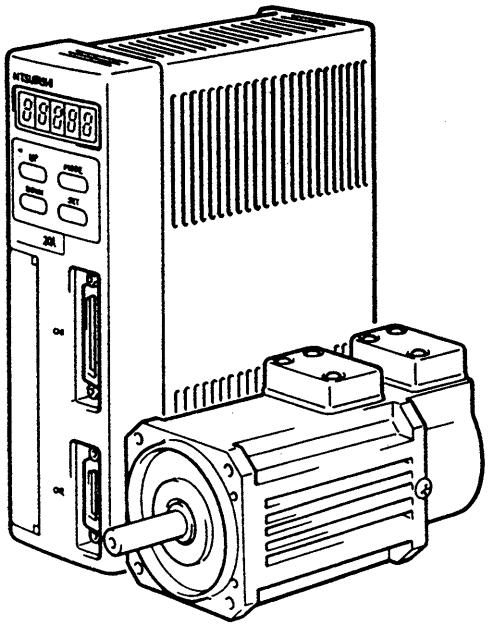
MITSUBISHI

General Purpose AC Servo

MELSERVO-J

Specifications and Instruction Manual



MITSUBISHI ELECTRIC

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⚠CAUTION

Incorrect handling or misuse of servo drive equipment may cause equipment damage or bodily harm! In addition to the safety and handling information given throughout this manual, please follow the below listed precautions to assure safe equipment operation.

1. Installation

(1) Maintain the operating environment, power supply voltage, etc. within the specified ranges.
(2) Do not connect AC power directly to the servo motor.
(3) Keep combustible materials away from the servo amplifier and any regenerative resistor. Provide for adequate heat dissipation around the servo amplifier and any regenerative resistor.
(4) Provide adequate protection to prevent oil, water, and foreign matter from entering the servo amplifier and servo motor.
(5) Do not subject the servo motor shaft or encoder to impact, or shock loads.
(6) Eliminate and prevent stress or damage to the encoder, servo motor, electromagnetic brake and other cables.
(7) The grounding terminals of the servo amplifier and servo motor must be connected together at one point and then connected to earth ground at one point.
(8) The load connected to the servo motor must be within the recommended moment of inertia load-ratio as noted in specifications.
(9) Do not connect a capacitive filter, etc, to the servo amplifier output.
(10) When using servo motors with gear reducers, observe noted restrictions pertaining to installation orientation, speed, torque characteristics, permissible moments of inertia loading, etc.
(11) Maintain servo motor shaft end loading within specified value.

2. OPERATION

(1) When using emergency stop switches, and/or forward and reverse stroke limit switches, test their proper operation before operating the machine.
(2) For safety, test machine operation at lowest possible speed.
(3) When furnished, the electromagnetic brake supplied on a servo motor is designed only for holding a properly sized load while the drive is stopped. The brake is not intended for bringing the load to a stop.
(4) Provide adequate protection to prevent oil, water, and foreign matter from entering the servo amplifier and servo motor.

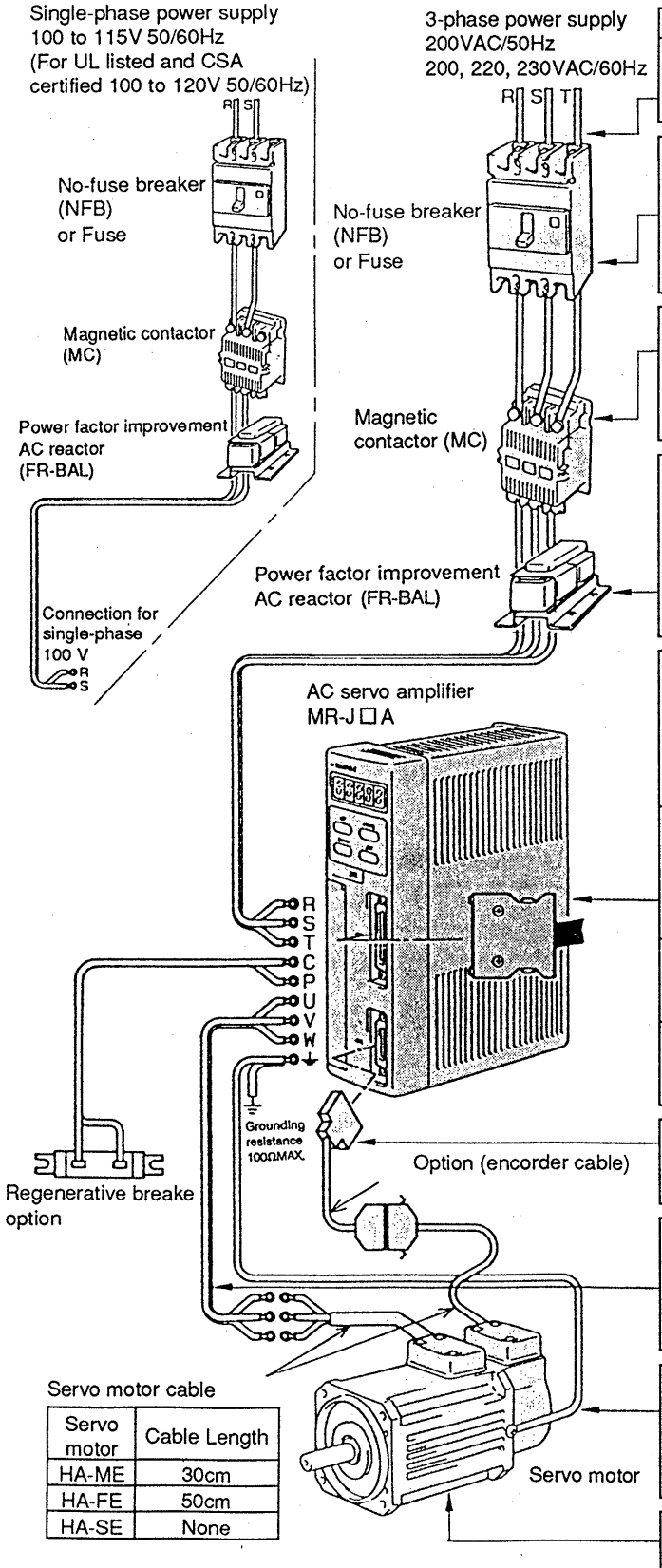
3. MAINTENANCE

(1) Three minutes must be allowed after power has been switched off to the equipment, before conducting maintenance, adjustments, repairs, etc.
(2) The encoder must not be disassembled or removed from the servo motor. To do so, will void warranty.
(3) The servo amplifier must not be tested with a megger.

Contents

1-1 General installation and operation

With the following information and guidance, the servo system will provide many years of reliable and efficient operation. Please use this information to assist in operation and installation.



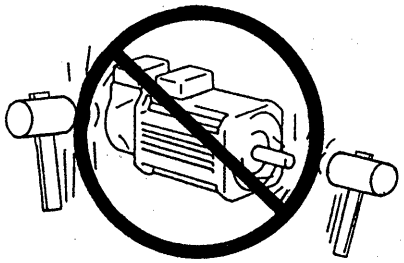
Points for handling	Refer to:
Power supply specifications Please use the servo within the tolerable power supply specifications.	Section 10-2
No-fuse breaker, leakage current breaker or fuse A large inrush current is applied to the servo when the power supply is switched ON. Refer to the selection table for the breaker or fuse.	Section 6-6 Section 6-11
The magnetic contactor use Always install this magnetic contactor. Do not start and stop the servo with this magnetic contactor, as the life of the servo may be shortened.	Section 2-2.1 Section 6-6
Reactor installation The optional reactor must be installed for power factor improvement or with a large power capacity (500KVA or more with a wiring distance less than 10m). Select the reactor according to the servo model.	Section 6-6
Installation site The life of the servo is affected by the anbient temperature. The maximum value for the ambient temperature is a MAX of 55 °C, and the unit should be used at an average of 40 °C.	Section 1-4
Wiring Incorrect wiring will lead to servo damage. The control signal line and main circuit should be separated a proper distance, to reduce noise.	Section 2-1 Section 3-6.1 Section 4-6.1
Position control mode specifications The position servo start-up and operations are noted.	Chapter 3
Speed control mode The speed servo start-up and operations are noted.	Chapter 4
Optional specifications The methods for using the auxitiary equipment and options are noted.	Chapter 6
Output side connecting equipment Do not connect a phase advancing capacitor, surge suppressor, or radio noise reduction filter (option FR-BIF). These may cause damage or faults in the equipment.	Section 1-2
Grounding Ground the servo motor and servo amplifier terminals at one point with the minimum distance to prevent an electric shock and noise.	Section 2-1
Servo motor assembly Do not shock the servo motor shaft or detector by hammering, etc.	Section 1-2 Section 2-1.3

1-2 Precautions when installing the unit

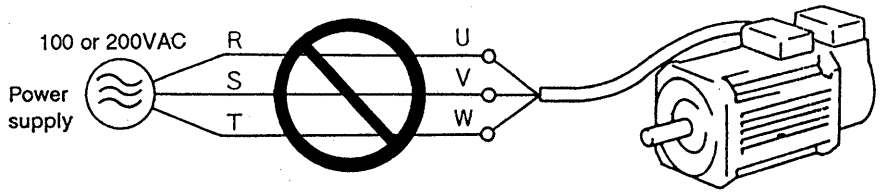
Improper handling of equipment may cause damage. The important points are noted below. Refer to these and other related items for proper use of the unit.

Handling

(1) Do not shock the servo motor or encoder. The servo motor may fail if the shaft is hammered or the servo motor dropped.



(2) Do not directly apply commercial power (200VAC) to the servo motor. The windings will be damaged and the servo motor magnet will be demagnetized. Always drive the servo motor with the specified servo amplifier.



Connections

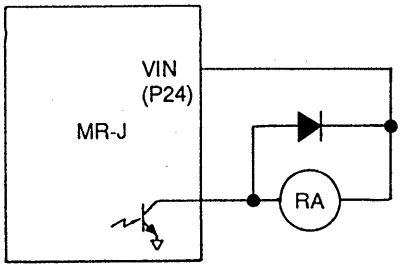
(1) Connect the servo amplifier and servo motor ground terminals on the amplifier side, and ground the terminals together with the minimum distance possible. To prevent an electrical shock and malfunctions, the terminals should be grounded at the resistance of 100Ω max.

(2) Always match the servo amplifier and servo motor U, V and W phases.
The rotation direction cannot be changed like a general-purpose servo motor by inverting two wires.

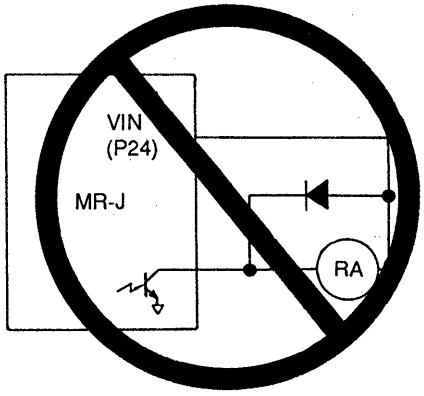
(3) The amplifier may be damaged if AC power is applied to the servo amplifier U, V and W terminals. Supply the correct AC power to the R, S and T terminals.
If a power supply voltage used is other than the specified, connect a power transformer.

(4) Connect the correct option to the regenerative option terminal (between C-P), and set the corresponding parameters.
The amplifier may be damaged and the regenerative resistor overheated or burnt out if these are incorrect.

(5) When connecting external relays, it is imperative that a diode be connected correctly across the relay-see diagram.



Correct Diode connections



Incorrect Diode connection

Operation and sequence

(1) The servo motor's electromagnetic brake is used only in times of emergency and holding. It has been designed as a holding device during power failures. If it is used for braking during deceleration, the brake will wear out quickly.

(2) Connect the power supply R, S and T terminals to the breaker and magnetic contactor. These are necessary to shut off the circuit to prevent secondary disasters when an alarm occurs or an erroneous current flows.

(3) An undervoltage alarm may occur when the servo amplifier is switched on again immediately being switched OFF. Switch the power on again after the waiting time shown in the following table.

(All values given are the MAX values.)

Model	J10A to 60A J10A1, 20A1 J10MA to 40MA J10MA1, 20MA1	J100A J70A J70MA	J200A	J350A	J40A1 J40MA1
Waiting time	10 sec.	11 sec.	12 sec.	13 sec.	15 sec.

⚠CAUTION

(1) A "high voltage" will remain in the servo amplifier for a short time even after the power is switched off.

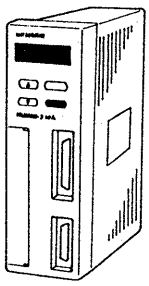
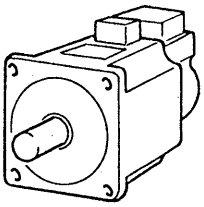
(2) The servo amplifier may be damaged if a megger test is performed. Megger tests must not be done. Continuity checks using a circuit tester are recommended.

(3) The servo motor encoder cannot be removed. Do not remove the cover, etc.

1-3 Inspection at delivery

Confirm the following items after unpacking.

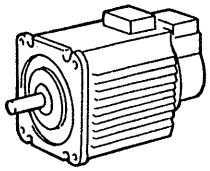
(1) Inspect the nameplate and confirm that the specifications are as ordered.

<table>
<tr><th></th><th>Appearance</th><th>Details on the nameplate</th><th>Details on the model (See Section 10-1)</th></tr>
<tr><td>Servo amplifier</td><td>MR-J□□(-UL)
  </td><td>Applicable motor capacity
Model
MITSUBISHI AC SERVO
MODEL MR-J10A
POWER 100W
AC INPUT AC200 to 230V 50/60Hz
OUTPUT 1.1A
SERIAL 210075AA
TC300A022G51
MITSUBISHI ELECTRIC CORPORATION MADE IN JAPAN
Manufacturing No. + current status
Rated output current
Applicable power supply</td><td>MR-J □ □ □ - □
Mitsubishi general-purpose AC servo amplifier MR-J series
Symbol | Corresponding servo motor
A | HA-FE, HA-SE
MA | HA-ME
Symbol | Power supply
None | 3-phase 200V
1 | Sigle-phase 100v
Symbol | Version
None | Japanese
UL | UL listed, CSA certified
Symbol | Capacity (W) | Symbol | Capacity (W)
10 | 50, 100 | 70 | 500, 750
20 | 200 | 100 | 850 to 1200
40 | 300, 400 | 200 | 1500, 2000
60 | 600 | 350 | 3000, 3500</td></tr>
<tr><td>Servo motor</td><td>HA-ME□(B)(G)
(-UL)
  </td><td>Model
MITSUBISHI AC SERVO MOTOR
HA-FE13
SERIAL
DATA
MITSUBISHI ELECTRIC CORPORATION 895504-01
Manufacturing date
Manufacturing No.</td><td>HA-ME □ 3 B G - □
AC servo motor HA-ME Series
Rated speed 3000r/min
Brake included
Reduction gear included
Symbol | Version
None | Japanese
UL | UL listed, CSA certified
Symbol | Rated output (W) | Symbol | Rated output (W)
05 | 50 | 4 | 400
1 | 100 | 7 | 750
2 | 200</td></tr>
</table>

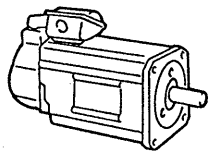
Servo motor

Appearance

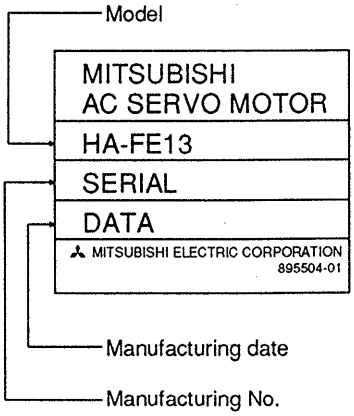
HA-FE □ (B)(G) (-UL)



HA-SE □ (C)(B) (G)(-UL)



Details on the nameplate



Details on the model (See Section 10-1)

HA-FE □ 3 B G - □

AC servo motor HA-FE Series

Rated speed 3000r/min

Brake included

Reduction gear included

Symbol	Version
None	Japanese
UL	UL listed CSA certified

Symbol	Rated output (W)	Symbol	Rated output (W)
05	50	3	300
1	100	4	400
2	200	6	600

HA-SE □ □ □ B G - □

AC servo motor HA-SE Series

Brake included

Reduction gear included

(Note)

Symbol	Connection
None	Lead wire
C	Connector

Symbol	Version
None	Japanese
UL	UL listed CSA certified

Symbol	Rated speed (r/min)
1	1000
2	2000
3	3000

Symbol	Rated output (W)	Symbol	Rated output (W)
5	500	15	1500
8	850	20	2000
10	1000	30	3000
12	1200	35	3500

Note: Connectors are used to connect the UL listed servo motor.

Options are noted in Chapter 6.

The low noise function and the HA-SE servo motors for 1,000 rpm and 3,000 rpm can be used only with the new version.

To identify the version: The version is indicated by the last one or two digits of the SERIAL number provided on the nameplate.

Old version: One alphabet character

New version: Two alphabet characters

1-4 Installation

Installation of the servo amplifier

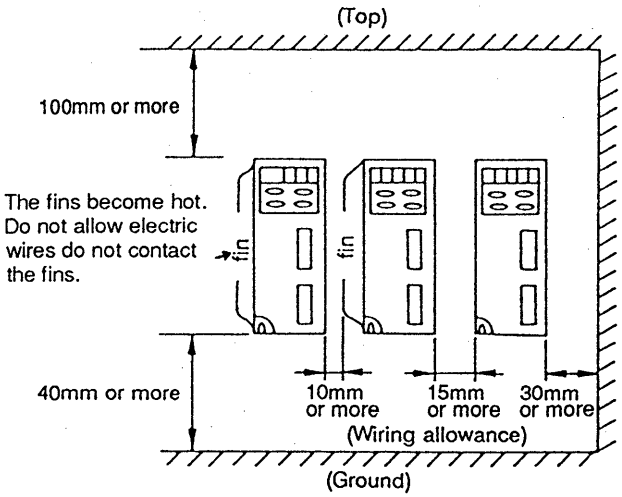
(1) Working environment

Ambient temperature	0 to 55 °C (with no freezing) (Note)
Ambient humidity	90%RH or less (with no dew condensation)
Vibration	5.9m/s^2 {0.6G} or less

Note: To ensure servo amplifier long life and high reliability, the temperature in the control box should be designed and maintained to be as low as possible. (but above the minimal)

(2) Installation direction and clearance

- Install the MELSERVO-J so that it can be seen from the front.
- When installing two servo amplifiers side by side in a closed panel, provide a 10mm clearance or more between the sides of the amplifiers. Also provide a 40mm clearance or more over the top and under the bottom of the servo amplifiers.
  When installing several servo amplifiers side by side, provide a 100mm clearance over the top of the servo amplifiers or install a ventilating fan to ensure proper heat dissipation.
- When using regeneration units, install them away from the servo amplifier.



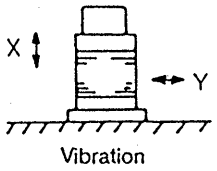
(3) Keep out foreign materials

- When installing unit on a panel or inside and enclosure, prevent drill chips and wire fragments from entering the servo amplifier.
- Prevent oil, water, and metallic dust from entering the amplifier through openings in the enclosure.
- Provide positive pressure in control enclosure by forcing in clean, dry, cool, non-toxic, non-corrosive, non-explosive air.

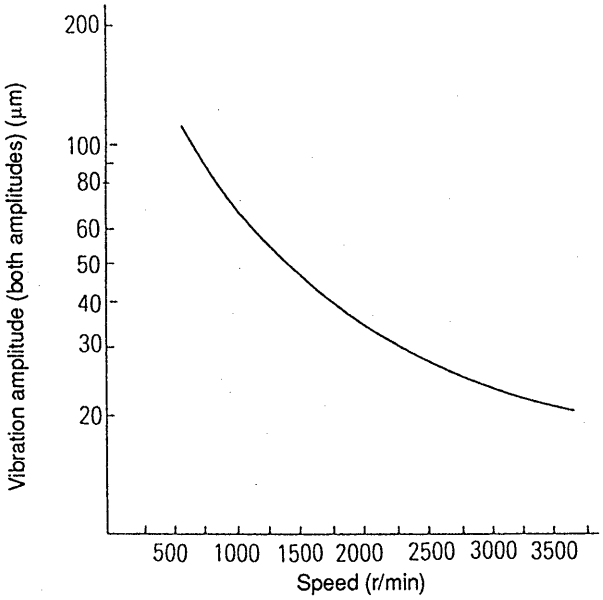
Installation of the servo motor

(1) Working environment

Ambient temperature		0 to 40 °C (with no freezing)
Ambient humidity		80%RH or less (with no dew condensation)
Vibration	**HA-FE, HA-ME**	X, Y: 19.6m/s^2 {2G}
	HA-SE 1.5kW or less	X: 9.8m/s^2 {1G} Y: 24.5m/s^2 {2.5G}
	HA-SE 2, 3.5kW	X: 19.6m/s^2 {2G} Y: 49m/s^2 {5G}

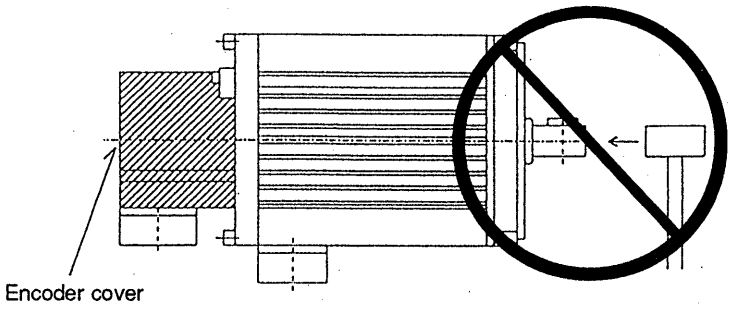


Graph of vibration servo amplitude vs, speed.



(2) Servo motor load-mounting precautions

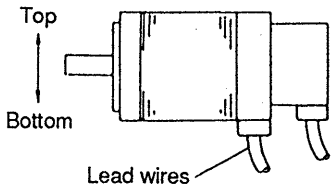
- Use the screw hole on the end of the shaft (only for the HA-FE servo motor) when mounting a pulley.
- When removing a pulley, use a pulley remover.
- Do not push or pull on encoder to move servo motor.
- During assembly, the shaft end must not be hammered. (The encoder may fail.)



- The oriertation of the encoder on the servo motor cannot be changed.

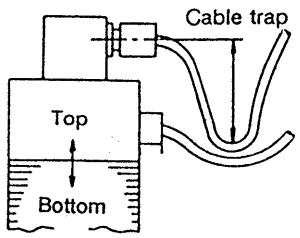
(3) Installation orientation

- The servo motor can be installed horizontally or vertically, with the shaft end up or down.
- Install the servo motor so that the cables face downward.
- When installing vertically, provide a cable trap so that oil and water do not enter the servo motor.



(4) Cable protection

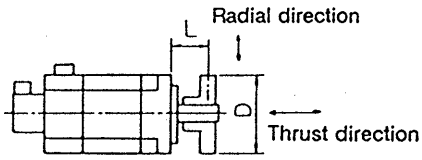
- Provide stress relief to cables. Prevent cable abrasion.
- In applications where the servo motor moves, the cable bending radius must be determined according to the bending life and type of wire.



(5) Tolerable load for the shaft

- Use flexible coupling, and make sure that the misalignment of the shaft is less than the maximum value.
- When using a pulley, sprocket or timing belt, select a diameter that will fit into the maximum radial load.

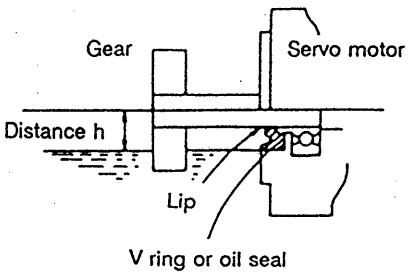
Servo Motor	Maximum radial load (N)	Maximum thrust load (N)
HA-ME053, 13	88 {9kgf} L=30	59 {6kgf}
HA-ME23, 43	245 {25kgf} L=30	98 {10kgf}
HA-ME73	392 {40kgf} L=30	147 {15kgf}
HA-FE053	108 {11kgf} L=30	98 {10kgf}
HA-FE13	118 {12kgf} L=30	98 {10kgf}
HA-FE23, 33	176 {18kgf} L=30	147 {15kgf}
HA-FE43, 63	323 {33kgf} L=40	284 {29kgf}
HA-SE52 to 152	980 {100kgf} L=55	490 {50kgf}
HA-SE53 to 153		
HA-SE81		
HA-SE202, 352	2058 {210kgf} L=79	980 {100kgf}
HA-SE203, 353		
HA-SE121 to 301		



(6) Oil and water protection

- The servo motor is not waterproof.
  Prevent oil and water from entering the servo motor.
- When installed to a gear box, maintain the oil level distance(h) from the servo motor shaft V ring oil seal according to the following chart.
  Also provide a breathing hole on the gear box to suppress the internal pressure.

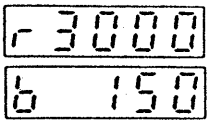
Motor	Distance h (mm)
HA-FE053, 13	8
HA-FE23, 33	12
HA-FE43, 63	14
HA-SE52 to 152	20
HA-SE53 to 153	
HA-SE81	
HA-SE202, 352	25
HA-SE203, 353	
HA-SE121 to 301	



- The HA-FE servo motor with oil seal is standard.
- The HA-ME servo motor is not supplied with an oil seal. Seal the gear box so that lubricant does not enter the servo motor.

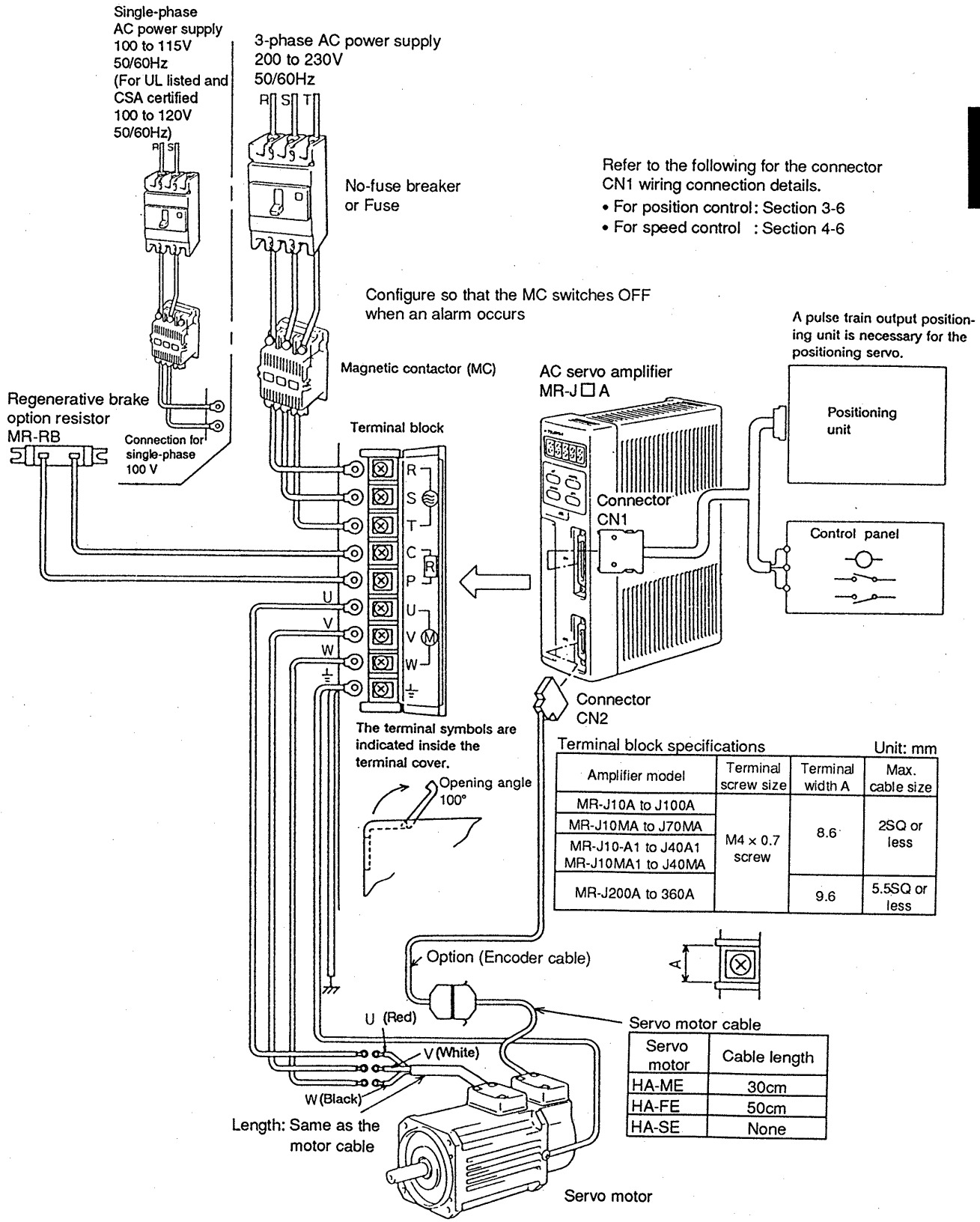
1-5 Making start up easier

The following chart lists the engineered-in functions and features that help make the start up and use of the Mitsubishi servo system easy and quick.

Main function	Explanation	Refer to:
[Auto tuning]	By detecting the current and speed at start up, the inertia of the load is automatically calculated. The optimum gain for obtaining smooth acceleration/deceleration is automatically selected.	Section 5-1.2
[Test operation without external commands] (Test mode operation 1)	The motor can now be rotated without external commands from the positioning unit or control unit, just by using the four buttons on the front panel of the servo amplifier. The rotation speed can also be set. This allows the machine movement test testing.	Section 5-2.3
[Operation without motor] (Test mode operation 2)	The servo amplifier can be operated without the motor. Confirmation of the functions with the control board unit and sequence checks are possible.	Section 5-2.4
[Digital input signal test]	The ON/OFF status of the servo ON, stroke end, ready etc., can be monitored. The wiring can be checked before operation or when the servo motor does not rotate.	Section 3-5.3 Section 4-5.3
[Forced output of the digital signals] (do <Output signal> check screen)	The digital outputs such as trouble, ready, positioning complete, zero speed and limiting torque can be forcibly switched ON/OFF for each point. Use this for checking the wiring.	Section 5-2.2
[Self diagnosis] (Display of reason for motor not operating)	The cause is displayed if the servo motor does not operate when the input signal is input. The servo motor can be restored to operation in a short time if errors as displayed are checked.	Section 5-2.1
[Automatic offset]	The analog speed command offset adjustment is performed. Set this before operation.	Section 5-2.6
[Various status display functions]	The speed, load ratio, or input/output status is displayed, and diagnosis is simple with this feature. (Ex.)  → Rotating speed 3000r/min → The peak load ratio is 150% of the motor rated load	Section 3-5 Section 4-5
[Connector relay terminal block]	An option that converts the connector to terminal blocks has been prepared. The connectors no longer need to be soldered.	Section 6-5

2-1 Connection of the power supply and servo motor

2-1.1 Connection systems



Terminal block specifications Unit: mm

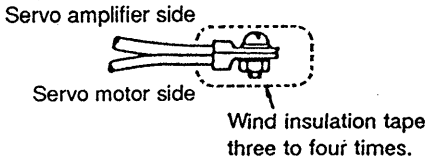
Amplifier model	Terminal screw size	Terminal width A	Max. cable size
MR-J10A to J100A	M4 x 0.7 screw	8.6	2SQ or less
MR-J10MA to J70MA			
MR-J10-A1 to J40A1 MR-J10MA1 to J40MA			
MR-J200A to 360A		9.6	5.5SQ or less

Servo motor	Cable length
HA-ME	30cm
HA-FE	50cm
HA-SE	None

2-1.2 Servo motor connection precautions

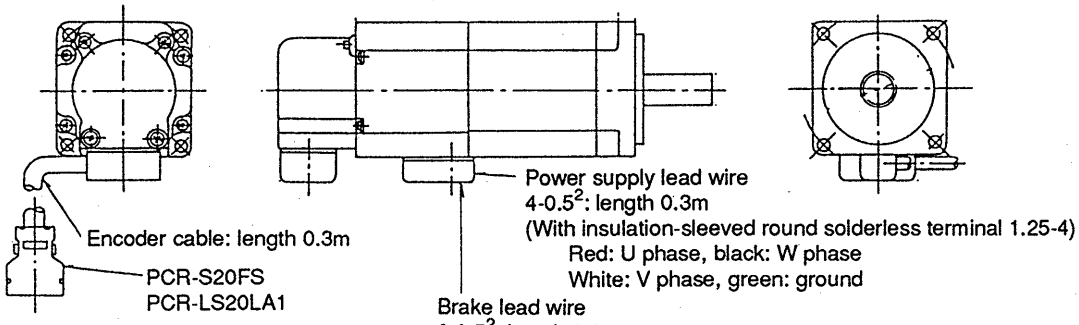
1) Always match the motor lead phases (U, V, W) with the servo amplifier output terminals (U, V, W).
2) The servo motor may be demagnetized or burntout if AC power is applied to the servo motor terminals (U, V, W).
   The servo motor cannot be connected to any terminals other than the servo amplifier output terminals (U, V, W).
3) Always ground the servo motor with the grounding terminal E. To ground, connect the servo amplifier grounding terminal, and the earth plate in the control panel to earth.
   Refer to Sections 3-6.2 and 4-6.2.
4) The user must supply a 24VDC power supply (the current capacity is given in Section 9-5) for the brake lead of the servo motor with electromagnetic brake is used.
   The power supply VDD (24VDC) in the servo amplifier cannot be used for the brake.

Note: Use a screw and nut when connecting servo amplifier and servo motor wires as shown in the diagram on the right.
Wind several layers of insulation tape around the connection. For the HA-SE servo motor, take care not to damage the insulation when connecting the terminal box.

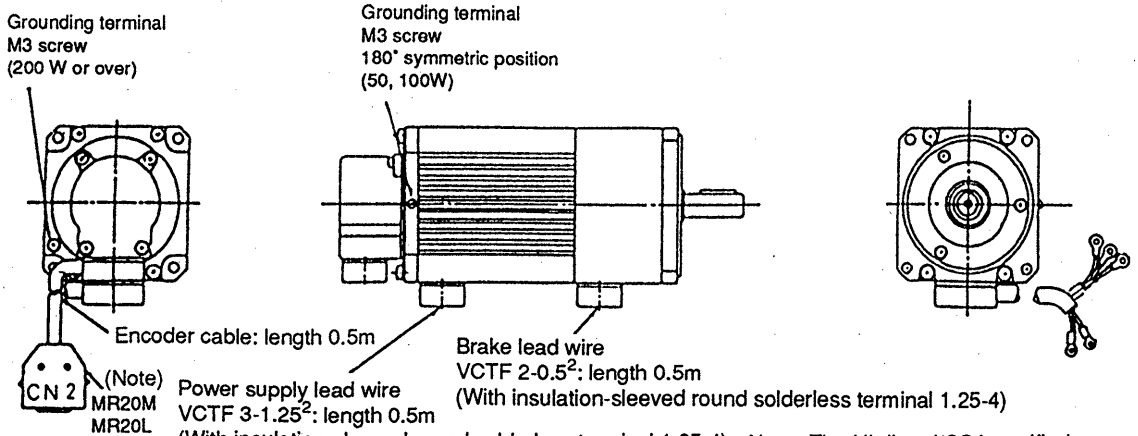


2-1.3 Servo motor terminal details

(1) HA-ME(-UL) series

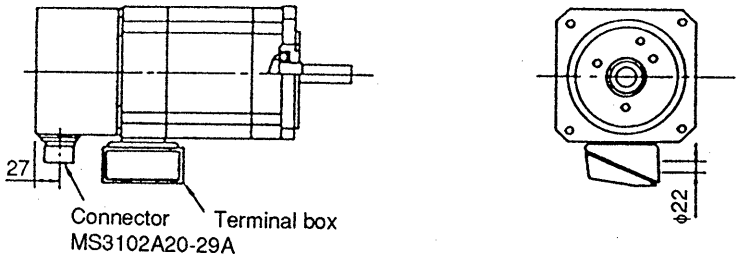


(2) HA-FE(-UL) series

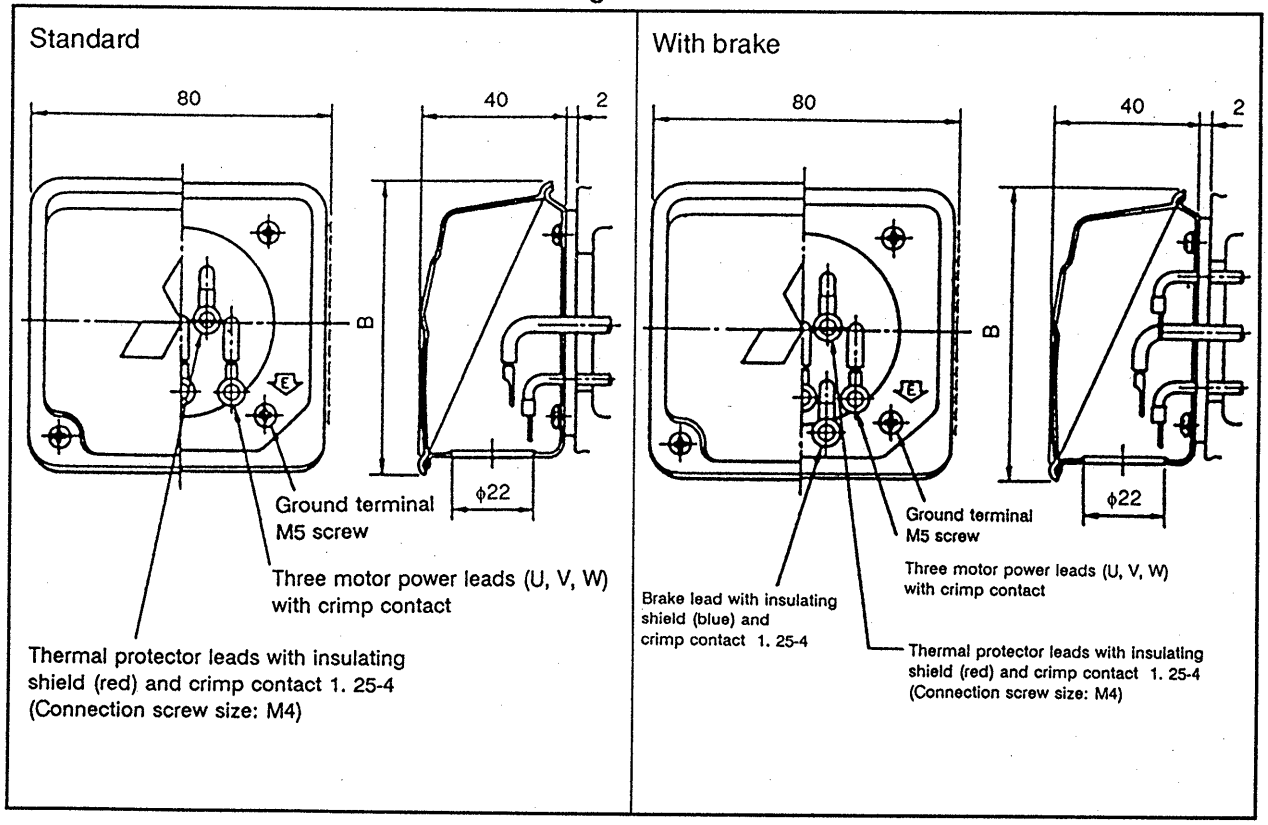


Note: The UL listed/CSA certified servo motor (HA-FH-UL) has the following connector:
PCR-S20FS
PCR-LS20LA1

(3) HA-SE series

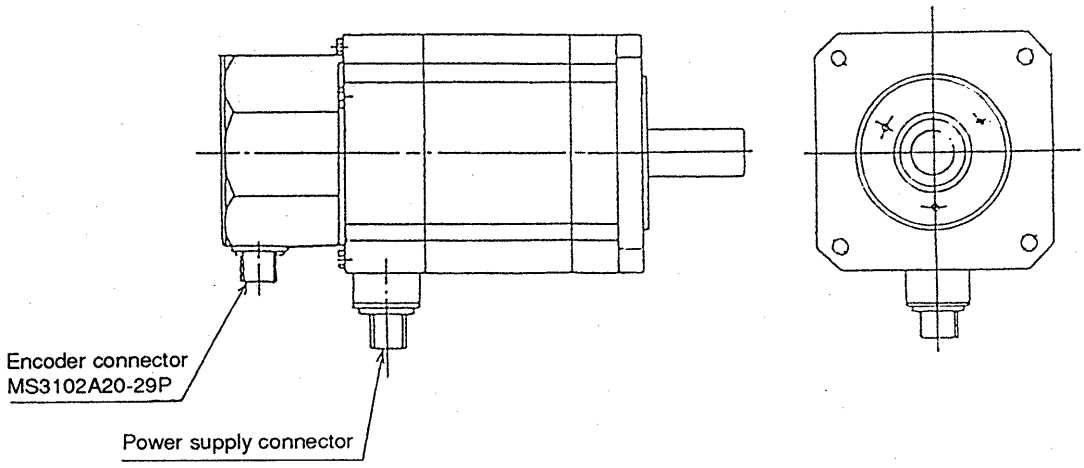


HA-SE servo motor terminal box detailed diagram



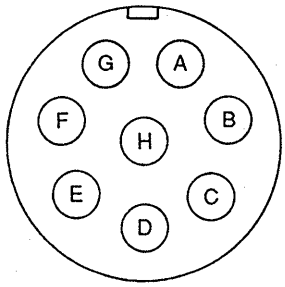
HA-SE102 to HA-SE352

(4) HA-SE-UL series



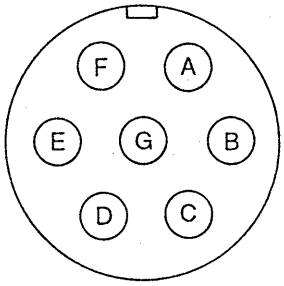
1000 r/min series	2000 r/min series	3000 r/min series	Power supply connector	Cable connector
———	HA-SE52C(B)-UL	HA-SE53C(B)-UL	MS3102A22-23P	MS3106B22-23S
———	HA-SE102C(B)-UL	HA-SE103C(B)-UL		
HA-SE81C(B)-UL	HA-SE152C(B)-UL	HA-SE153C(B)-UL		
HA-SE121C(B)-UL	HA-SE202C(B)-UL	HA-SE203C(B)-UL	MS3102A24-10P	MS3106B24-10S
HA-SE201C(B)-UL	HA-SE352C(B)-UL	HA-SE353C(B)-UL		
HA-SE301C(B)-UL	———	———		

Cable connector (Cannon make)
MS3106B22-23S



Symbol	Signal
A	Power supply (U)
B	Power supply (V)
C	Power supply (W)
D	Ground
E	Thermal protector
F	Thermal protector
G	Blank
H	Blank

Cable connector (Cannon make)
MS3106B24-10S



Symbol	Signal
A	Power supply (U)
B	Power supply (V)
C	Power supply (W)
D	Ground
E	Thermal protector
F	Thermal protector
G	Blank

(5) The details of each servo motor encoder's connector pin layout are noted on the reference section given below.

