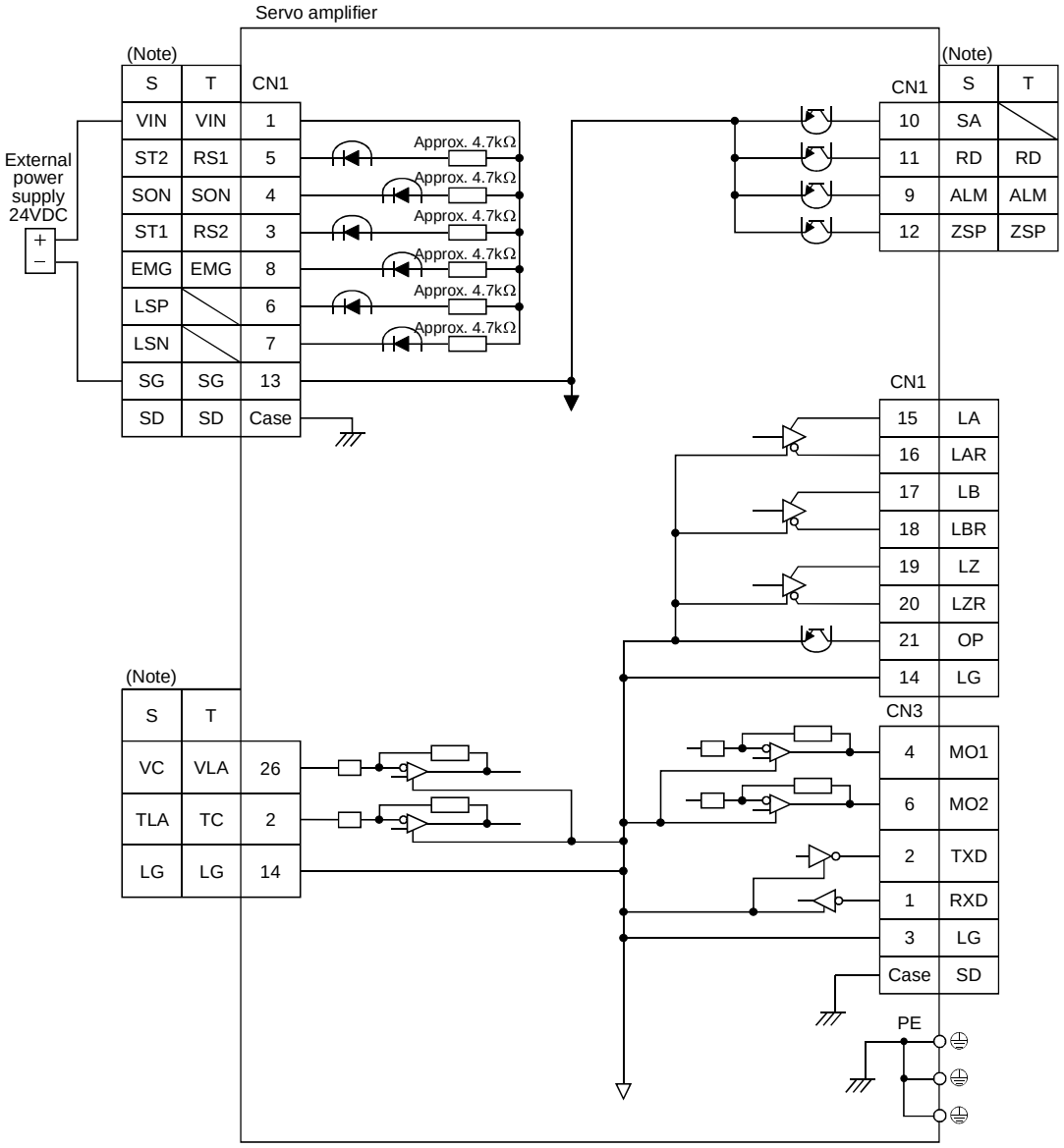
15.2.2 Internal connection diagram of servo amplifier

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

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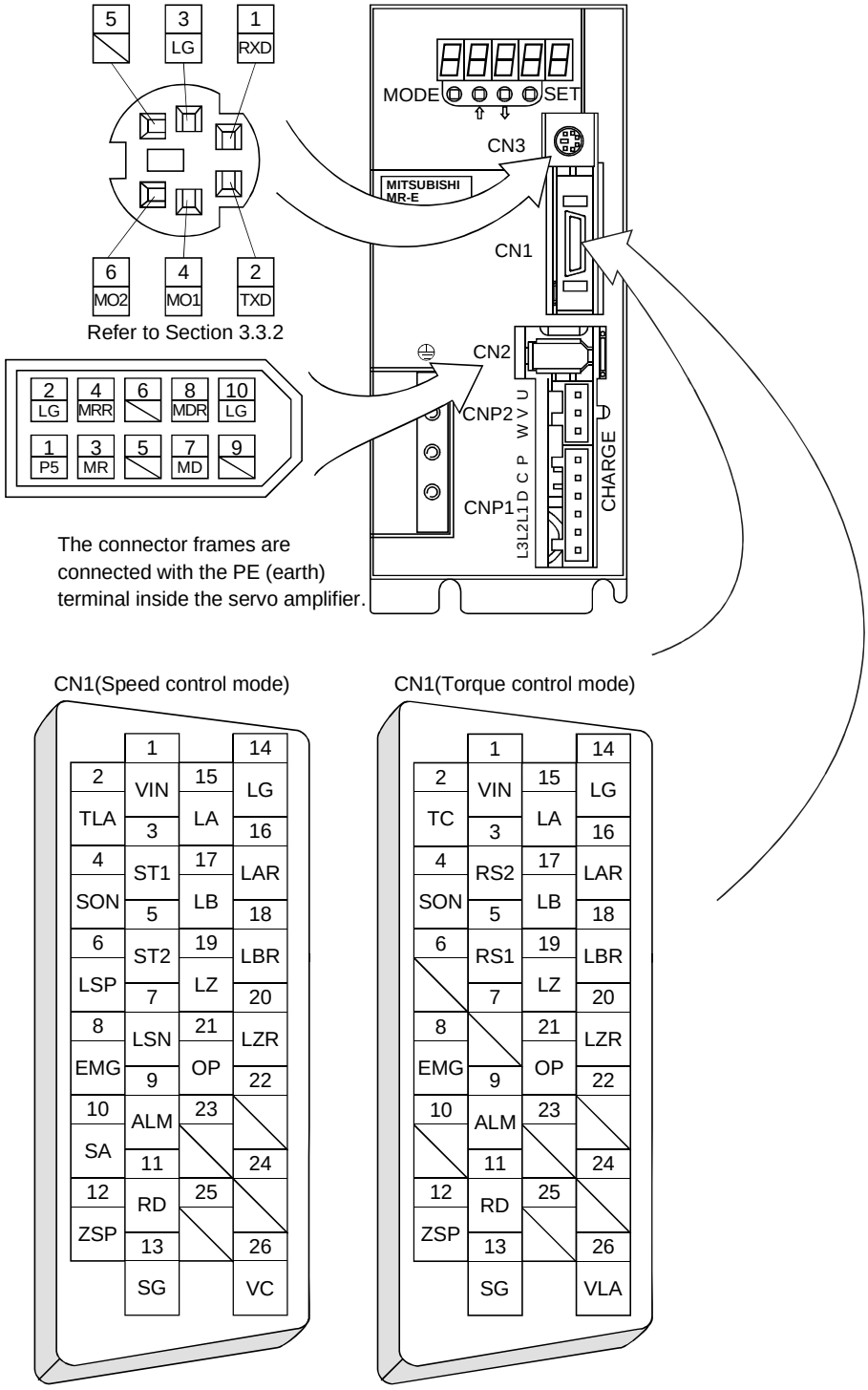
15.2.3 Connectors and signal arrangements

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



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(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.	(Note1) I/O	(Note2) 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

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15.2.4 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.