Servo motor	Refer to:
HA-ME	Section 6-4.4(1)
HA-ME-UL	
HA-FE	Section 6-4.4(2)
HA-FE-UL	Section 6-4.4(1)
HA-SE HA-SE-UL	Section 6-4.4(3)

Note: The connection cable between the servo motor encoder and amplifier is an option. Refer to Section 6-4 for details of producing this cable.

2-1.4 Wiring the servo amplifier terminal block

FIELD WIRING REFERENCE TABLE FOR INPUT (R, S, T) AND OUTPUT (U, V, W)

Servo amplifire	SCREW SIZE	SCREW TORQUE (POUND INCH)	CRIMPING TERMINALS TYPE AND TOOL TYPE (Note 1)		WIRE SIZE/ TEMP RATING (Note 2)
			CRIMPING TERMINALS	CRIMPING TOOLS	
MR-J350A	M4	13	35787-0 32543-0	59239	AWG10/75°C
MR-J200A	M4	13	34169-0	59239-0	AWG12/75°C
OTHER MODELS	M4	13	32959	47387	AWG14/75°C

Note: 1. Manufacturer: AMP INCORPORATED, HARRISBURG, PA 17105
2. Use copper wire only.

2-2 Power supply

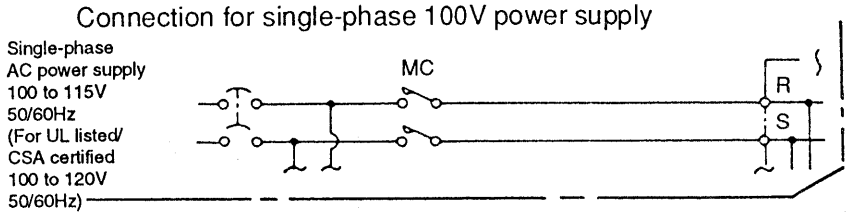
2-2.1 Power and main control circuit wiring

The AC power and main control circuit should be wired as shown below.

Basic connection

The control circuit will be enabled when the AC power is applied to terminals R,S,(T).
Allow at least one second for initialization, then close the "Servo on" contact to enable the drive.
The main circuit will be switched off when the reset (RES) contact is closed. This will cause the servo motor to coast to a stop.

Connection for single-phase 100V power supply



Connection for 3-phase 200V power supply

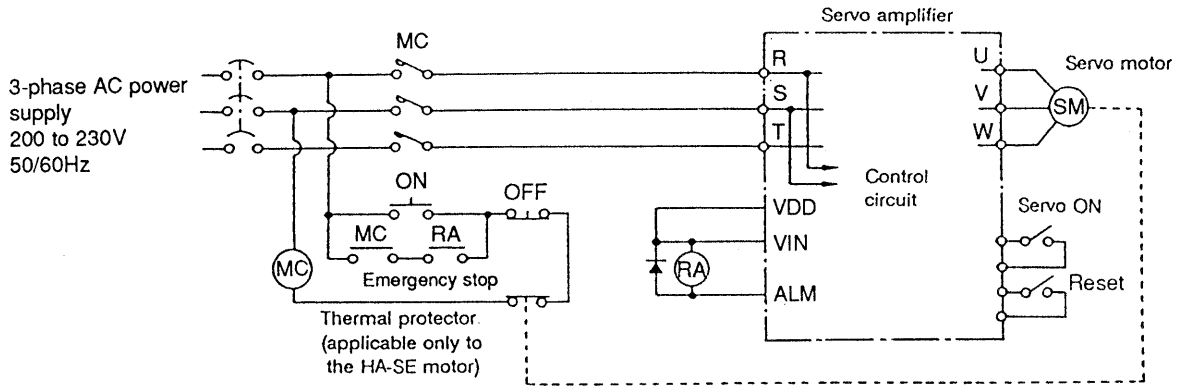


Fig. 2-1 Main circuit connection diagram

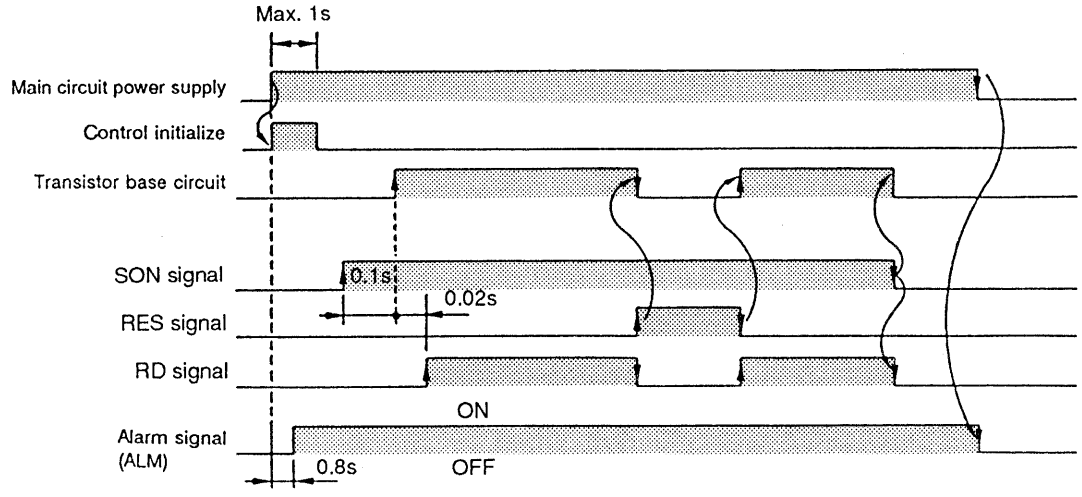


Fig. 2-2 Timing chart when power is swiched on

2-2.2 Emergency stop circuit

Use the dynamic brake (optional) when the motor must be stopped immediately when an alarm or emergency occurs.
Refer to Section 6-2 for wiring and timing chart.

2-2.3 Alarm occurrence timing chart

When an alarm occurs in the servo amplifier, the transistor's bases will be shut off and the servo motor will coast to stop. The power should be shut off. (Refer to Fig. 2-1.)
To restart the drive, remove the cause, and switch the power ON.

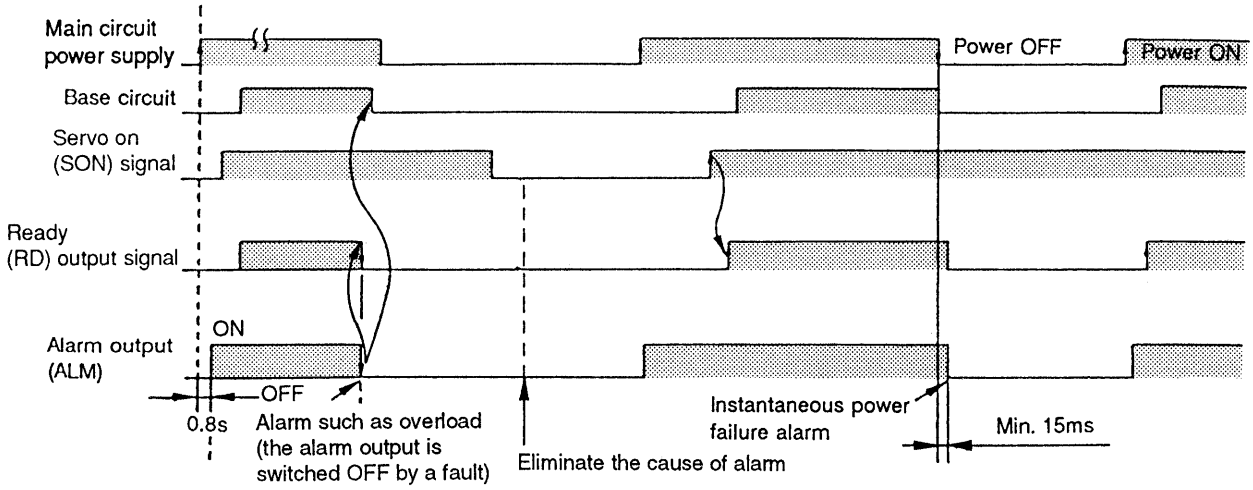


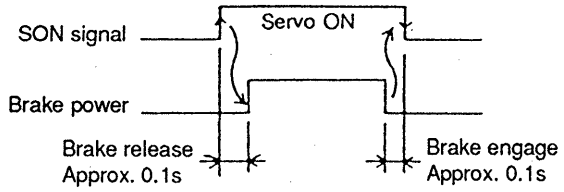
Fig. 2-3 Timing chart during alarm

Important Do not repeatedly restart the drive without removing the cause of an overload or over current alarm. Continued attempts to run under these conditions could damage the servo amplifier.

2-2.4 Electromagnetic brake operation (Refer to section 9-5)

For applications requiring a brake to hold the motor shaft (vertical lift applications), an electromagnetic brake should be used with the servo motor. Please note the following:

1) The brake is a fail-safe type. The brake will operate when the power supply (24VDC) is off.
2) When operating the brake, always switch OFF the "servo ON" signal.
3) In all applications take the braking delay time into consideration.



- If a time delay cannot be provided at servo off, the DC power for the brake should be switched off when the "servo ON" signal switches OFF in order to minimize switching delay.

  Braking delay time:

  DC OFF: Approx. 0.03s

2-3 Servo amprifier display operation

Status display flow chart

The servo amplifier status can be monitored and parameters can be set with the display section (5-digit, 7-segment display) on the front of the servo amplifier. Confirm the parameter settings before operation, diagnose errors, confirm external sequences, and confirm the operation status with this display.

An example of the display flow chart (for the position servo) is shown below. Refer to Section 3-5.1 or 4-5.1 for a detailed flow chart for the position or speed control. For details of the display, refer to the subsequent pages.

Momentarily press "MODE" to move across chart. Momentarily gress "UP" or "DOWN" to move up or down colums.

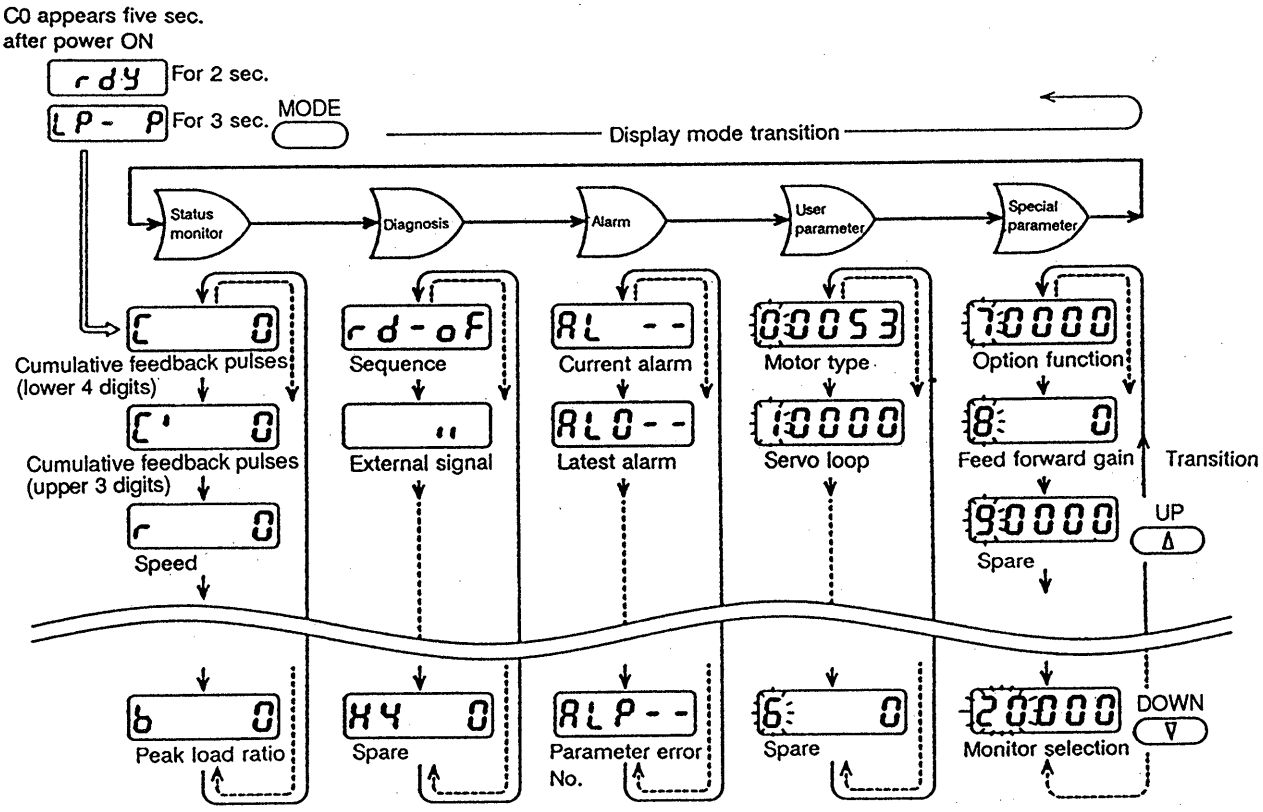
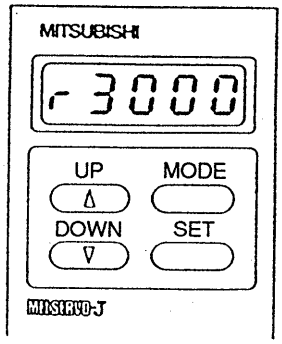


Fig. 2-4 Details of the display

Display and button operation

(1) Layout of the display section•



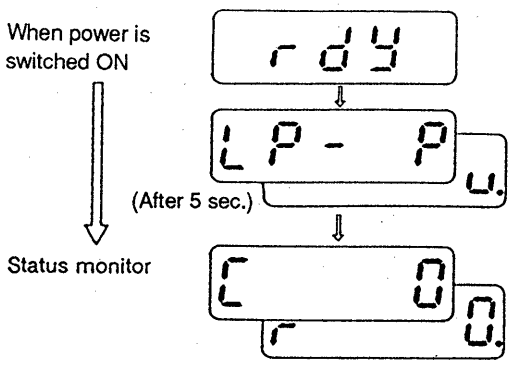
Button functions:

MODE : The setting status, diagnosis/setting, parameter and display details.

SET : This is used to set the parameter data.

UP, DOWN : This is used to change the display in each mode and to change the data numerical values.

(2) Display after power is switched ON



- When the power is switched ON, "rdy", indicating initialization, will be displayed for approx. 2 seconds. Keys pressed during this display will be ignored.
- Next, the servo type will be displayed.
  LP-P: positioning servo
  LP-U: speed servo
- Then, the status will show.
  : positioning servo
  : speed servo

(3) Mode details

1) Status display mode
The display details are selected by pressing the "UP" or "DOWN" button.

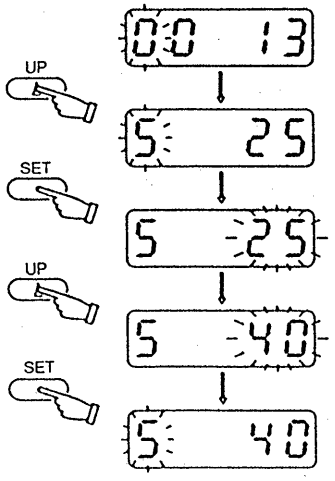
2) Diagnosis/setting mode
Automatic tuning, ON/OFF status diagnosis of the external input/output signals, and test operation with the operation buttons is possible.

3) Alarm mode
The alarm code will be displayed from any screen when an alarm occurs.

4) Parameter mode
The parameters required for the motor type, e.g. control method (position, speed) electronic gears, and acceleration/deceleration times, must be set before operation.
Refer to the parameter tables in Sections 3-5.5 and 4-5.5, and set with the following procedure.

Note: Parameters marked "*" in the table are validated when the power is cycled after setting.
To ensure safety, set the parameters with the "servo ON" signal swiched OFF.
Confirm that the setting for Pr. 0 and Pr. 1 is correct before operation.

Operation procedure



- Enter the parameter mode by pressing the "MODE" button. "0" will flicker as the Pr. No.
- Select the Pr. No. to be set with the "UP, DOWN" buttons.
- The parameter to be set, Pr. 5, and the data will be displayed.
- The data part will flicker when the "SET" button is pressed.
- Change the data with the "UP, DOWN" buttons.
- Press the "SET" button, and the setting will be completed.

Note: Some parameters will not be validated unless the power is switched OFF and ON once (ex. Pr. 0, Pr. 1). Refer to Sections 3-5.5 and 4-5.5 for details.

3-1 Wiring

Wire according to the wiring diagram. Refer to Section 3-7 for the definitions and use of the servo amplifier signals and functions.
Examples of operation with positioning unit AD71 or FX-1GM are shown in Section 3-6.1.

3-2 Checking wiring

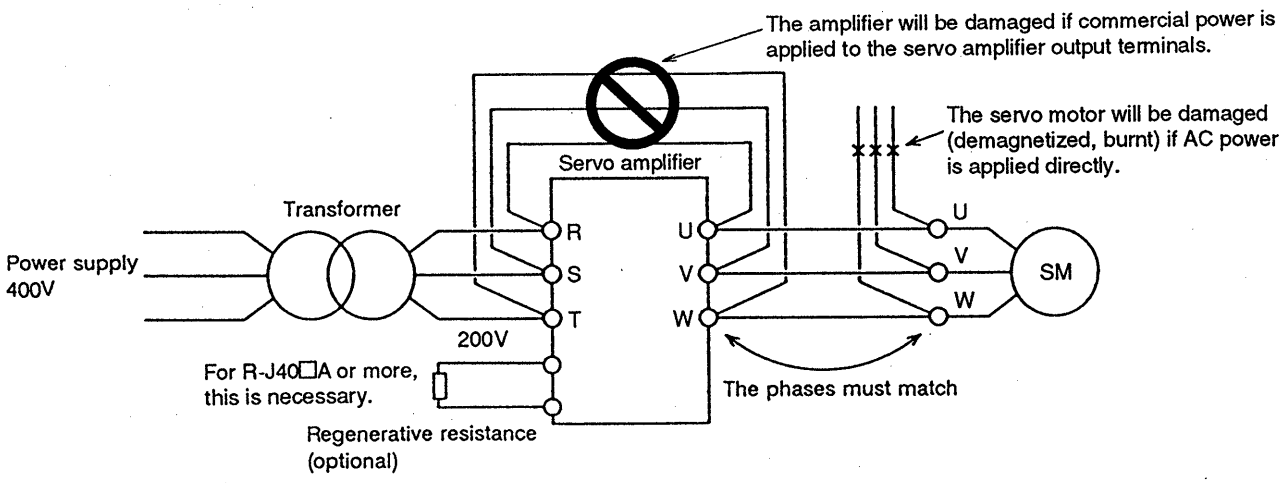
(1) Refer to the wiring diagram and confirm that the wiring is correct. (Refer to Section 3-6)

(2) Especially note the following wiring. The unit may be damaged if it is miswired.

Main circuit

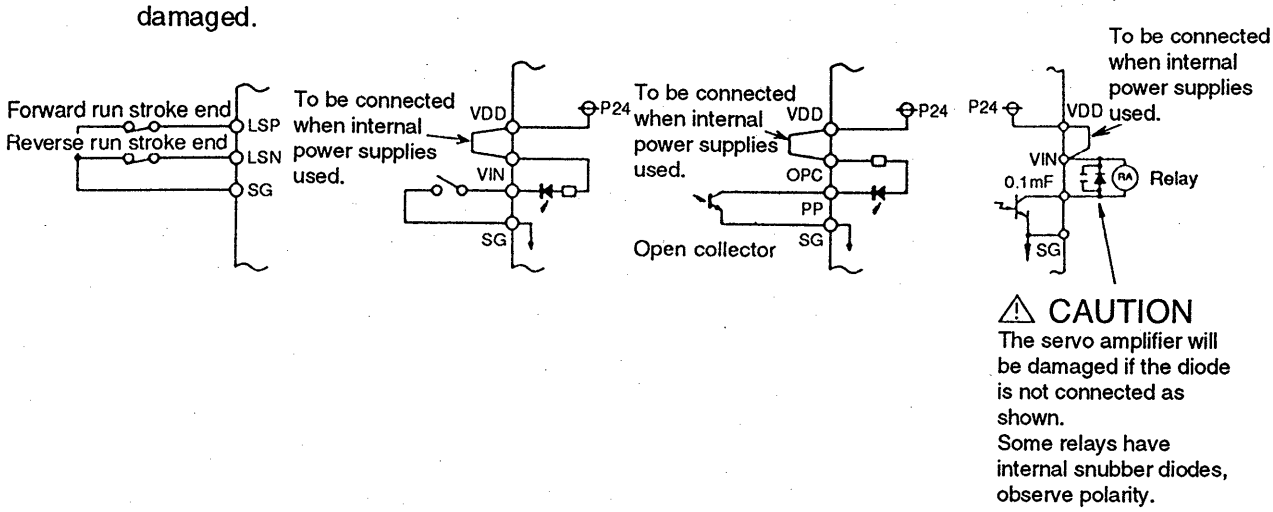
1) A source of AC power which conforms to the specification must be connected to the servo amplifier power supply terminals (R, S, T). If the power does not conform to the specification, drop the voltage to the specified voltage by using a transformer.
2) Power supply lines (R, S, T) must not be connected to the servo motor output terminals (U, V, W).
3) The phases of the output terminals (U, V, W) and servo motor terminals (U, V, W) must match.
4) AC power must not be directly applied to the servo motor.

3-phase 200 V series



Control circuit

1) Stroke end limit switches LSs (LSP, LSN on CN1) and SG must connected as shown below (normally closed). "Jumper" circuit when there is no limit switch on the machine.
2) Connect 24VDC to the interface power supply terminal (VIN). Connect VIN and VDD when using the power supply in the servo amplifier (VDD).
3) If the pulse train is an open collector type, connect the open collector power supply (OPC) terminal and VDD. Do not connect when a differential type is used.
4) When connecting a relay to the open collector output terminals, insert a diode parallel to the relay. The diode must be connected with correct polarity. Otherwise, the servo amplifier will be damaged.



⚠ CAUTION

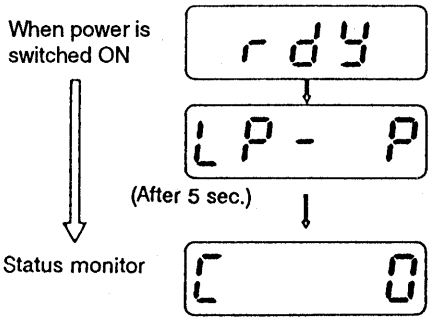
The servo amplifier will be damaged if the diode is not connected as shown.
Some relays have internal snubber diodes, observe polarity.

3-3 Switching power on and setting parameters

The setting of the 1) motor type and 2) servo loop type has been set factory set. These parameters are validated when the power is switched OFF once after setting and then switching ON again.

(1) Switching power ON

Switch the SON signal OFF and switch ON the AC power.



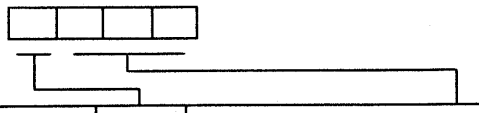
- When the power is switched ON, "rdy", indicating initialization, will be displayed for approx. 2 seconds.
- Next, the servo type will be displayed.
  LP-P: positioning servo
- Status display
  The cumulative feedback pulse will be displayed.

(2) Setting parameters

After switching the power ON, the parameters must be set as needed.
The unit may not operate properly if the following three items are not set correctly. Always confirm the settings, and set as needed.

1) Motor type (Parameter No. 0 MTY)

Refer to the combination table below and set the parameter according to the type of servo motor being used. The servo motor may be damaged if not set correctly. Values in shaded areas in the table shown below are initial values.

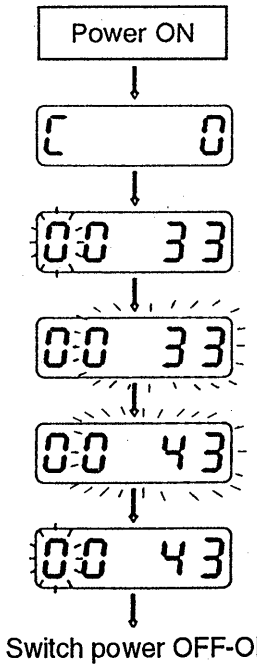


		Servo motor series	Servo motor rating (parameter setting value)											
Amplifier	MR-J	–	10A 10A1	20A 20A1	40A 40A1	60A	70A	100A	200A	350A	10MA 10MA1	20MA 20MA1	40MA 40MA1	70MA
Motor	HA-FE	0	053	23	33	63	–	–	–	–	–	–	–	–
			13	–	43	–	–	–	–	–	–	–	–	–
			–	–	–	–	–	–	–	–	–	–	–	–
	HA-SE	1	–	–	–	–	52	102	152	352	–	–	–	–
			–	–	–	–	53	103	202	353	–	–	–	–
			–	–	–	–	–	81	153	301	–	–	–	–
			–	–	–	–	–	121	203	–	–	–	–	–
			–	–	–	–	–	–	201	–	–	–	–	–
	HA-ME	3	–	–	–	–	–	–	–	–	053	23	43	73
			–	–	–	–	–	–	–	–	13	–	–	–

The setting for the HA-FE and HA-SE servo motors cannot be made by the MR-J□MA servo amplifier.

Setting example

Operate HA-FE43 with servo amplifier MR-J40A.
The value for Parameter No. 0 for this combination of servo motor and servo amplifier must be changed from the factory setting. The table on the previous page shows that the value must be changed from "33" to "43". Use the following procedure to change the value.



Press the [MODE] button three times.

The initial value (HA-FE33) will be displayed. Press the [SET] button.

The data section will flicker. Change the data to 0 43 with the [UP] and [DOWN] buttons.

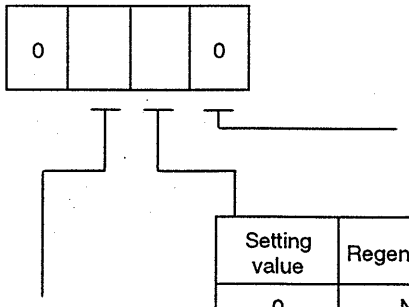
Press the [SET] button.

The setting will be finished, and the parameter No. section will flicker.

The data will be registered and the setting completed.

2) Servo loop type (Parameter No. 1 STY)

The servo loop type, Parameter No. 1, defines whether the drive is a speed or position type. The value of the parameter also defines the auto tuning mode and whether the regenerative option is to be used. If a model above the MR-J40A is used, the regenerative option must be installed. Set the parameter value according to the following chart.



Setting value	Regenerative option(combination)	Regenerative power (W)	Applicable amp.
0	No regenerative option	—	
1	MR-RB013	10	MR-J10A to MR-J100A MR-J10A1 to MR-J40A1 MR-J10MA to MR-J70MA MR-J10MA1 to MR-J40MA1
2	MR-RB064	30	
3	MR-RB064 x 2	100	
4	MR-RB064	60	MR-J200A
5	MR-RB10 x 2	150	
6	MR-RB30 x 2	500	
7	MR-RB10	100	MR-J350A
8	MR-RB30	300	
9	MR-RB50	500	

3) Electronic gears (Parameters No. 2, 3 CMX, CDV)

Set this according to the machine. Normally the movement amount for one command pulse is set to a value such as 1μm, 10μm. Refer to Section 3-5.5 (2) for setting methods.

3-4 Operation

The servo motor is operated with the following procedure after the power is switched ON and the parameters have been set.

Power ON

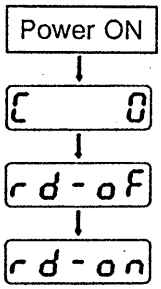
Parameter setting

Servo ON

The "servo ON" signal is switched ON. The operable status is entered, and the motor is servo-locked. If the motor is not servo-locked, the "servo ON" signal is not ON. Confirm the status with the monitor, and check the wiring.

[Diagnosis screen]

- Servo ON/OFF check

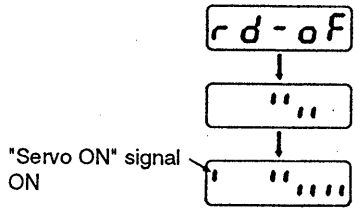


Press the [MODE] button once.

Switch servo ON.

This display will show when the servo ON turns ON.

- Input signal check
  When the following steps are carried out from the above rd-oF display, the input signal ON/OFF status can be checked.



Press the [UP] button once.

The external input/output signal ON/OFF status will be displayed. Switch the servo ON. When the servo ON switch ON, the following will be displayed.

* The ready and positioning completed signals will be output simultaneously and displayed.

Command pulse train input

- When a pulse train is input from the positioning unit, the motor will begin to rotate. First, drive the servo motor at a low speed with JOG, and confirm the rotation direction and stroke, etc. If the servo motor is not rotating as desired, check the input signal again. Refer to Sections 3-5.3 and 5-2.
- Confirm the motor speed, command pulse frequency and load ratio, etc. on the servo amplifier status display monitor.
- When the checking of the machine operation has been completed, confirm automatic operation with the positioning unit program.

Interruption and stopping of operation

The operation will be interrupted or stopped when the following are carried out.

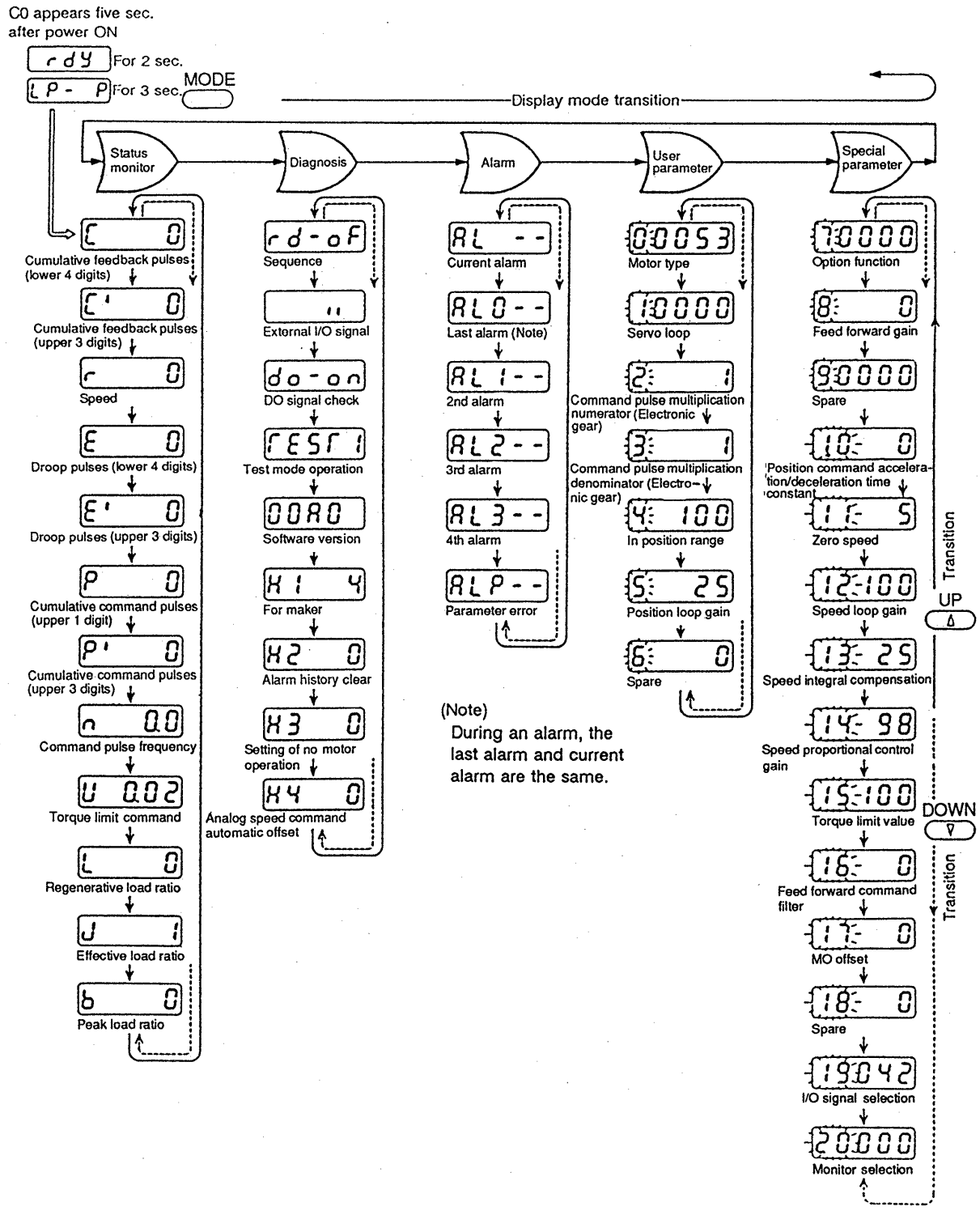
1) Servo OFF ..... The main transistor's base current will be shut off and the servo motor will coast to stop.
2) Reset ..... The main transistor's base will be shut off and the servo motor will coast to stop. The dynamic brake (optional) will not operate.
3) Stroke end OFF ..... The motor will stop immediately and be locked by the servo. Rotation in the reverse direction will be possible.
4) Alarm ..... The main transistor's base will be shut off when an alarm occurs.

3-5 The display and setting functions

3-5.1 Display flow chart

Details of the display

The status can be monitored and parameters set with the display section (5-digit, 7-segment display) on the front of the servo amplifier. Confirm the parameter settings before operation, diagnosis trouble, confirm external sequences, and confirm the operation status with this display.
An example of the display flow chart (for the position servo) is shown below. Refer to sections 3-5.2 to 3-5.5 for details on the display.



3-5.2 Status display

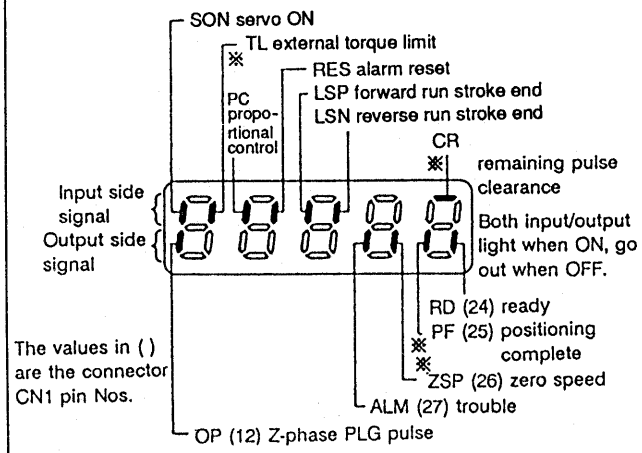
The various states during operation are displayed. The display details can be changed freely with the UP and DOWN buttons. The display when the power is switched ON is set to Pr. 20.

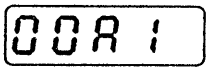
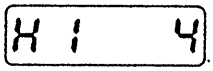
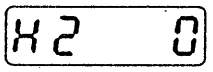
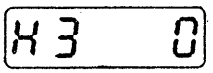
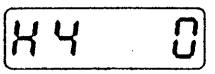
Name	Sym-bol	Display range, unit	Details
Cumulative feedback pulses (lower 4 digits)	C	–9999999 to 9999999 pulses	The feedback pulses (4-times multiplying) are counted. When the count overflows, it returns to zero. The lower 2nd, 3rd and 4th digit decimal points will light for reverse run pulses (negative values). The display will be reset to "0" when the "SET" button is pressed.
Cumulative feedback pulses (upper 3 digits)	C'		
Speed	r	3.0.0.0 to 3000 r/min	The servo motor speed is displayed. The lower 2nd, 3rd and 4th digit decimal points will light during reverse run.
Cumulative droop pulses (lower 4 digits)	E	–65535 to 65535 pulses	The details of the position deviation counter are displayed. The lower 2nd, 3rd and 4th digit decimal points will light for reverse run pulses (negative values).
Cumulative droop pulses (upper 1 digit)	E'		
Cumulative command pulses (lower 4 digits)	P	–9999999 to 9999999 pulses	The command pulses before the pulses are multiplied with the electronic gear are displayed. The lower 2nd, 3rd and 4th digit decimal points will light for reverse run pulses (negative values). The display will be reset to "0" when the "SET" button is pressed.
Cumulative command pulses (upper 3 digits)	P'		
Command pulse frequency	n	–200.0 to 200.0 kpps	The command pulse frequency, before the pulses are multiplied with the electronic gear, is displayed. During reverse run, the lower 3rd and 4th decimal points light, and the lower 2nd decimal point will go out.
Speed command voltage	F	±10.00V	The speed command voltage is displayed. During negative voltage, the lower 2nd and 4th decimal points light, and the lower 3rd decimal point goes out.
Torque limit command	U	0 to 10.00V	The torque limit command voltage is displayed.
Regenerative load ratio	L	0 to 100%	The regenerative load ratio for the regenerative option tolerance value selected in Pr. 1 is displayed in %. A short time (approximately 30 to 40 minutes) is required for stabilizing.
Effective load ratio (Note)	J	0 to 300%	The load ratio for the rated torque is displayed in %. The servo motor temperature is assumed, so the effective torque and display value are not linear. A short time (approximately 10 to 20 minutes) is required for stabilizing.
Peak load ratio	b	0 to 300%	The load ratio is displayed in % according to the rated torque.

* Note: When the display value is not 100%, the display value and effective load ratio will differ. Refer to Section 4-5.2 for this relationship. When the display value is 90, 80 or 70, the effective load ratio is 95, 89 or 84%.

3-5.3 Diagnosis mode

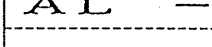
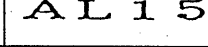
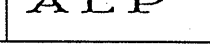
This is used to confirm the status of the external sequence, etc.

Name	Display	Details
Sequence (automatic tuning)	rd-oF	Not ready. The unit is being initialized after the servo ON has been switched ON, or an alarm has occurred. Automatic tuning can be performed from this screen. (Refer to Section 5-1 for details.)
	rd-on	Ready. Enter the operable status after initialization after switching the servo ON. Automatic tuning can be performed from this screen.
External input/ output signal		The external input/output signal ON-OFF status is displayed. The upper of the vertical line of each segment in the 5-digit LED is the input signal, and the lower corresponds to the output signal. The figure on the left shows the status when all input/output signals are switched ON. The relation of each segment's vertical line and input/output signal is shown on the left. Note 1. The input signal pin Nos. marked "*" respond to the factory default setting. (Change these with parameter No. 19.)
DO signal check	do-on	The [,,,!] DO signal check display will appear when the [SET] button is pressed for more than two seconds. The output from connector CN1's 24, 25, 26 and 27 pins enter the state where they can be forcibly switched ON/OFF. Always operate these with the servo switched OFF. (Refer to Section 5-3 for details.)
Test mode operation	TEST 1	The [d 200] (200r/min) speed display will appear when the [SET] button is pressed for more than two seconds, and the test operation state will be entered. Always operate this with the servo switched OFF. (Refer to Section 5-4 for details.)

Name	Display	Details
Software version		For MITSUBISHI use
For MITSUBISHI		For MITSUBISHI use
Alarm history clear		Change DATA from 0 to 1, press "SET", and the alarm history will be cleared. (Refer to Section 5-2.5 for details.)
No-motor operation setting		Change the DATA to 53, press "SET" and the unit will operate without the motor. (Refer to Section 5-2.4 for details.)
VC input/ automatic offset		The automatic tuning of the speed command input voltage offset will be executed with "13" and "SET". (Refer to Section 5-1.2 for details.)

3-5.4 Alarm mode

The history of past alarms, and parameter errors are displayed in this mode.

Name	Display example	Details
Current alarm		This shows that an alarm has not occurred.
		This shows that alarm 33 (overvoltage) has occurred. During an alarm, A and the first character's decimal point will flicker. (This will flicker even when the screen is changed.)
Alarm history		This shows that alarm 50 (overload) occurred one alarm ago.
Parameter error		This shows that there is an error in the Pr. 5 data.

Functions during an alarm

(1) The alarm mode display can be entered from any screen other mode.

(2) Other displays can be viewed when an alarm occurs, but the first digit's (5th digit) decimal point will flicker, so you can determine if an alarm is occurring.

(3) To reset after an alarm has occurred, switch the power OFF, or switch the external reset signal ON.

(4) When resetting the alarm from the servo amplifier unit, press the [SET] button with the current alarm displayed.

Note: Create a sequence so that when an alarm occurs, the main circuit contactor MC will be switched off. (Refer to Section 2-2.1.)