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(1) Input signals

POINT
・The acceptance delay time of each input signal is less than 10ms.

<table>
<tr><th rowspan="2">Signal</th><th rowspan="2">Symbol</th><th rowspan="2">Connec-tor pin No.</th><th rowspan="2">Functions/Applications</th><th rowspan="2">I/O division</th><th colspan="2">Control mode</th></tr>
<tr><th>S</th><th>T</th></tr>
<tr><td>Forward rotation stroke end</td><td>LSP</td><td>CN1 6</td><td rowspan="2">To start operation, short LSP-SG and/or LSN-SG. 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.)
<table><tr><th colspan="2">(Note) Input signals</th><th colspan="2">Operation</th></tr><tr><th>LSP</th><th>LSN</th><th>CCW direction</th><th>CW direction</th></tr><tr><td>1</td><td>1</td><td>○</td><td>○</td></tr><tr><td>0</td><td>1</td><td></td><td>○</td></tr><tr><td>1</td><td>0</td><td>○</td><td></td></tr><tr><td>0</td><td>0</td><td></td><td></td></tr></table>Note. 0: LSP/LSN-SG off (open)
1: SP/LSN-SG on (short)
Set parameter No. 41 as indicated below to switch on the signals (keep terminals connected) automatically in the servo amplifier:
<table><tr><th>Parameter No.41</th><th>Automatic ON</th></tr><tr><td>□□1□</td><td>LSP</td></tr><tr><td>□1□□</td><td>LSN</td></tr></table></td><td rowspan="2">DI-1</td><td rowspan="2">○</td><td rowspan="2"></td></tr>
<tr><td>Reverse rotation stroke end</td><td>LSN</td><td>CN1 7</td></tr>
<tr><td>Outside torque limit selection</td><td>TL</td><td></td><td>Turn TL off to make Internal torque limit 1 (parameter No. 28) valid, or turn it on to make Analog torque limit (TLA) valid.
For details, refer to (1)(C), Section 15.2.5.</td><td>DI-1</td><td>△</td><td></td></tr>
<tr><td>Internal torque limit selection</td><td>TL1</td><td></td><td>When using this signal, make it usable by making the setting of parameter No. 43 to 48.
(Refer to (5), Section 3.4.1.)</td><td>DI-1</td><td>△</td><td>△</td></tr>
</table>

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<table>
<tr><th rowspan="2">Signal</th><th rowspan="2">Symbol</th><th rowspan="2">Connec-tor pin No.</th><th rowspan="2">Functions/Applications</th><th rowspan="2">I/O division</th><th colspan="2">Control mode</th></tr>
<tr><th>S</th><th>T</th></tr>
<tr><td>Forward rotation start</td><td>ST1</td><td>CN1 -3</td><td rowspan="2">Used to start the servo motor in any of the following directions:
<table><tr><th colspan="2">(Note) Input signals</th><th rowspan="2">Servo motor starting direction</th></tr><tr><th>ST2</th><th>ST1</th></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-SG off (open)
1: ST1/ST2-SG 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.</td><td rowspan="2">DI-1</td><td rowspan="2"></td><td rowspan="2">○</td></tr>
<tr><td>Reverse rotation start</td><td>ST2</td><td>CN1 -5</td></tr>
<tr><td>Forward rotation selection</td><td>RS1</td><td>CN1 -5</td><td rowspan="2">Used to select any of the following servo motor torque generation directions:
<table><tr><th colspan="2">(Note) Input signals</th><th rowspan="2">Torque generation direction</th></tr><tr><th>RS2</th><th>RS1</th></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: off
1: on</td><td rowspan="2">DI-1</td><td rowspan="2"></td><td rowspan="2">○</td></tr>
<tr><td>Reverse rotation selection</td><td>RS2</td><td>CN1 -3</td></tr>
<tr><td>Speed selection 1</td><td>SP1</td><td></td><td rowspan="3"><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.
<table><tr><th colspan="3">(Note) Input signals</th><th rowspan="2">Speed command</th></tr><tr><th>SP3</th><th>SP2</th><th>SP1</th></tr><tr><td>0</td><td>0</td><td>0</td><td>Analog speed command (VC)</td></tr><tr><td>0</td><td>0</td><td>1</td><td>Internal speed command 1 (parameter No. 8)</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Internal speed command 2 (parameter No. 9)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Internal speed command 3 (parameter No. 10)</td></tr><tr><td>1</td><td>0</td><td>0</td><td>Internal speed command 4 (parameter No. 72)</td></tr><tr><td>1</td><td>0</td><td>1</td><td>Internal speed command 5 (parameter No. 73)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Internal speed command 6 (parameter No. 74)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Internal speed command 7 (parameter No. 75)</td></tr></table>Note 0: SP1/SP2/SP3-SG off (open)
1: SP1/SP2/SP3-SG on (short)
<Torque control mode>
Used to select the limit speed for operation.
When using SP1 to SP3, make it usable by making the setting of parameter No. 43 to 48.
<table><tr><th colspan="3">(Note) Input signals</th><th rowspan="2">Speed liimit</th></tr><tr><th>SP3</th><th>SP2</th><th>SP1</th></tr><tr><td>0</td><td>0</td><td>0</td><td>Analog speed limit (VLA)</td></tr><tr><td>0</td><td>0</td><td>1</td><td>Internal speed limit 1 (parameter No. 8)</td></tr><tr><td>0</td><td>1</td><td>0</td><td>Internal speed limit 2 (parameter No. 9)</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Internal speed limit 3 (parameter No. 10)</td></tr><tr><td>1</td><td>0</td><td>0</td><td>Internal speed limit 4 (parameter No. 72)</td></tr><tr><td>1</td><td>0</td><td>1</td><td>Internal speed limit 5 (parameter No. 73)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Internal speed limit 6 (parameter No. 74)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Internal speed limit 7 (parameter No. 75)</td></tr></table>Note 0: SP1/SP2/SP3-SG off (open)
1: SP1/SP2/SP3-SG on (short)</td><td>DI-1</td><td>△</td><td>△</td></tr>
<tr><td>Speed selection 2</td><td>SP2</td><td></td><td>DI-1</td><td>△</td><td>△</td></tr>
<tr><td>Speed selection 3</td><td>SP3</td><td></td><td>DI-1</td><td>△</td><td>△</td></tr>
</table>

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Signal	Symbol	Connector pin No.	Functions/Applications	I/O division	Control mode	
					S	T
Servo-on	SON	CN1-4	Same as MR-E-☐A. (Refer to (1) in Section 3.3.2)	DI-1	○	○
Reset	RES			DI-1	△	△
Proportion control	PC			DI-1	△	△
Emergency stop	EMG	CN1-8		DI-1	○	○
Gain changing	CDP			DI-1	△	△
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 (1)(a) in Section 15.2.5.) 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 (2)(a) in Section 15.2.5.) 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 (1)(a) in Section 15.2.5.) 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 (2)(c) in Section 15.2.5.).	Analog input		○

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(2) Output signals

Signal	Symbol	Connector pin No.	Functions/Applications	I/O division	Control mode S	Control mode T
Speed reached	SA		SA-SG are connected when the servo motor speed has nearly reached the preset speed. When the preset speed is 50r/min or less, SA-SG are kept connected.	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. (Refer to (2) in Section 3.3.2)	DO-1	○	○
Ready	RD	CN1-11		DO-1	○	○
Zero speed	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	Control mode T
Digital I/F power supply input	VIN	CN1-1	Same as MR-E- □ A. (Refer to (4) in Section 3.3.2)		○	○
Open collector power input	OPC	CN1-2			○	○
Digital I/F common	SG	CN1-13			○	○
Control common	LG	CN1-14			○	○
Shield	SD	Plate			○	○

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15.2.5 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:

The maximum speed is achieved at ±10V. The speed at ±10V can be changed using parameter No. 25.

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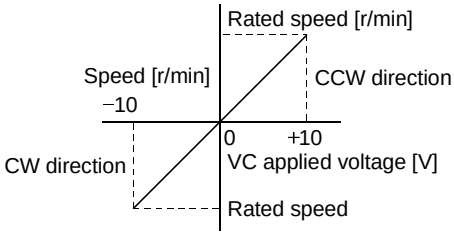
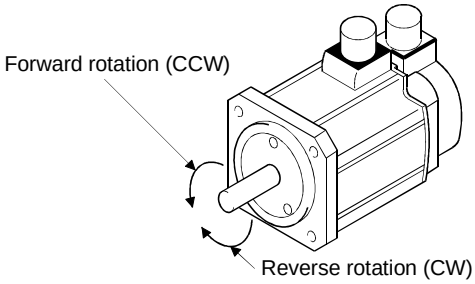


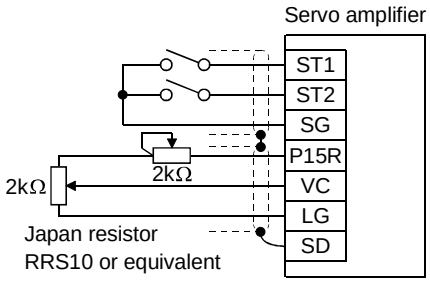


The following table indicates the rotation direction according to forward rotation start (ST1) and reverse rotation start (ST2) combination:

(Note) External input signals		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.0: off
1: on

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



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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-SG off (open)
1 : SP1/SP2/SP3-SG on (short)

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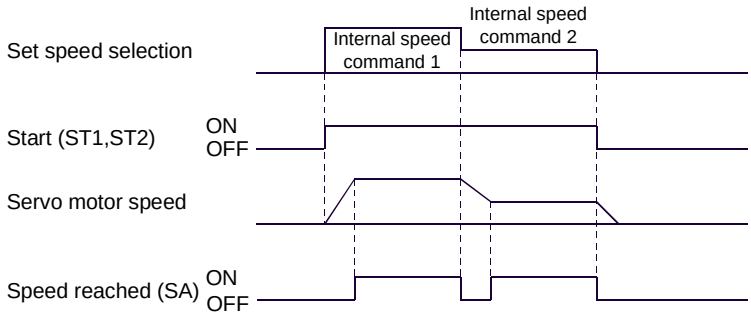
The speed may be changed during rotation. In this case, the values set in parameters No. 11 and 12 are used for acceleration/deceleration.
When the speed has been specified under any internal speed command, it does not vary due to the ambient temperature.

(b) Speed reached (SA)

SA-SG are connected when the servo motor speed nearly reaches the speed set to the internal speed command.



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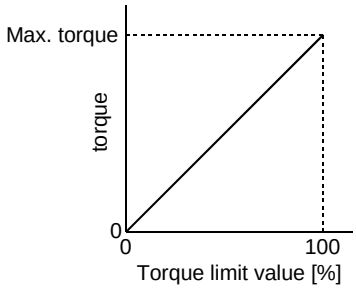
(c) Torque limit

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.



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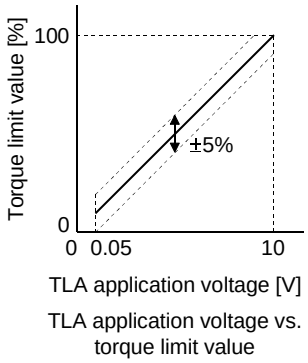
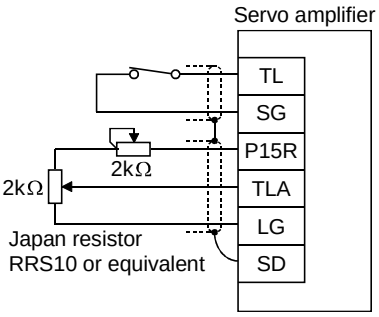
A relationship between the applied voltage of the analog torque limit (TLA) and the torque limit value of the servo motor is shown below. Torque limit values will vary about 5% relative to the voltage depending on products.

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. 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 value 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

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(2) Torque control mode

(a) Torque control

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.

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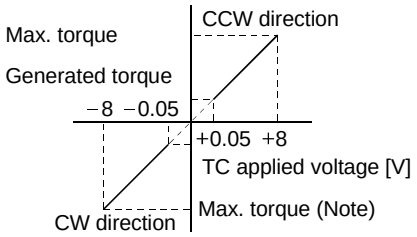
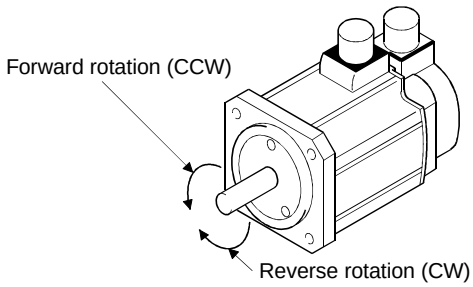




Generated torque limit values will vary about 5% relative to the voltage depending on products.

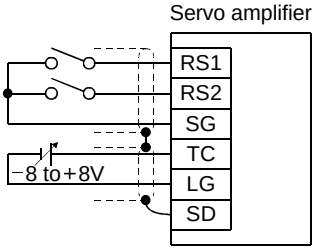
Also the torque may vary if the voltage is low (−0.05 to +0.05V) and the actual speed is close to the limit value. In such a case, increase the speed limit value.

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		
RS2	RS1	Torque control command (TC)		
		+ Polarity	0V	− Polarity
0	0	Torque is not generated.	Torque is not generated.	Torque is not generated.
0	1	CCW (reverse rotation in driving mode/forward rotation in regenerative mode)		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:



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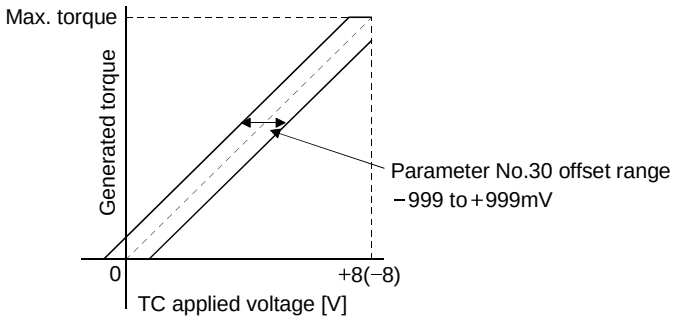
2) Analog torque command offset

Using parameter No. 30, the offset voltage of −999 to +999mV can be added to the TC applied voltage as shown below.



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(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) in this section. Note that the analog torque limit (TLA) is unavailable.

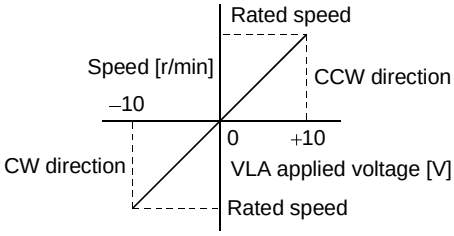
(c) Speed limit

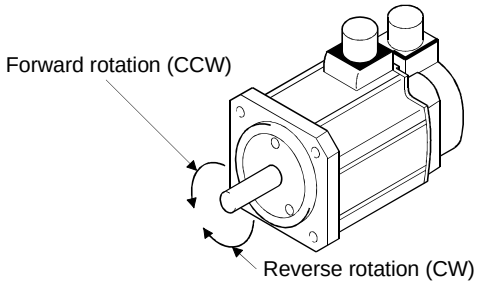
1) Speed limit value and speed

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/m greater than the desired speed limit value.



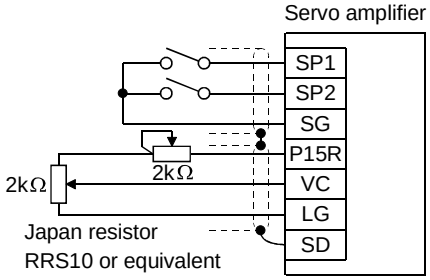


The following table indicates the limit direction according to forward rotation selection (RS1) and reverse rotation selection (RS2) combination:

(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:



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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 command (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).