3-5.5 Parameters

(1) Parameter list

Table 3-1 Parameter list for positioning servo

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
User parameter	0	*MTY	Motor type	####		
	1	*STY	Servo loop (1) Positioning/speed servo (2) Regenerative resistor option (3) Auto tuning selection	0000		0 to 7395h
	2	CMX	Command pulse multiplication (numerator) electronic gears	1		1 to 9999
	3	CDV	Command pulse multiplication (denominator) electronic gears	1		1 to 9999
	4	INP	In-position range	100	pulse	0 to 9999
	5	PGN	Position loop gain	25	rad/s	5 to 150
	6	—	Spare	0		
Special parameters	7	*OPS	Option functions (1) Command pulse input format (2) Command pulse input signal logic (3) Speed proportional command valid	0000		0 to 111Fh
	8	FFC	Feed forward gain	0	%	0 to 100
	9	—	Spare	0		
	10	PST	Position command acceleration/deceleration time constant (smoothing)	0	10ms(1ms)	0 to 999 (-99 to 0)
	11	ZSP	Zero speed	5	10r/min	1 to 500
	12	VGN	Speed loop gain	100		70 to 999
	13	VIC	Speed integral compensation	25	ms	1 to 999
	14	VDC	Speed proportional control gain	98	%	0 to 100
	15	TLL	Torque limit value	100	%	0 to 100
	16	FST	Feed forward command filter	0		0 to 7
	17	MOO	Analog monitor, offset	0	mV	-20 to 100
	18	—	Spare	0		
	19	IPO	Input/output signal selection	042		0 to 1AFh
	20	*DMD	Monitor selection (1) Status display when power is switched ON (2) Encoder output division rate (3) Analog monitor output selection	000		0 to DFBh

####: The initial value (factory default value) will differ according to the servo amplifier size

* : These are validated when the power is cycled after setting.

(2) Explanation of parameters

Table 3-2 Details of positioning servo parameters

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
User parameter	0	*MTY	Motor type: □□□□ The highlighted values in the table are the initial values.			

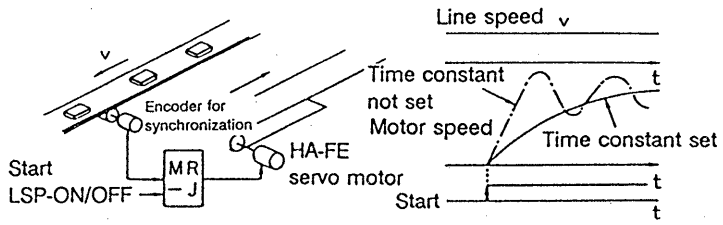
Amplifier	Motor	Motor series	Motor rating (parameter setting value)											
	MR-J	–	10A 10A1	20A 20A1	40A 40A1	60A	70A	100A	200A	350A	10MA 10MA1	20MA 20MA1	40MA 40MA1	70MA
Motor	HA-FE	0	**053**	**23**	**33**	**63**	–	–	–	–	–	–	–	–
			13	–	43	–	–	–	–	–	–	–	–	–
			–	–	–	–	–	–	–	–	–	–	–	–
	HA-SE	1	–	–	–	–	**52**	**102**	**152**	**352**	–	–	–	–
			–	–	–	–	53	103	202	353	–	–	–	–
			–	–	–	–	–	81	153	301	–	–	–	–
			–	–	–	–	–	121	203	–	–	–	–	–
			–	–	–	–	–	–	201	–	–	–	–	–
	HA-ME	3	–	–	–	–	–	–	–	–	053	23	43	73
			–	–	–	–	–	–	–	–	13	–	–	–

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
User parameter	1	*STY	Servo loop type: The servo loop and validity of the regenerative option are set. 0□□0 0: Positioning servo (pulse train) 1: Speed servo (analog, three internal speeds) 4: Low noise mode, position servo (pulse train) 5: Low noise mode, speed servo (analog, three internal speeds) 0: No regenerative option 1: Regenerative option (MR-RB013) 2: Regenerative option (MR-RB033) 3: Regenerative option (MR-RB064x2 series) 4: Regenerative option (MR-RB064) 5: Regenerative option (MR-RB10x2 series) 6: Regenerative option (MR-RB30x2 series) 7: Regenerative option (MR-RB10) 8: Regenerative option (MR-RB30) 9: Regenerative option (MR-RB50) The combination of the regenerative option and servo amplifier is restricted. Refer to Section 6-1. 0: Automatic tuning valid (medium response) 1: Automatic tuning valid (fast response) 2: Automatic tuning valid (slow response) 3: Automatic tuning invalid	0000		0 to 7395h

Continued on the next page.

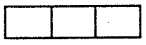
Class	Pr.	Abb.	Name	Initial Value	Unit	Range
User parameter	2	CMX	Electronic gears Command pulse multiplication (numerator): The multiplier of the input command pulses is set here.	1		1 to 9999
	3	CDV	Electronic gears Command pulse multiplication (denominator): The divisor of the input command pulses is set here. (Ex.) Input command pulse Position command $f1 \rightarrow \boxed{\frac{CMX}{CDV}} \rightarrow f2 = f1 \times \frac{CMX}{CDV}$ Setting range $\frac{1}{50} < \frac{CMX}{CDV} < 20$	1		1 to 9999
	4	INP	In-position range When the number of droop pulses as set in this parameter is counted, the positioning completed output is set.	100	pulse	0 to 9999
	5	PGN	Position loop gain The position loop gain is set here. The value will change automatically when automatic tuning is executed.	25	rad/s	5 to 150
	6		Spare	0		
Special parameter	7	*OPS	Special function selection: 0 _ _ 0 8 4 2 1 (a) Command pulse input format 0: forward/reverse run pulse train input 1: symbol/pulse train input 2: 2-phase pulse train input (x1) 3: 2-phase pulse train input (x2) 4: 2-phase pulse train input (x4) (b) Command pulse input signal logic 0: input signal negative logic 1: input signal positive logic 0: speed proportional command invalid Valid only when the external input signal PC is ON. 1: speed proportional command valid (c) LSP, LSN Stop pattern when OFF 0: immediate stop 1: erasing stop For the setting method, refer to Section 3-7.	0		1 to 111Fh
	8	FFC	Feed forward gain The feed forward gain of the position loop is set. When set to 100%, the droop pulses will be zero when operating at a constant speed. The overshoot will increase when sudden acceleration or deceleration is carried out. (As a guideline, at FFC=100%, the acceleration/deceleration time to the rated speed is 1s or more.)	0	%	1 to 100

Continued on the next page.

<table>
<tr><th>Class</th><th>Pr.</th><th>Abb.</th><th>Name</th><th>Initial Value</th><th>Unit</th><th>Range</th></tr>
<tr><td rowspan="10">Special parameter</td><td>9</td><td></td><td>Spare</td><td>0</td><td></td><td></td></tr>
<tr><td>10</td><td>PST</td><td>Position command acceleration/deceleration time constant (smoothing)
This parameter is used to apply a low pass filter to the command pulse train.
(Ex.)
When commanded from an encoder for synchronization, synchronized operation can be started smoothly even when started during line operation.
 
</td><td>0</td><td>10msec
1msec</td><td>0 to 9999
-99 to 0</td></tr>
<tr><td>11</td><td>ZSP</td><td>Zero speed
The speed for switching on the zero speed output signal (ZSP) is set here.</td><td>5</td><td>10r/min</td><td>1 to 500</td></tr>
<tr><td>12</td><td>VGN</td><td>Speed loop gain
The speed loop gain is set here.
The value will change automatically when automatic tuning is executed.</td><td>100</td><td></td><td>70 to 999</td></tr>
<tr><td>13</td><td>VIC</td><td>Speed integral compensation
The time constant for integral compensation is set.
The value will change automatically when automatic tuning is executed.</td><td>25</td><td>msec</td><td>1 to 999</td></tr>
<tr><td>14</td><td>VDC</td><td>Speed proportional control gain
The proportional control will be validated when parameter Pr. 7 is set or the proportional control input signal (PC) is switched ON.
The proportional integral control will be activated when set to 100, and the proportional gain will decrease with a smaller value.</td><td>98</td><td>%</td><td>0 to 100</td></tr>
<tr><td>15</td><td>TLL</td><td>Torque limit value
With a maximum torque of 100%, the proportion of MAX torque to be used is set.
When the external torque limit input signal (TL) switches ON, the smaller of the external torque limit value or this parameter set value will be used.
The MAX torque set with this parameter will be 8V when the torque is monitored with monitor output.</td><td>100</td><td>%</td><td>0 to 100</td></tr>
<tr><td>16</td><td>FST</td><td>Feed forward command time constant
The filter time constant for the position loop feed forward command is set here.
<table><tr><th>Set value</th><th>Filter time constant</th><th>Set value</th><th>Filter time constant</th></tr><tr><td>0</td><td>0ms</td><td>4</td><td>8</td></tr><tr><td>1</td><td>1</td><td>5</td><td>16</td></tr><tr><td>2</td><td>2</td><td>6</td><td>32</td></tr><tr><td>3</td><td>4</td><td></td><td></td></tr></table></td><td>0</td><td>$2^{(x-1)}$ms
X: Set value
0ms when set to X=0</td><td>0 to 7</td></tr>
</table>

Continued on the next page.

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
Special parameter	17	MOO	Analog monitor offset The offset for the analog monitor output is set here.	0	mV	-20 to 100
	18		Spare	0		
	19	IPO	I/O signal selection The input signal functions of the connector CN1 pins 32 and 33, and the output signal functions of pins 25 and 26 are selected.	042		1 to 1AFh



Input pin function selection

Setting	Pin 32	Pin 33
1	PC	YL
2	CR	TL
6	CR	PC

(For signal name, refer to Section 3-7.)
← Initial value

Output pin function selection

Setting	Pin 25	Pin 26
1	ZSP	PF
2	TLC	PF
4	PF	ZSP
6	TLC	ZSP

← Initial value

Alarm code output
0: invalid
1: valid
The alarm codes from the output pins (24, 25, 26) during an alarm are output in 3 bits.

Note: The alarm code will be output when an alarm occurs and the ALM output is switched OFF.

Alarm name	Alarm No.	ZSP (26)	PF (25)	RD (24)	Code
Undervoltage	AL10	0	1	0	2
Memory error 1 (RAM, ROM)	12	0	0	0	0
Memory error 2 (EEPROM)	15	0	0	0	0
Magnetic polarity detection error	16	0	1	1	3
PCB error (A/D error)	17	0	0	0	0
Over-regeneration	30	1	0	0	4
Overspeed	31	1	0	1	5
Overcurrent	32	0	0	1	1
Overvoltage	33	1	0	0	4
Command frequency error	35	1	0	1	5
Parameter error	37	0	0	0	0
Fin overheating	45	1	1	0	6
Overload	50	1	1	0	6
Excessive difference	52	1	0	1	5
Screen changed during servo ON	90	1	1	1	7

1: continuity with SG, 0: no continuity

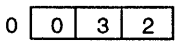
Continued on the next page.

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
Special parameter	20	*DMD	Monitor selection The display, monitor output and encoder output division rate are set.  Display status selection when power is ON 0: Cumulative feedback pulses (lower 4 digits) 1: Cumulative feedback pulses (upper 3 digits) 2: Speed 3: Droop pulses (lower 4 digits) 4: Droop pulses (upper 3 digits) 5: Cumulative command pulses (lower 4 digits) 6: Cumulative command pulses (upper 3 digits) 7: Command pulse frequency 8: Torque limit command voltage 9: Regenerative load ratio A: Effective load ratio b: Peak load ratio * Encoder output division rate is validated by switching the power ON/OFF. Analog monitor output selection setting is made valid by pressing the [SET] button.	0		0 to dFbh

Setting	Setting of encoder output (FPA, FPB) division rate	Analog monitor output selection
00	1/1	Speed monitor (full scale: 8V)
01	1/2	
02	1/3	
03	1/4	
0F	1/16	
10	1/17	
1F	1/32	
40	1/1	Torque monitor (full scale: 8V)
41	1/2	
42	1/3	
5F	1/32	
80	1/1	Speed monitor (Zero center meter, full scale: 5V ±4V)
9F	1/32	
C0	1/1	Torque monitor (Zero center meter, full scale: 5V ±4V)
dF	1/32	

Refer to Table 3-5 in Section 3-7 (4) 5).

(Setting example)
Encoder output: 1/4
Analog monitor output: Speed monitor
When "Speed" is set as the default status monitor, set



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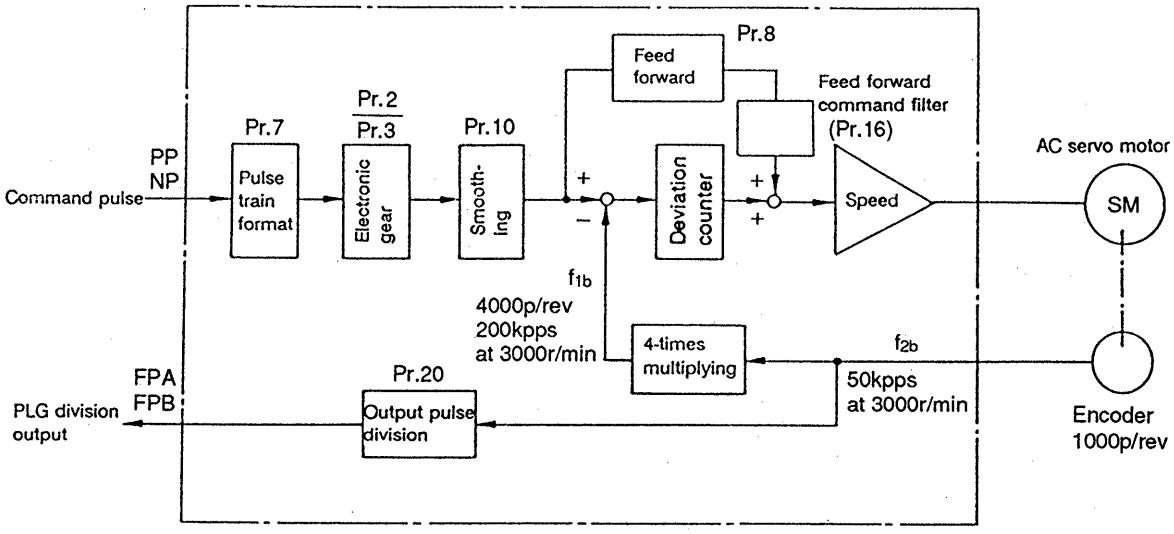
(3) Relationship of the command pulse and feedback pulse

The relationship of the command pulse and feedback pulse varies according to the setting of each parameter. This relationship is shown in the following diagram.



1) Setting example for operating with AD71

AD7 max. output pulse frequency	Parameter				Motor		Feedback pulse frequency	
	Pulse train format	Electronic gear		Smoothing	Type (rated rotation speed)	PLG	f_1b	f_2b
	Pr.7	Pr.2	Pr.3	Pr.10				
200 kpps (A type)	0000 Forward/ reverse run pulse train	1	1	0	HA-ME (3000 r/min)	1000 p/rev	200 kpps	50 kpps
		1	1		HA-FE (3000 r/min)	1000 p/rev	200 kpps	50 kpps
		1	1		HA-SE (1000 r/min) (2000 r/min) (3000 r/min)	1000 p/rev	200 kpps	50 kpps

2) Smoothing (Pr. 10)

(a) When the electronic gear rate is large (10-fold or more) and the speed is low, the speed will not be smooth, and will cause a pulsating type of rotation. Here, the rotation will smooth-out when Pr. 10 is set to "1" (10ms).

(b) When an acceleration/deceleration time is not applied to the command pulse train, and if the command pulse frequency changes suddenly, an overshoot or excessive difference alarm "AL-52" will occur. Set the acceleration/deceleration time constant with Pr. 10.

3) Feed forward (Pr. 8)

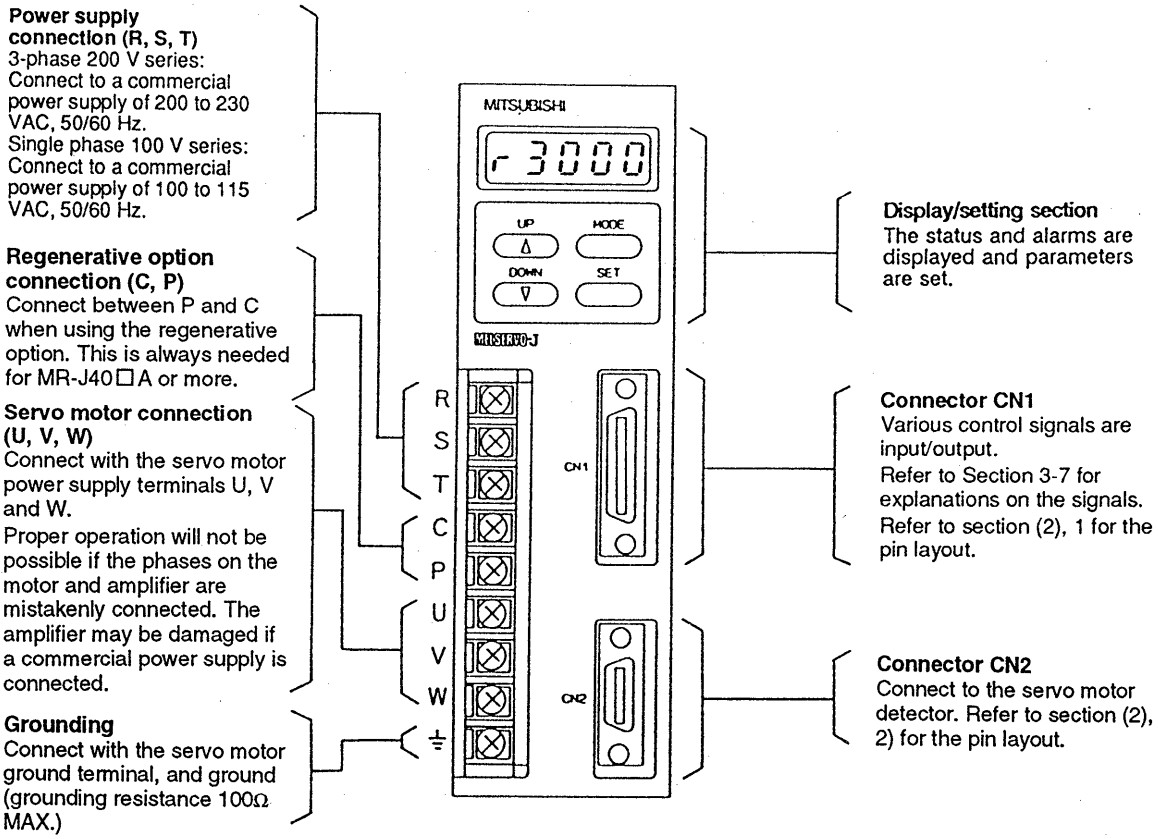
This function cancels the delay caused by the droop pulses in the deviation counter. If the delay becomes a problem, gradually increase the setting in Pr. 8, and set within the range where overshooting does not occur. This cannot be used if the acceleration/deceleration is rapid.

4) Feed forward command filter (Pr. 16)

A filter is used for the feed forward command.

3-6 Wiring

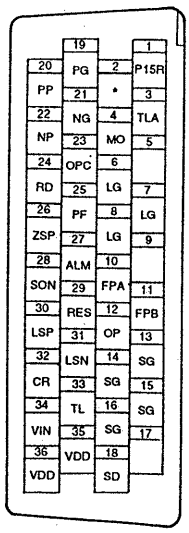
(1) Servo amplifier front view



(2) Connector pin layout diagram

The connector pin layout diagram looking from the cable wiring side is shown below. The pin number is indicated on the upper row, and the signal name on the lower row.

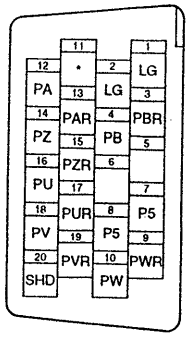
1) CN1 (connector for control signals)
Model PCR-S36FS connector
(Made by HONDA)
PCR-LS36LA (case)



Pin No.
Signal name

Connector pin layout diagram

2) CN2 (connector for PLG signals)
Model PCR-S20FS connector
(Made by HONDA)
PCR-LS20LA1 (case)



Pin No.
Signal name

Connector pin layout diagram

3-6.1 Standard connection diagram

(1) Example of connection with AD71

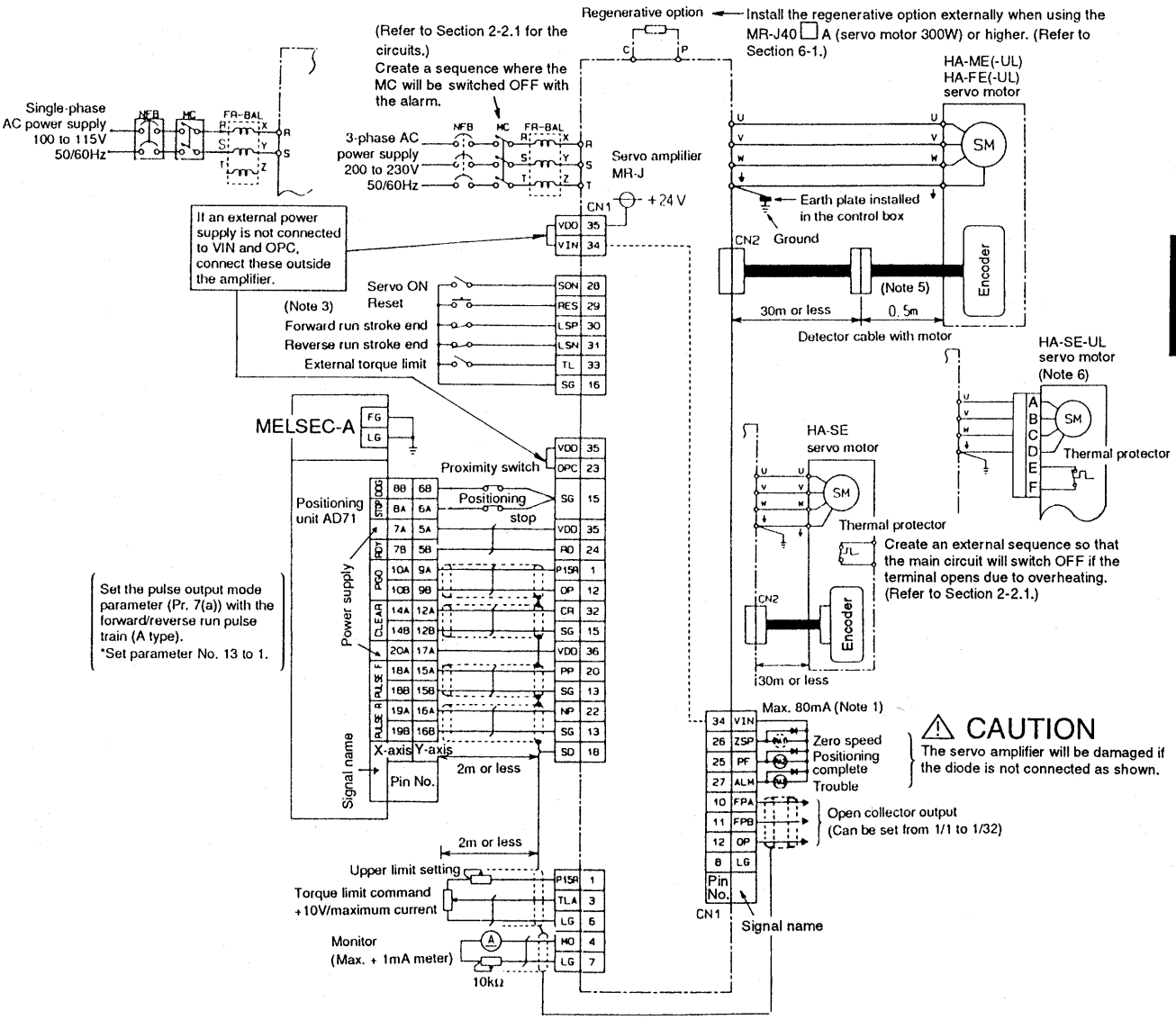


Fig. 3-1 Standard connection diagram I for position control operation

Note:
1. The total current to the external relays should not exceed 80mA. When it exceeds 80mA, supply the I/F power from an external source (refer to Section 3-6.3).
2. The servo amplifier may be damaged if the diode polarity is inverted and connected.
3. Always connect the stroke end LSP and LSN during operation (normally closed).
4. The pins with the same signal name are connected inside the servo amplifier.
5. 0.3m for the HA-ME series.
6. For the UL listed and CSA certified HA-SE servo motor, connectors are used for connection with the power supply. (Refer to Section 2-1.4.)
   Motor side: MS3102A22-23P or MS3102A24-10P
   Cable side: MS3106B22-23S or MS3106B24-10S

(2) Example of connection with FX-1GM

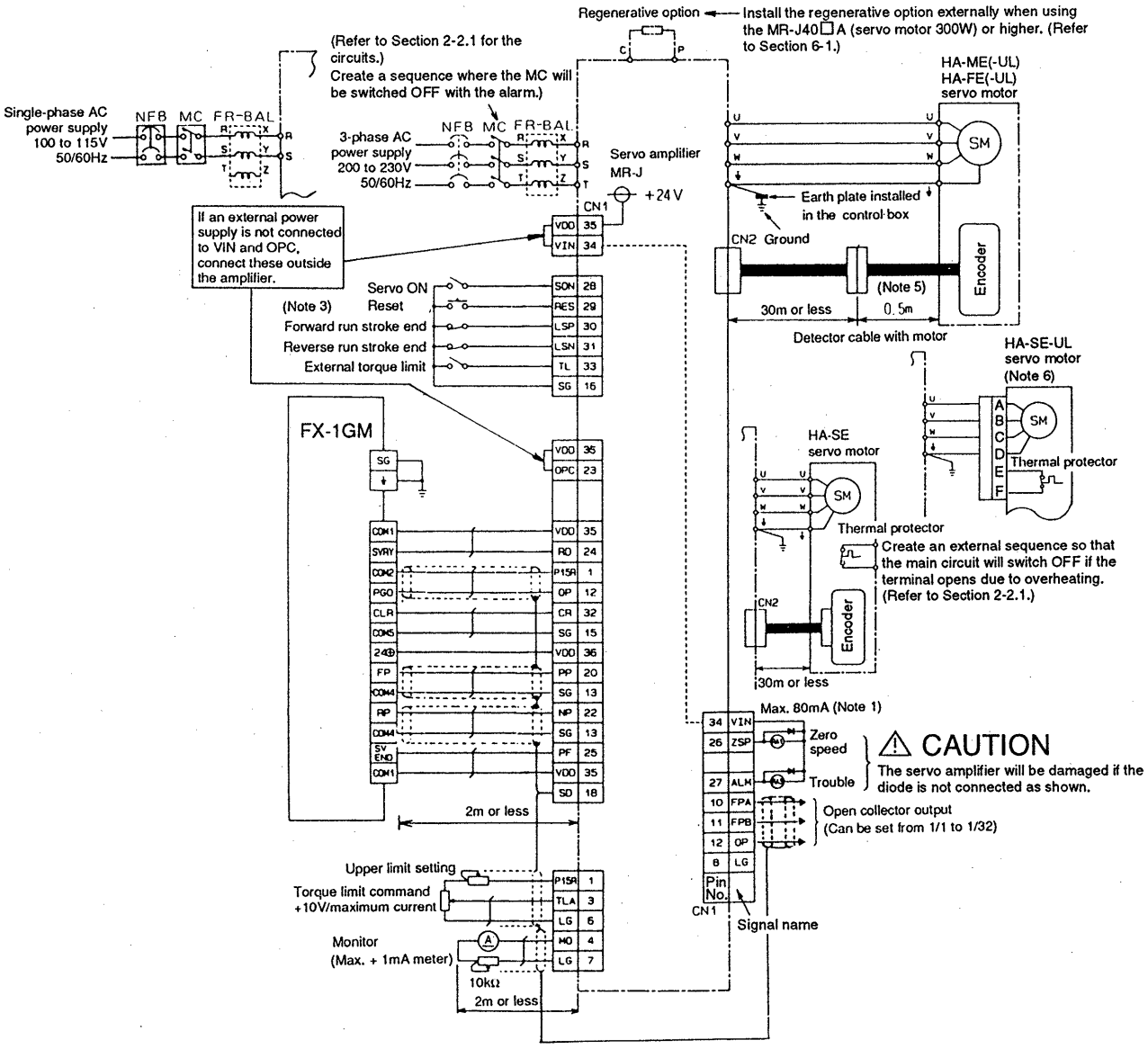
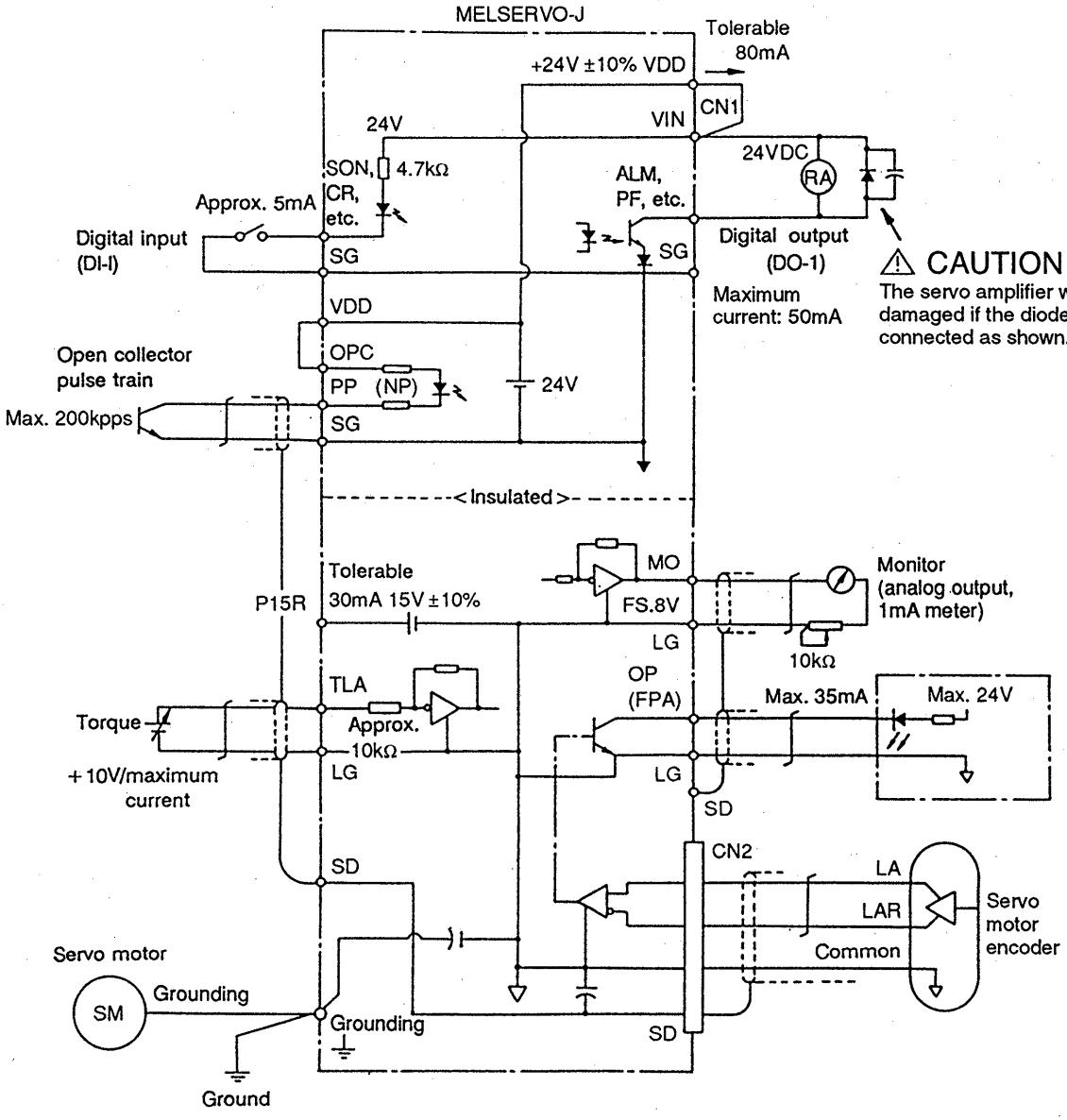


Fig. 3-1 Standard connection diagram I for position control operation

Note:
1. The total current to the external relays should not exceed 80mA. When it exceeds 80mA, supply the I/F power from an external source (refer to Section 3-6.3).
2. The servo amplifier may be damaged if the diode polarity is inverted and connected.
3. Always connect the stroke end LSP and LSN during operation (normally closed).
4. The pins with the same signal name are connected inside the servo amplifier.
5. 0.3m for the HA-ME series.
6. For the UL listed and CSA certified HA-SE servo motor, connectors are used for connection with the power supply. (Refer to Section 2-1.4.)
   Motor side: MS3102A22-23P or MS3102A24-10P
   Cable side: MS3106B22-23S or MS3106B24-10S

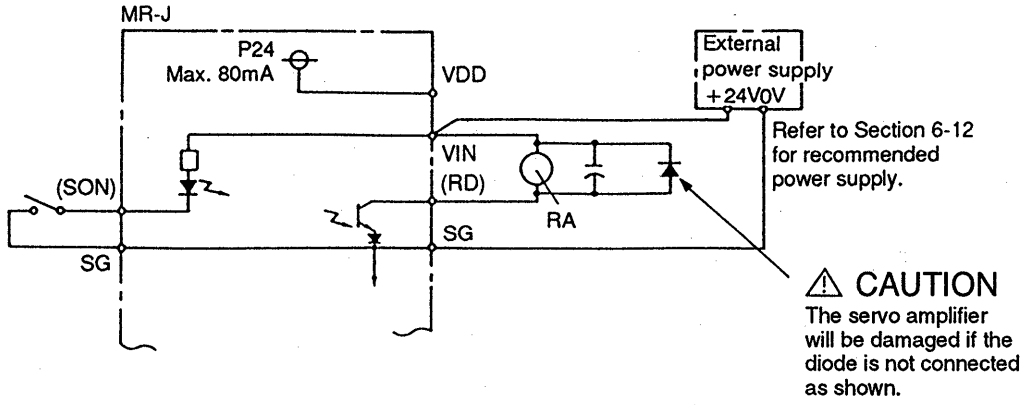
3-6.2 Common line diagram for position servo

The internal power supply (24V, 15V) and the common lines of the servo amplifier are shown below. The power supply is separated in two systems, so properly wire these. Use shields if the unit is affected by external noise, and carefully ground these.



3-6.3 Interface power supply

The power supply VDD (+24V) built into the servo amplifier can be used for digital input/output signals. If the current capacity is insufficient, do not connect VDD and VIN, instead use an external power supply.



3-7 Explanation of signals

(1) Explanation of signals

Table 3-3 List of terminals

Signal name	Symbol	Pin No.	Explanation	I/O class
Servo ON	SON	28	Operation is possible when the servo ON signal is switched ON. The base is shut off when switched OFF, and the servo motor will coast to stop.	DI-1
Alarm reset	RES	29	The alarm can be reset when the alarm reset signal is switched ON for 50msec or more. However, memory, card and parameter errors cannot be reset with this signal. For regenerative and overload errors, the base will be shut off and the servo motor will coast to stop if this signal is switched ON before the regenerative resistor or power transistor cools down. The CPU will not be reset with this signal. The CPU is reset by switching the power OFF →ON.	
Forward run stroke end Reverse run stroke end	LSP LSN	30 31	The servo motor will not rotate unless the forward run or reverse run stroke end signal is ON. If the forward run stroke end is switched OFF, the servo motor will not rotate in the forward direction. If the reverse run stroke end is switched OFF, the servo motor will not rotate in the reverse direction.	
Clear	CR	32	The droop pulses will be cleared when the clear signal is switched ON.	
External torque limit	TL	(*1) 33	When the external torque limit signal is switched ON, the torque output by will be limited to the torque limit command (TLA) value from an external source.	
Proportional control	PC		When the proportional control signal is switched ON, the speed servo loop will be changed from a proportional integral type to a proportional type.	
Forward run pulse train Reverse run pulse train	PP, PG NP, NG	20, 19 22, 21	The command pulse is input • For the open collector type, connect the 24V power supply VDD and open collector power supply OPC, and input each pulse train between PP-SG, NP-SG.	DI-2
Pulse train Pulse train Symbol	PP, PG NP, NG	20, 19 22, 21	• For the differential receive type, open the open collector power supply OPC and input each pulse train between PP-PG and NP-NG.	
A-phase pulse train B-phase pulse train	PP, PG NP, NG	20, 19 22, 21	• Select the forward/reverse run pulse method, symbol + pulse method, A B phase pulse method and the input pulse positive/negative logic with parameter No. 7.	
Torque limit command	TLA	3	Input the motor torque limit value when the external torque limit signal is switched ON. The maximum torque is 0 to +10V. (The maximum torque given in Section 10-2 is reached at 0V.)	Analog input
15V power supply	P15R	1	+15V±10% is output between P15R and the control common LG. The maximum current available is 30mA.	——
Control commond	LG	6, 7, 8	This is the common terminal for the torque limit command TLA, monitor MO, A B Z-phase PLG pulse FPA, FPB, OP signals.	

Continued on the next page.

Signal name	Symbol	Pin No.	Explanation	I/O class
Open collector power supply	OPC	23	Connect this terminal to a 24V power supply VDD when inputting the pulse train with the open collector method.	——
24V power supply	VDD	35, 36	+24V±10% is output between VDD and common SG. The maximum current available is 80mA.	——
24V common	SG	13, 14, 15, 16	This is the common terminal for the 24V power supply.	——
Digital I/F power supply input	VIN	34	A 24V power supply is input for the digital I/F. Connect between VIN and VDD when using the 24V power supply in the servo amplifier.	——
Shield	SD	18	Connect one end of the shield wire.	——
Ready	RD	24	The ready signal switches ON when the servo ON signal is input and the servo in active.	DO-1
Trouble	ALM	27	The trouble signal will switch OFF when an alarm occurs in the servo. If there is no trouble, the trouble signal will switch ON approx. 0.8 seconds after the power is turned ON.	
Positioning complete	PF	(*2) 25 26	The positioning complete signal switches ON when the number of droop pulses is smaller than the in-position range set in the parameter.	
Zero speed detection	ZSP		The zero speed signal switches ON when the motor speed drops below the zero speed set as in the parameter.	
Limiting torque	TLC		The limiting torque signal switches ON when the torque output reaches the torque limit value.	
A-phase PLG pulse	FPA	10	The feedback pulse from the encoder mounted onto the servo motor is output. The feedback pulse can be divided from 1/1 to 1/32 with the parameter.	DO-2
B-phase PLG pulse	FPB	11	When the servo motor is rotating in the forward direction, the FPA will be the pulse that is a 90° phase shift forward from FPB.	
Z-phase PLG pulse	OP	12	One pulse will be output with one servo motor rotation.	
Monitor	MO	4	The servo motor speed or torque is output as or analog voltage. Select whether to output the speed or torque with parameter No. 20. When outputting the speed, this is 8V/maximum speed, and when outputting the torque, this will be 8V/maximum torque as set in parameter No. 15. Output accuracy: ±5%	Analog output

*1: Assign clear, external torque limit, or proportional control to pins 32 or 33. Select with parameter NO. 19. The initial setting value is CR-32, TL-33.

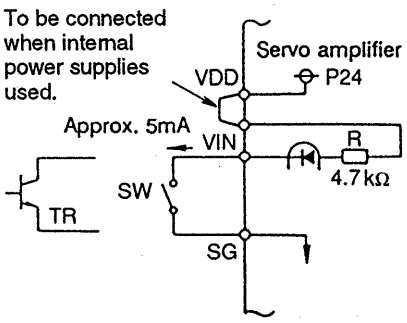
*2: Assign positioning complete, zero speed detection, or limiting torque to pins 25 and 26. Select with parameter NO. 19. The initial setting value is PF-25, ZSP-26.

(2) Interface

The details of each interface noted in Table 3-3 (I/O class) are shown below.

Digital input interface (DI-1)

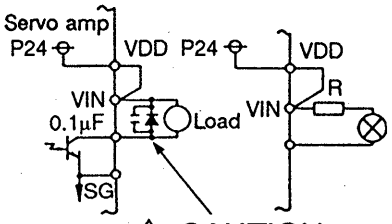
Apply a signal with a miniature relay or open collector transistor (TR).



Digital input interface (DO-1)

The lamp, relay or photocoupler can be driven.
Tolerable current: 50mA
Rush current: 100mA

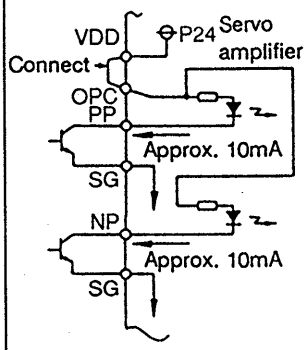
Note: For an inductive load install an absorber (D.C.), and for lamp load install a resistor (R) for rush current suppression.

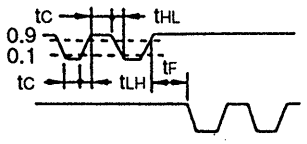


⚠ CAUTION
The servo amplifier will be damaged if the diode is not connected as shown.

Pulse train input interface (DI-2)

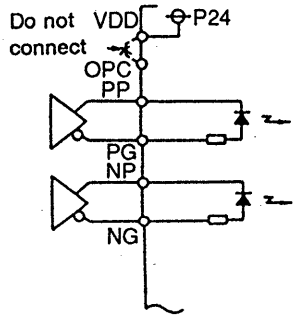
• Open collector type Max. 200 kpps

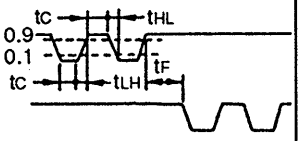




tHL=tLH<0.2μs
tC>2μs
tF>3μs

• Differential receiver type Max. 200 kpps

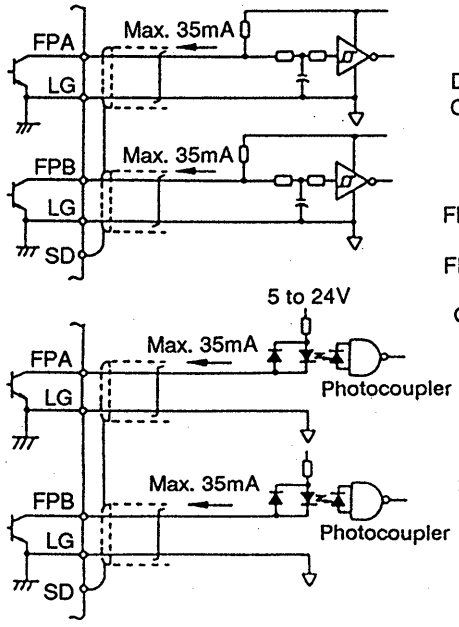




tLH=t<0.2μs
tC>2μs
tF>3μs

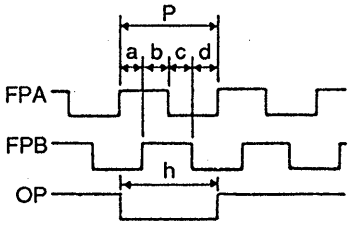
Pulse train output interface (DO-2)

• Interface example



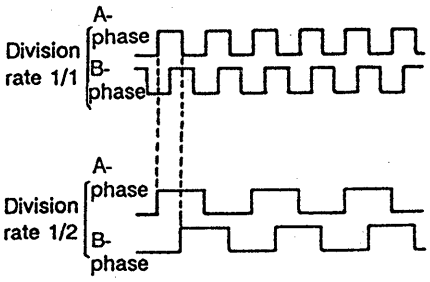
• Phase relation

During servo motor CCW rotation



• Division waveform

Either ON or OFF width is a multiple of each division. (50% duty)

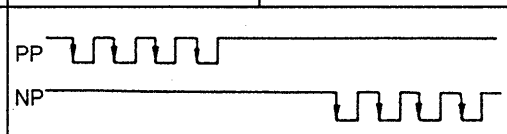
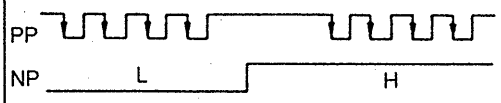
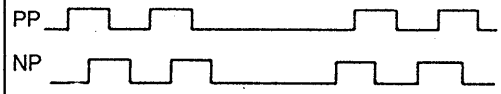
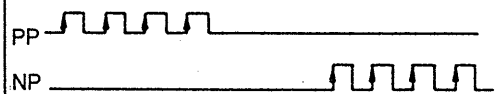
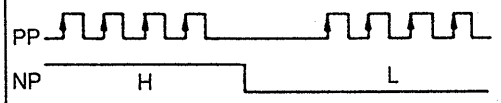
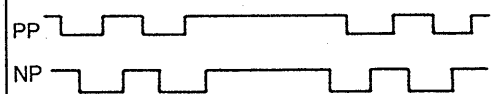


1. a,b,c,d=P/4±P/8±1μs
   (This is established regardless of the output division rate.)
2. h=P'±P'/2±1μs
   (P' equals to the duration of one FPA pulse when the output division rate is 1/1.)

(3) Command pulse train format

The position command pulse train can be input in any of three formats (forward/reverse run pulse train, symbol + pulse train, AB-phase pulse train), and the positive and negative logic can be selected. Select the command section pulse train format from the following table, and set with the servo amplifier parameter No. 7.

Table 3-4 Specified pulse format

Command pulse train format		Forward run / Reverse run	Pr. 7 setting		Remarks
Negative logic	Forward run pulse train Reverse run pulse train		(Factory default setting) 0000		AD71 (A type) Note: When the A and B types are mistaken, one side will be inoperable.
	Symbol + pulse train		0001		AD71 (B type)
	A-phase pulse train B-phase pulse train		×1 multiply	0002	Pulse train after multiply Set so that the frequency will be below 200kpps.
			×2 multiply	0003	
			×4 multiply	0004	
Positive logic	Forward run pulse train Reverse run pulse train		0008		
	Symbol + pulse train		0009		
	A-phase pulse train B-phase pulse train		×1 multiply	000A	Pulse train after multiply Set so that the frequencywill be below 200kpps.
			×2 multiply	000B	
			×4 multiply	000C	

Note: ⌐ and ¬ indicate the timing of reading the command pulse.

(4) Explanation of output signals

1) Torque limit:

Normally, the torque is limited in the servo amplifier to the value set in parameter No. 15. If there are mechanical system limits such as with the gear capacity, the max. torque is set smaller with Pr. 15. To change the torque limit value from an external source, wire as shown in the right diagram, and switch the external torque limit command TL ON. The torque limit value will be the smaller of the TLA level and Pr. 15 level.

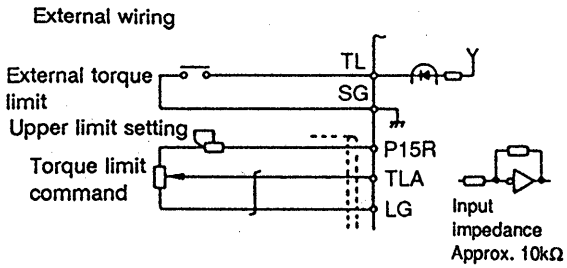


Fig. 3-3 External torque limit connection diagram

Torque limit command and motor torque

The relation of the TLA voltage level and the motor generated torque is shown on the right. The motor generated torque will have a difference of about 5% depending on the motor.
If the speed command is low such as 50mV, a proper limit will not be applied, and the torque will fluctuate. If there are problems, increase the limit value.

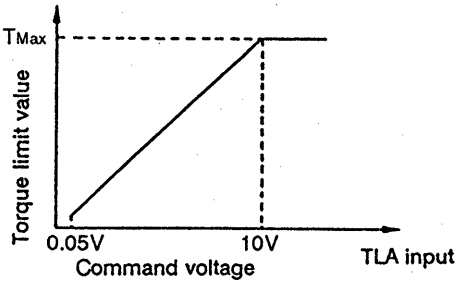


Fig. 3-4 Torque limit level

2) Limiting torque (TLC):

This switches ON when the servo motor torque reaches the set torque limit value such as during acceleration or deceleration.
If the external torque limit is not applied, this will turn ON at the output of torque whose torque limit has been set with Pr. 15.

3) Zero speed (ZSP):

This switches ON when the servo motor speed drops to or below that set with Pr. 11.
The detection has a hysteresis as shown on the right.

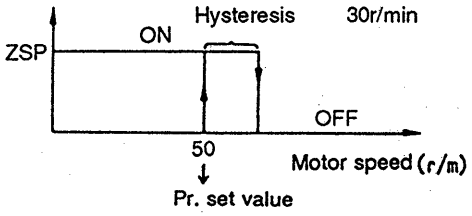


Fig. 3-5 Zero speed detection level

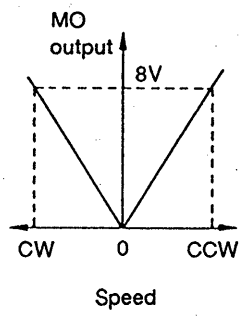
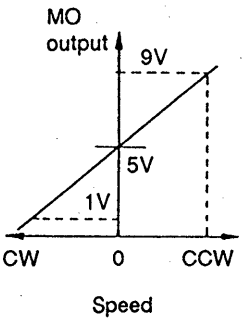
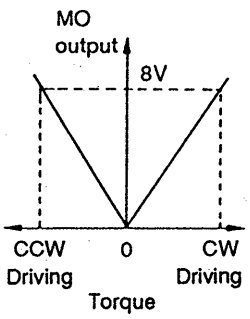
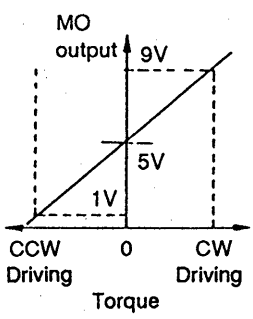
4) Positioning complete (PF):

This switches ON when the droop pulses in the deviation counter are in the positioning complete range (in-position) set in parameter No. 4. When operating at a low speed, the droop pulses will be small, so when the positioning complete range No. 4 is large, the PF signal will stay ON for a longer time.

5) Analog monitor output (MO)

Any of the following four levels can be selected with parameter No. 20.

Table 3-5 Monitor output pattern

Monitor	Speed		Torque (motor current)	
Pr. 20	Factory default value 0□□	8□□	4□□	C□□
MO output details	(+8V/maximum speed) 	(5±4V/maximum speed) 	(+8V/No. 15 setting Max. torque) 	(5±4V/No. 15 setting Max. torque) 

4-1 Wiring

Wire according to the wiring diagram. Refer to Section 4-7 for the definition and use of the servo amplifier signals and functions.

4-2 Checking wiring

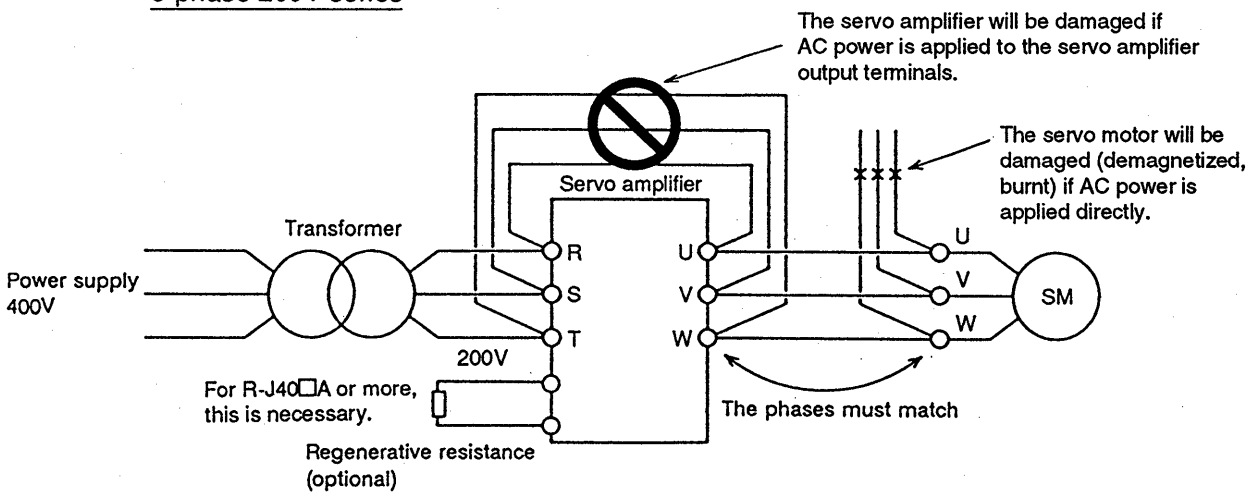
(1) Refer to the wiring diagram and confirm that the wiring is correct. (Section 4-6)

(2) Especially note the following wiring. The unit may be damaged if it is miswired.

Main circuit

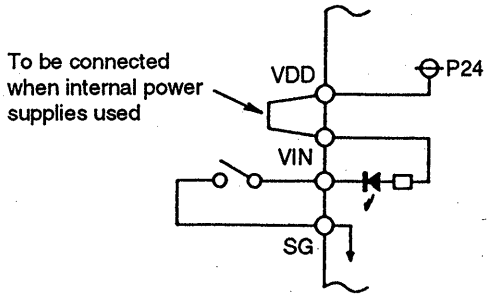
1) A source of AC power which conforms to the specification must be connected to the servo amplifier power supply terminals (R, S, T). If the power does not conform to the specification, drop the voltage to the specified voltage by using a transformer.
2) Power supply lines (R, S, T) must not be connected to the servo motor output terminals (U, V, W).
3) The phases of the output terminals (U, V, W) and motor terminals (U, V, W) must match.
4) AC power must not be directly applied to the servo motor.

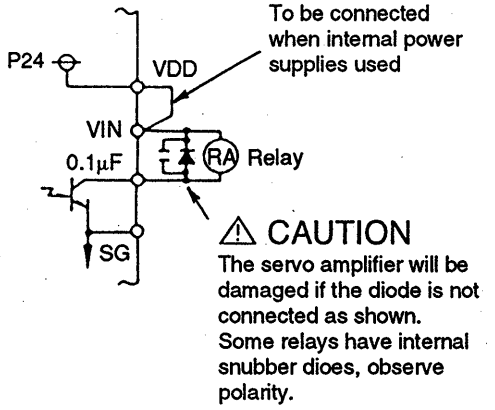
3-phase 200V series



Control circuit

1) Connect 24VDC to the interface power supply terminal (VIN). Connect VIN and VDD when using the power supply in the servo amplifier (VDD).
2) When connecting a relay to the open collector output terminals, insert a diode parallel to the relay. The diode must be connected with us shown. Otherwise, the servo amplifier will be damaged.

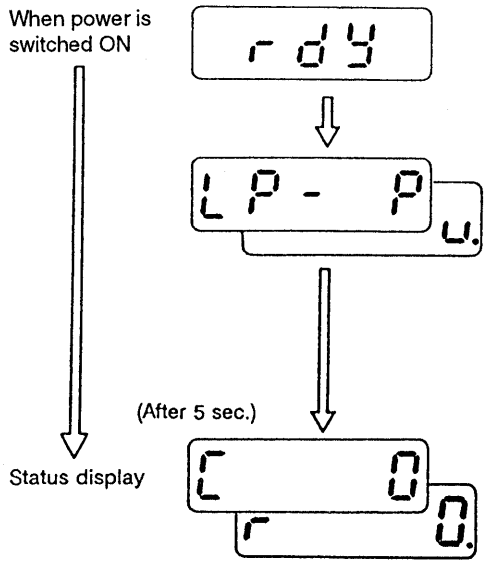




4-3 Switching power on and setting parameters

The setting of the 1) motor type and 2) servo loop type has been factory set. These parameters are validated when the power is swiched OFF once after setting and then switching ON again.

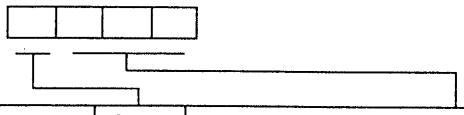
(1) Switching power ON
Switch the SON signal OFF and switch ON the power.



- When the power is turned ON, "rdy", indicating initialization, will be displayed for approx. 2 seconds.
- Next, the servo type will be displayed.
  The initial value is set at the positioning servo. After setting the motor type (refer to section (2), 1)), set to the speed servo (refer to section (2), 2)).
  LP-P: Positioning servo
  LP-V: Speed servo
- Status display
  The cumulative feedback pulses will be displayed when the power is switched ON.

(2) Setting parameters
After switching the power ON, the parameters must be set as needed.
The unit may not operate properly if the following two items are not set correctly. Always confirm the settings, and set as needed.

1) Motor type (Parameter No. 0 MTY):
Refer to the combination table below and set the parameter according to the type of motor being used. The motor may be damaged if not set correctly. Values in shaded areas in the table shown below are factory set values.



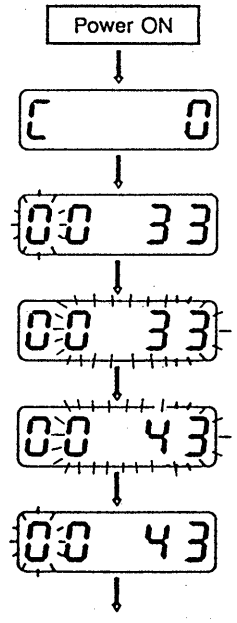
		Servo motor series	Servo motor rating (parameter value No.0)											
Amplifier	MR-J	–	10A 10A1	20A 20A1	40A 40A1	60A	70A	100A	200A	350A	10MA 10MA1	20MA 20MA1	40MA 40MA1	70MA
Motor	HA-FE	0	053	23	33	63	–	–	–	–	–	–	–	–
			13	–	43	–	–	–	–	–	–	–	–	–
			–	–	–	–	–	–	–	–	–	–	–	–
	HA-SE	1	–	–	–	–	52	102	152	352	–	–	–	–
			–	–	–	–	53	103	202	353	–	–	–	–
			–	–	–	–	–	81	153	301	–	–	–	–
			–	–	–	–	–	121	203	–	–	–	–	–
			–	–	–	–	–	–	201	–	–	–	–	–
	HA-ME	3	–	–	–	–	–	–	–	–	053	23	43	73
			–	–	–	–	–	–	–	–	13	–	–	–

The setting for the HA-FE and HA-SE servo motors cannot be made by the MR-J □ MA servo amplifier.

Setting example

The value for Parameter No.0 for this combination of servo motor and servo amplifier must be changed from the factory setting. The table on the previous page shows that the value must be changed from "33" to "43".

Use the following procedure to change the value.



Switch power OFF→ON

Press the [MODE] button three times.

The initial value (HA-FE33) will be displayed.
Press the [SET] button.

The data section will flicker.
Change the data to 0 43 with the [UP] and [DOWN] buttons.

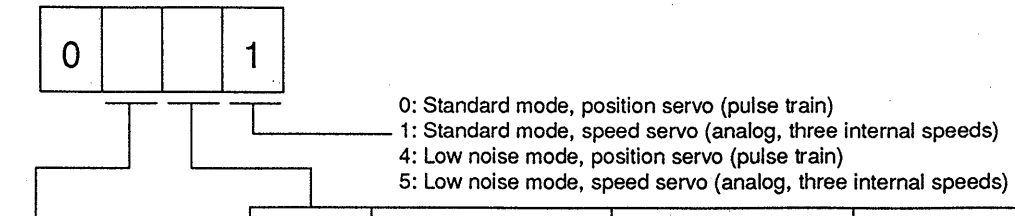
Press the [SET] button.

The setting will be finished, and the parameter No. section will flicker.

The data will be registered and the setting completed.

2) Servo loop type (Parameter No. 1 STY):

The servo loop type, Parameter No.1, defines whether the drive is a speed or position type. The value of the parameter also defines the auto tuning mode and whether the regenerative option is to be used. If a model above the MR-J40A is used, the regenerative option must be installed. Set the parameter value according to the following chart.



Setting value	Regenerative option (combination)	Tolerable power (W)	Applicable amplifier
0	No regenerative option	—	MR-J10A, 20A
1	MR-RB013	10	MR-J10A to MR-J100A MR-J10A1 to MR-J40A1 MR-J10MA to MR-J70MA MR-J10MA1 to MR-J40MA1
2	MR-RB033	30	
3	MR-RB064 × 2	100	
4	MR-RB064	60	MR-J200A
5	MR-RB10 × 2	150	
6	MR-RB30 × 2	500	
7	MR-RB10	100	MR-J350A
8	MR-RB30	300	
9	MR-RB50	500	

4-4 Operation

The servo motor is operated with the following procedure after the power is switched ON and the parameters have been set.

Power ON

↓

Parameter setting

↓

Servo ON

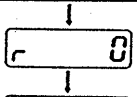
The "servo ON" signal is switched ON.
The operable status is entered, and the servo motor is servo locked. If the servo motor is not servo locked at this point, the "servo ON" signal is not ON. Confirm the status with the monitor, and check the wiring.

[Diagnosis screen]

- Servo ON/OFF check

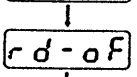
Power ON

↓



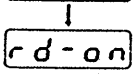
Press the [MODE] button once.

↓



Switch servo ON.

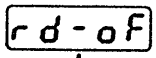
↓



This display will show when the "servo ON" switches ON.

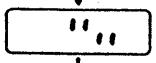
- Input signal check

When the following steps are carried out from the above display, the input signal ON/OFF status can be checked.



Press the [UP] button once.

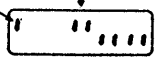
↓



The external input/output signal ON/OFF status will be displayed. Switch the servo ON.

↓

Servo ON signal



When the servo switches ON, the screen on the left will be displayed.

* The ready and positioning complete signals will be output simultaneously and displayed.

Forward run start signal (reverse run start signal) ON

- When the start signal switches ON, the motor will rotate at the speed set with the external command. First, set this to a low speed to confirm the rotation direction and movement status of the machine. Set the acceleration/deceleration times in parameters No. 5 and 6. If the motor is not rotating as desired, check the input signal again. Refer to Sections 4-5.3 and 5-2.
- When operating with the internal parameter speed, select signals DI1, and DI2.
- The servo motor speed and load rate, etc. can be checked on the servo amplifier's status display monitor.

↓

Operation interrupt/stop

The operation will be interrupted or stopped when the following are carried out.

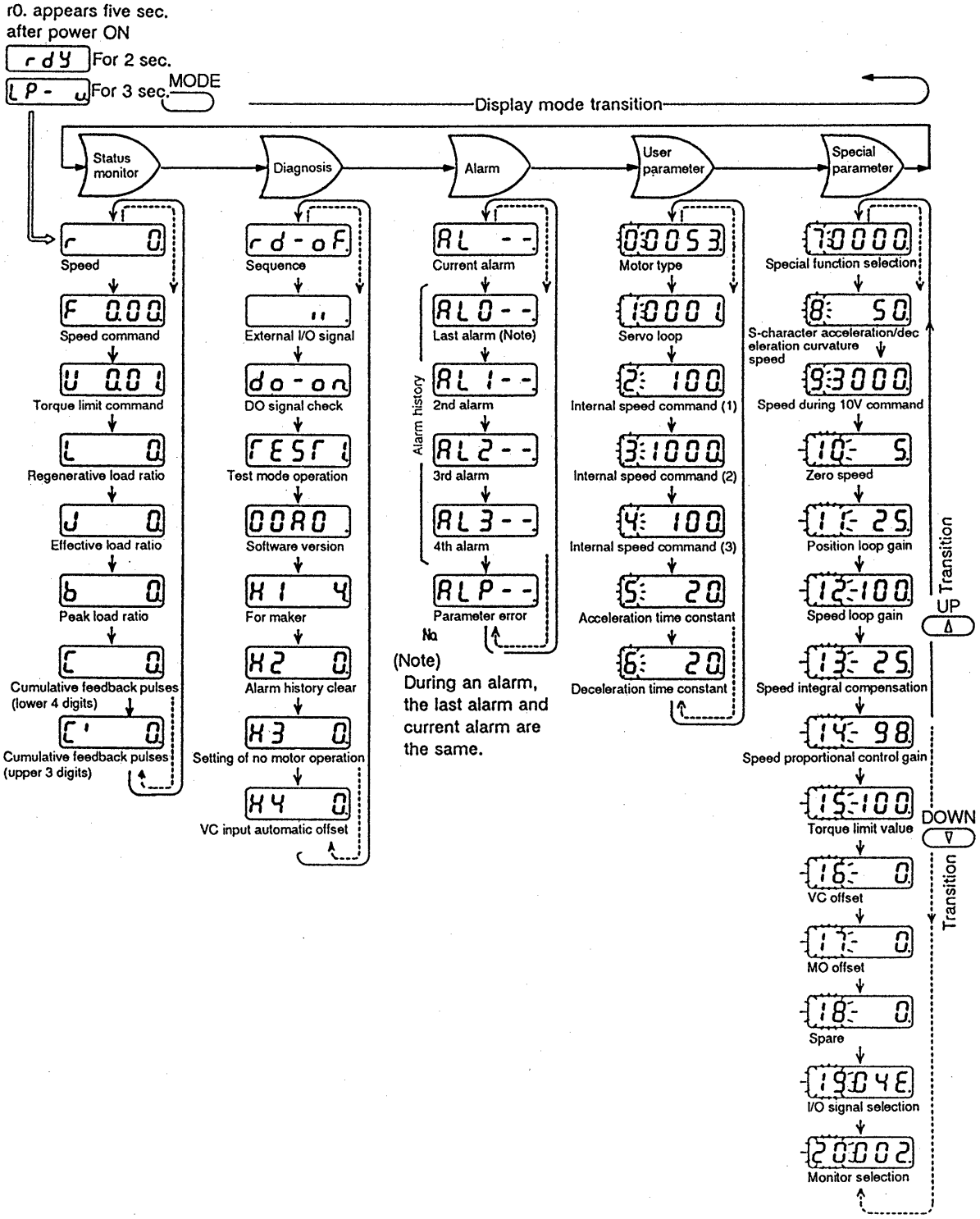
1) Servo OFF ..... The main transistor's base current will be shut off and the servo motor will coast to stop.
2) Reset ..... The base will be shut off and the motor will coast to stop. The dynamic brake (optional) will not operate.
3) Start signal OFF ..... The servo motor will stop and be locked by the servo when both start signals (ST1 and ST2) are switched OFF or ON.
4) Alarm ..... The base will be shut off when an alarm occurs.

4-5 Display and setting function

4-5.1 Display flow chart

Details of the display

The status can be monitored and parameters set with the display section (5-digit, 7-segment display) on the front of the servo amplifier. Confirm the parameter settings before operation, diagnose trouble, confirm external sequences, and confirm the operation status with this display.
An example of the display flow chart (for the speed servo) is shown below. Refer to sections 4-5.2 to 4-5.5 for details on the display.
When using as a speed servo, the least digit decimal point on the 7 segment LED will light constantly.

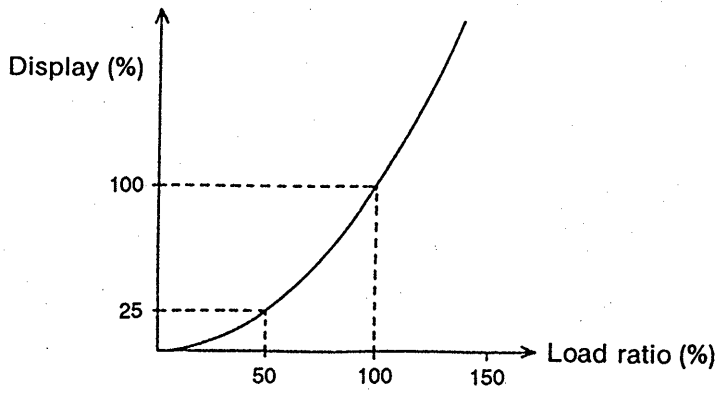


4-5.2 Status display

The various states during operation are displayed. The display details can be changed freely with the UP and DOWN buttons. The display when the power is switched ON is set to Pr. 20.

Name	Sym-bol	Display range, unit	Details
Speed	r	3.0.0.0 to 3000 r/min	The servo motor speed is displayed. The lower 2nd, 3rd and 4th digit decimal points will light during reverse run. Forward run: 3000. Reverse run: 3.0.0.0. (The lowermost decimal point will always light during speed servo.)
Speed command voltage	F	± 10.00V	The speed command voltage is displayed. During negative voltage, the lower 2nd and 4th decimal points light, and the lower 3rd decimal point goes out. Positive voltage: 10.00. Negative voltage: 1.00.0.
Torque limit command	U	0 to 10.00V	The torque limit command voltage is displayed.
Regenerative load ratio	L	0 to 100%	The regenerative load ratio for the regenerative option tolerance value selected in Pr. 1 is displayed in %. A short time (approximately 30 to 40 minutes) is required for stabilizing.
Effective load ratio (Note)	J	0 to 300%	The load ratio for the rated torque is displayed in %. The servo motor temperature is assumed, so the effective torque and display value are not linear. A short time (approximately 10 to 20 minutes) is required for stabilizing.
Peak load ratio	b	0 to 300%	The load ratio is displayed in % according to the rated torque.
Cumulative feedback pulses (lower 4 digits)	C	-9999999 to 9999999 pulses	The feedback pulses (4-times multiplying) are counted and displayed. When the counter overflows, it will be cleared to zero. For the reverse run pulses (negative), the lower 2nd, 3rd and 4th digit's decimal points will light. The display will be reset to "0" when the "SET" button is pressed.
Cumulative feedback pulses (upper 3 digits)	C'		

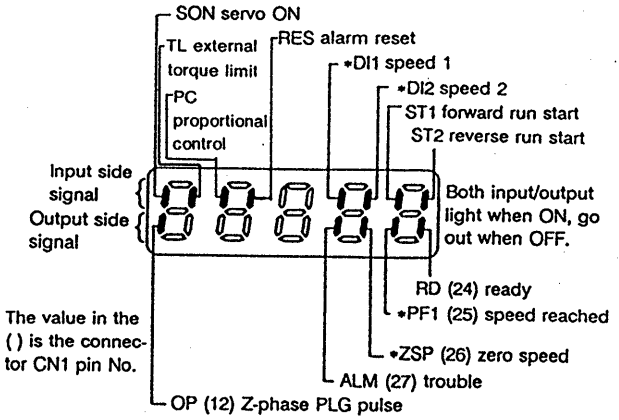
Note: When the display value is not 100%, the display value and effective load ratio will differ. Actual relationship between the load ratio and display is as shown below.

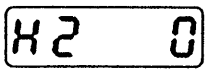
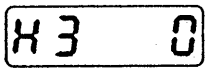
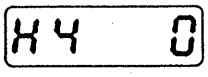


Effective load ratios for display values 90, 80 and 70 are 95, 89 and 84(%).

4-5.3 Diagnosis mode

This is used to confirm the status of the external sequence, etc.

Name	Display	Details
Sequence (automatic tuning)	rd-oF	Not ready. The unit is being initialized after the servo ON has been switched ON, or an alarm has occurred. Automatic tuning can be performed from this screen. (Refer to Section 5-1 for details.)
	rd-on	Ready. Enter the operable status after initialization after switching the servo ON. Automatic tuning can be performed from this screen.
External input/ output signal		The external input/output signal ON-OFF status is displayed. The upper vertical line of each segment in the 5-digit LED is the input signal, and the lower corresponds to the output signal. The figure on the left shows the status when all input/output signals are switched ON. The relation of each segment's vertical line and input/output signal is shown on the left. Note 1. The output signal pin Nos. marked * respond to the factory default setting. (Change these with parameter No. 19.)
DO signal check	do-on	The [...!] DO signal check display will appear when the [SET] button is pressed for more than two seconds. The output from connector CN1's 24, 25, 26 and 27 pins enter the state where they can be forcibly switched ON/OFF. Always operate these with the servo ON signal switched OFF. (Refer to Section 5-3 for details.)
Test mode operation	TEST 1	The [d 200] (200r/min) speed display will appear when the [SET] button is pressed for more than two seconds, and the test operation state will be entered. Always operate this with the servo ON signal switched OFF. (Refer to Section 5-4 for details.)
Software version	00A1	MITSUBISHI USE
For MITSUBISHI	H1 4	MITSUBISHI USE

Name	Display	Details
Alarm history clear		Change DATA from 0 to 1, press "SET" button, and the alarm history will be cleared. (Refer to Section 5-6 for details.)
No-motor operation setting		Change DATA to 53, press "SET" button and the unit will operate without the motor. (Refer to Section 5-5 for details.)
VC input/ automatic offset		The automatic tuning of the speed command input voltage offset will be executed with "13" and "SET". (Refer to Section 5-7 for details.)

4-5.4 Alarm mode

The current alarm, history of past alarms, and parameter errors are displayed in this mode, refer to Section 3-5.4 for details on the alarm display and functions during an alarm.

4-5.5 Parameters

(1) Parameter list

Table 4-1 Parameter list for speed servo

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
User parameters	0	*MTY	Motor type	####		
	1	*STY	Servo loop (1) Positioning/speed servo (Note) The unit is set to positioning servo as the default, so change to "0001" for the speed servo. (2) Regenerative resistor option (3) Auto tuning selection	0000		0 to 7395h
	2	SC1	Internal speed command (1)	100	r/min	0 to max speed
	3	SC2	Internal speed command (2)	1000	r/min	0 to max speed
	4	SC3	Internal speed command (3)	2000	r/min	0 to max speed
	5	STC	Acceleration time constant	20	10ms	0 to 5000
	6	STB	Deceleration time constant	20	10ms	0 to 5000
Special parameters	7	*OPC	Special functions (1) Speed S-character acceleration/deceleration (2) Servo lock validity when speed selection I and II signals are OFF	0		0 to 113h
	8	SCH	S-character acceleration/deceleration, curvature point speed	50	r/min	50 to 5000
	9	VCM	Speed at 10V command	Rated	r/min	0 to 6000
	10	ZSP	Zero speed	5	10r/min	1 to 500
	11	PGN	Position loop gain	25	rad/s	5 to 150
	12	VGN	Speed loop gain	100		70 to 999
	13	VIC	Speed integral compensation	25	ms	1 to 999
	14	VDC	Speed proportional control gain	98	%	0 to 100
	15	TLL	Torque limit value	100	%	0 to 100
	16	VCO	VC offset Note)	Default setting	mV	–99 to 99
	17	MOO	Analog monitor, offset	0	mV	–20 to 100
	18	—	Spare	0		
	19	IPO	Input/output signal selection	04E		0 to 1AFh
	20	*DMD	Monitor selection (1) Status display when power is switched ON (2) Encoder output division rate (3) Analog monitor output selection	002		0 to DF7h

: The initial value (factory default value) will differ according to the amplifier size.

* : These are validated when the power is switched OFF/ON after setting.

Note: The default value is set so that the motor speed with a speed command voltage of 0V will be less than ± 6r/min.

(2) Explanation of parameters

Table 4-2 Details of speed servo parameters

<table>
<tr><th>Class</th><th>Pr.</th><th>Abb.</th><th>Name</th><th>Initial Value</th><th>Unit</th><th>Range</th></tr>
<tr><td rowspan="2">User parameters</td><td>0</td><td>*MTY</td><td>Motor type:
□□□□

<table>
<tr><th colspan="2"></th><th>Motor series</th><th colspan="12">Motor rating (parameter set value)</th></tr>
<tr><td>Ampli-fier</td><td>MR-J</td><td>—</td><td>10A
10A1</td><td>20A
20A1</td><td>40A
40A1</td><td>60A</td><td>70A</td><td>100A</td><td>200A</td><td>350A</td><td>10MA
10MA1</td><td>20MA
20MA1</td><td>40MA
40MA1</td><td>70MA</td></tr>
<tr><td rowspan="12">Motor</td><td rowspan="3">HA-FE</td><td rowspan="3">0</td><td>053</td><td>23</td><td>33</td><td>63</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>13</td><td>—</td><td>43</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td rowspan="6">HA-SE</td><td rowspan="6">1</td><td>—</td><td>—</td><td>—</td><td>—</td><td>52</td><td>102</td><td>152</td><td>352</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>—</td><td>—</td><td>—</td><td>—</td><td>53</td><td>103</td><td>202</td><td>353</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>81</td><td>153</td><td>301</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>121</td><td>203</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>201</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td rowspan="2">HA-ME</td><td rowspan="2">3</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>053</td><td>23</td><td>43</td><td>73</td></tr>
<tr><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>13</td><td>—</td><td>—</td><td>—</td></tr>
</table>
Note: When combining with a servo motor whose rated speed is not equal to the initial value, change settings of Pr. 2, 3, 4 and 9. A parameter alarm (AL 37) may occur if the power is switched ON without changing the settings.</td><td>The highlighted values in the table are the initial values.</td><td></td><td></td></tr>
<tr><td>1</td><td>*STY</td><td>Servo loop type:
The servo loop and validity of the regenerative option are set here.
0□□1

0: Standard mode, position servo (pulse train)
1: Standard mode, speed servo (analog, three internal speeds)
4: Low noise mode, position servo (pulse train)
5: Low noise mode, speed servo (analog, three internal speeds)

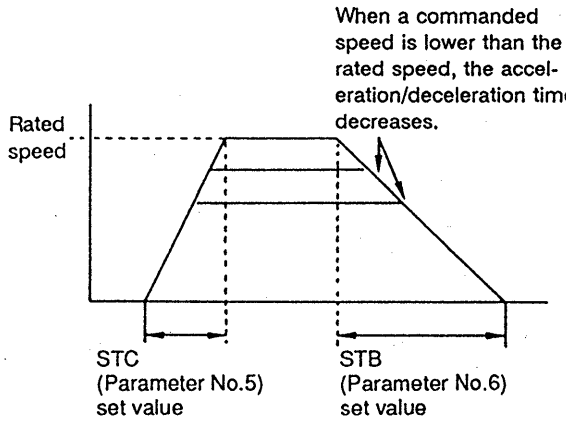
0: No regenerative option
1: Regenerative option (MR-RB013)
2: Regenerative option (MR-RB033)
3: Regenerative option (MR-RB064 × 2 series)
4: Regenerative option (MR-RB064)
5: Regenerative option (MR-RB10 × 2 series)
6: Regenerative option (MR-RB30 × 2 series)
7: Regenerative option (MR-RB10)
8: Regenerative option (MR-RB30)
9: Regenerative option (MR-RB50)

There are limits to the combination of the regenerative option and servo amplifier. Refer to Section 6-1.

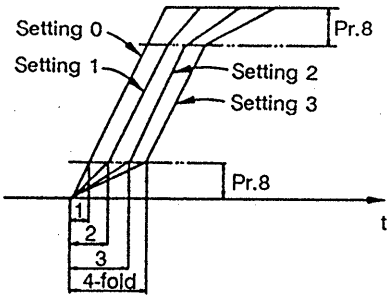
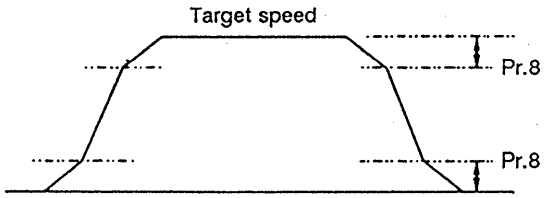
0: Automatic tuning valid (medium response)
1: Automatic tuning valid (fast response)
2: Automatic tuning valid (slow response)
3: Automatic tuning invalid</td><td>0000

(Note)
The factory default setting is set to the position servo. Change Pr. 1 when using as a speed servo.</td><td></td><td>0 to 7395h</td></tr>
</table>

Continued on the next page.

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
User parameters	2	SC1	Internal speed command (1) The first of the three internal speed commands is set. This is selected when input signal DI1 is switched ON.	100	r/min	0 to Max. speed
	3	SC2	Internal speed command (2) The second of the three internal speed commands is set. This is selected when input signal DI2 is switched ON.	1000	r/min	0 to Max. speed
	4	SC3	Internal speed command (3) The third of the three internal speed commands is set. This is selected when both input signals DI1 and DI2 are switched ON.	2000	r/min	0 to Max. speed
	5	STC	Acceleration time constant The acceleration time to reach the rated speed for the speed command (external analog, internal three speeds) is set here. 	20	10 msec	0 to 5000
	6	STB	Deceleration time constant The deceleration time to reach zero speed for the speed command (external analog, internal three speeds) is set here.	20	10 msec	0 to 5000

Continued on the next page.

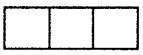
Class	Pr.	Abb.	Name	Initial Value	Unit	Range
Special parameters	7	*OPC	Special function selection: 0 _ _ _ S-character acceleration/deceleration selection 0: S-character acceleration/deceleration invalid (trapezoid acceleration/deceleration will be used.) 1: S-character acceleration/deceleration (1) valid 2: S-character acceleration/deceleration (2) valid 3: S-character acceleration/deceleration (3) valid The slope at the start and stop of the S-character acceleration/deceleration will increase in 2, 3, and 4-fold as shown below.  Selection of validity of servo lock during forward /reverse run start signal (ST1, ST2) OFF 0: Servo lock valid 1: Servo lock invalid Note: When servo lock is valid, the application of an external force in the rotating direction during a stop of the motor generates a counterforce to maintain the position. When servo lock is invalid, the counterforce is generated but does not return the motor shaft to the original position.	0000		0000 to 113h
	8	SCH	S-character acceleration/deceleration time constant changing speed The speed for changing the S-character acceleration/deceleration slope is set.  	50	r/min	50 to 5000
	9	VCM	Speed during 10V command The speed for when a 10V is input to the external speed command voltage is set. Change this when operating the HA-FE servo motor at more than 3000r/min. (Ex.) Set to "4000" to run with the 10V command at 4000r/min.	Rated	r/min	0 to 6000

Continued on the next page.

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
Special parameters	10	ZSP	Zero speed The output signal (ZSP) is switched ON when the speed is below the set zero speed.	5	10r/min	1 to 500
	11	PGN	Position loop gain The position loop gain during servo lock is set here. This value will change automatically when automatic tuning is executed.	25	rad/S	5 to 150
	12	VGN	Speed loop gain The speed loop gain is set. The value will change automatically when automatic tuning is executed.	100		70 to 999
	13	VIC	Speed integral compensation The time constant for integral compensation is set here. The value will change automatically when automatic tuning is executed.	25	msec	1 to 999
	14	VDC	Speed proportional control gain The proportional control will be validated when the proportional control input signal (PC) is switched ON. The proportional integral control will be activated when set to 100, and the proportional gain will decrease with a smaller value.	98	%	0 to 100
	15	TLL	Torque limit value With a maximum torque of 100%, the MAX torque to be used is set. When the external torque limit input signal (TL) switches ON, the smaller of the external torque limit value or this parameter set value will be valid. The MAX torque set with this parameter will be 8V when the torque is monitored with monitor output.	100	%	0 to 100
	16	VCO	External speed command (VC) offset The offset for the external speed command analog input is set here. Set a value where the servo motor will not rotate with the speed command zero. Refer to Section 5-7 for the automatic offset adjustment.	Factory setting	2mV	-99 to 99
	17	MOO	Analog monitor offset The offset for the analog monitor output is set here.	0	mV	-20 to 100
	18		Spare	0		

Continued on the next page.

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
Special parameters	19	IPO	Input/output signal selection The input signal functions of the connector CN1 pins 32 and 33, and the output signal functions of pins 25 and 26 are selected.	04E		1 to 1AFh



Input pin function selection

Setting	Pin 32	Pin 33	
1	PC	TL	(For signal names, refer to Table 4-3.)
2	DI1	TL	
3	DI2	TL	
6	DI1	PC	
7	DI2	PC	
b	DI2	DI1	
E	DI1	DI2	← Initial value

Output pin function selection

Setting	Pin 25	Pin 26	
1	ZSP	PF	
2	TLC	PF	
4	PF	ZSP	← Initial value
6	TLC	ZSP	

Alarm code output
0: invalid
1: valid
The alarm codes from the output pins (24, 25, 26) during an alarm are output in 3 bits.

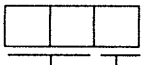
Note: The alarm code will be output when an alarm occurs and the ALM output is turned off.

Alarm name	Alarm No.	ZSP (26)	PF (25)	RD (24)	Code
Undervoltage	AL10	0	1	0	2
Memory error 1 (RAM, ROM)	12	0	0	0	0
Memory error 2 (EEPROM)	15	0	0	0	0
Polarity detection error	16	0	1	1	3
PCB error (A/D error)	17	0	0	0	0
Over-regeneration	30	1	0	0	4
Overspeed	31	1	0	1	5
Overcurrent	32	0	0	1	1
Overvoltage	33	1	0	0	4
Command frequency error	35	1	0	1	5
Parameter error	37	0	0	0	0
Fin overheating	45	1	1	0	6
Overload	50	1	1	0	6
Excessive difference	52	1	0	1	5
Screen changed during servo ON	90	1	1	1	7

1: continuity with SG, 0: no continuity

Continued on the next page.