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(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

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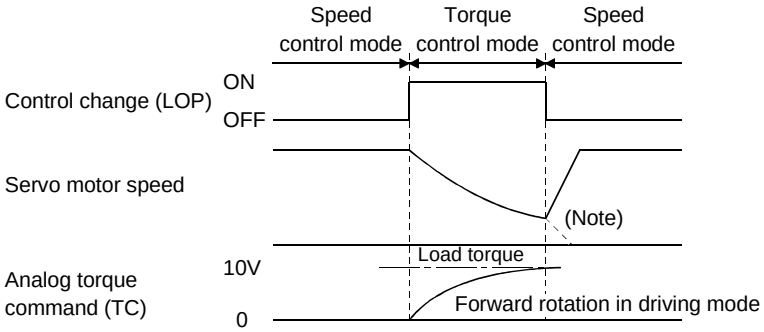
The control mode may be changed at any time. A change timing chart is shown below:



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).

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15.3 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. ・During power-on for some after power-off, do not touch or close a parts (cable etc.) to the servo amplifier heat sink, regenerative brake resistor, the servo motor, etc. Their temperatures may be high and you may get burnt or a parts may damaged.

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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.

15.3.1 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

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 Sections 6.5 for the setting method.

Parameter No.	Name	Setting	Description
0	Control mode, regenerative brake option selection	□0□2	Speed control mode Regenerative brake 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 2	1500	Set 1500r/min.
10	Internal speed command 3	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.

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(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 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 3.9, (2) for the servo motor equipped with electromagnetic brake. Note that simultaneous ON or simultaneous OFF of stroke end (LSP, 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 occurs.

(d) Stroke end (LSP/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.

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15.3.2 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.)

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(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 Sections 6.5 for the setting method.

Parameter No.	Name	Setting	Description
0	Control mode, regenerative brake option selection	□0□4	Torque control mode Regenerative brake option is not used.
1	Function selection 1	□□02	Input filter 3.555ms (initial value) Electromagnetic brake interlock (MBR) is not used.
8	Internal speed limit 1	1000	Set 1000r/min.
9	Internal speed limit 2	1500	Set 1500r/min.
10	Internal speed limit 3	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 2000ms
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.

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(6) Stop

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

Refer to Section 3.9, (2) 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

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

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15.4 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.

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The symbols in the control mode column of the table indicate the following modes:
S : Speed control mode
T : Torque control mode

15.4.1 Item list

	No.	Symbol	Name	Control mode	Initial value	Unit	Customer setting
Basic parameters	0	*STY	Control mode ,regenerative brake 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		

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	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	(Note3)0	(r/min)	
			Analog speed limit maximum speed	T	(Note3)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	(Note2)	mV	
			Analog speed limit offset	T	(Note2)	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	0.1 times	
	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	P･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	0.1 times	
	62		For manufacturer setting		100	%	
	63	VG2B	Speed control gain 2 changing ratio	S	100	%	
	64	VICB	Speed integral compensation changing ratio	S	100	%	

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	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.

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15.4.2 Details list

<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="2">Basic parameters</td><td>0</td><td>*STY</td><td>Control mode, regenerative brake option selection
Used to select the control mode and regenerative brake option.

Select the control mode.
0:Speed
1:Speed and torque
2:Torque
Motor series selection
0:HC-KFE
1:HC-SFE
Selection of regenerative brake option
0:Not used
(The built-in regenerative brake resistor used.)
2:MR-RB032
3:MR-RB12
4:MR-RB32
5:MR-RB30
6:MR-RB50
Motor capacity selection
0:100W
1:200W
2:400W
3:500W
4:750W
5:1kW
6:1.5kW
7:2kW

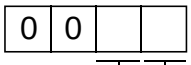
POINT
· Wrong setting may cause the regenerative brake option to burn.
· If the regenerative brake option selected is not for use with the servo amplifier, parameter error (AL.37) occurs.</td><td>100W
: 0000

200W
: 1000

400W
: 2000

700W
: 4000

1kW
: 5010

2kW
: 6010</td><td></td><td>Refer to Name and function column.</td><td>S·T</td></tr>
<tr><td>1</td><td>*OP1</td><td>Function selection 1
Used to select the input signal filter, the function of pin CN1-12.
 
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 signal</td><td>0002</td><td></td><td>Refer to Name and function column.</td><td>S·T</td></tr>
</table>

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="8">Basic parameters</td><td>2</td><td>ATU</td><td>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
<table><tr><th>Set value</th><th>Response level</th><th>Machine resonance frequency guideline</th></tr><tr><td>1</td><td rowspan="16">Low response
↑
Middle response
↑
High response</td><td>15Hz</td></tr><tr><td>2</td><td>20Hz</td></tr><tr><td>3</td><td>25Hz</td></tr><tr><td>4</td><td>30Hz</td></tr><tr><td>5</td><td>35Hz</td></tr><tr><td>6</td><td>45Hz</td></tr><tr><td>7</td><td>55Hz</td></tr><tr><td>8</td><td>70Hz</td></tr><tr><td>9</td><td>85Hz</td></tr><tr><td>A</td><td>105Hz</td></tr><tr><td>B</td><td>130Hz</td></tr><tr><td>C</td><td>160Hz</td></tr><tr><td>D</td><td>200Hz</td></tr><tr><td>E</td><td>240Hz</td></tr><tr><td>F</td><td>300Hz</td></tr></table>· 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.)
<table><tr><th>Set value</th><th>Gain adjustment mode</th><th>Description</th></tr><tr><td>0</td><td>Interpolation mode</td><td>Fixes position control gain 1 (parameter No. 6).</td></tr><tr><td>1</td><td>Auto tuning mode 1</td><td>Ordinary auto tuning.</td></tr><tr><td>2</td><td>Auto tuning mode 2</td><td>Fixes the load inertia moment ratio set in parameter No. 34. Response level setting can be changed.</td></tr><tr><td>3</td><td>Manual mode 1</td><td>Simple manual adjustment.</td></tr><tr><td>4</td><td>Manual mode 2</td><td>Manual adjustment of all gains.</td></tr></table></td><td>0105</td><td></td><td>Refer to Name and function column.</td><td>S</td></tr>
<tr><td>3</td><td></td><td>For manufacturer setting</td><td>1</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td>Don't change this value by anymeans.</td><td>1</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td>100</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>PG1</td><td>Position loop gain 1
Used to set the gain of position loop.
Increase the gain to improve trackability 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.</td><td>35</td><td></td><td></td><td>S</td></tr>
<tr><td>7</td><td></td><td>For manufacturer setting
Don't change this value by anymeans.</td><td>3</td><td></td><td></td><td></td></tr>
</table>

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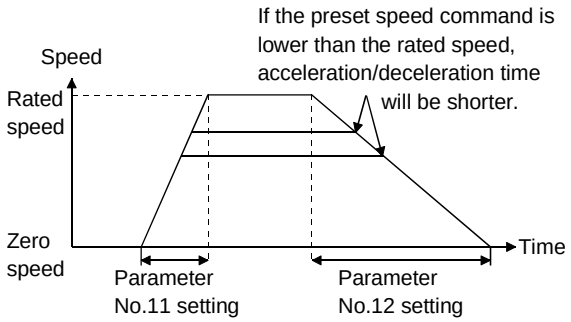
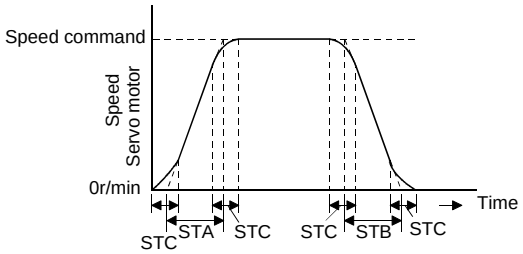
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	8	SC1	Internal speed command 1 Used to set speed 1 of internal speed commands.	100	r/min	0 to instantaneous permissible speed	S
			Internal speed limit 1 Used to set speed 1 of internal speed limits.				T
	9	SC2	Internal speed command 2 Used to set speed 2 of internal speed commands.	500	r/min	0 to instantaneous permissible 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 instantaneous permissible 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.  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 $\frac{2000000}{STA}$ 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] $\left(\frac{2000000}{20000} = 100[ms] < 200[ms] \right)$ Limited to 100[ms] since During deceleration: 200[ms] $\left(\frac{2000000}{5000} = 400[ms] > 200[ms] \right)$ 200[ms] as set since	0	ms	0 to 1000	S·T