Class	Pr.	Abb.	Name	Initial Value	Unit	Range
Special parameters	20	DMD	Monitor selection The display, monitor output and encoder output division rate are set here.		002	0 to DF7h

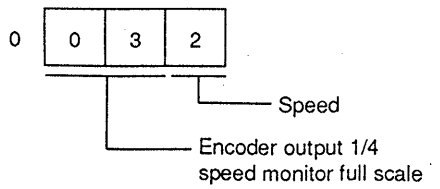


Display status selection when power is ON
0: Cumulative feedback pulses (lower 4 digits)
1: Cumulative feedback pulses (upper 3 digits)
2: Speed
3: Speed command voltage
4: Torque limit command voltage
5: Regenerative load ratio
6: Effective load ratio
7: Peak load ratio

Encoder output division ratio setting is made valid by re-setting the power.
Analog monitor output selection setting is made valid by pressing the [SET] button.

Setting	Setting of encoder output (FPA, FPB) division rate	Analog monitor output selection
00 01 02 03 : 0F 10 : 1F	1/1 1/2 1/3 1/4 : 1/16 1/17 : 1/32	Speed monitor (full-scale: 8V) Refer to the explanation of terminals in Section 7-4 (3), 8) for details.
40 41 42 : 5F	1/1 1/2 1/3 : 1/32	Torque monitor (full-scale: 8V)
80 : 9F	1/1 : 1/32	Speed monitor (Zero center meter, full-scale: 5V ± 4V)
C0 : dF	1/1 : 1/32	Torque monitor (Zero center meter, full-scale: 5V ± 4V)

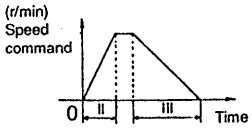
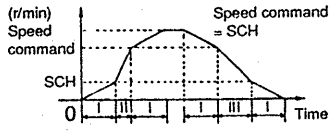
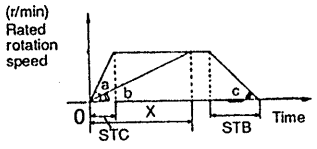
(Setting example)
Encoder output division rate: 1/4
Analog monitor output: Speed monitor (repeated full-scale)
"Speed" is set as the default status monitor:



(3) Acceleration/deceleration patterns

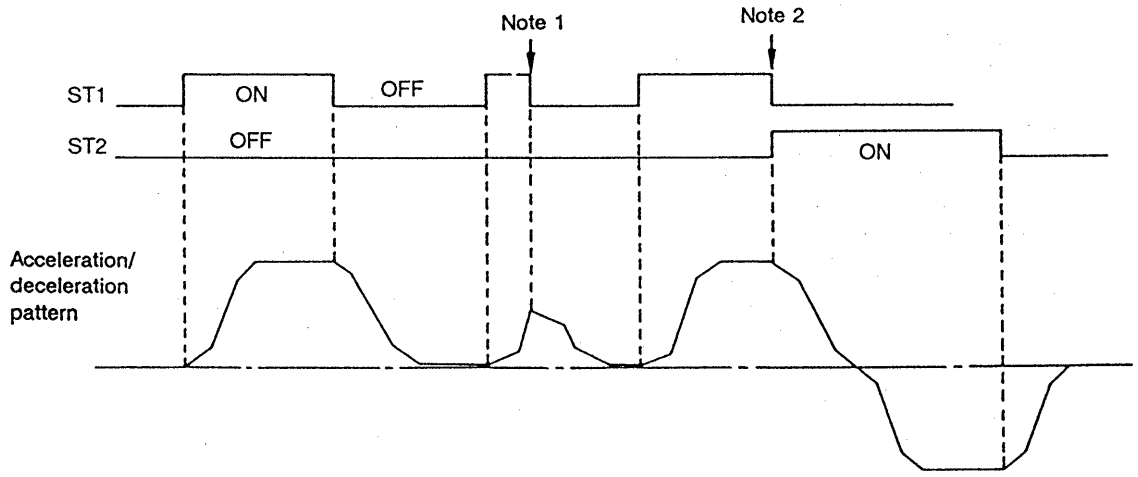
The acceleration/deceleration patterns that can be set with the internal parameters are explained below. Acceleration/deceleration patterns other than those explained cannot be set.

1) Setting example

No.	Parameter No. (name) setting value				Acceleration/deceleration pattern	Explanation
	Pr. 5 STC	Pr. 6 STB	Pr. 7 Lower 1 digit OPC	Pr. 8 SCH		
1	STC	STB	0	SCH (Ignored)	Acceleration/deceleration pattern 1 (OPC=0)  	When the start signal (ST1, ST2) switches ON, the acceleration will be according to the acceleration time set in Pr. 5, and the deceleration will be according to the deceleration time set in Pr. 6. Only one setting for each acceleration and deceleration time can be set.
	Trapezoid acceleration/ deceleration					
2	STC	STB	1	SCH	Acceleration/deceleration pattern 2 (OPC=1~3)  	The acceleration time is set in Pr. 5, the deceleration time in Pr. 6. The acceleration and deceleration between 0 and SCH and between (speed command value) and (speed command value-SCH) will both be the times of STC*2 (twice STC).
	S-character acceleration/ deceleration (1)					
3	STC	STB	2	SCH	Constants I : Acceleration/deceleration according to inclination b II : Acceleration according to inclination a III: Deceleration according to inclination c  	The time for S-character acceleration/deceleration (1) will be STC*3 (three times STC) between 0 and SCH and between (speed command value) and (speed command value-SCH).
	S-character acceleration/ deceleration (2)					
4	STC	STB	3	SCH	When OPC = 1, X = STC x 2 When OPC = 2, X = STC x 3 When OPC = 3, X = STC x 4	The time for S-character acceleration/deceleration (1) will be STC*4 (four times STC) between 0 and SCH and between (speed command value) and (speed command value-SCH).
	S-character acceleration/ deceleration (3)					

2) S-character acceleration/deceleration time chart

a. Start signal (ST1, ST2) and acceleration/deceleration pattern

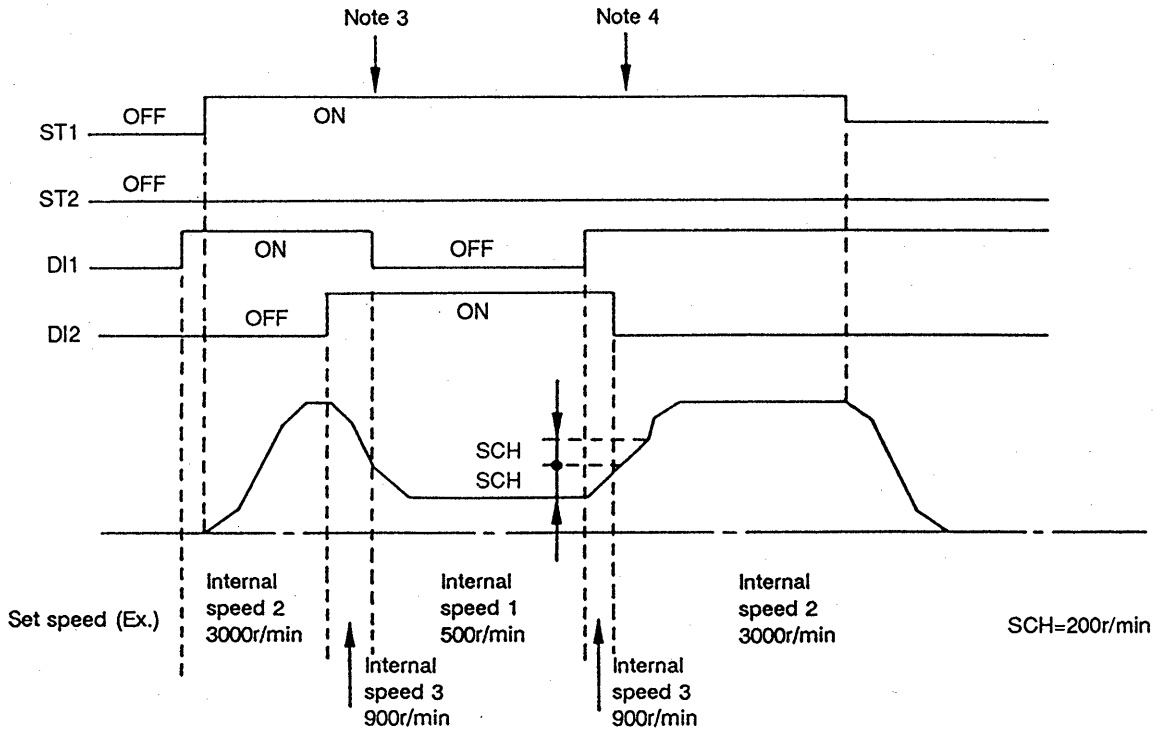


Note 1: If the start signal switches OFF during acceleration, the motor will S-character decelerate.

2: To change over from forward run (ST1) to reverse run (ST2), the motor will S-character decelerate to stop from forward run, and then will S-character accelerate to reverse run.

b. Speed selection (DI1, DI2) and acceleration/deceleration patterns

If the speed change from the current speed command to the next speed command is not 2*SCH (twice SCH) or more, the acceleration/deceleration will be a gradual acceleration/deceleration time (STC*(fold set in Pr. 7)). Even when the speed is changed by the internal speed commands the acceleration/deceleration times will be one type for both acceleration and deceleration.



Note 3: When decelerating from internal speed 2 (3000r/min) to internal speed 3 (900r/min), and the acceleration/deceleration time is changed gradually at 1100r/min, a change to internal speed 1 (500r/min) will cause a gradual acceleration/deceleration time to be applied between 1100r/min and 500r/min.

4: The gradual acceleration/deceleration time range may extend in the same way also during acceleration.

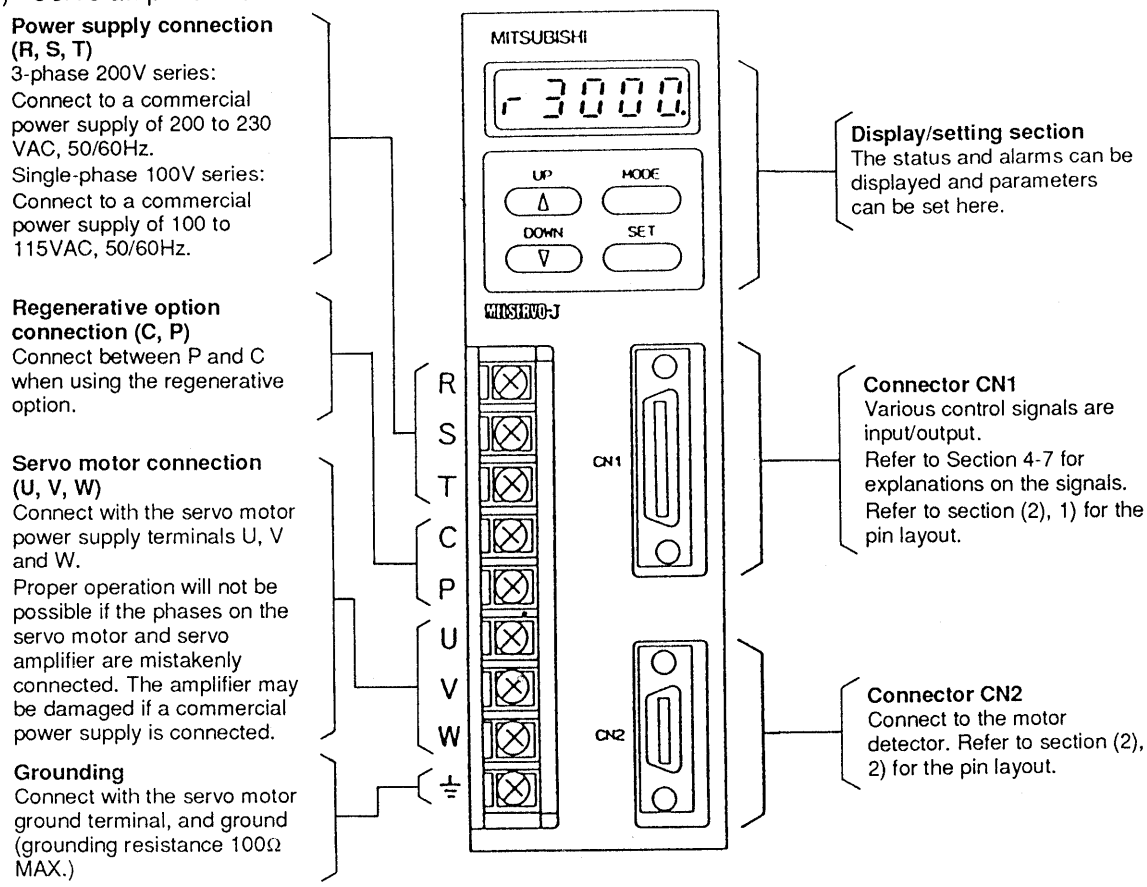
3) External analog speed command and S-character acceleration/deceleration

a. If the change in the external analog speed command (hereafter VC command) is 2*SCH or less, the speed will change with a gradual acceleration/deceleration time.
(If there is a large noise or ripple in the VC command, set a gradual acceleration/deceleration time range in the area where the noise or ripple occurs. A filter will be applied to these noises and ripples, and the servo motor speed will be smoothed.)

b. If the VC command changes, and the VC command with servo amplifier input sampling changes 2*SCH or more, an S-curve acceleration/deceleration pattern will be created. Thus, a gradual acceleration/deceleration time that is longer than the SCH duration may be applied.

4-6 Wiring

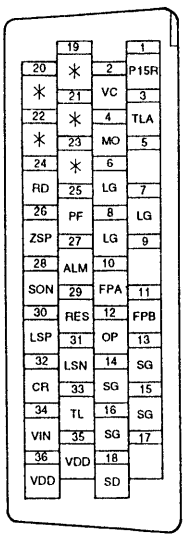
(1) Servo amplifier front view



(2) Connector pin layout diagram

The connector pin layout diagram looking from the cable wiring side is shown below. The pin number is indicated on the upper row, and the signal name on the lower row.

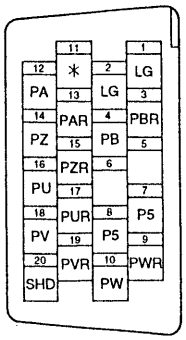
1) CN1 (connector for control signals)
Model PCR-S36FS connector
(Made by HONDA)
PCR-LS36LA (case)



Pin No.
Signal name

Connector pin layout diagram

2) CN2 (connector for PLG signals)
Model PCR-S20FS connector
(Made by HONDA)
PCR-LS20LA1 (case)



Pin No.
Signal name

Connector pin layout diagram

4-6.1 Standard connection diagram

(1) Standard connection for speed control operation

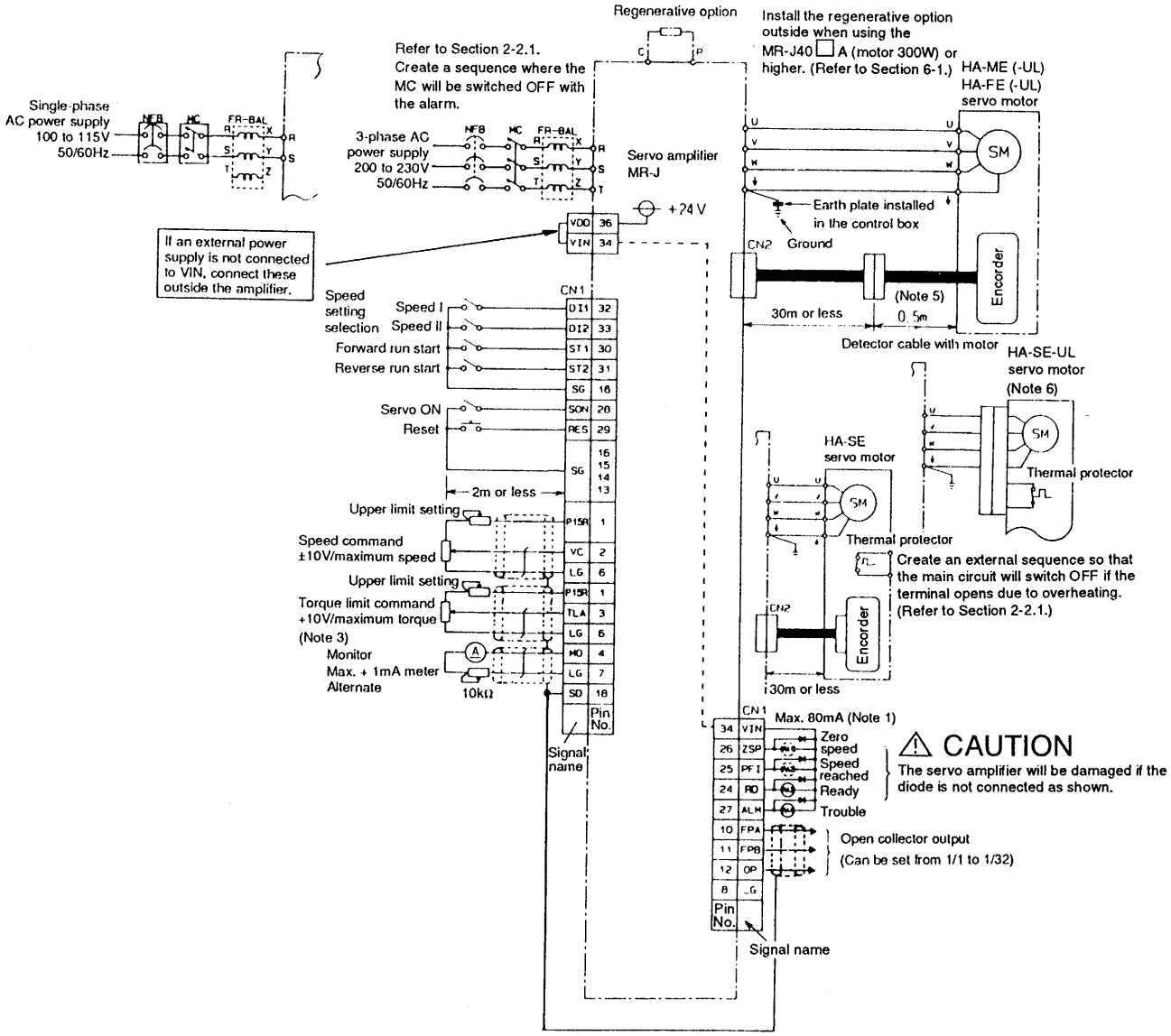
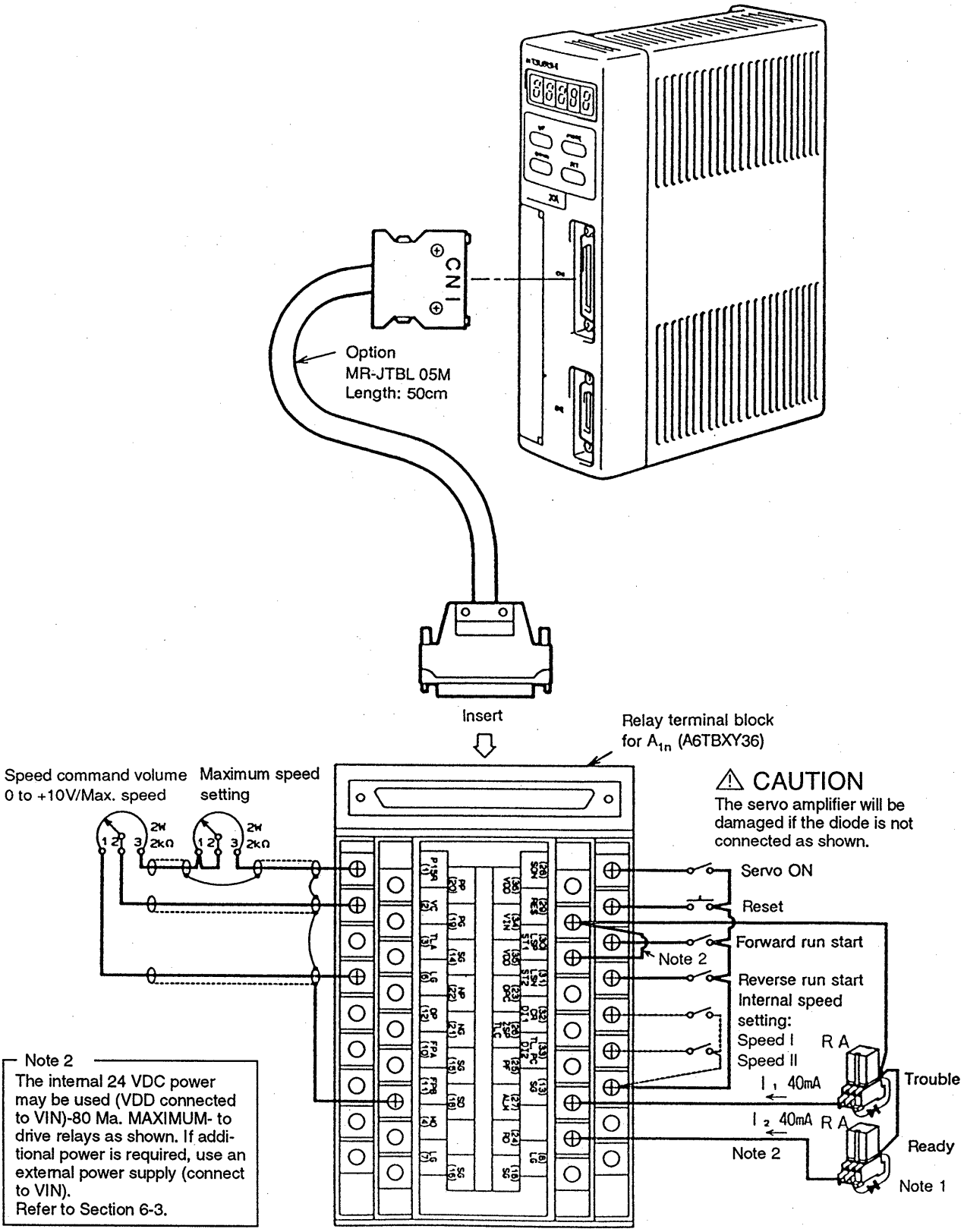


Fig. 4-1 Standard connection diagram for speed control operatio

Note:
1. The total current to the external relays should not exceed 80mA.
2. The servo amplifier may be damaged if the diode polarity is inverted and connected.
3. When validating the external torque limit, validate the torque limit function with the parameter setting.
4. The pins with the same signal name are connected inside the servo amplifier.
5. 0.3m for the HA-ME series.
6. For the UL listed and CSA certified HA-SE servo motor, connectors are used for connection with the power supply. (Refer to Section 2-1.4.)
   Motor side: MS3102A22-23P or MS3102A24-10P
   Cable side: MS3106B22-23S or MS3106B24-10S

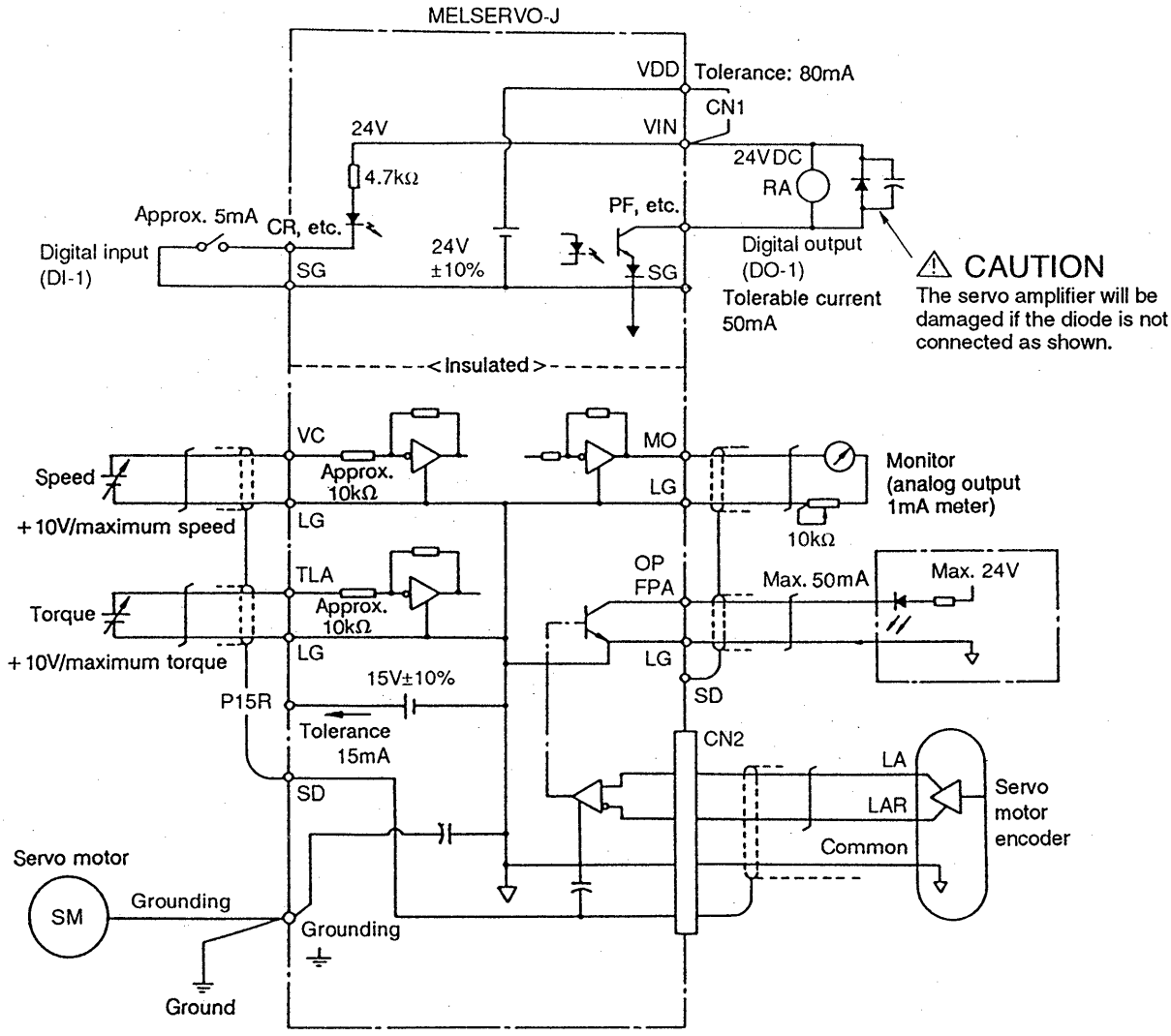
(2) Basic wiring

• Connection example using a relay terminal block



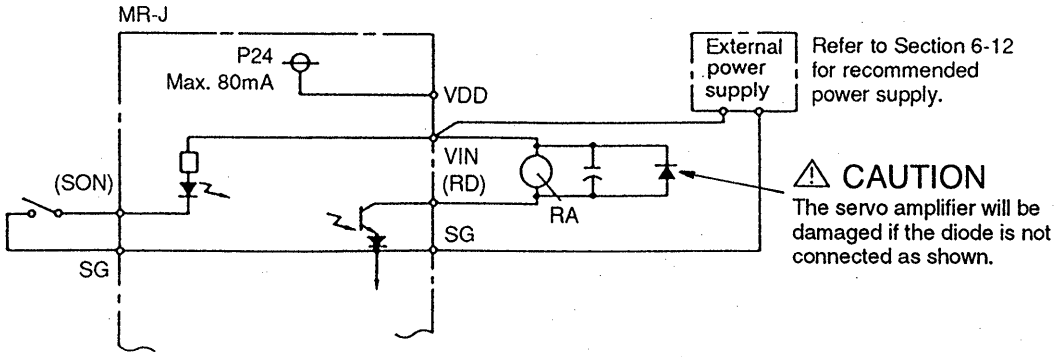
4-6.2 Common line diagram for speed servo

The internal power supply (24V, 15V) and the common lines of the servo amplifier are shown below. The power supply is separated into two systems, properly wire these. Use shields if the unit is affected by external noise, and carefully ground these.



4-6.3 Interface power supply

The power supply VDD (+24V) built into the servo amplifier can be used for digital input/output signals. If the current capacity is insufficient, do not connect VDD and VIN, instead use an the externally installed power supply.



4-7 Explanation of signals

(1) Explanation of signals

Table 4-3 List of signals

Signal name	Symbol	Pin No.	Explanation	I/O class
Servo ON	SON	28	Operation is possible when the servo ON signal is switched ON.	DI-1
Reset	RES	29	The alarm can be reset when the alarm reset signal is switched ON for 50msec or more. However, memory, card and parameter errors cannot be reset with this signal. For regenerative and overload errors, the alarm cannot be reset with the alarm reset signal until the regenerative resistor or power transistor cools down.	
Forward run start	ST1	30	The motor will rotate when the forward run start signal is switched ON. The servo motor will run forward when the speed command (VC) is a positive voltage, and will run reverse when a negative voltage. When switched OFF, the servo motor will stop, and when both ST1 and ST2 are ON, will not run.	
Reverse run start	ST2	31	The motor will rotate when the reverse run start signal is switched ON. The servo motor will run reverse when the speed command (VC) is a positive voltage, and will run forward when a negative voltage.	
Speed I selection	DI1	32 33 (*1)	According to the combination of DI1 and DI2, the motor speed is set by the speed command (VC) or the internal speed command, (SC1, SC2, SC3). These are set.	
Speed II selection	DI2			
External torque limit	TL		When the external torque limit signal is switched ON, the torque output by the servo motor will be limited to the torque limit command (TLA) value, input with analog from an external source.	
Proportional contro	PC		When the proportional control signal is switched ON, the speed servo loop will be changed from a proportional integral type to a proportional type.	
Speed command	VC	2	The motor speed is set. The speed will be 0 to ±10V/ 0 to ±3000r/min. However, the servo motor speed input with 10V can be changed with parameter No. 9. Input impedance is approximately 10kΩ	Analog input
Torque limit command	TLA	3	Input the motor torque limit value when the external torque limit signal is switched ON. The relation is 0 to +10V/0 to maximum torque, as noted in Section 10-2. Input impedance is approximately 10kΩ	
15V power supply	P15R	1	+15V±10% is output between P15R and the control common LG. The maximum current available is 30mA.	——
Control common	LG	6, 7, 8	This is the common terminal for the torque limit command TLA, monitor MO, A, B, and Z-phase PLG pulse FPA, FPB, OP signals.	
24V power supply	VDD	35, 36	+24V±10% is output between VDD and common SG. The maximum current available is 80mA.	

Continued on the next page.

Signal name	Symbol	Pin No.	Explanation	I/O class
24V common	SG	13, 14, 15, 16	This is the common terminal for the 24V power supply.	——
Digital I/F power supply input	VIN	34	A 24V power supply is input for the digital I/F. Connect between VIN and VDD when using the 24V power supply in the servo amplifier.	——
Shield	SD	18	Connect one end of the shielded wire.	——
Ready	RD	24	The ready signal switches ON when the servo ON signal is input and the servo can be run.	DO-1
Trouble	ALM	27	The trouble signal will switch OFF when an alarm occurs in the servo. The trouble signal will switch ON approx. 0.8 seconds after the power is switched ON.	
Speed reached	PF	25	The speed reached signal switches ON when the motor speed reaches the speed set in the speed command (VC) or parameter (SC1, SC2, SC3).	
Zero speed	ZSP	26 Select ZSP or TLC with the parameter.	The zero speed signal switches ON when the servo motor speed drops below the zero speed set in the parameter.	
Limiting torque	TLC		The limiting torque signal switches ON when the torque output reaches the torque limit value.	
A-phase PLG pulse	FPA	10	The feedback pulse from the encoder mounted onto the servo motor is output. The feedback pulse can be divided from 1/1 to 1/32 with the corresponding parameter.	DO-2
B-phase PLG pulse	FPB	11	When the motor is rotating in the forward direction, the FPA will be the pulse that is a 90° phase forward from FPB.	
Z-phase PLG pulse	OP	12	One pulse will be output with one servo motor rotation.	
Monitor	MO	4	The motor speed or torque is output as an analog voltage. Select whether to output the speed or torque with the corresponding parameter. When outputting the speed, this is maximum speed (8V), and when outputting the torque, this is the maximum torque (8V). Use parameter No. 15 to select.	Analog output

*1: Assign speed I, speed II, external torque limit, or proportional control to pins 32 or 33. Select with parameter NO. 19. The initial setting value is DI1-32, DI2-33.

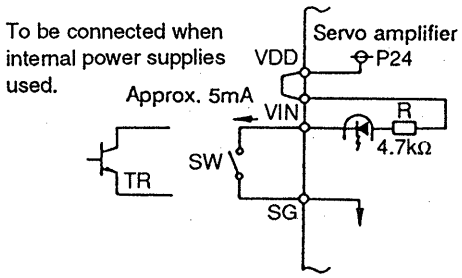
*2: Assign speed reached, zero speed, or limiting torque to pins 25 and 26. Select with parameter NO. 19. The initial setting value is PF-25, ZSP-26.

(2) Interface

The details of each interface noted in Table 4-3 (I/O class) are shown below. Refer to this, and connect with external equipment.

Digital input interface (DI-1)

Apply a signal with a miniature relay or open collector TR.

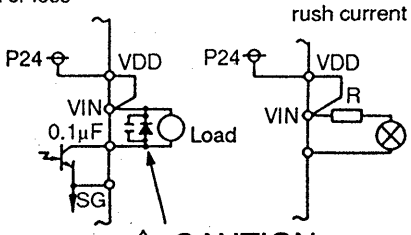


Digital input interface (DO-1)

The lamp, relay or photocoupler can be driven.

Allowable current:
50mA or less
In-rush current:
100mA or less

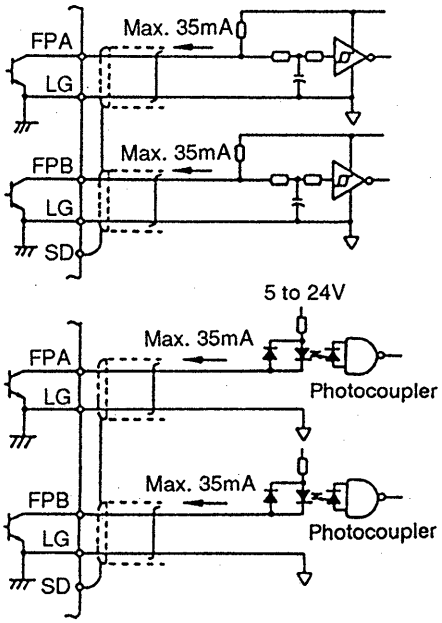
Note: For an inductive load install a suppressor (D.C.), and for lamp load install a resistor (R) for in-rush current suppression.



⚠ CAUTION
The servo amplifier will be damaged if the diode is not connected as shown.

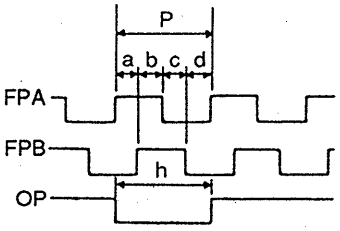
Pulse train output interface (DO-2)

• Interface example



• Phase relation

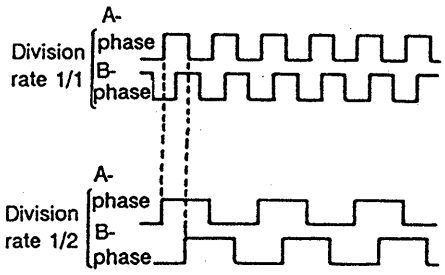
During motor CCW rotation



1. a, b, c, d=P/4±P/8±1μs
   (This is established regardless of the output division rate.)
2. h=P'±P'/2±1μs
   (P' equals to the duration of one FPA pulse when the output division rate is 1/1.)

• Division waveform

Either ON or OF width is a multiple of each division. (50% duty)



(3) Explanation of signals

1) Speed command input (VC):

(a) Speed command level:
The relation of the speed command level and motor speed is shown on the right.

Note: The figure shows the example when the motor has a rated speed of 3000r/min. When the servo motor has a rated speed of 2000r/min., this will be 2000r/min at ±10V.
By changing Pr. 9 (the speed at 10V command), the speed when 10V is applied can be changed.
When using a servo motor with 4000r/min, the setting of Pr. 9 must be changed.
A negative power supply is not built into the servo amplifier, so when using both a positive and negative command, also use an external negative power supply.

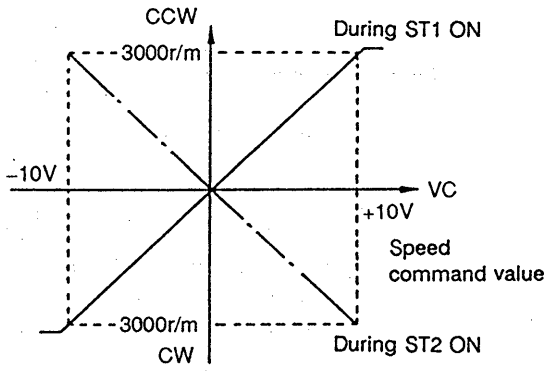


Fig. 4-2 External speed command level

(b) Speed command circuit:
When a speed command is given using the +15V (P15R) power supply in the servo amplifier, there will be a ±2% temperature fluctuation in the command voltage. Use a rotary coil type potentiometer to raise the speed setting resolution.

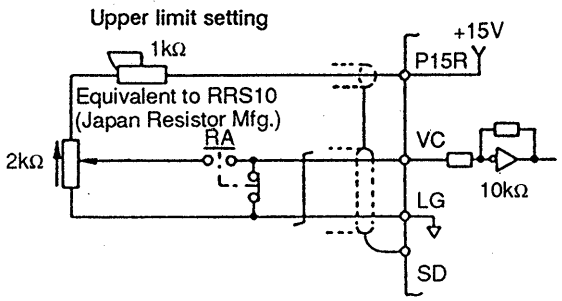
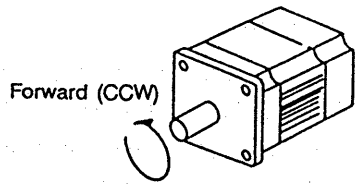


Fig. 4-3 External speed command circuit

2) Start signals (ST1, ST2):
The servo motor is started and stopped with forward/reverse start signals (ST1, ST2). The relation of the external speed command (VC) polarity, (ST1, ST2) and the motor's forward/reverse direction is noted on the right.

Table 4-4 Servo motor rotation direction

External speed command (VC) polarity	Forward start signal ST1 ON	Reverse start signal ST2 ON
+ Positive polarity	Forward	Reverse
- Negative polarity	Reverse	Forward



When ST1 and ST2 are both switched ON or OFF, the motor will decelerate and stop with the deceleration time constant set in parameter (STB), and will be servo locked.
If either ST1 or ST2 is ON and VC=0, Pr. 7 can be used to make servo lock invalid.
For details, refer to Section 4-5.5 Parameters.

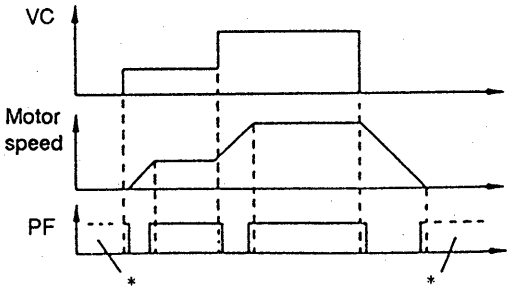
3) Speed selection (DI1, DI2):
One of four speed commands is selected by the inputs DI1 and DI2 according to the following table. The rotation direction is set with either ST1 or ST2.

Table 4-5 Internal speed selection signal

Speed command sourse		DI1	DI2
Parameter setting speed	1st speed (SC1)	ON	OFF
	2nd speed (SC2)	OFF	ON
	3rd speed (SC3)	ON	ON
External speed command (VC)		OFF	OFF

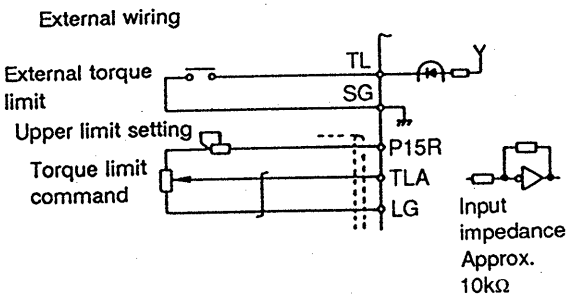
Note 1: When operating with the internal speed command, there will be no fluctuation in the speed caused by changes in the ambient temperature.

4) Speed reached (PF):
PF will remain ON when the speed command (VC, SC1, SC2, and SC3) is 30r/min or less.
PF will remain OFF when ST1 and ST2 are both OFF.

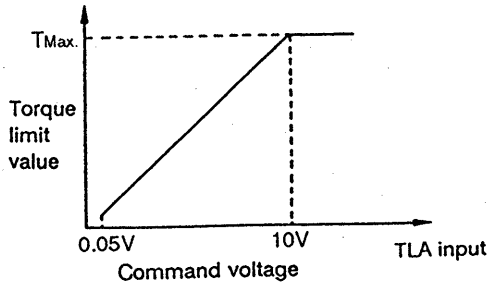


* PF will not switch ON when ST1 and ST2 are both OFF

5) Torque limit
Normally the torque is limited in the servo amplifier to the value set in parameter No. 15. If there are mechanical system limits such as with the gear capacity, the Max. torque can be set smaller with Pr. 15. To change the torque limit value from an external source, wire as shown in the diagram (at right), and switch ON the external torque limit command TL. The torque limit value will be the smaller of the TLA level or Pr. 15 level.



Torque limit command and motor torque:
The relation of the TLA voltage level and the motor generated torque is shown on the right. The servo motor generated torque will have a difference of about 5% depending on the servo motor.



If the speed command is low such as 50mV or less, a proper limit will not be applied, and the torque will fluctuate. If there are problems, increase the limit value.

6) Limiting torque (TLC):
This switches ON when the servo motor torque reaches the set torque limit value such as during acceleration or deceleration.
If the external torque limit is not applied, this will switch ON at the output of torque whose torque limit has been set with Pr. 15.

7) Zero speed (ZSP):
This switches ON when the motor speed drops to or below that set with Pr. 11.
The detection has a hysteresis as shown in Fig.4-4.

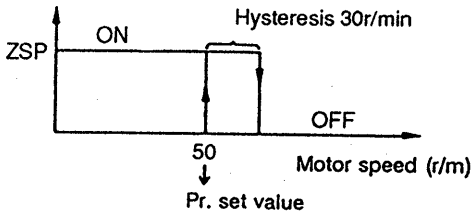
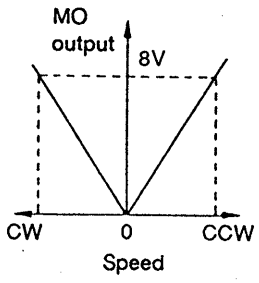
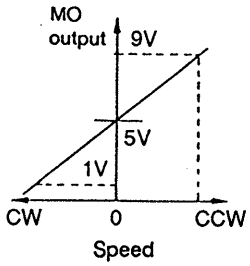
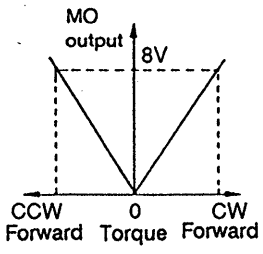
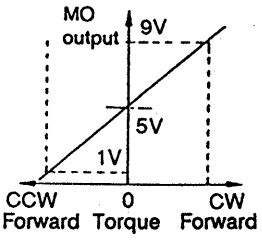


Fig. 4-4 Zero speed detection level

8) Analog monitor output (MO):
Any of the following four levels can be selected with parameter No. 20.

Table 4-6 Monitor output pattern

Monitor	Speed		Torque (motor current)	
Pr. 20	Factory default value 0□□	8□□	4□□	C□□
MO output details	(+8V/maximum speed)	(5±4V/maximum speed)	(+8V/Pr. 15 setting Max. torque)	(5±4V/Pr. 15 setting Max. torque)
				

Contents

5-1 Adjustments

5-1.1 Start-up adjustment sequence

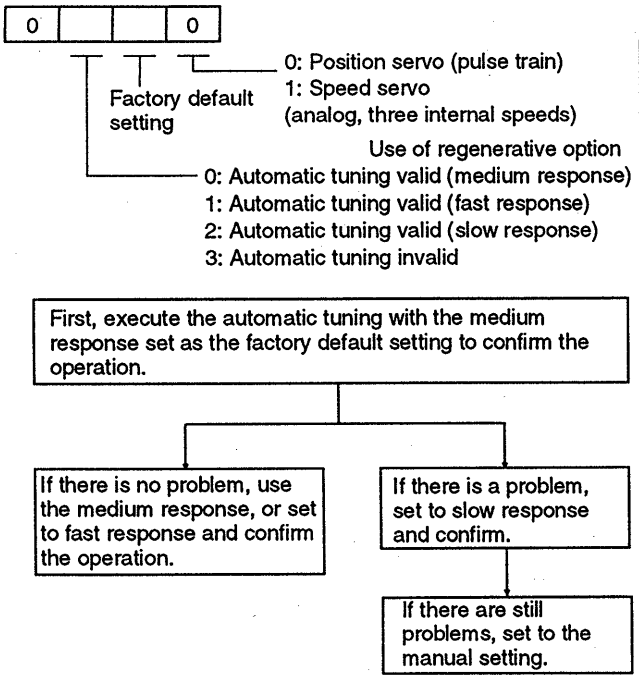
The following table lists faults, checks and actions corresponding to the steps of the servo start-up sequence. The alarm codes are shown below as they would be displayed on the servo amplifiers LED display.

No.	Start-up sequence	Fault		Check/action	Assumed cause	Refer to:
1	Power ON	• LED is not lit.		Not improved by disconnecting connectors CN1, CN2.	Servo amplifier failure	—
		• LED flickers.		Improved by disconnecting connector CN1.	Power supply of the CN1 cable is shorted.	
				Improved by disconnecting connector CN2.	1) Power supply of the CN2 cable is shorted. 2) Encoder failure	
		Alarm occurs	AL-12, 15, 17	Disconnect connectors CN1, CN2.	If not improved, the amplifier has failed.	Section 8-4
			AL-37	Check ALP□□ (parameter number).		
			AL-10	Check the power supply voltage.	Power supply voltage low.	
			AL-16	Check the CN2 cable for disconnection.	1) CN2 cable connection fault 2) Cable disconnection, servo amplifier failure, encoder failure	
			AL-30	Check the power supply voltage.	1) Power supply voltage too high. 2) If the power supply voltage is normal, the servo amplifier has failed.	
			AL CPU AL CO	Switch the power off, then on.	If not improved, the servo amplifier has failed.	
2	Switch on the servo ON signal.	Alarm occurs.	AL-32	Disconnect cables from the servo amplifier output terminals (U, V, W) and switch on the servo.	1) If not improved, the servo amplifier has failed. 2) If improved, a short circuit or ground fault has occurred in the wiring or servo motor.	Section 8-4
			AL-50	• Check the status display (peak load ratio b). It is about 300 as soon as the servo is switched on, and the alarm occurs in 1 to 2 seconds. • Motor shaft moves slightly and is then locked.	1) Servo amplifier output terminal (U, V, W) wiring fault 2) Encoder wiring fault	Section 3-5 Section 4-5 Section 8-4
				• Servo motor shaft oscillates. The alarm occurs in several to several ten seconds.	1) Load inertia is large and servo is instable. (a) Execute auto tuning. (b) Set the position loop gain (parameter No. 5 or No. 11) to "7". (Make servo gain adjustment.)	
		Not servo locked. (The motor shaft is free.)		• Check the rotation trouble display or external I/O signal display.	(a) Servo ON signal is not input (wiring fault) (b) VIN and VDD are not connected.	Section 3-5 Section 4-5 Section 5-2.1
				With the servo OFF, turn the servo motor shaft and check the cumulative feedback pulses.	If a change of 4000 pulses does not occur after one revolution of the servo motor, the encoder has failed or cable wiring is faulty.	

No.	Start-up sequence	Fault	Check/action	Assumed cause	Refer to:
3	Input the position (speed) command. (Test run)	Servo motor does not rotate.	• Check the rotation trouble display.	1) Wiring fault (a) VIN and VDD are not connected.	Section 3-5 Section 4-5 Section 5-2.1
			1) Position servo: Check the cumulative command pulse P display.	1) Wiring fault (a) VDD and OP are not connected. 2) Pulses are not input.	
			2) Speed servo: Check the speed command voltage F display.	1) Wiring fault 2) Speed command (analog) is not input.	
4	Make gain adjustment.	Rotating ripples (speed fluctuation) is large at low speed.	Make gain adjustment with the following procedure: 1) Decrease the setting of the speed integral compensation (Pr. 13). (The limit value is "10" or where the machine begins to make a sound.) 2) Increase the setting of the speed loop gain (Pr. 12). (The limit value is where the machine begins to make a sound.)	Gain adjustment fault	Section 5-3.1
		Load inertia is large and the servo motor oscillates.	Make gain adjustment with the following procedure: 1) Execute auto tuning or set the position loop gain to "7". 2) Increase the setting of the speed loop gain (Pr. 12). (The limit value is where the machine begins to make a sound.) 3) Gradually increase the setting of the position loop gain (Pr. 5 or Pr. 11). (The limit value is where overshooting begins to occur at a stop.)	Gain adjustment fault	Section 5-1.3
5	Cyclic operation	Position offset occurs. (Position servo)	Check the controller's output counter command pulse value (P) and feedback pulse value (C) and the actual servo motor position.	Pulse count error, etc. due to noise	Section 8-5

5-1.2 Automatic tuning

First, confirm the setting details in parameter 1.



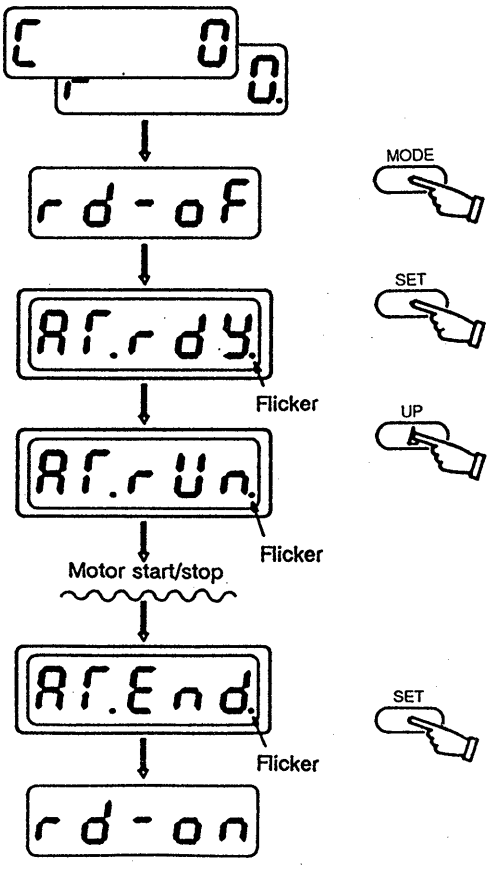
According to machine inertia (rigidity) or drive method, guidelines for fast, medium and slow response.

Drive method			Fast response	Medium response	Slow response
Horizontal drive	Ballscrew	Direct coupling	O		
		With speed reducer		O	
	Rack and pinion	Direct coupling		O	
		With speed reducer		O	
	Timing belt	Direct coupling		O	
		With speed reducer		O	
	Chain	Direct coupling			O
		With speed reducer			O
	Roll feed	Direct coupling	O		
		With speed reducer	O		
	Automated guided vehicle	Direct coupling			O
		With speed reducer			O

Note: In vertical drive applications gain adjustment should be made manually.

In executing automatic tuning:
1) Use the acceleration/deceleration times between 50ms and 5s.
2) Always use the ⌐¬ type acceleration/deceleration command pattern.
3) Set the speed to 500r/min or higher.

(Operation method)



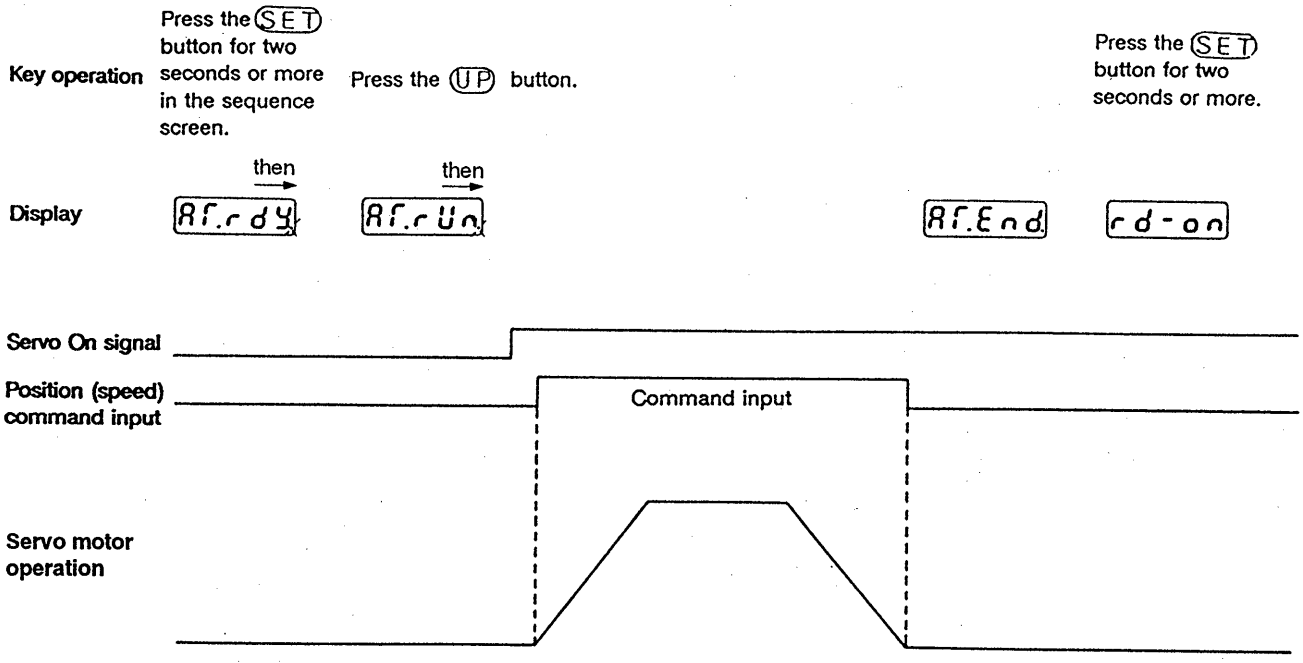
About 5 seconds after the power is switched ON, the status display will be shown.

C 0: Position servo

r 0: Speed servo

- Select the display for the diagnosis setting.
- Press the "SET" button for two seconds or more.
- The ready screen "ATrdy" will be displayed.
- The tuning screen "AT. run" will appear when the "UP" button is pressed.
- Switch the servo ON, apply an external command, and start and stop the motor.
- Tuning will end, and "ATEnd" will be displayed. Press the "UP" button to try again.
- The original screen will be displayed when the "SET" button is pressed for two seconds or more.

(Timing chart for automatic tuning operation)



Explanation:

The automatic tuning screen is displayed.	The unit enters automatic tuning mode.	When the position (speed) command is input, the actual motor current (speed) and operation simulator current (speed) will be compared, and the inertia of the load directly coupled with the motor will be estimated.	When the servo motor stops, the parameters for the optimum position loop gain (PGN), speed loop gain (VGN), and speed integral compensation (VIC) will be set according to the of load inertia, and the automatic tuning mode will end.	The screen will return to the sequence screen.

Position (speed) command for automatic tuning

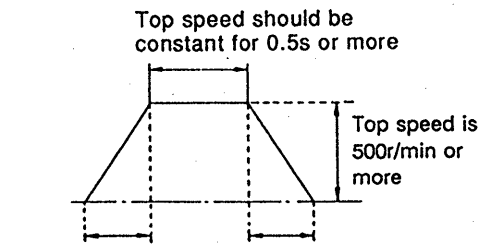
Automatic tuning requires a position (speed) command to initiate automatic tuning. Choice of inputs and required conditions are as specified below.

(1) Input of the position (speed) command for using automatic tuning

1) For positioning servo, use:
   • Pulse train position command
2) For speed servo, use:
   • External analog speed command
   • Internal three speed commands
3) Test mode operation 1 (operation without command)

(2) Conditions of position (speed) command input

1) The acceleration/deceleration time is between 50ms and 5s (the acceleration and deceleration times may differ.)
   Set the acceleration/deceleration time so that the servo motor acceleration/deceleration torque is less than the maximum torque within the above range.
2) A trapezoid acceleration/deceleration is made at the operation speed of 500r/min or more.
3) The operation speed is constant 0.5s or more. (With the positioning servo, if the position loop gain (PGN) is less than the initial value of 25 before automatic tuning, the top speed must be constant 0.5s or more.)



4) Caution
   Perform auto tuning with the servo motor shaft coupled to a load. If auto tuning is performed without a load (servo motor alone), the following may occur:

   a. Auto tuning is not completed; or

   b. The result of auto tuning will be faulty and the servo motor shaft will be oscillated and instable.

   In such a case, stop the auto tuning and set each gain manually. (Refer to Section 5-1.3.)

(3) If a position (speed) command input with conditions other than those above is applied:

1) Automatic tuning will not be completed (the display will remain as [AT.rUn] and will not switch to [AT.End]).
2) The parameter (PGN, VGN, and VIC) set values will not be the optimum values.

(4) Machine conditions for automatic tuning

In the following machines, correct gains may not be obtained even when automatic tuning is executed.

1) Machines with fluctuating load inertia or load torque.
2) Machines with large backlash.
3) Machines with low rigidity, or where mechanical resonance occurs easily.

5-1.3 Adjustment of the loop gain

The servo amplifier has gain parameters for adjusting its operation. Normally, stable operation can be obtained with automatic tuning. However, if the load is large, or undesirable vibration or noise occur during operation, adjust the parameters to obtain the best performance. Refer to the following explanation when adjusting the parameters.

When vibration and noise occur during operation
In most cases, the servo gain set does not match the load. Follow the procedure below to set the parameters.

(1) Parameters for adjustment and their features

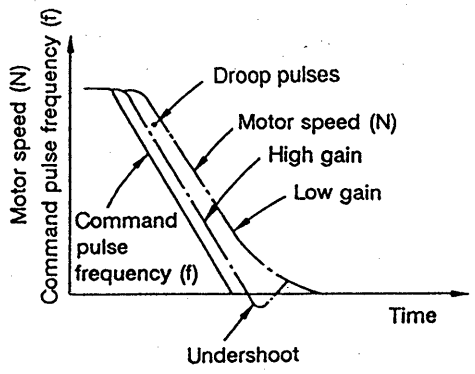
The related parameters and guidelines for setting values are indicated. The initial setting is designed to be optimum for J_L/J_M. If the load is large and vibration and noise occur, make setting after checking the following adjustment method:

1) Position loop gain (PGN)

The position loop gain specifies the number of droop pulses in the position deviation counter during operation. If the PGN is high, the droop pulses will decrease, and the setting time while the motor is stopped can be decreased. If this is set too high, undershooting or vibration during stopping may occur.

If only the PGN is increased when the load inertia ratio is large, the control system will be unstable, and vibration will occur. Set after adjusting the speed loop gain.

For general machines, set PGN to about 35. For machines with a large load inertia, reduce the PGN. To decrease the positioning settling time, increase the PGN. Note that the limit value is a setting where undershooting occurs.



(Remarks) Position loop gain and droop pulses
The droop pulses during operation can be represented by the following equation with the speed and position loop gain.

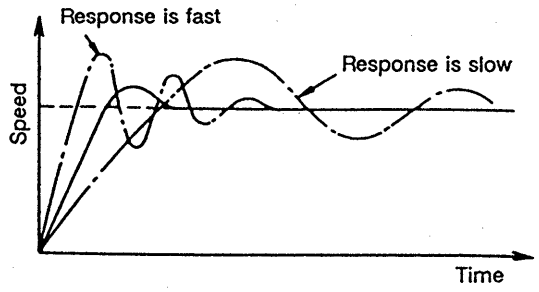
$$\varepsilon = \frac{f}{Kp} \quad \text{..... (5-1)}$$

Here, e : number of droop pulses (pulse)
f : command pulse frequency (pps)
Kp : position loop gain (rad/s)

When Kp is increased too much, the motor will vibrate. When Kp is lowered too far, the droop pulses will increase, and an alarm (AL52 excessive difference) will occur during high speed operation.

2) Speed loop gain (VGN)

If the load inertia ratio (JL/JM) is too large, the speed response of the control system will lower, and will be instable. Generally, increase the speed loop gain (VGN). If the VGN is increased too much at this time, vibration (abnormal noise) will occur during operation and stopping. This value is the limit value of the VGN. In consideration of the machine's variations and age, set the VGN to a value 50 to 80 smaller than the limit value. The servo motor speed and waveform relative to the step input of a 1V speed command can be observed by using the monitor output as shown below:

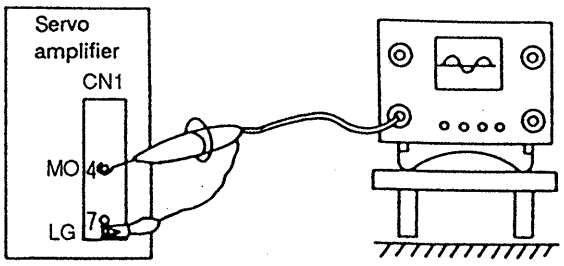


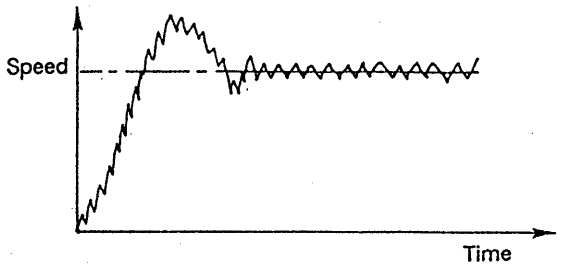
3) Speed integral compensation (VIC)

This is used to increase the frequency response of the speed control loop to improve the transient characteristics. For example, if the overshoot during acceleration/deceleration does not decrease with the VGN setting, the VIC setting can be increased. Also, when speed fluctuation or the like is large, setting the VIC setting can be derreased.

(2) Observation of signal

Display the servo motor speed on an oscilloscope, etc. Use the check pin speed monitor to display the speed feedback signals. The Cathode-ray oscilloscope should be isolated from ground, and make sure that the probe does not contact other connector pins.





Note: The speed feedback signal (speed monitor) viewed on the oscilloscope may have ripples of short durations as shown on the left. These ripples are produced because of the PWM system used for monitor output.

(3) Adjustment procedures

1) General adjustment

a. Gradually increase the speed loop gain VGN (Pr. 12) and set a value about 50 to 80 smaller than a point where machine vibration occurs (gear noise increases).

b. Generally, the position loop gain PGN (Pr. 5 or Pr. 11) may remain unchanged from the initial value and need not be adjusted.
Note that the position loop gain should be decreased when the load inertia is large and overshooting at a stop is not eliminated when the setting in above a. is executed.

2) To reduce the speed fluctuation of the motor at low speed

a. Gradually decrease the speed integral compensation VIC (Pr. 13) and set a value about 5 larger than a point where machine vibration occurs (gear noise increases).

b. Make adjustment as described in above 1).

3) When the servo motor oscillates at noticeably low frequency (4 to 6 times/second) at the time of servo ON (When the load inertia is much greater than the servo motor inertia):

a. Set the position loop gain PGN (Pr. 5 or Pr. 11) to "7".

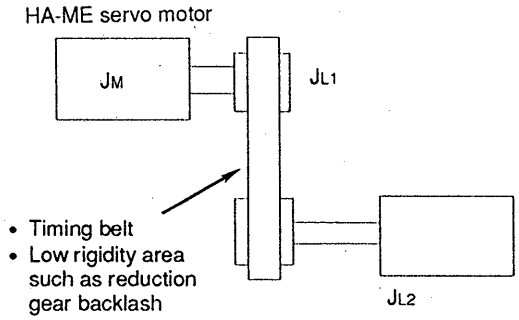
b. Make adjustment as described in above 1) a.

c. Gradually increase the position loop gain and set a value smaller than at a point where undershooting occurs at a stop.

4) To reduce the positioning settling time to improve stopping performance (This adjustment may only be made when the load inertia is not much greater than the servo motor inertia):
Make adjustment as described in above 1) a. Especially when the position loop gain PGN is increased, the positioning settling time can be reduced.

5-1.4 Clever usage of the ultracompact HA-ME servo motor

The ultracompact HA-ME servo motor is designed with an extremely small inertial to provide a high power rate. If a machine is designed to have a small inertia, therefore, it can operate with high performance. However, if the machine cannot be designed to have a small inertia, note the following:



JM : Servo motor inertial
JL1 : Inertia of coupling or pulley connected to servo motor shaft
JL2 : Inertia of machine shaft
(All values have been converted into the equivalent values at the servo motor shaft.)

Design the machine to satisfy the following expressions:

1) $\frac{JL1+JL2}{JM} \leq 30$ ..... Recommended load inertia

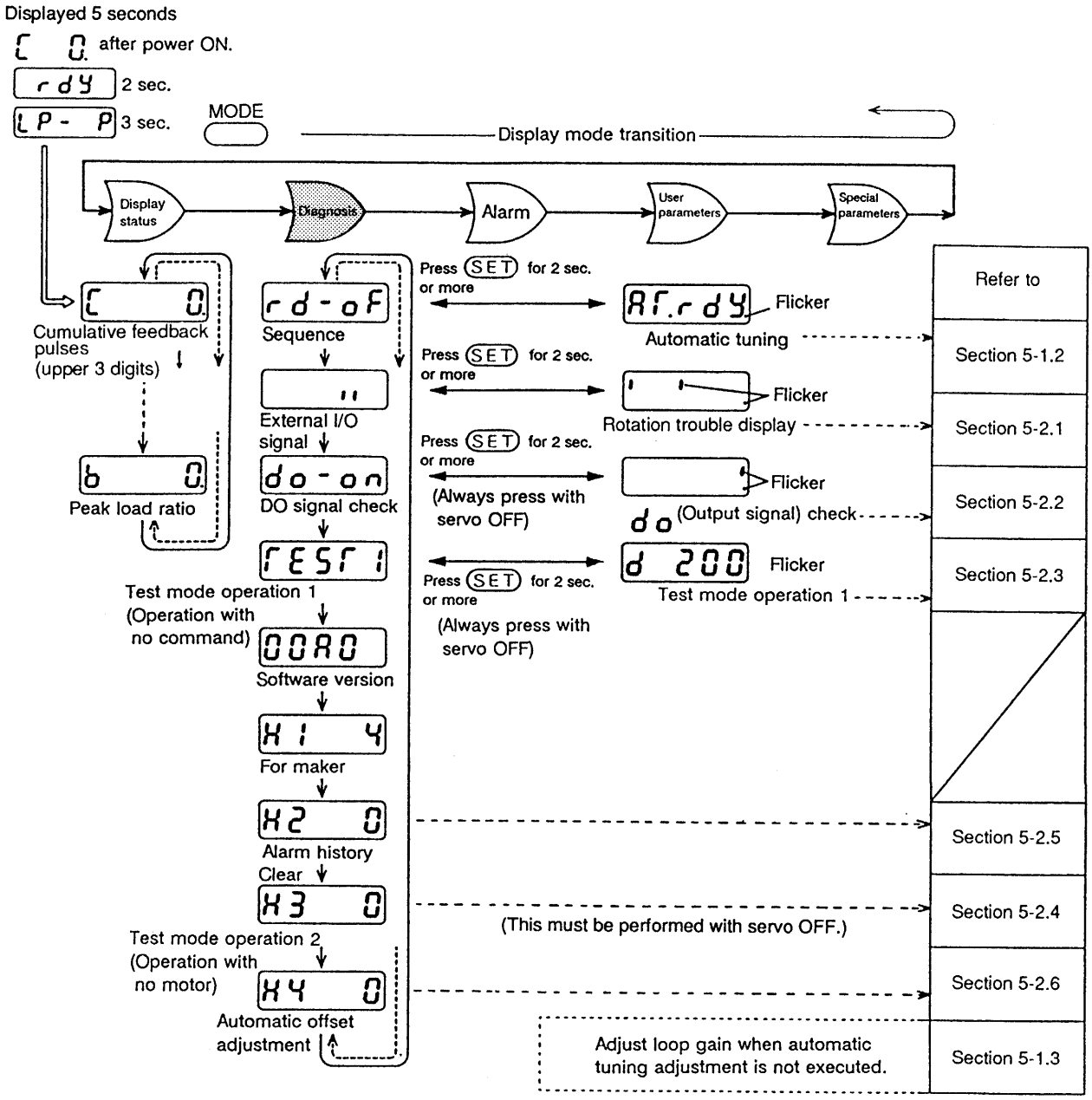
2) $\frac{JL2}{JM+JL1} \leq 8$

Note: The smaller the above values, the higher the performance of the system.

After installing the servo to the machine, gradually increase the setting of parameter No. 12 (speed loop gain) and set a value "50" to "80" smaller than a point where the machine begins to make a sound.

5-2 Adjustments and application operations

Functions that are handy during start up, such as test operation and automatic tuning, can be used in the diagnosis mode.



5-2.1 Rotation trouble display mode

When the servo motor does not rotate, the reason will be displayed by the flickering LED segments. Check the input conditions on this display when the servo motor does not rotate.

(1) Operation procedure

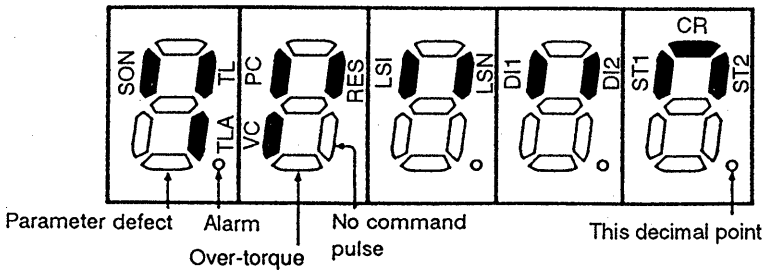
1) How to select the rotation trouble display

- Select the external signal screen with the MODE, UP, and DOWN buttons.
- Press the SET button for two seconds or more.

2) How to exit the rotation trouble display

- Press SET for two seconds or more. The external signal screen will be displayed.

(2) Rotation trouble screen



The trouble display mode will be entered when the "SET" button is pressed for two seconds or more. The segment will flicker to indicate incorrect input signals when the servo motor is not rotating.

If the LED segment is flickering, the reasons for the servo motor not rotating can be determined from the following chart.

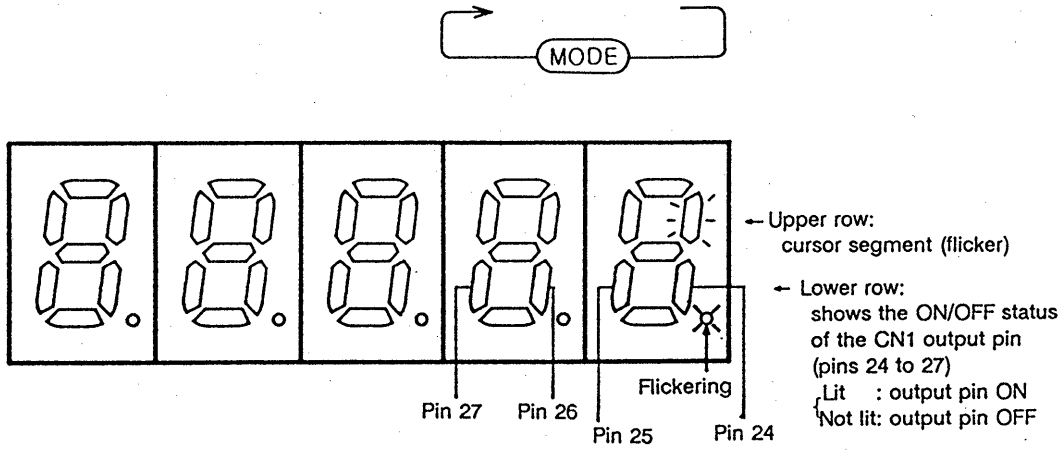
Flickering segment	Reason for not rotating	Positioning servo/ speed servo
SON	SON signal is not ON.	Positioning/speed
RES	The RES signal is not OFF.	Positioning/speed
LSP, LSN	The LSP is not ON during forward run. The LSN is not ON during reverse run.	Positioning
ST1, ST2	Both ST1 and ST2 are ON or both are OFF.	Speed
No command pulse	The command pulse is not input. (This will also flicker if the frequency is low (approximately 1kpps or less).)	Positioning
VC	Both DI1 and DI2 are off, and the external analog speed command is 0V.	Speed
Parameter defect	The internal three speeds aré set with DI1 and DI2, and the parameter value is zero.	Speed
TL, TLA over-torque	The machine struck something, the load torque is too large, or the torque limit value is smaller than the load torque.	Positioning/speed
Alarm	An alarm has occurred. • If an alarm occurs when this screen is displayed, the current alarm screen will be displayed forcibly. If this screen is displayed when an alarm has occurred, the alarm segment will flicker.	Positioning/speed

The segments in this screen will flicker when the servo motor is not rotating. Therefore, even when the servo motor is rotating normally, if the servo motor is stopped with input conditions, the segment corresponding to that input condition will flicker. The segments may also flicker temporarily during the motor acceleration/deceleration, etc.

5-2.2 Do (output signal) check mode

This mode is used to forcibly switch each output signal ON or OFF regardless of the servo's conditions. Use this to check the wiring of the servo amplifier.

(1) do (output signal) check screen



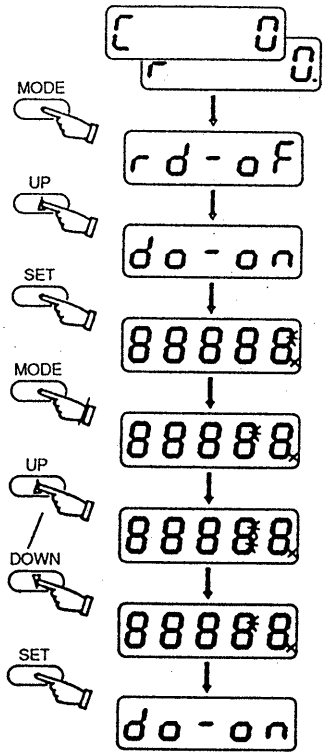
Definition of keys

Name of keys	Definition
MODE	The cursor segment is moved to the left.
UP	The lower row of the cursor segment lights and the CN1 output pin switches ON.
DOWN	The lower row of the cursor segment goes out and the CN1 output pin switches OFF.
SET (Two seconds or more)	The screen returns to the do-on display. Nothing will change if not pressed for two seconds or more.

Assignment of output pins

Output pin No.	Functions of the CN1 output pins			
	Positioning servo		Speed servo	
24	Ready (RD)		Ready (RD)	
25	Positioning complete (PF)	Limiting torque (TLC) can also be selected with Pr. 19.	Speed reached (PF)	Limiting torque (TLC) can also be selected with Pr. 19.
26	Zero speed (ZSP)		Zero speed (ZSP)	
27	Trouble (ALM)		Trouble (ALM)	

(2) Operation procedure



About 5 seconds after the power is switched ON, the status display will be given.

C 0 : Position servo

r 0 : Speed servo

- Select the do (output signal) check display "do-on" with the "MODE and UP" buttons.
- Press the "SET" button for two seconds or more.
- Press "MODE" to select the pin of the desined output to be switched on.
- When (CN1 pin 26) has been selected:
- Switch ON the output pin (CN1 pin 26) with the "UP" button.
- Switch OFF the output pin (CN1 pin 26) with the "DOWN" button.
- Select "do-on" by pressing the "SET" button for two seconds or more.

5

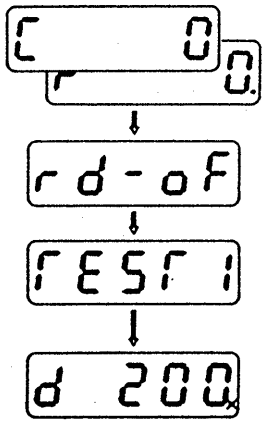
Note:

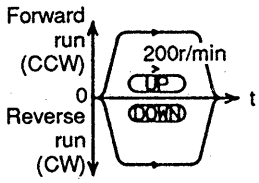
- When selecting the do (output signal) check screen, always switch the servo OFF.
- When the do (output signal) check screen is selected, all output signals will be set to OFF.

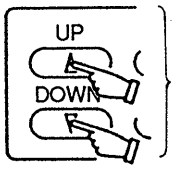
5-2.3 Test mode operation 1 (operation with no commands)

This mode allows the servo motor to be rotated without connecting connector CN1.

(Operation procedure)







About 5 seconds after the power is switched ON, the status display will be given.

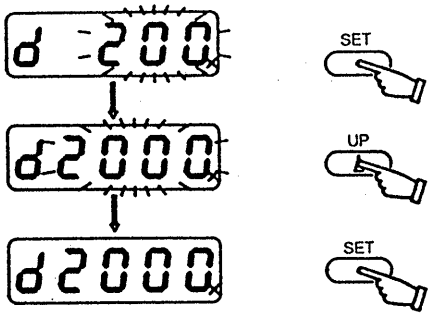
C 0 : Position servo

r 0 : Speed servo

- Display "TEST1" in the test operation screen with the "MODE and UP" keys.
- Press the "SET" key for two seconds or more.
- Test operation can be done in the approximately 0.7 seconds acceleration/deceleration time with the "UP and DOWN" keys.
- The motor will rotate while the "UP" or "DOWN" key is pressed.

  The acceleration/deceleration time constants can be changed by changing the data in the corresponding parameters.
  However, the value will be 0.5 seconds longer.

(Changing the rotation speed)



- 200 will flicker with the "SET" key.
  (The "SET" key must be pressed for less than two seconds.)
- Set to the desired speed with the "UP and DOWN" keys.
- The speed can be set to 2000r/min with the "SET" key.

Definition of keys

Name of keys	Definition	
MODE	The test mode operation status display will change.	
UP	When the data value in the set rotation speed display screen is flickering, the set speed will increase.	
		The servo motor will rotate forward (CCW) when other than above.
DOWN	When the data value in the set rotation speed display is flickering, the set speed will decrease.	
		The servo motor will rotate reverse (CW) when other than above.
SET		Use to change the set value in the set rotation speed display, when pressed for less than two seconds in the set rotation speed display.
		Return to the test operation display "TEST1" (top screen), when pressed for two seconds or more.

Note

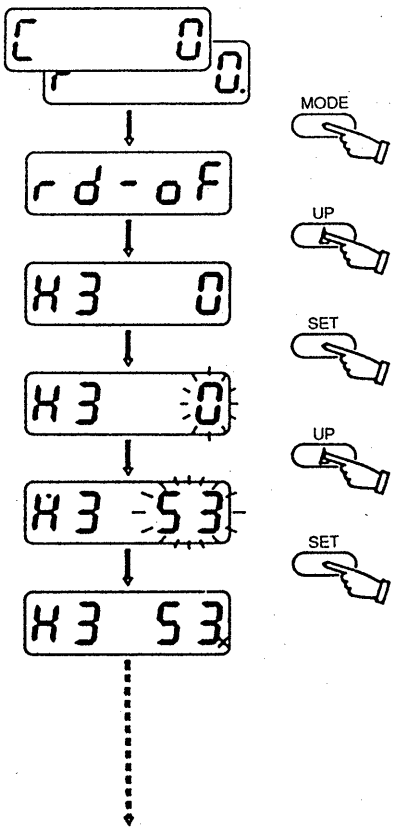
- The servo ON signal must be OFF when switching to the test operation mode or leaving the test operation mode.
- For the positioning servo, there may be a maximum of 20r/min deviation between the set rotation speed and actual rotation speed.
- The acceleration time for the positioning servo in test operation will be the value set in Pr. 10 plus 0.5 seconds. For the speed servo, the acceleration/deceleration time will be the value set in Pr. 5 and 6 plus 0.5 sec. S-character acceleration/deceleration is not possible.

5-2.4 Test mode operation 2 (operation without motor)

This mode is used to output the output signals and to display the status in the same way as when the motor is rotating, without connecting the servo motor.
The upper programmable controller (PC) sequence can be checked without connecting the servo motor.

(1) Operation method

To enter mode for operation without motor



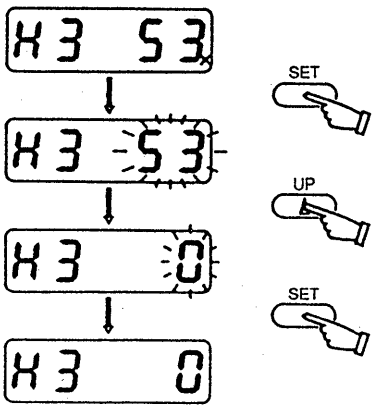
About 5 seconds after the power is switched ON, the status display will be given.

C 0 : Position servo
r 0. : Speed servo

- Select the operation without motor setting display "H3 0" with the "MODE and UP" keys.
- "0" will flicker when the "SET" key is pressed.
- Using the "UP" key, set the data value so that "53" flickers.
- When the "SET" key is pressed, the decimal point of the lowermost digit will flicker, and the mode for operation without motor will start.
  (Always carry out the above with the servo ON signal OFF.)

- If the servo ON signal is input and the same command as for rotating the servo motor is input, the output signal will be output accordingly. The speed and cumulative feedback pulses can be viewed in the status monitor display.
  (The screen operation is the same as for standard operation.)

To leave this mode

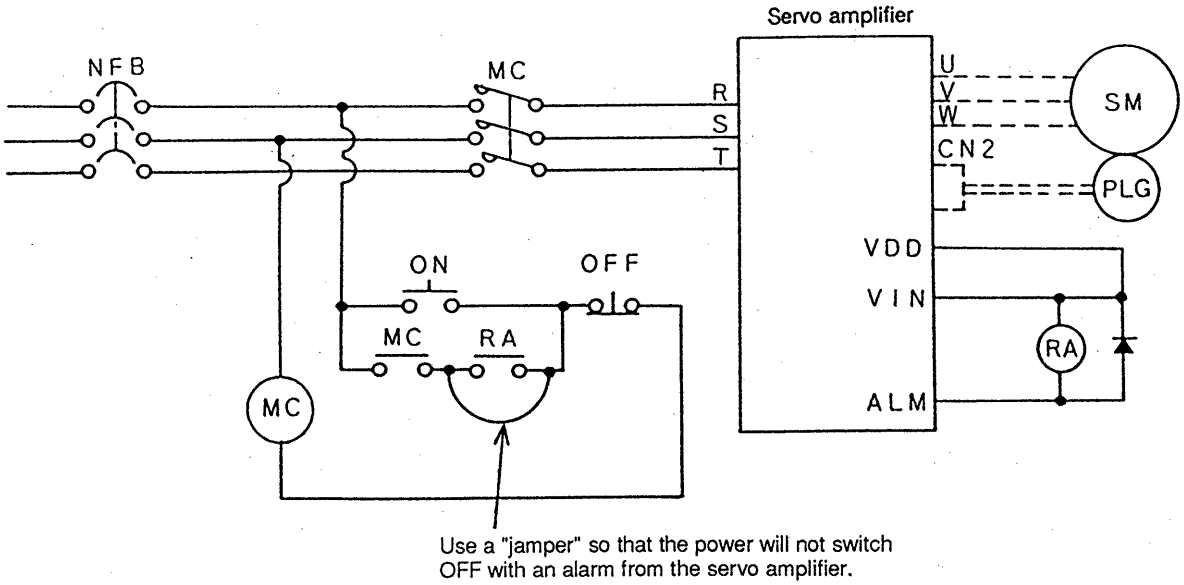


- Call out the operation without motor setting mode "H3 53" with the "MODE and UP" keys.
- "53" will flicker when the "SET" key is pressed.
- Using the "DOWN" key, set the data value to one other than "53".
- When the "SET" key is pressed, the decimal point of the lowermost digit will go out, and the mode for operation without motor will be left.
  (Always carry out the above operation with the servo ON signal OFF.)