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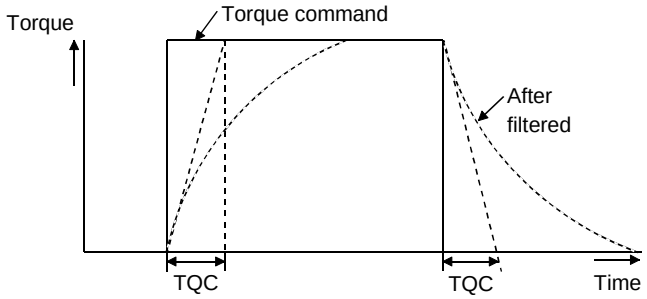
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Basic parameters	14	TQC	Torque command time constant Used to set the constant of a low pass filter in response to the torque command.  TQC: Torque command time constant	0	ms	0 to 20000	T
	15	*SNO	Station number setting Used 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 baudrate, select various communication conditions, and clear the alarm history. 0 Serial baudrate selection 0: 9600 [bps] 1: 19200[bps] 2: 38400[bps] 3: 57600[bps] Alarm history clear 0: Invalid 1: Valid 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

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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: 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 to B = Cannot be used. Analog monitor 2 (MO2) / Analog monitor 1 (MO1)	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: 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

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td>Basic parameters</td><td>19</td><td>*BLK</td><td>Parameter block
Used to select the reference and write ranges of the parameters.
Operation can be performed for the parameters marked ○.
<table>
<tr><th>Set value</th><th>Operation</th><th>Basic parameters No. 0 to No. 19</th><th>Expansion parameters 1 No. 20 to No. 49</th><th>Expansion parameters 2 No. 50 to No. 84</th></tr>
<tr><td rowspan="2">0000 (Initial value)</td><td>Reference</td><td>○</td><td></td><td></td></tr>
<tr><td>Write</td><td>○</td><td></td><td></td></tr>
<tr><td rowspan="2">000A</td><td>Reference</td><td>No. 19 only</td><td></td><td></td></tr>
<tr><td>Write</td><td>No. 19 only</td><td></td><td></td></tr>
<tr><td rowspan="2">000B</td><td>Reference</td><td>○</td><td>○</td><td></td></tr>
<tr><td>Write</td><td>○</td><td></td><td></td></tr>
<tr><td rowspan="2">000C</td><td>Reference</td><td>○</td><td>○</td><td></td></tr>
<tr><td>Write</td><td>○</td><td>○</td><td></td></tr>
<tr><td rowspan="2">000E</td><td>Reference</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>Write</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td rowspan="2">100B</td><td>Reference</td><td>○</td><td></td><td></td></tr>
<tr><td>Write</td><td>No. 19 only</td><td></td><td></td></tr>
<tr><td rowspan="2">100C</td><td>Reference</td><td>○</td><td>○</td><td></td></tr>
<tr><td>Write</td><td>No. 19 only</td><td></td><td></td></tr>
<tr><td rowspan="2">100E</td><td>Reference</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>Write</td><td>No. 19 only</td><td></td><td></td></tr>
</table></td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>S・T</td></tr>
</table>

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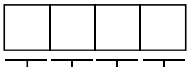
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	20	*OP2	Function selection 2 Used to select restart after instantaneous power failure, servo lock at a stop in speed control mode, and slight vibration suppression control.  Restart after instantaneous power failure If the input power supply voltage had reduced in the speed control mode to stop the servo motor due to the undervoltage alarm (AL.10) but the supply voltage has returned to normal, the servo motor can be restarted by merely switching on the start signal without resetting the alarm. 0: Invalid 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 Don't change this value by anymeans.	0000			

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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 Don't change this value by anymeans.	0			
	24	ZSP	Zero speed Used to set the output range of the zero speed (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	r/min	0 1 to 50000	S
			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	r/min	0 1 to 50000	T
	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

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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 output A/B-phase pulses are as indicated below: A・B-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 $= \frac{\text{Resolution per servo motor revolution}}{\text{Set value}}$ [pulses/rev] At the setting of 8, for example, the actually output A/B-phase pulses are as indicated below: A・B-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. (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 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

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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	0.1 times	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 Don't change this value by any means.	0			

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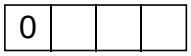
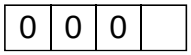
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="2">Expansion parameters 1</td><td>41</td><td>*DIA</td><td>Input signal automatic ON selection
Used to set automatic servo-on (SON) ▪ forward rotation stroke end (LSP) ▪ reverse rotation stroke end (LSN).
 

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)</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>S ▪ T
S</td></tr>
<tr><td>42</td><td>*DI1</td><td>Input signal selection 1
Used to assign the control mode changing signal input pins and to set the clear (CR).
 

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 parameter cannot be used.</td><td>0002</td><td></td><td>Refer to Name and function column.</td><td>S/T</td></tr>
</table>

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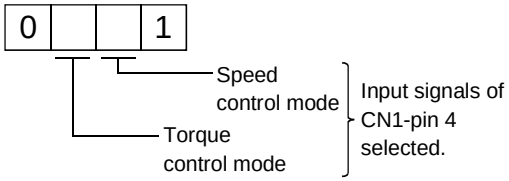
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td>Expansion parameters 1</td><td>43</td><td>*DI2</td><td>
Input signal selection 2 (CN1-4)
Allows any input signal to be assigned to CN1-pin 4.
Note that the setting digit and assigned signal differ according to the control mode.


Signals that may be assigned in each control mode are indicated below by their symbols.
Setting of any other signal will be invalid.
<table>
<tr><th rowspan="2">Set value</th><th colspan="2">(Note) Control mode</th></tr>
<tr><th>S</th><th>T</th></tr>
<tr><td>0</td><td></td><td></td></tr>
<tr><td>1</td><td>SON</td><td>SON</td></tr>
<tr><td>2</td><td>RES</td><td>RES</td></tr>
<tr><td>3</td><td>PC</td><td>PC</td></tr>
<tr><td>4</td><td>TL</td><td>TL</td></tr>
<tr><td>5</td><td>CR</td><td>CR</td></tr>
<tr><td>6</td><td>SP1</td><td>SP1</td></tr>
<tr><td>7</td><td>SP2</td><td>SP2</td></tr>
<tr><td>8</td><td>ST1</td><td>RS2</td></tr>
<tr><td>9</td><td>ST2</td><td>RS1</td></tr>
<tr><td>A</td><td>SP3</td><td>SP3</td></tr>
<tr><td>B</td><td></td><td></td></tr>
<tr><td>C</td><td></td><td></td></tr>
<tr><td>D</td><td>TL1</td><td>TL1</td></tr>
<tr><td>E</td><td>CDP</td><td>CDP</td></tr>
<tr><td>F</td><td></td><td></td></tr>
</table>
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.
</td><td>0111</td><td></td><td>Refer to Name and function column.</td><td>S・T</td></tr>
</table>