(The mode for operation without motor will be exited when the power is switched off.)

(2) Precautions

1) Operation in this mode without the motor wiring (terminal block U, V, W) and encoder wiring (connector CN2), and when the power is switched ON without the connector CN2, an alarm will be output (AL-16 polarity detection error). Therefore, make sure that the servo amplifier power will not switch OFF even when an alarm is output from the servo amplifier, as shown below.



When entering this mode without CN2, the decimal point of the uppermost digit on the operation display explained on the previous page, will flicker to indicate an alarm (AL-16). However, the moment that "53" is set by pressing the [SET] button in the H3 screen the alarm (AL-16) will be reset, and the flickering of the decimal point of the uppermost digit will go out.

2) Differences between operation without motor and actual motor operation
In the operation without motor, the operation will be simulated with the load torque zero and the load inertia being the same as the servo motor inertia. The output signals and data for status display will be created. Therefore, the following points will differ from actual servo motor operation.

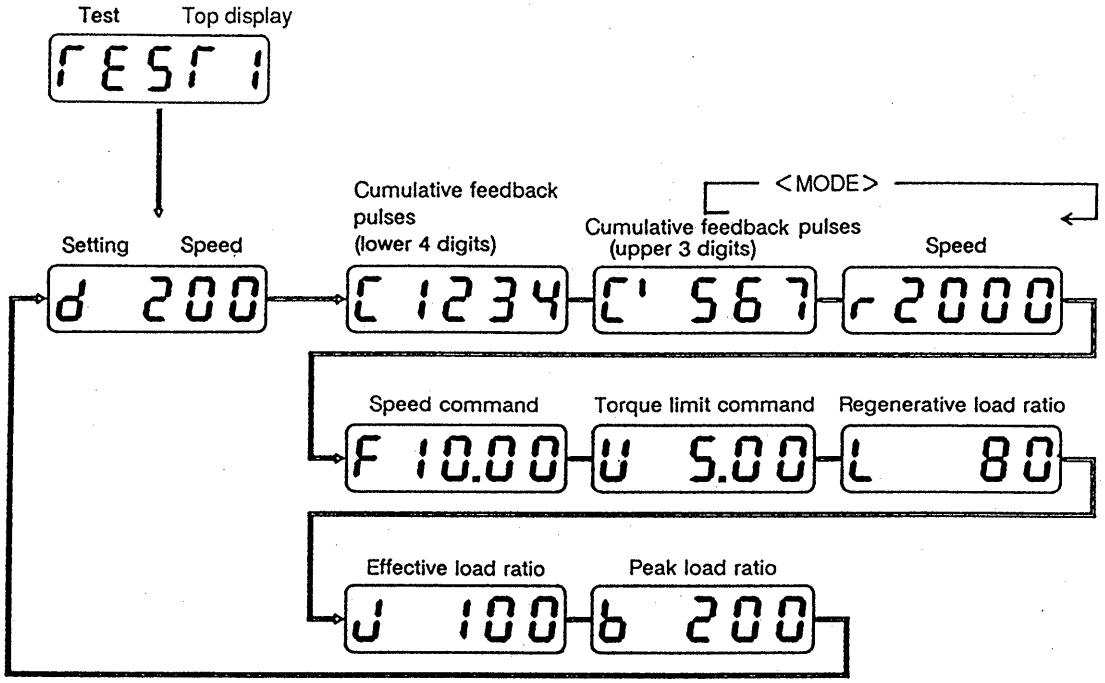
- Acceleration/deceleration time when step acceleration/deceleration is executed.
- Effective torque and peak load ratio display values
- The regenerative load will always be zero.
- The A-phase, B-phase, Z-phase, and PLG pulse output (FPA, FPB, OP) will not be output. Consider this when a circuit uses a PLG pulse output to form a closed loop.

3) Always enter and leave this mode motor when the "servo ON" signal is OFF. (AL90 will occur if the unit enters or leaves the mode with the "servo ON" signal ON.)

4) Before entering this mode, set the parameters of position loop gain, speed loop gain, and speed integration compensation to the factory setting (initial values).

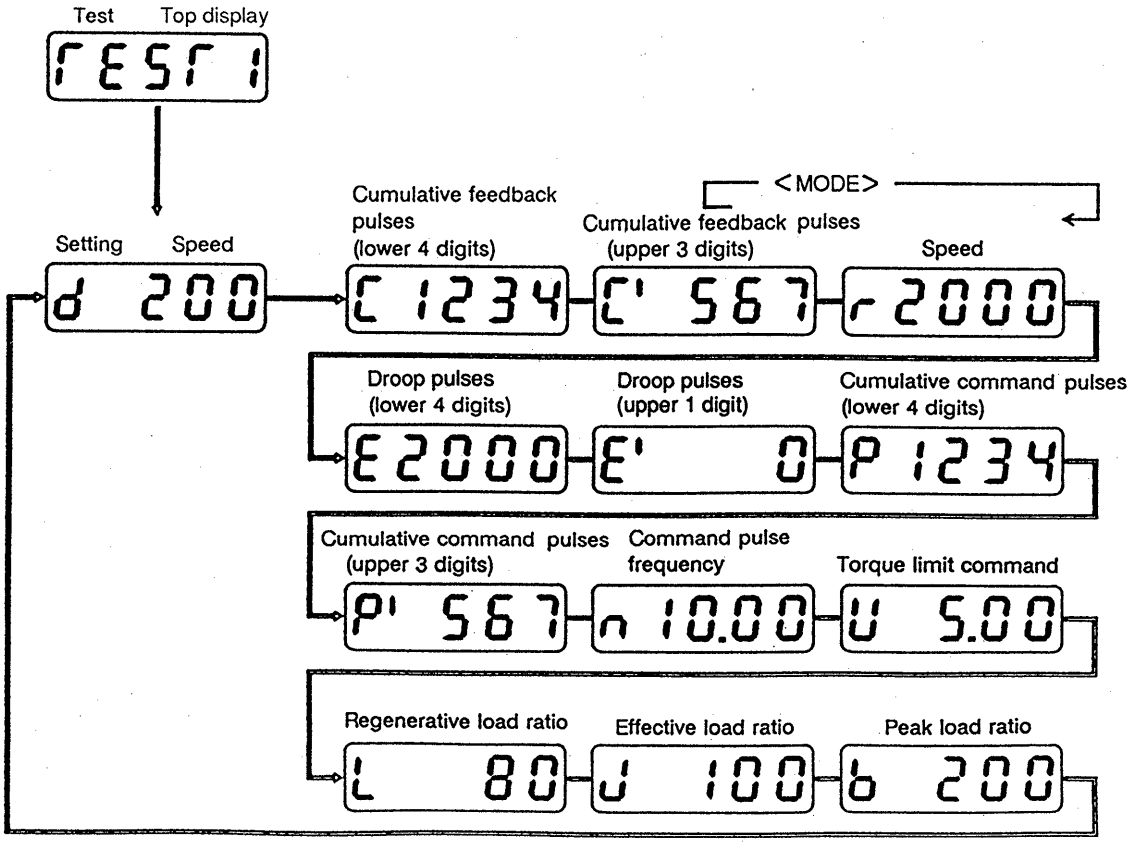
(Test operation status display)

- Speed servo



The set speed will be 200r/min when switched to the test operation screen.

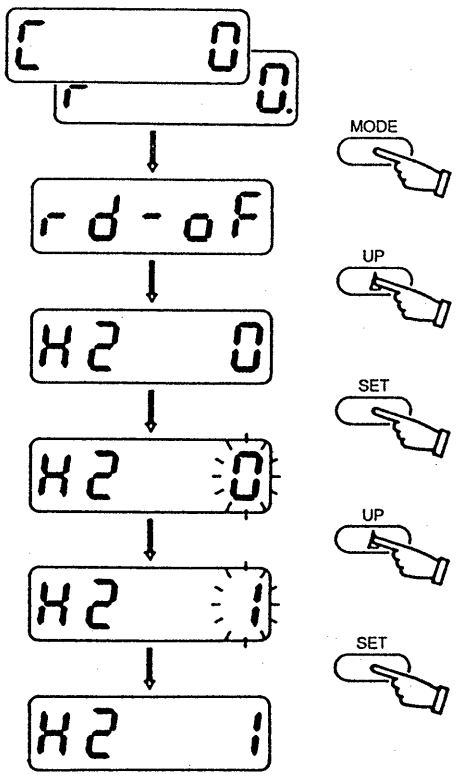
- Positioning servo



5-2.5 Alarm history clear (H2 display)

This mode is used to display and clear fault alarms that have occurred. The last four alarm codes are saved. Use the following procedure to clear the alarms.

(Operation procedure)



About 5 seconds after the power is turned ON, the status will be displayed.

C 0: Position servo

r 0.: Speed servo

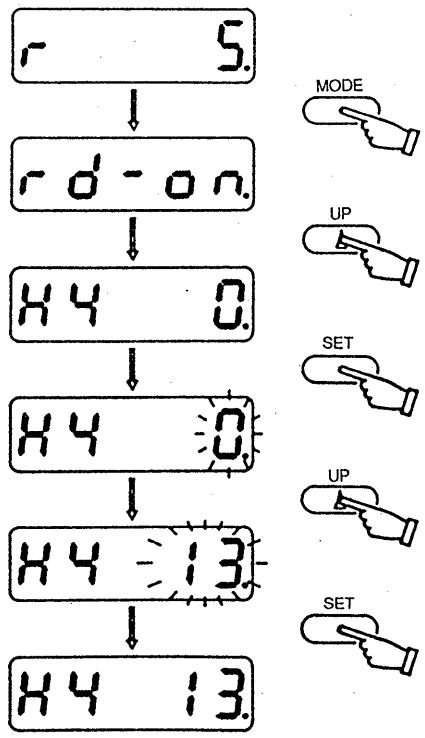
- Select the alarm history clear mode "H2 0" with the "MODE and UP" keys.
- "0" flickers with the "SET" key.
- Press the "UP" key once to make "1" flicker.
- The alarm history will be cleared when the "SET" key is pressed.

(Note) Any data other than "1" set in this mode will be ignored.

5-2.6 Offset adjustment mode (speed servo)

In this mode, an offset voltage can automatically be adjusted to zero. When the servo motor is rotating slowly with an internal or external analog circuit offset voltage, the following procedure can be used to automatically adjust the offset voltage to zero.

(1) Operation procedure



- Set the speed command (VC) input to zero (V).
- Select the analog speed command automatic offset adjustment display "H4 0" with the "MODE and UP" keys.
- "0" flickers with the "SET" key.
- Press the "UP" key to make "13" flicker.
- When the "SET" button is pressed, the automatic offset adjustment will be executed. (The parameter NO. 16 VC offset value will be automatically rewritten.)

(2) Precautions

1) Automatic offset adjustment cannot be executed when the speed command input voltage is ± 50mV or more at the servo amplifier's CN1 connector input pin.

2) Automatic offset adjustment can be operated in the servo ON state.
If automatic offset adjustment is executed when the SON signal and ST1 signal are ON and the servo motor is rotating slowly with the offset voltage, it can be confirmed that the motor will almost stop.

5-2.7 Check of the digital input/output signal (external input/output signal) mode

The ON-OFF status of the external input/output signal is indicated.
The function of the input/output signals and power ON can be checked.

(1) Refer to Section 3-5.3 for the details of the position control external input/output signals.

(2) Refer to Section 4-5.3 for the details of the speed control external input/output signals.

6-1 Regenerative option

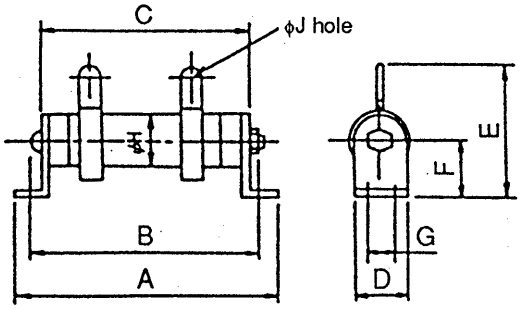
The servo amplifier does not have a built-in regenerative feature. The following regenerative options are available.

For the selection of the regenerative option, refer to Section 10-2. In principle, the MR-J40□ and larger units require an external regenerative option(s). Note that when the load inertia is small on a horizontal shaft or when the maximum operating speed is low, for example, the regenerative option(s) may not be required. Refer to Section 9-4 and select the regenerative option(s).

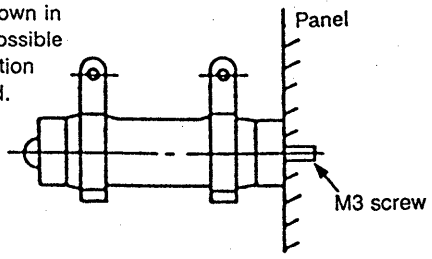
- **Application chart**

Servo amplifier	Regenerative option specifications			
	Model	Qty	Resistor	Regenerative power (W)
MR-J10A to 100A MR-J10A1 to 40A1 MR-J10MA to 70MA MR-J10MA1 to 40MA1	MR-RB013	1	52Ω	10
	MR-RB033	1	52Ω	30
	MR-RB064	2	52Ω	100 (2 pcs. connected in series)
MR-J200A	MR-RB064	1	26Ω	60
	MR-RB10	2	26Ω	150 (2 pcs. connected in series)
	MR-RB30	2	26Ω	500 (2 pcs. connected in series)
MR-J350A	MR-RB10	1	13Ω	100
	MR-RB30	1	13Ω	300
	MR-RB50	1	13Ω	500

Model: MR-RB013, 033, 064, 10



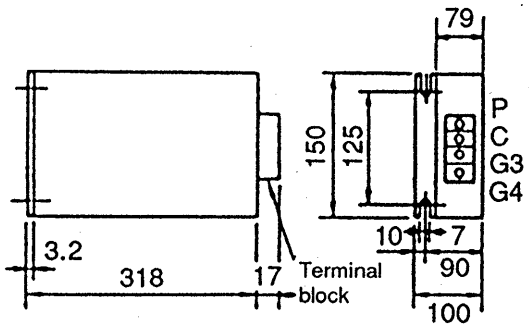
Installation as shown in the diagram is possible when the installation fitting is removed.



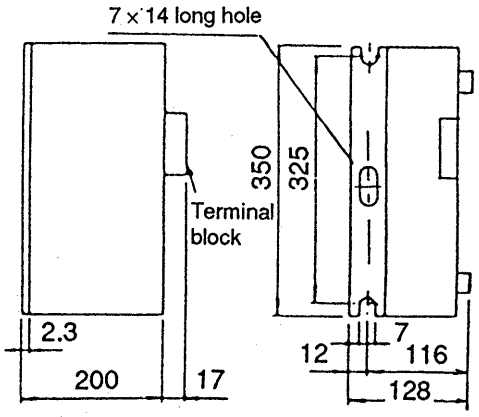
- **Application chart**

Regenerative option	Outer dimensions [mm]								
	A	B	C	D	E	F	G	H	J
MR-RB013	110	101	85	18	35	16	4.5	18	3.2
MR-RB033	192	173	152	26	54	22	6	26	3.2
MR-RB064	306	287	266	26	54	22	6	26	4.3
MR-RB10	335	309	274	40	78	40	9.5	40	5.5
MR-RB30 MR-RB50	The outer dimensions are shown in the page before.								

MR-RB30(300W) Weight: 2.9kg



MR-RB50(500W) Weight: 5.6kg



Note: Forcibly cool the unit with a cooling fan
(air flow 1.0m^3/min or more, 92mm □ fan or more)

- **Designation of the regenerative option**

MR-RB □□

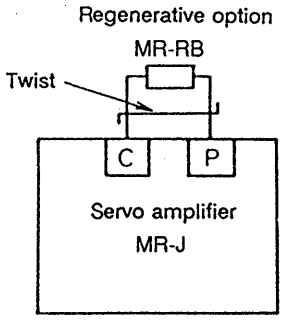
Regenerative power (unit: 100W)

Resistance

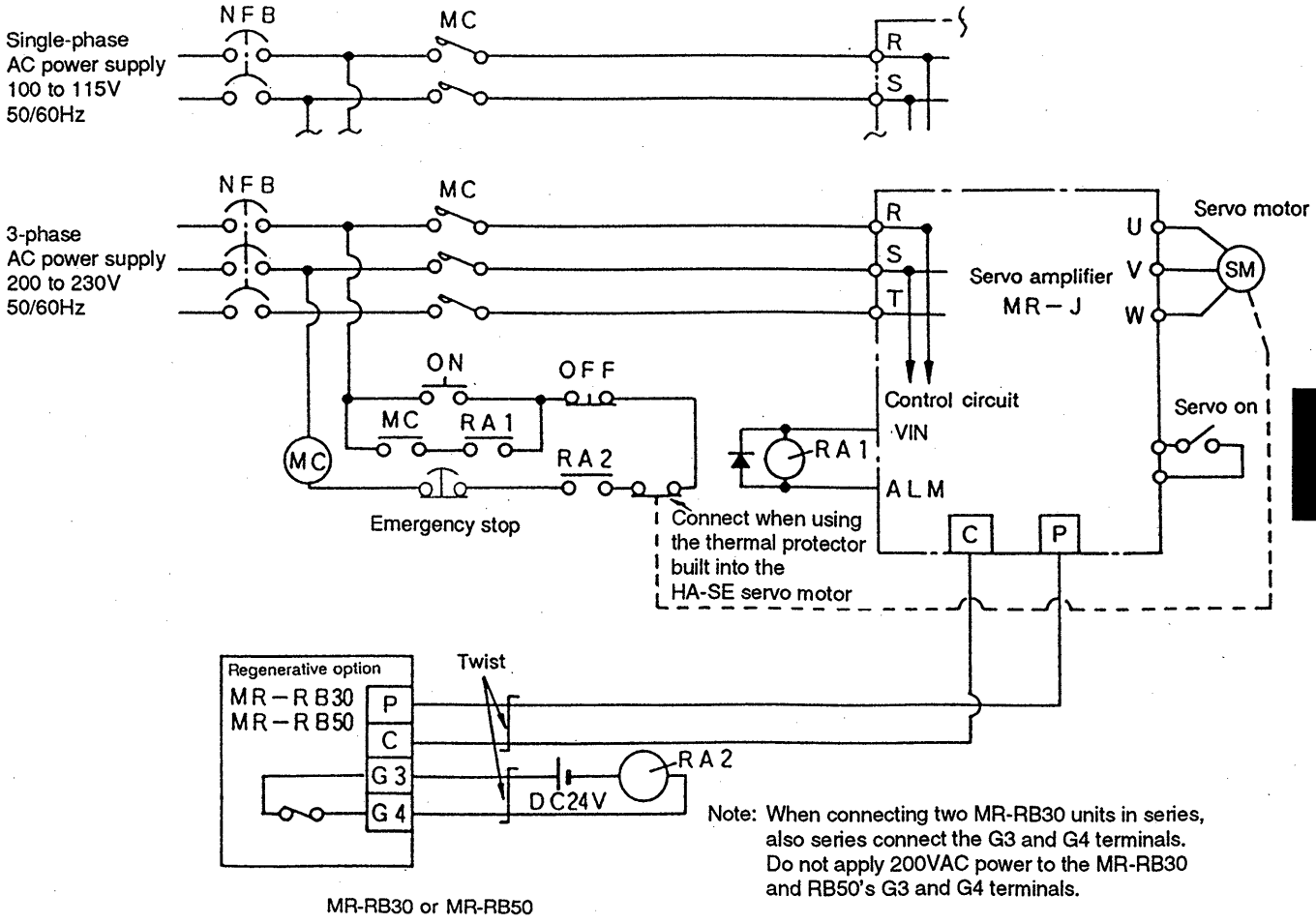
Symbol	Resistance (Ω)
0	13
1	6.67
2	40
3	52
4	26

- **Connection of the regenerative unit**

  Use the following connection when the regenerative frequency is high and the regenerative option is used.



MR-RB013 to MR-RB10



Note: When connecting two MR-RB30 units in series, also series connect the G3 and G4 terminals. Do not apply 200VAC power to the MR-RB30 and RB50's G3 and G4 terminals.

MR-RB30 or MR-RB50

Precautions for use

1. Always twist the regenerative unit wires, and use the shortest wiring possible (5m or less).
2. Do not directly install the regenerative unit onto non-heatproof wall as the unit temperature rises to approximately 150°C. Use heat resistant wiring or use out heat resistant silicone tubes, etc. on the wires, and route the wires so that they do not contact the regenerative unit.

6-2 Dynamic brake option

The dynamic brake option is used to quickly stop the servo motor without coasting during a power failure or when the protective circuit (alarm) is activated. Select the correct unit from the table below. The dimensions are shown in the lower right diagrams.

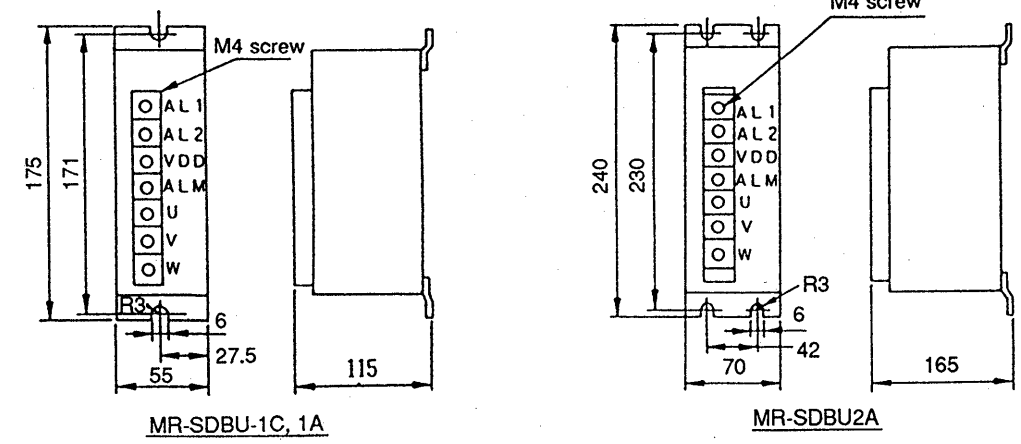
(1) Dynamic brake model number

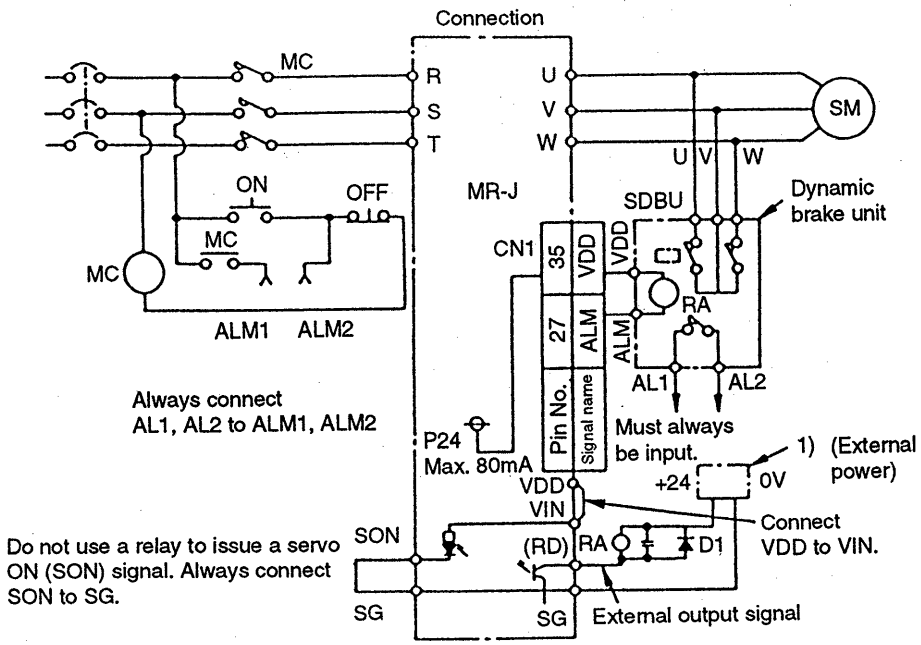
Servo amplifier	Model	Weight
MR-J10A to 60A MR-J10A1 to 40A1 MR-J10MA to 40MA MR-J10MA1 to 40MA1	MR-SDBU-1C	0.8kg
MR-J70A, 70MA	MR-SDBU-1A	1.0kg
MR-J100A		
MR-J150A	MR-SDBU-2A	2.0kg
MR-J200A		
MR-J350A		

(2) Dynamic brake unit

Use this to suddenly stop the servo motor without coasting during a power failure or when the protective circuit is activated.

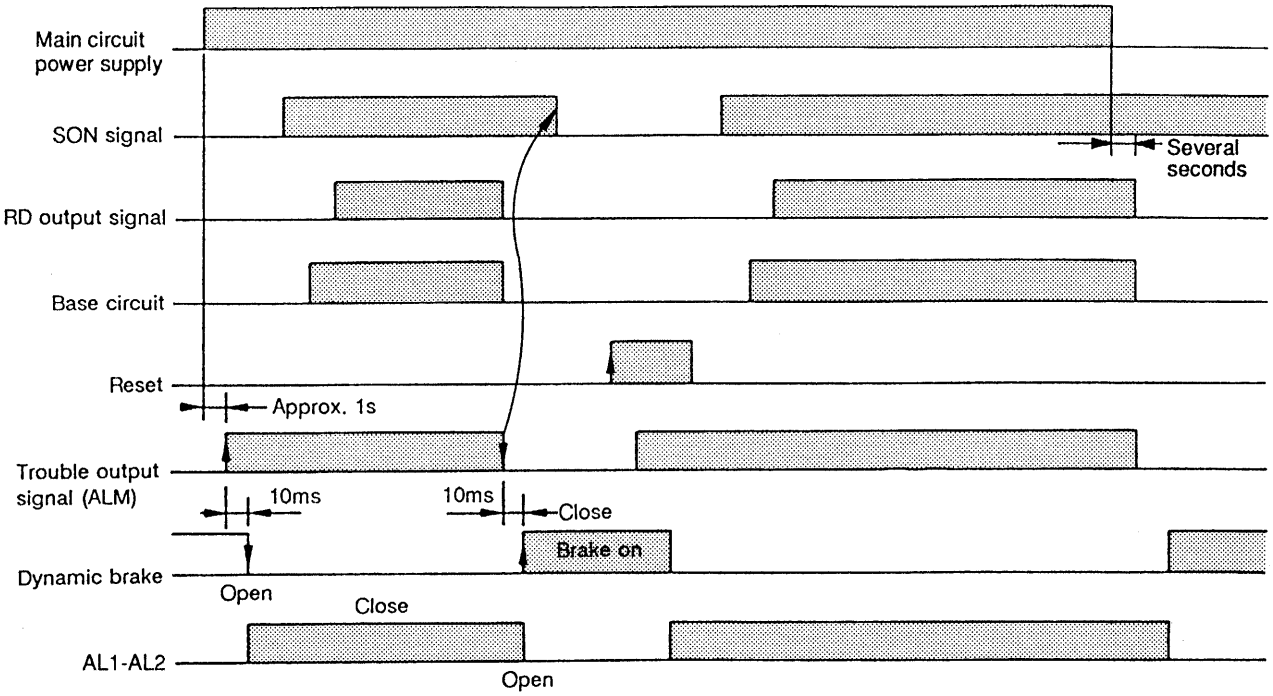
External dimension diagram





Note: 1. The ALM signal is used for the dynamic brake. Use AL1 and AL2 on the dynamic brake unit for the trouble signal.
2. The AL1-AL2 will open during power off, an alarm or emergency stop. The operation will be approximately 10msec later than the CN1 pin 27 ALM signal.
3. The brake unit is rated for short-time use. Do not use it frequently.
4. Use of the MR-J power during dynamic brake use.
   (1) Always use the internal VDD power for the dynamic brake.
   (2) Always use the external power 1) for the output signals (RD, PF, etc.).
5. To hold the motor shaft in lifting applications when servo is OFF, use a magnetic brake, etc. (The dynamic brake cannot hold the servo motor shaft.)
6. To quickly stop the servo motor in emergency, use a sequence, in addition to the circuit shown above, to zero the speed command or position command.

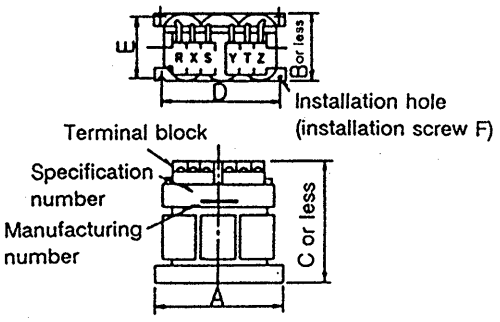
(3) Timing chart during dynamic brake use



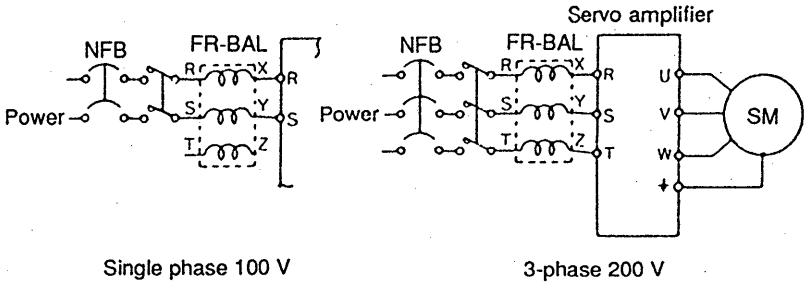
6-3 Power factor improvement reactor FR-BAL

Use a neactor to improve the power factor and to suppress the in-rush current when the servo amplifier connected directly to a power transformer (500kVA or more, with wiring length of 10m or less).

Outer dimensions



Connection



Single phase 100 V

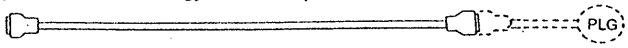
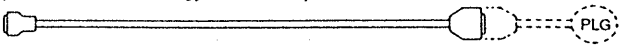
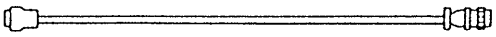
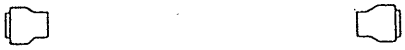
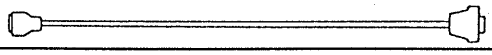
3-phase 200 V

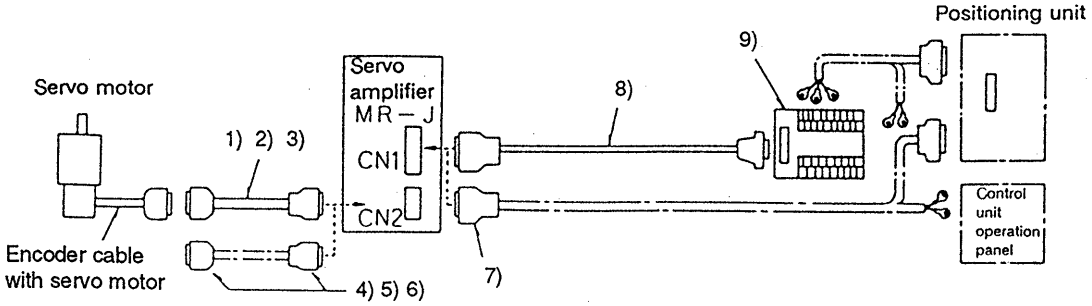
Unit: mm

Model	Dimensions						Weight (kg)
	A	B	C	D	E	F	
FR-BAL-0.4K	135	64	120	120	45	M4	2
FR-BAL-0.75K	135	74	120	120	57	M4	2
FR-BAL-1.5K	160	76	145	145	55	M4	4
FR-BAL-2.2K	160	96	145	145	75	M4	6
FR-BAL-3.7K	220	95	200	200	70	M5	8.5
FR-BAL-7.5K	220	125	205	200	100	M5	14.5

6-4 Cables and connectors

6-4.1 Option list

		Model	Product	Details
Use one of these for CN2	1)	MR-JMCBL☐M	Encoder cable for HA-ME (-UL)/FE-UL series motor (50W to 750W)	Servo Amplifier side connector PCR-S20FS,PCR-LS20LA1 (Honda Tsushin Kogyo Co., Ltd.) / Relay connector PCR-E20PMRS-SL, PCR-S20PLMA2 / Servo Motor encoder 
	2)	MR-JCBL☐M	Encoder cable for HA-FE series motor (50W to 600W)	Servo Amplifier side connector (CN2) PCR-S20FS,PCR-LS20LA1 (Honda Tsushin Kogyo Co., Ltd.) / Relay connector MR-20RF, MR-20LK2 / Servo Motor encoder 
	3)	MR-JSCBL☐M	Encoder cable for HA-SE (-UL) series motor (500W to 3500W)	Servo Amplifier side connector (CN2) PCR-S20FS,PCR-LS20LA1 (Honda Tsushin Kogyo Co., Ltd.) / Encorder side connector MS3106B20-29S, MS3057-12A 
	4)	MR-HCNS	Encoder connector set for HA-ME(-UL) /FE-UL series motor	Servo Amplifier side connector (CN2) PCR-S20FS: connector PCR-LS20LA1: case (Honda Tsushin Kogyo CO., Ltd.) / Relay connector PCR-E20PMRS-SL: connector PCR-S20PLMA2: case (Honda Tsushin Kogyo CO., Ltd.) 
	5)	MR-JCNS	Encoder connector set for HA-FE series motor	Servo Amplifier side connector (CN2) PCR-S20FS: connector PCR-LS20LA1: case (Honda Tsushin Kogyo CO., Ltd.) / Relay connector MR-20RF: connector MR-20LK2: case (Honda Tsushin Kogyo CO., Ltd.) 
	6)	MR-JSCNS	Encoder connector set for HA-SE (-UL) series motor	Servo Amplifier side connector (CN2) PCR-S20FS: connector PCR-LS20LA1: case (Honda Tsushin Kogyo CO., Ltd.) / Encorder side connector MS3106B20-29S, MS3057-12A 
Use either for CN1	7)	MR-JCN1	CN1 connector	Servo Amplifier side connector (CN1) PCR-S36FS: connector PCR-LS36LA: case (Honda Tsushin Kogyo CO., Ltd.) 
	8)	MR-JTBL05M	Cable for CN1 relay terminal block	Servo Amplifier side connector (CN1) PCR-S36FS, PCR-LS36LA / Relay terminal block side connector FCN-367J040-AU/F 
9)		A6TBXY36	CN1 relay terminal block	



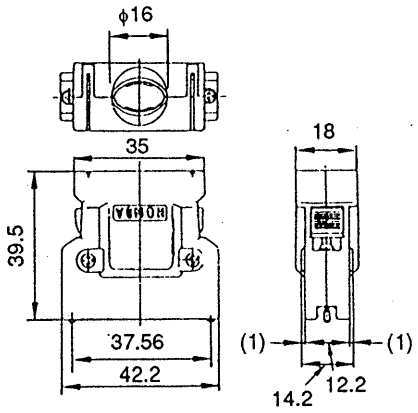
6-4.2 Connector diagrams

Use the following for the signal line connectors.

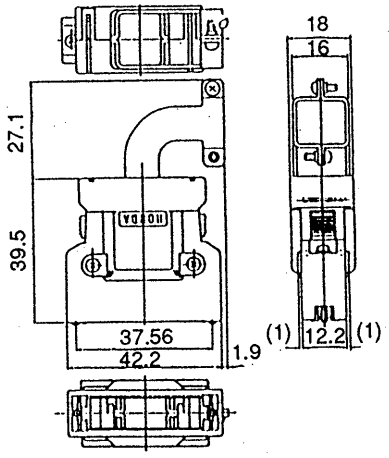
(Unit: mm)

Servo amplifier Connector for CN1 (Made by Honda)

• Case appearance



PCR−LS36LA



PCR−LS36LAW

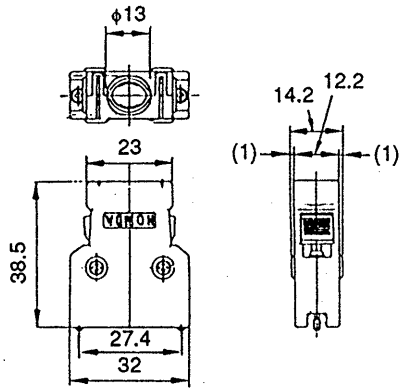
No. of pins	Model	
	Connector	Case
36	PCR-S36FS (solder connection type)	PCR-LS36LA PCR-LS36LAW (Note)
	PCR-S36F (insulation displacement termination type) (Note)	

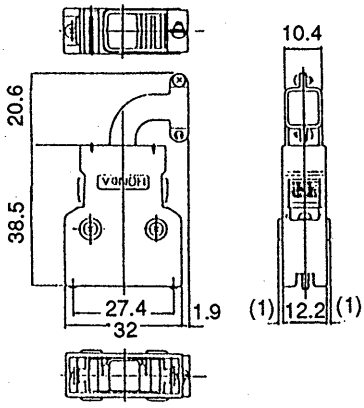
Insulation displacement termination tool: FHAT-0002A

Note: Not available from Mitsubishi.

Servo amplifier Connector for CN2 (Made by Honda)

• Case appearance





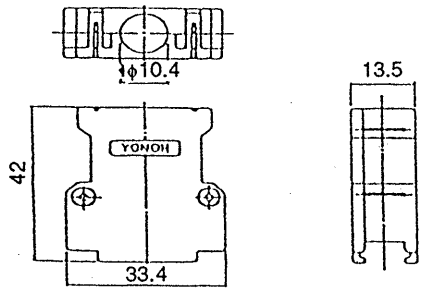
No. of pins	Model	
	Connector	Case
20	PCR-S20FS (solder connection type)	PCR-LS20LA1 PCR-LS20LA1W (Note)
	PCR-S20F (insulation displacement termination type) (Note)	

Insulation displacement termination tool: FHAT-0002A

Note: Not available from Mitsubishi.

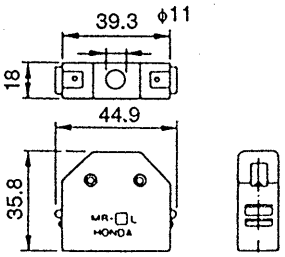
(Unit: mm)

Connector for encoder (Made by Honda) Applicable to HA-ME (-UL)/FE-UL motors



No. of pins	Model	
	Connector	Case
20	PCR-E20PMRS-SL (solder connection type)	PCR-S20PMLA2

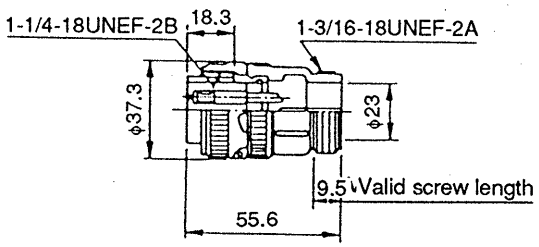
Connector for encoder (Made by Honda) Applicable to HA-FE motors



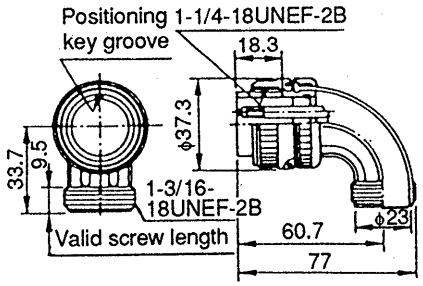
No. of pins	Model	
	Connector	Case
20	MR-20RF	MR-20LK2

Connector for encoder (Made by DDK, Ltd., Japan Aviation Electronics) Applicable to HA-SE(-UL) motor

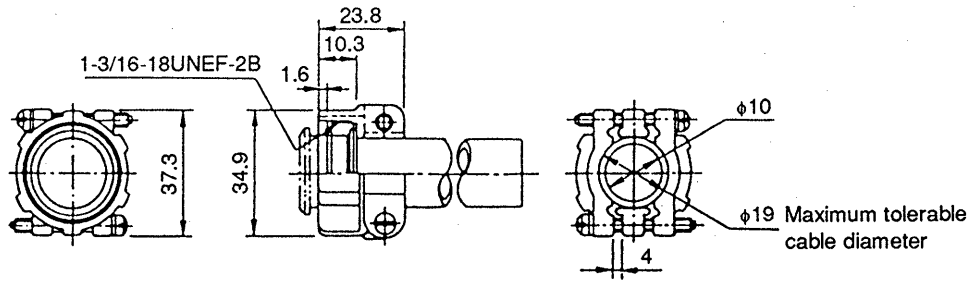
Straight plug MS3106B20-29S



Angle plug MS3108B20-29S



Cable clamp MS3507-12A



6

6-4.3 Cable specifications

Use the following or equivalent twisted pair shielded wires for the motor encoder and control signal connections. If the wiring between the motor and amplifier is long and the servo motor is required to move, use the cables which have the flexibility resistance characteristics as below.