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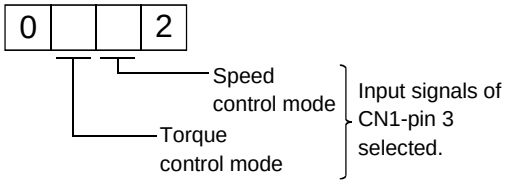
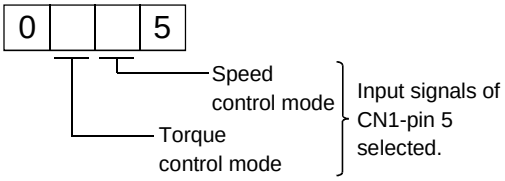
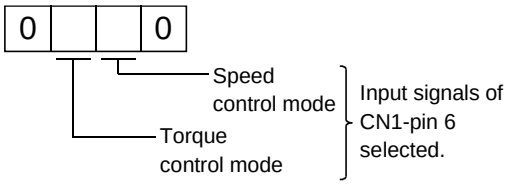
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 1	44	*DI3	Input signal selection 3 (CN1-3) Allows any input signal to be assigned to CN1-pin 3. The assignable signals and setting method are the same as in input signal selection 2 (parameter No. 43).  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).  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).  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

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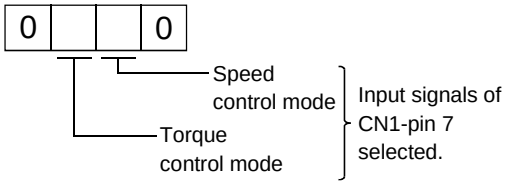
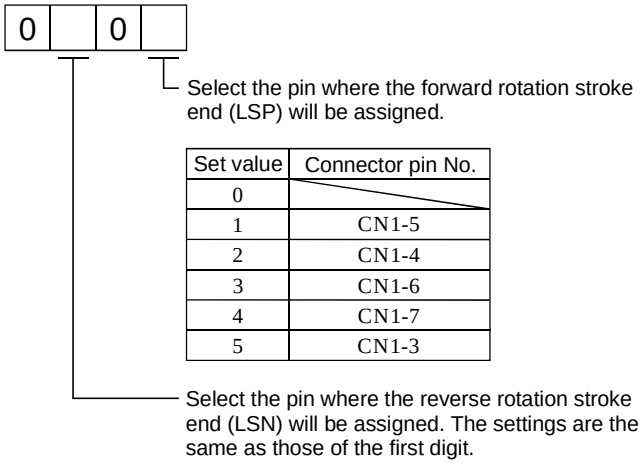
<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="2">Expansion parameters 1</td><td>47</td><td>*DI6</td><td>Input signal selection 6 (CN1-7)
Allows any input signal to be assigned to CN1-pin 7.
The assignable signals and setting method are the same as in input signal selection 2 (parameter No. 43).
 

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.</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>S·T</td></tr>
<tr><td>48</td><td>*LSPN</td><td>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.
 

<table><tr><th>Set value</th><th>Connector pin No.</th></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></td><td>0403</td><td></td><td>Refer to Name and function column.</td><td>S·T</td></tr>
</table>

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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td>Expansion parameters 1</td><td>49</td><td>*DO1</td><td>
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
<table>
<tr><th rowspan="2">Set value</th><th colspan="3">Connector pins</th></tr>
<tr><th>CN1-10</th><th>CN1-11</th><th>CN1-12</th></tr>
<tr><td>0</td><td>SA</td><td>RD</td><td>ZP</td></tr>
<tr><td>1</td><td colspan="3">Alarm code is output at alarm occurrence.</td></tr>
</table>
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<table>
<tr><th colspan="3">(Note) Alarm code</th><th rowspan="2">Alarm display</th><th rowspan="2">Name</th></tr>
<tr><th>CN1 pin 10</th><th>CN1 pin 11</th><th>CN1 pin 12</th></tr>
<tr><td rowspan="9">0</td><td rowspan="9">0</td><td rowspan="9">0</td><td>88888</td><td>Watchdog</td></tr>
<tr><td>AL.12</td><td>Memory error 1</td></tr>
<tr><td>AL.13</td><td>Clock error</td></tr>
<tr><td>AL.15</td><td>Memory error 2</td></tr>
<tr><td>AL.17</td><td>Board error 2</td></tr>
<tr><td>AL.19</td><td>Memory error 3</td></tr>
<tr><td>AL.37</td><td>Parameter error</td></tr>
<tr><td>AL.8A</td><td>Serial communication time-out error</td></tr>
<tr><td>AL.8E</td><td>Serial communication error</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">1</td><td rowspan="2">0</td><td>AL.30</td><td>Regenerative error</td></tr>
<tr><td>AL.33</td><td>Overvoltage</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>AL.10</td><td>Undervoltage</td></tr>
<tr><td rowspan="4">1</td><td rowspan="4">1</td><td rowspan="4">0</td><td>AL.45</td><td>Main circuit device overheat</td></tr>
<tr><td>AL.46</td><td>Servo motor overheat</td></tr>
<tr><td>AL.50</td><td>Overload 1</td></tr>
<tr><td>AL.51</td><td>Overload 2</td></tr>
<tr><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">1</td><td>AL.24</td><td>Main circuit</td></tr>
<tr><td>AL.32</td><td>Overcurrent</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>AL.31</td><td>Overspeed</td></tr>
<tr><td rowspan="3">1</td><td rowspan="3">0</td><td rowspan="3">1</td><td>AL.16</td><td>Encoder error 1</td></tr>
<tr><td>AL.1A</td><td>Motor combination error</td></tr>
<tr><td>AL.20</td><td>Encoder error 2</td></tr>
</table>
Note: 0:off
1:on
Setting of warning (WNG) output
Select the connector pin to output warning. The old signal before selection will be unavailable.
<table>
<tr><th>Set value</th><th>Connector pin No.</th></tr>
<tr><td>0</td><td>Not output.</td></tr>
<tr><td>1</td><td>CN1-11</td></tr>
<tr><td>2</td><td>CN1-9</td></tr>
<tr><td>3</td><td>CN1-10</td></tr>
<tr><td>4</td><td>CN1-12</td></tr>
</table>
</td><td>0000</td><td></td><td>Refer to Name and function column.</td><td>S・T</td></tr>
</table>

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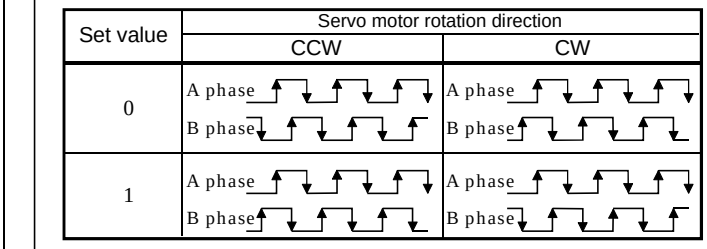
Class	No.	Symbol	Name and function	Initial value	Unit	Setting range	Control mode
Expansion parameters 2	50		For manufacturer setting Don't change this value by any means.	0000			
	51	*OP6	Function selection 6 Used to select the operation to be performed when the reset (RES) switches on. 0 _ 0 0 Operation 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 Don't 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
	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 . 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 Don't 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 Don't change this value by any means.	10			



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<table>
<tr><th>Class</th><th>No.</th><th>Symbol</th><th>Name and function</th><th>Initial value</th><th>Unit</th><th>Setting range</th><th>Control mode</th></tr>
<tr><td rowspan="2">Expansion parameters 2</td><td>58</td><td>NH1</td><td>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☐☐).
<table><tr><th>Setting value</th><th>Frequency</th><th>Setting value</th><th>Frequency</th><th>Setting value</th><th>Frequency</th><th>Setting value</th><th>Frequency</th></tr><tr><td>00</td><td>Invalid</td><td>08</td><td>562.5</td><td>10</td><td>281.3</td><td>18</td><td>187.5</td></tr><tr><td>01</td><td>4500</td><td>09</td><td>500</td><td>11</td><td>264.7</td><td>19</td><td>180</td></tr><tr><td>02</td><td>2250</td><td>0A</td><td>450</td><td>12</td><td>250</td><td>1A</td><td>173.1</td></tr><tr><td>03</td><td>1500</td><td>0B</td><td>409.1</td><td>13</td><td>236.8</td><td>1B</td><td>166.7</td></tr><tr><td>04</td><td>1125</td><td>0C</td><td>375</td><td>14</td><td>225</td><td>1C</td><td>160.1</td></tr><tr><td>05</td><td>900</td><td>0D</td><td>346.2</td><td>15</td><td>214.3</td><td>1D</td><td>155.2</td></tr><tr><td>06</td><td>750</td><td>0E</td><td>321.4</td><td>16</td><td>204.5</td><td>1E</td><td>150</td></tr><tr><td>07</td><td>642.9</td><td>0F</td><td>300</td><td>17</td><td>195.7</td><td>1F</td><td>145.2</td></tr></table>Notch depth selection
<table><tr><th>Setting value</th><th>Depth</th><th>Gain</th></tr><tr><td>0</td><td rowspan="4">Deep
to
Shallow</td><td>−40dB</td></tr><tr><td>1</td><td>−14dB</td></tr><tr><td>2</td><td>−8dB</td></tr><tr><td>3</td><td>−4dB</td></tr></table></td><td>0000</td><td rowspan="2"></td><td rowspan="2">Refer to Name and function column.</td><td rowspan="2">S·T</td></tr>
<tr><td>59</td><td>NH2</td><td>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</td><td>0000</td></tr>
</table>

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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.) Low-pass filter selection 0: Valid (Automatic adjustment) 1: Invalid When you choose "valid", $\frac{\text{VG2 setting}\times 10}{2\pi(1+\text{GD2 setting}\times 0.1)}$ [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 control 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	×0.1 times	0 to 3000	S
	62		For manufacturer setting Don't 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	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

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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 Don't 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.				
	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

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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 Don't change this value by any means.	00			
	78			10000			
	79			10			
	80			10			
	81			100			
	82			100			
	83			100			
	84			0000			

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15.5 Display and operation

POINT

- For the alarm mode, parameter mode output signal (DO) forcible output and test operation mode, refer to Chapter 6.

15.5.1 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).

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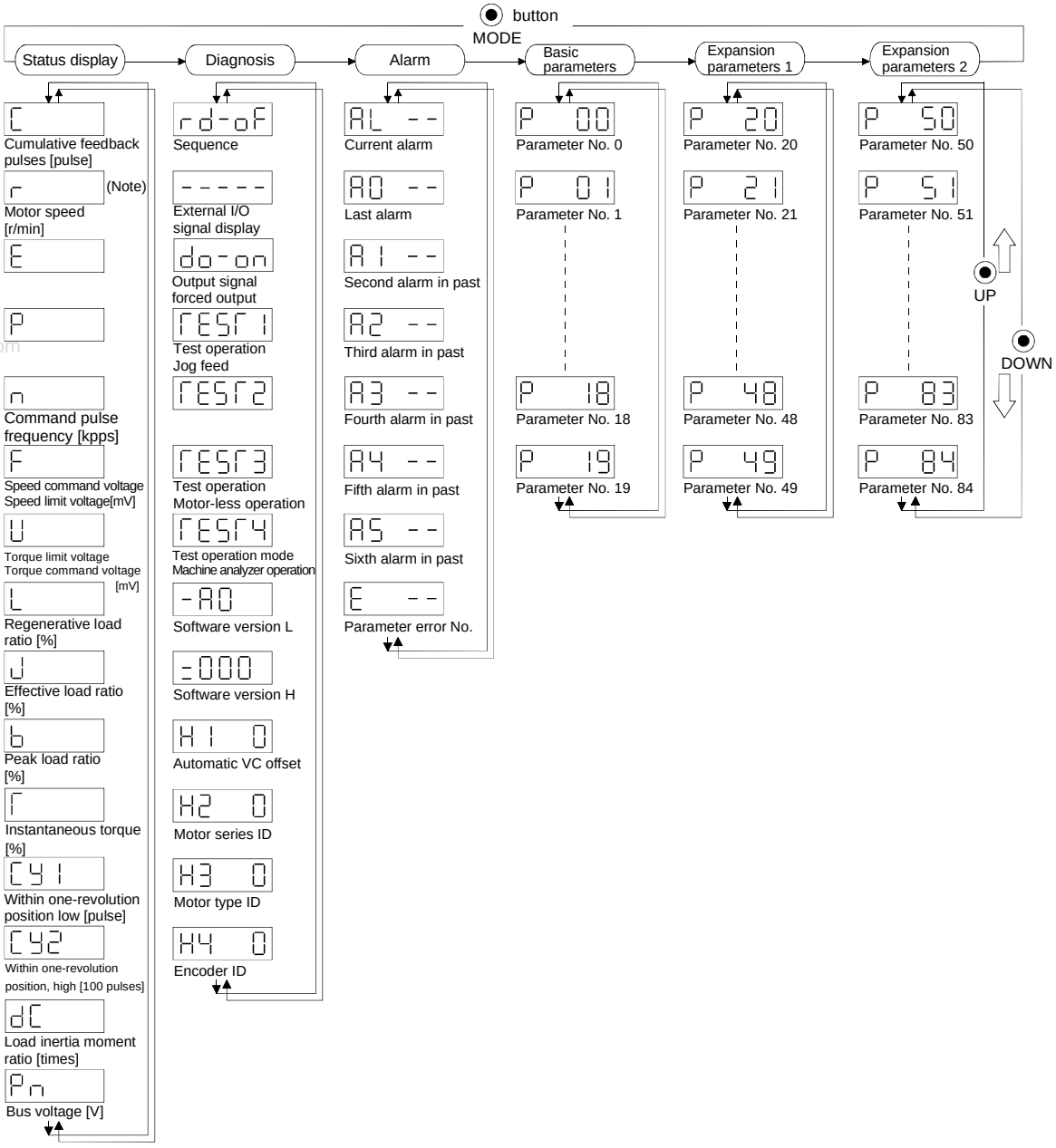

Note: The initial status display at power-on depends on the control mode.
Speed control mode: Servo Motor speed(r),
Torque control mode: Torque command voltage(U)
Also, parameter No. 18 can be used to change the initial indication of the status display at power-on.

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15.5.2 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) Position control mode, speed control mode Analog torque limit (TLA) voltage is displayed.	0 to +10V
			(2) Torque control mode Analog torque command (TLA) voltage is displayed.	−10 to +10V
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	0.1 Times	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

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(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

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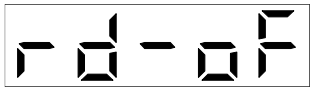
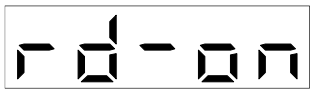
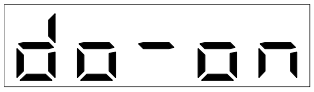
15.5.3 Diagnostic mode

Name		Display	Description
Sequence			Not ready. Indicates that the servo amplifier is being initialized or an alarm has occurred.
			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 signal (DO) forced output			The digital output signal can be forced on/off. For more information, refer to section 6.7.
Test operation mode	Jog feed		Jog operation can be performed when there is no command from the external command device. For details, refer to section 6.8.2.
			Screen for manufacturer setting. When this screen is being displayed, do not press any other buttons than "UP" and "DOWN".
	Motorless operation		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		Merely connecting the servo amplifier allows the resonance point of the mechanical system to be measured. The servo configuration software (MRZJW3-SETUP154E or later) is required for machine analyzer operation. Gain search cannot be used.
Software version low			Indicates the version of the software.
Software version high			Indicates the system number of the software.
Automatic VC offset			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.

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Name	Display	Description
Motor series		Press the "SET" button to show the motor series ID of the servo motor currently connected.
Motor type		Press the "SET" button to show the motor type ID of the servo motor currently connected.
Encoder		Press the "SET" button to show the encoder ID of the servo motor currently connected.

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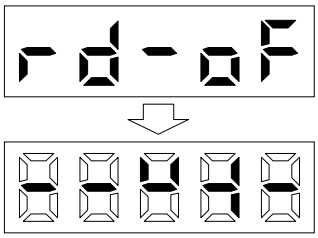
15.5.4 External I/O signal display

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.



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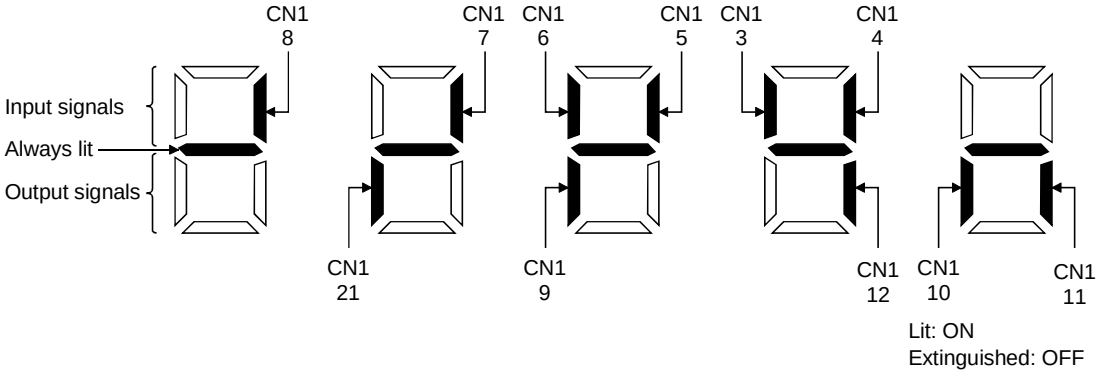
(2) Display definition



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. The signal of CN1A-18 is always output.

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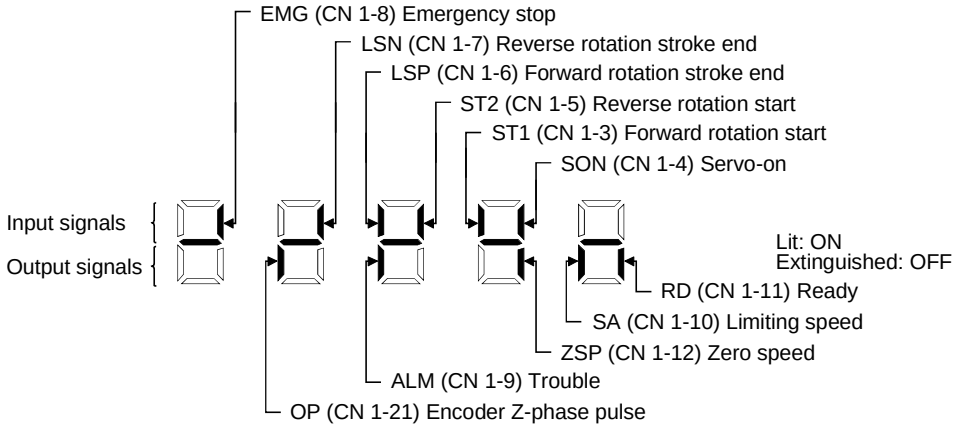
(3) Default signal indications

(a) Speed control mode



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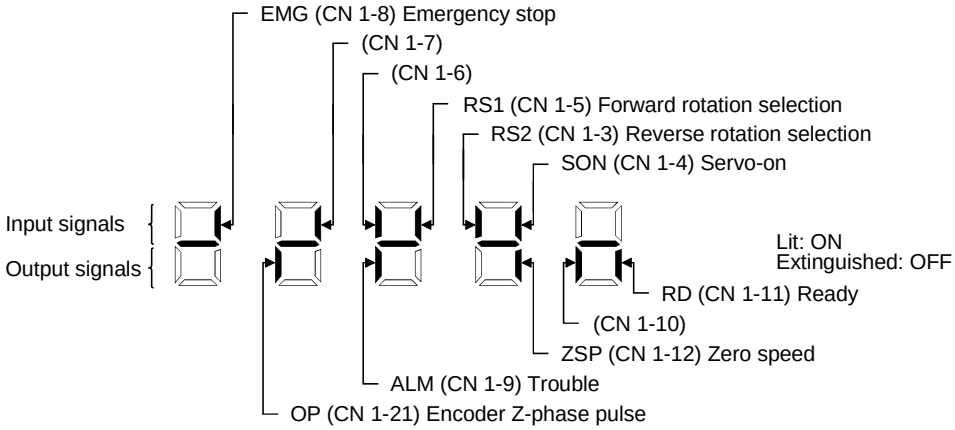
(b) Torque control mode



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15.6. Troubleshooting

15.6.1 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)	・LED is not lit. ・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.	(1), Section 5.1.2
			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.

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(2) Torque control mode

No.	Start-up sequence	Fault	Investigation	Possible cause	Reference
1	Power on (Note)	・LED is not lit. ・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.	(1), Section 5.1.2
			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.

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15.6.2 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.
Set "□□□1" in parameter No. 49 to output the alarm code in ON/OFF status across the corresponding pin and SG. 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.
The alarms marked ○ in the alarm deactivation column can be deactivated by the corresponding operations.

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	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

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REVISIONS

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

Print data	*Manual number	Revision
Sep.,2002	SH(NA)030031-A	First edition
Mar.,2003	SH(NA)030031-B	"Note 2" in (1) Environmental Condition is deleted from Safety Precautions 4. The "concerning sale" item is deleted. The "Compliance with EU Directives (2)" paragraph is added. The "Compliance with UL and C-UL Standards (4)" note is deleted. Section 1.2: Parts of figures are changed. "Note 3" is changed. Section 1.3: Mass of 2kW is added. Section 1.5 (2): Note is deleted. Section 1.6: Note 2 is deleted. Section 1.7 (2): Figure is changed. Section 1.8 (2): Figure is changed. Section 3.1.2: Part of figure is changed. Section 3.7.1: Figure is changed. Section 3.7.2: Paragraph and table are changed. Section 3.8.1: Point is added. Section 3.8.2: Note is deleted. Part of figure is changed. Section 3.8.3 (2): Note is deleted. Section 4.1 (1) (e): Paragraph is changed. Section 5.1.2 (2): Initial setting of parameter No. 0 is examined and note is deleted. Paragraph for third digit of parameter No. 20 is added. TLC/VLC output selection of parameter No. 22 is added. Paragraph is added to parameter No. 42. Body of description is added to parameters No. 43 to 48. Description of setting of first digit of parameter No. 49 is changed. Section 10.2.1: Name of AL.E9 is changed. Section 10.2.2: AL. 12, 13 and 14 are changed. AL. 37 3. is added. Section 11.1: Dimensional drawing is changed. Section 11.2 (4): Dimensional drawing is added. Section 12.1: "Note 2" is deleted. Section 12.2: "Note 3" is deleted. Section 12.3: Note is deleted. Section 13.1.1: "Note 2" is deleted. Section 13.1.1 (2) (b): Note is deleted. Section 13.1.2: Paragraphs 20, 21, 22 and 23 are added. Section 13.2.1: Cable size of 2kW is changed. Note is changed. Part of description is deleted. Table of recommended crimp terminal is deleted. Section 13.2.2: Note is deleted. Amperage of 70A to 200A fuses of MR-E is changed. Section 13.2.3: Note is deleted. Section 13.2.7: Note is deleted. Section 13.2.8: Note is deleted.

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Print data	*Manual number	Revision
Mar.,2003	SH(NA)030031-B	Chapter 14: Point is deleted. Section 14.2: Rating plate is changed. Section 14.7.3: Added. Chapter 15: Added.

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MODEL	
MODEL CODE	

MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE:MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100-8310

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