1) Multi-core shielded wire for detector (total-shielded wire)

Core number size (mm)	Finish diameter (mm)	Characteristics of one wire	
		Components (no./mm)	Conductive resistivity (Ω/km)
12 pairs × 0.2	11.0	40/0.08	100.5

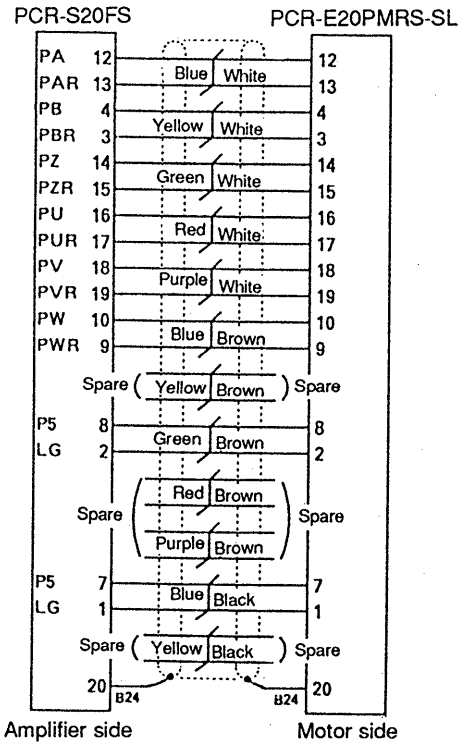
2) Two-core shielded wire

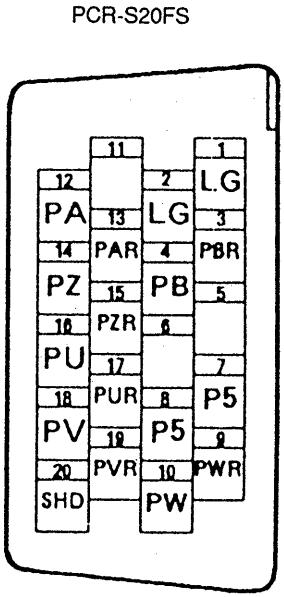
Core number size (mm)	Finish diameter (mm)	Characteristics of one wire	
		Components (no./mm)	Conductive resistivity (Ω/km)
2 × 0.3	4.18	19/0.16	54.8 × 2

6-4.4 Connection diagram for option cables

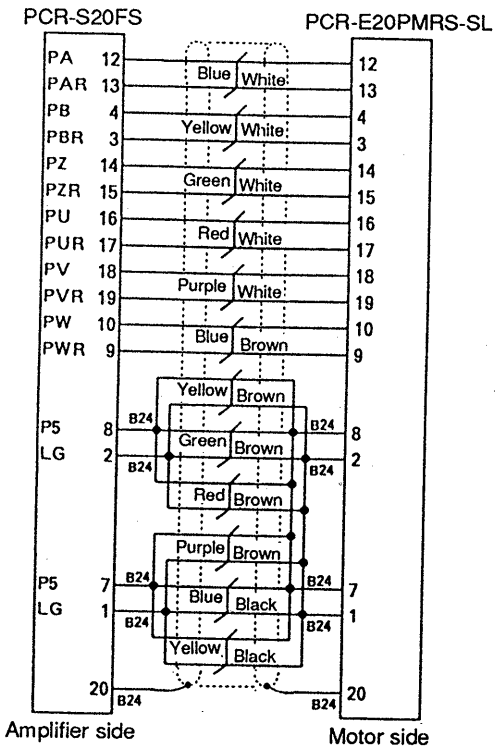
(1) MR-JMCBL☐M

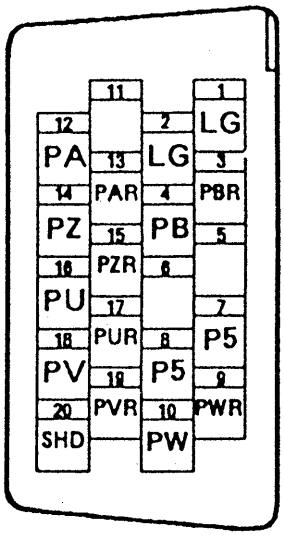
MR-JMCBL5M
(5m)





MR-JMCBL10M to
MR-JMCBL30M
(10m to 30m)

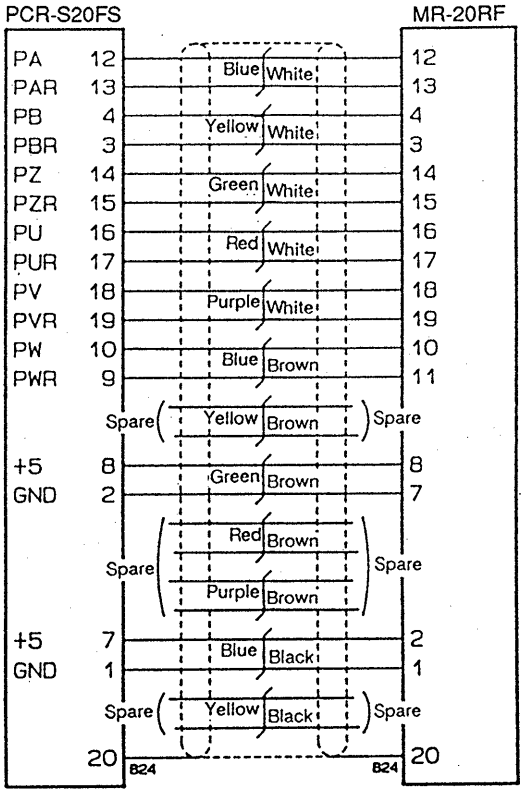


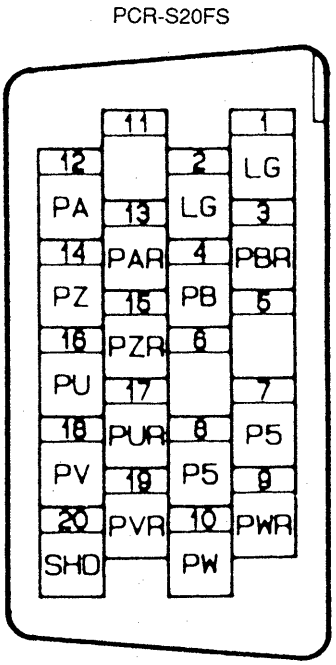


6

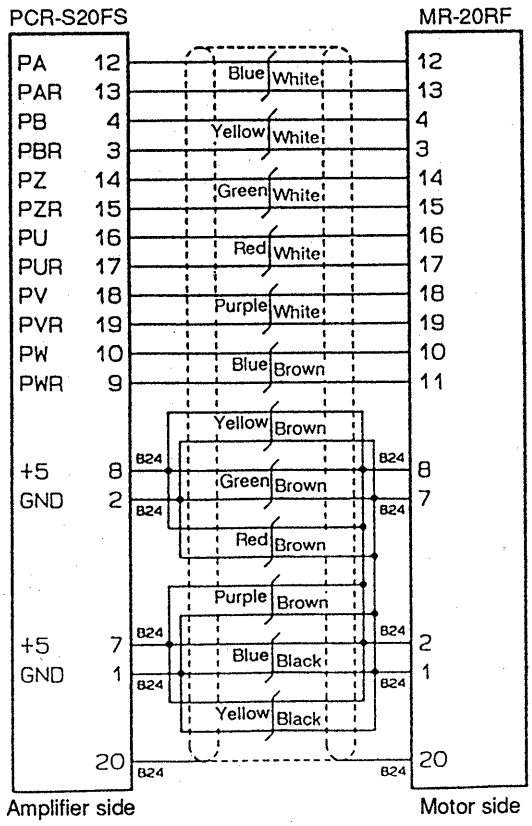
(2) MR-JCBL□M

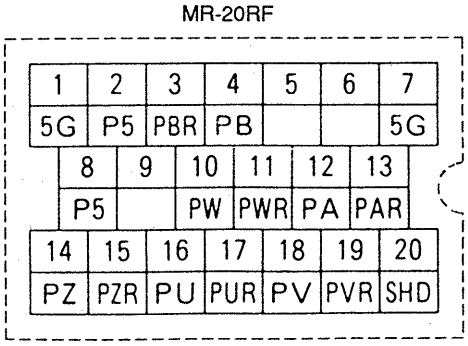
MR-JCBL5M
(5m)





MR-JCBL10M to
MR-JCBL30M
(10 to 30m)



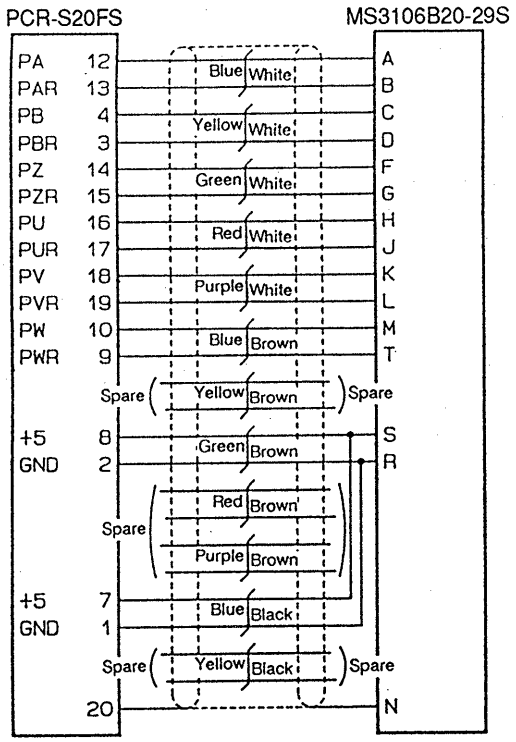


Layout diagram looking
from wiring side

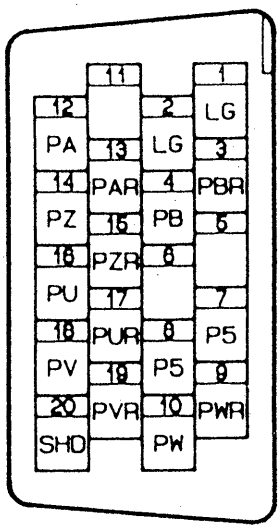
Connector pin layout
diagram for encoder
signal connectors

(3) MR-JSCBL□M

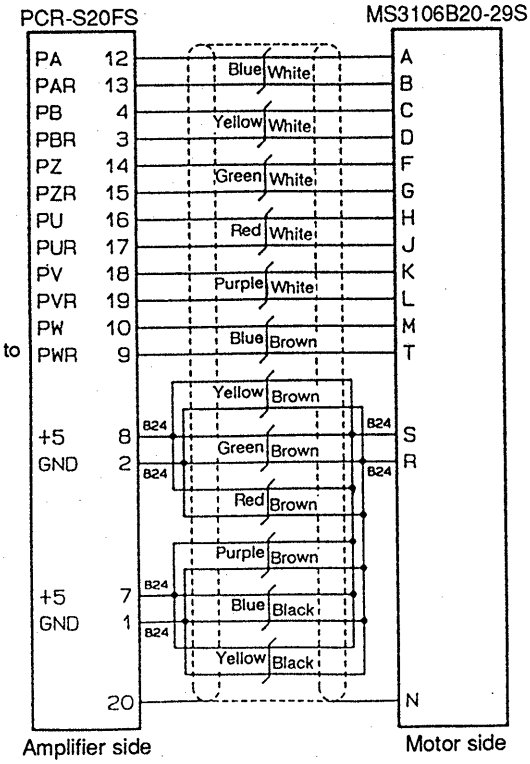
MR-JSCBL5M
(5m)



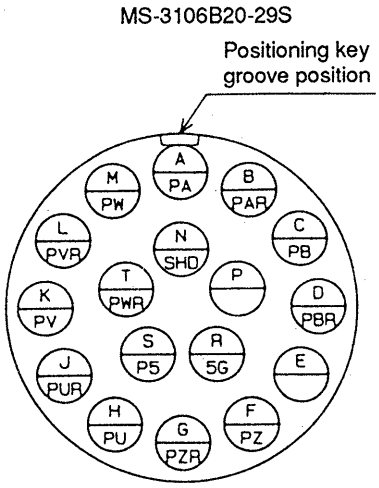
PCR-S20FS



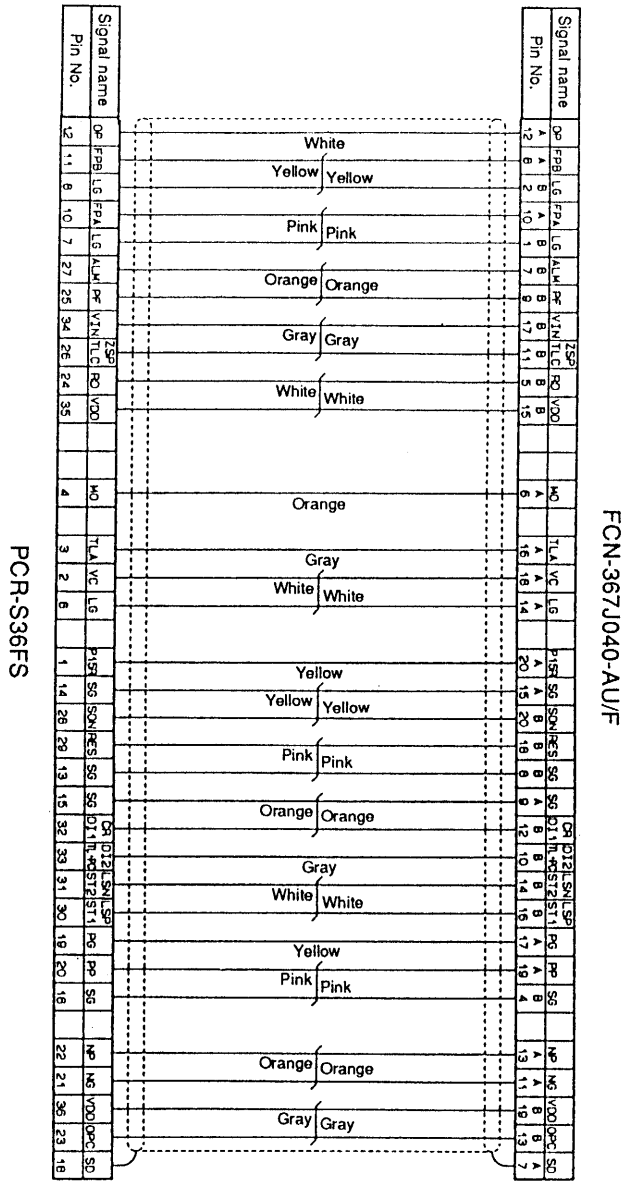
MR-JSCBL10M to
MR-JSCBL30M
(10m to 30m)



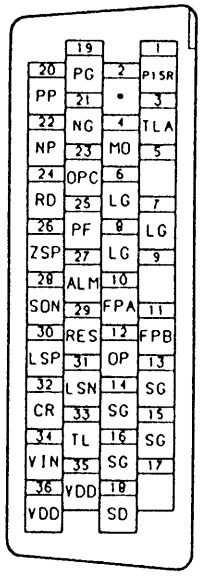
MS-3106B20-29S



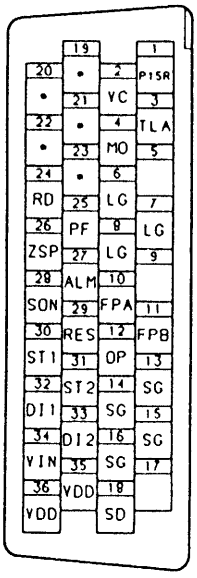
(4) MR-JTBL05M



PCR-S36FS



For positioning servo



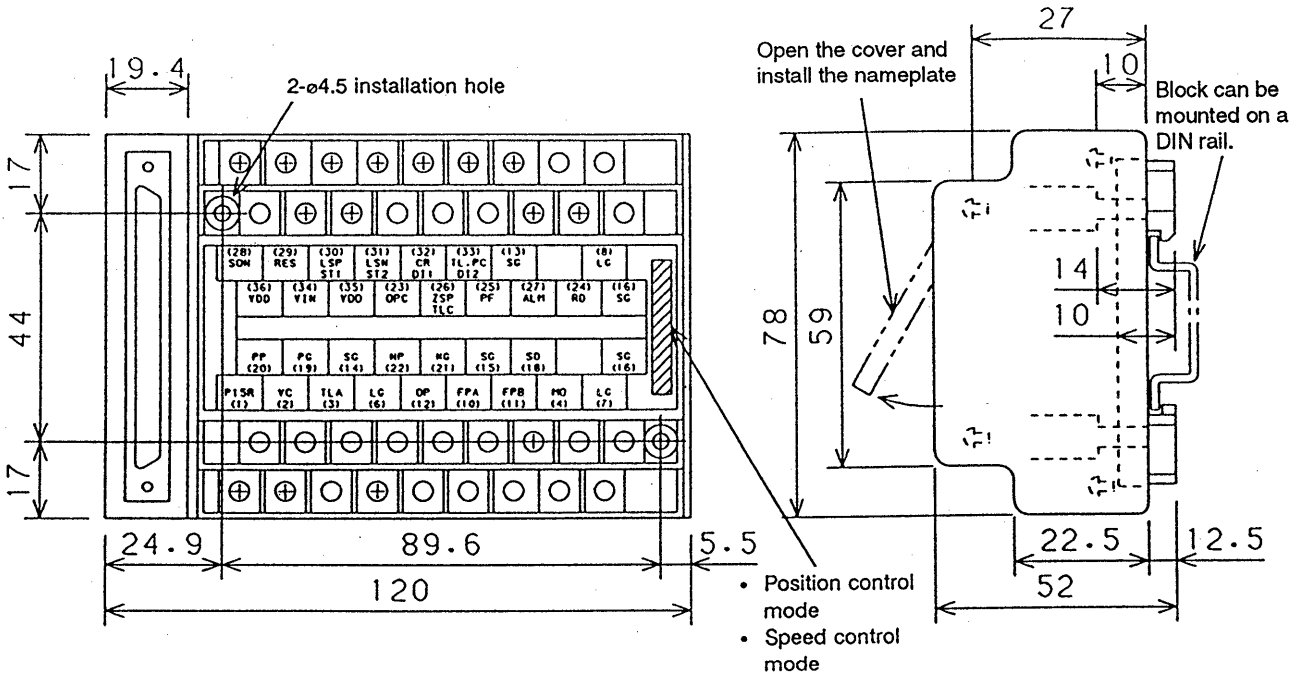
For speed servo

FCN-367 J040-AU/F

(Looking from the wiring side)

6-5 Junction terminal block (Model: A6TBXY36)

(1) Outer dimensions(mm)



(2) Instruction for using the junction terminal block with MR-JTBL cable together

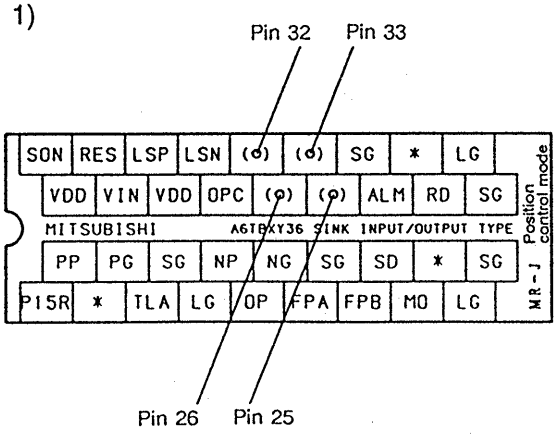
Note 1. When connecting the junction terminal block (A6TBXY36) with the MR-JTBL☐M cable, the terminal symbols will be different, use the correct enclosed nameplate.

2. The "*" marked terminals on the terminal symbol name plate 1) and 2) (next page) are connected internally, do not connect them or use them for junction terminals.

3. For the "( )" marked terminals on the terminal symbol nameplate, enter the corresponding signal designation as selected in parameter 19.

- **Position control mode terminal symbol nameplate**

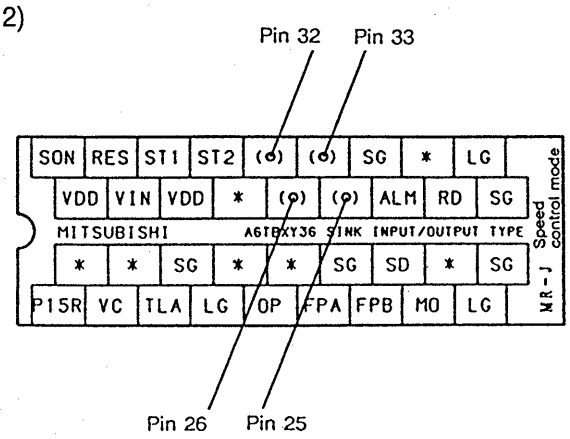
1)



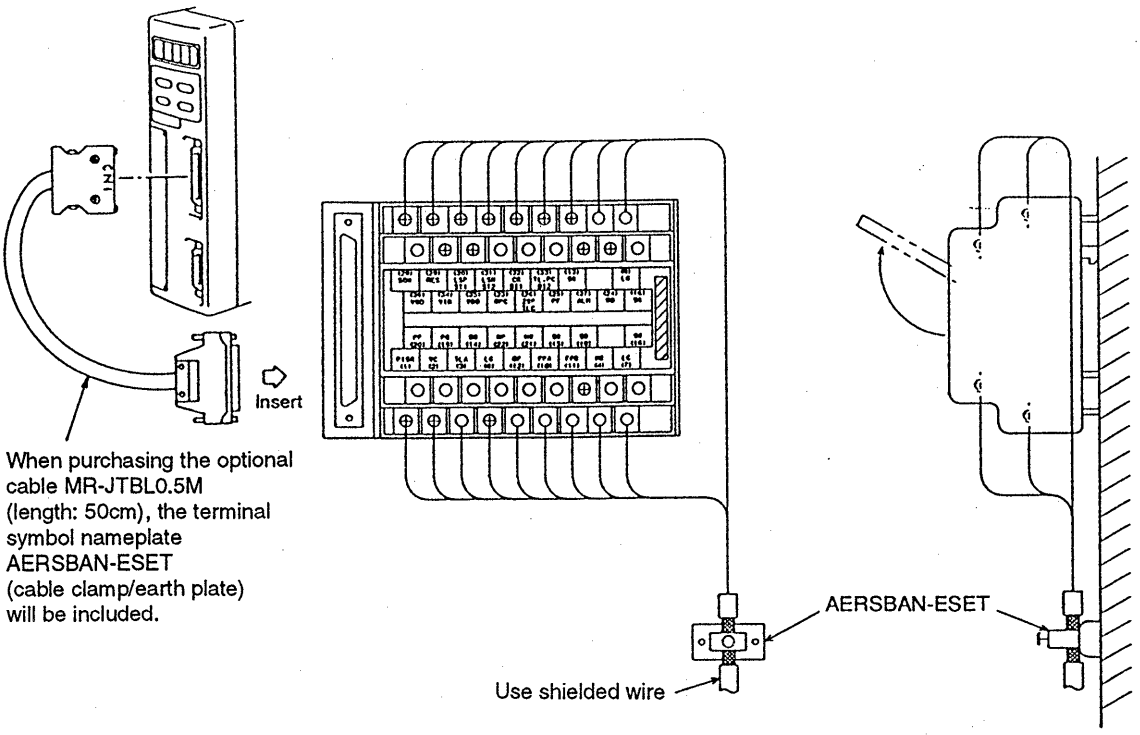
Refer to Section 3-5.5 for the setting details and explanation of the 25, 26, 32 and 33 pins in the position control mode.

- **Speed control mode terminal symbol nameplate**

2)



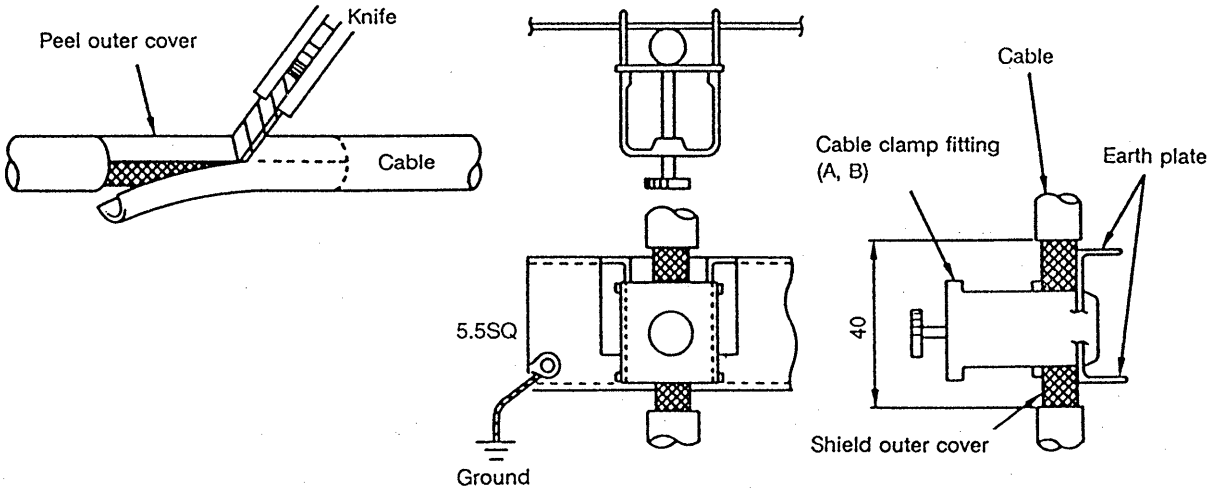
Refer to Section 4-5.5 for the setting details and explanation of the 25, 26, 32 and 33 pins in the speed control mode.



Use the AERSBAN-ESET (cable clamp /earth plate) enclosed with the cable when connecting the relay terminal block (A6TBXY36).

3) Detailed diagram of AERSBAN-ESET (Cable clamp/earth plate) installation

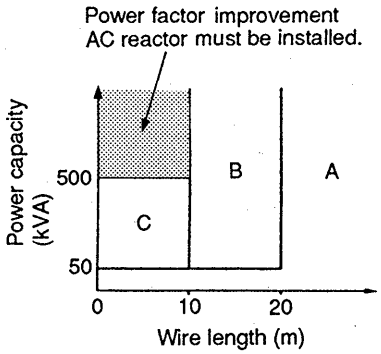
When installing AERSBAN-ESET (cable clamp/earth plate), peel part of the cable cover, and expose the outer shield.
Insent the exposed part into the cable clamp on the earth plate, and tighter clamp.



6-6 Electrical wires, breakers and magnetic contactors

Select the electrical wires for the main circuit, breakers and magnetic contactor according to the following chart.

- Select the No-Fused Breaker (NFB) while taking the power capacity and wire size into consideration.
- Install a magnetic contactor (MC), that meets the power capacity and wiring length into the AC input power supply, so that the power will be switched off when an alarm occurs.
- The wire (core) size is for wire length 30m or less.
- When connecting directly to a large capacity power transformer (500kVA or more, with wiring 10m or less), an excessive current will flow when the power is switched on, and may damage the converter section. Install a reactor (FR-BAL) (option) to suppress the current.



Servo amplifier	No-fuse breaker (NFB)	Fuse		
		Type (Manufacturer)	Class	Amp.
MR-J10A, 20A, 10A1	NF30 type 5A	NON-10 (Buss) or OT10 (Gould)	K5	10
MR-J10MA, 20MA, 10MA1	NF30 type 5A	NON-10 (Buss) or OT10 (Gould)		10
MR-J40A, 40MA	NF30 type 10A	NON-15 (Buss) or OT15 (Gould)		15
MR-J60A	NF30 type 15A	NON-20 (Buss) or OT20 (Gould)		20
MR-J70A, 70MA	NF30 type 15A	NON-20 (Buss) or OT20 (Gould)		20
MR-J100A	NF30 type 15A	NON-25 (Buss) or OT25 (Gould)		25
MR-J200A	NF30 type 20A	NON-40 (Buss) or OT40 (Gould)		40
MR-J350A	NF30 type 30A	NON-70 (Buss) or OT70 (Gould)		70
MR-J20A1, 20MA1	NF30 type 10A	NON-10 (Buss) or OT10 (Gould)		10
MR-J40A1, 40MA1	NF30 type 15A	NON-10 (Buss) or OT10 (Gould)		10

Servo amplifier	Magnetic contacctor (MC)			Wire size (mm^2)			Reactor FR-BAL
	A	B	C	Terminals R,S,T	Terminals U,V,W	Terminals P,C	
MR-J10A, 20A, 10A1	S-K18	S-K21	S-K21	2	2	2	FR-BAL-0.4K
MR-J10MA, 20MA, 10MA1	S-K18	S-K21	S-K21	2	2	2	FR-BAL-0.4K
MR-J40A, 40MA	S-K18	S-K21	S-K21	2	2	2	FR-BAL-0.75K
MR-J60A	S-K18	S-K21	S-K21	2	2	2	FR-BAL-1.5K
MR-J70A, 70MA	S-K21	S-K25	S-K50	2	2	2	FR-BAL-1.5K
MR-J100A	S-K21	S-K25	S-K50	2	2	2	FR-BAL-2.2K
MR-J200A	S-K18	S-K18	S-K18	3.5	3.5	2	FR-BAL-3.7K
MR-J350A	S-K20	S-K20	S-K20	5.5	5.5	2	FR-BAL-7.5K
MR-J20A1, 20MA1	S-K18	S-K21	S-K21	2	2	2	FR-BAL-0.75K
MR-J40A1, 40MA1	S-K18	S-K21	S-K21	2	2	2	FR-BAL-1.5K

6-7 Selection of relays

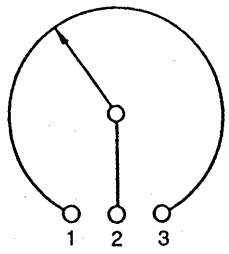
Relay used especially for switching analog input command and digital input command (interface DI-1)	Protect defective contacts with a small current signal (twin contacts). (Ex.) OMRON: type G2A, MY
Relay used for digital output signals (interface DO-1)	Small relay with 12VDC, 24VDC or 24VDC of 40mA or less (Ex.) OMRON: type MY

6-8 Selection of the external speed command and external torque limit command potentiometers (pof)

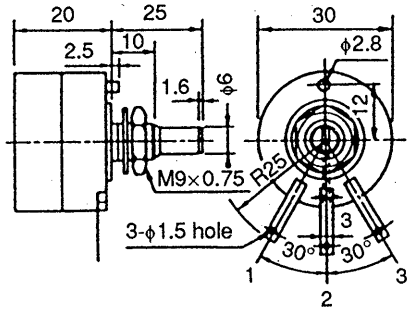
Single-rotation type

Model WA2WYA2SEBK2KΩ
Wire-wound variable resistor 2W2kΩ
B characteristics
Shaft rotation angle 300° ± 5°
Note: Maker (Japan Resistor Manufacture Co., Ltd.) standard WA2W can be used.

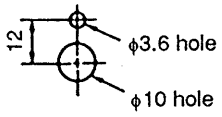
Connection diagram



External dimension diagram [Unit: mm]



Detailed diagram of panel holes [Unit: mm]

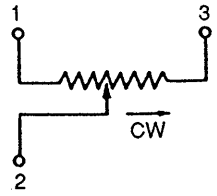


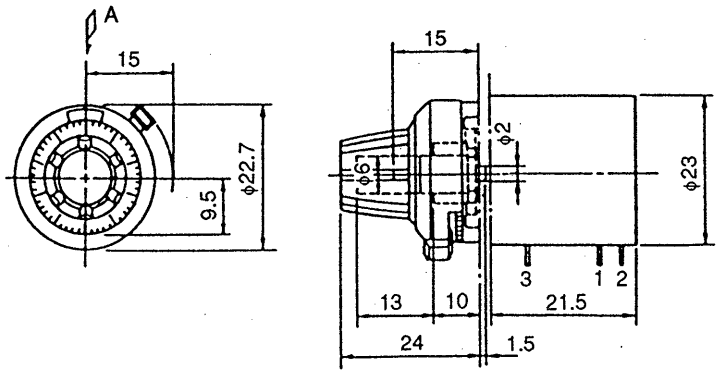
Rated Power	Resistance	Resistance Tolerance	Dielectric Strength (for 1 minute)	Insulation Resistance	Mechanical Rotary Angle	Rotary Torque
2W	2kΩ	±10%	700V A.C.	100MΩ or more	300° ±5°	10 to 100g –cm or less

Multi-rotation type

Model Helical pot RRS10 (M) 2kΩ
Multi-dial 23M (10 revolutions)
Japan Resistor Manufacture Co., Ltd.

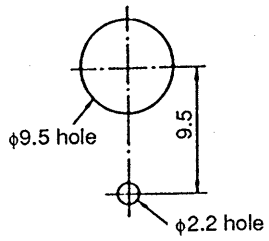
Connection diagram





View A

Detailed diagram of panel holes [Unit: mm]
Panel thickness: 2 to 6mm



Rated Power	Resistance	Resistance Tolerance	Dielectric Strength (for 1 minute)	Insulation Resistance	Mechanical Rotary Angle	Rotary Torque
1W	2kΩ	±5%	750V A.C.	1,000MΩ or more	3600° +10° –0°	100g–cm or less

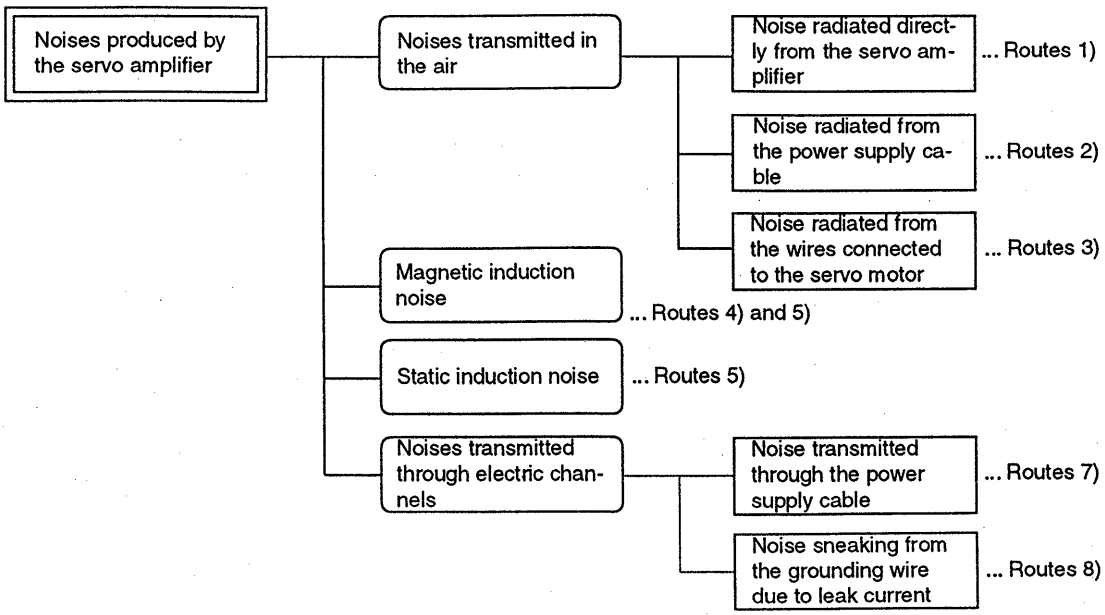
6-9 Noise reduction techniques

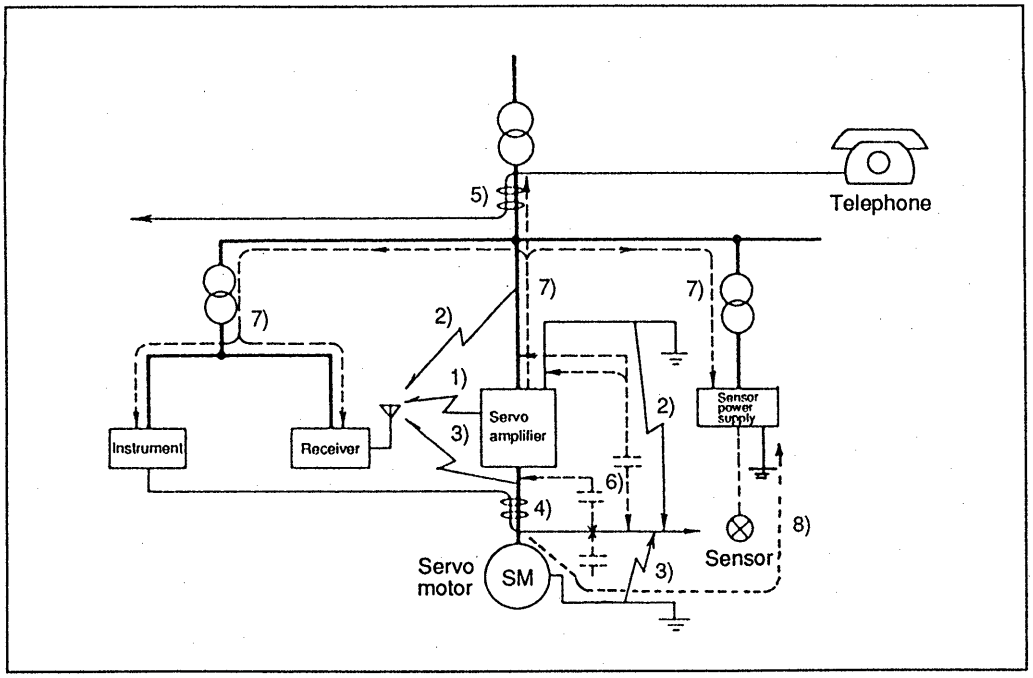
Noises are classified into external noises which enter the servo amplifier and cause it to malfunction and those radiated by the servo amplifier which cause peripheral devices to malfunction. The servo amplifier is designed to resist noises. However, since it is an electronic device which uses small signals, it requires general noise reduction as mentioned below. And, since the output of the servo amplifier is chopped by high carrier frequencies, the servo amplifier can be a source of noise. If peripheral devices malfunction due to noises produced by the servo amplifier, noise preventive measures must be provided. The measures will vary slightly according to the route of noise transmission.

1) General reduction techniques
   - Avoid laying power lines (input and output cables) and signal cables side by side or bundling not bundle them together. Separate power lines from signal cables.
   - Use shielded twisted-wire pair cables for connecting to a encoder and for control signal transmission, and connect the shield to the SD terminal.
   - Ground the servo motor, servo amplifier, etc. together at one point (no loops).
2) Reduction techniques for external noises that case the servo amplifier to malfunction

   If there are noise sources (such as magnetic contactor, magnetic brake, and a large number of relays) which make a large amount of noise near the servo amplifier and the servo amplifier may malfunction, the following techniques 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 wire and the control signal cables with cable clamp fittings.
3) Techniques for noises radiated by the servo amplifier that case peripheral devices malfunction

   Noises which the servo amplifier produces are classified into those which are radiated from the cables connected to the servo amplifier body and the servo amplifier main circuits (input and output circuits), those which are induced electromagnetically or statically by the signal cables of the peripheral devices which are located close to the main circuit wires, and those which are transmitted through the power supply cables.





Noise transmission route	Countermeasures
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 installed on a panel together with a servo amplifier or close to a servo amplifier, such devices may malfunction due to noise transmitted through the air. The following techniques are required. (1) Provide maximum clearance between the devices which are liable to be influenced by noise and servo amplifier. (2) Provide maximum clearance between the signal cables which are liable to be influenced by noise and the I/O cables of the servo amplifier. (3) Avoid laying power lines (I/O cables of the servo amplifier) and signal cables side by side or bundling them together. (4) Insert a line noise filter on the I/O cables or a radio frequency noise filter on the input line. (5) Use shielded wires for the 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 may be transmitted through the signal cables and malfunction may occur. The following are required. (1) Provide maximum clearance between the devices which are liable to be influenced by noise and servo amplifier. (2) Provide maximum clearance between the signal cables which are liable to be influenced by noise and the I/O cables of the servo amplifier. (3) Avoid laying power lines (I/O 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 backward through the power supply cable and the devices may malfunction. The following techniques are required. (1) Insert a radio frequency noise filter (FR-BIF) on the power cables (I/O cables) of the servo amplifier. (2) Insert a radio frequency noise filter (FR-BLF, 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 will flow through the grounding wire of the servo amplifier to the peripheral devices and malfunction may occur. In that case, malfunction may be prevented by disconnecting the grounding wire of the peripheral device.

(1) Data line filter

Noise can be prevented by installing a data line filter onto the pulse output cable of the pulse train command unit (AD71, etc.) or the servo motor encoder cable. Use the following data line filter or equivalent.

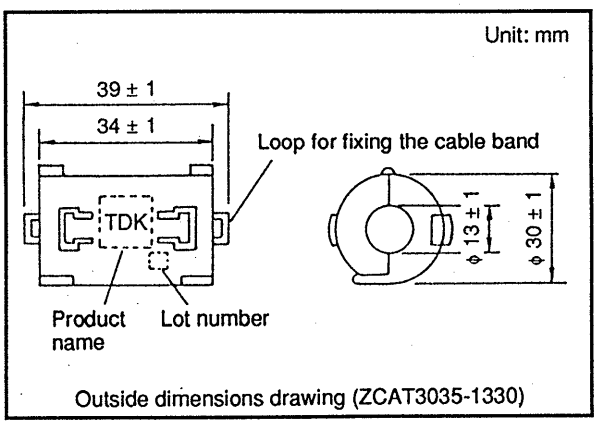
Ex: Data line filter: ZCAT3035-1330 [Made by TDK]
ESD-SR-25 [Made by Tokin]

Note: Contact the manufacturer for details of dimensions and type names.

Impedance specifications (ZCAT3035-1330)

Impedance (Ω)	
10 to 100MHz	100 to 500MHz
80	150

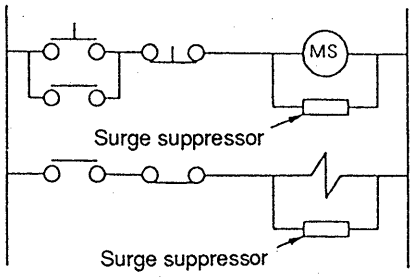
Note: The above impedance value includes the impedance of the cable (measured value) and is not a guaranteed value.

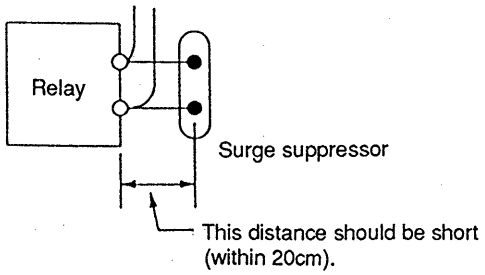


Outside dimensions drawing (ZCAT3035-1330)

(2) Surge suppressor

The recommended surge suppressor for installation an AC relay, AC valve, AC magnetic brake or the like in the vicinity of the amplifier is shown below. Use this product or equivalent.

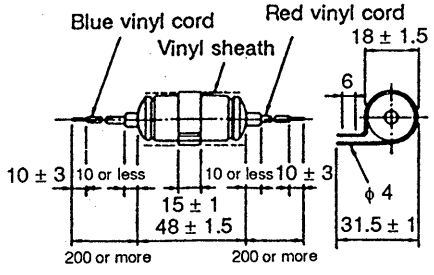




(Ex.) 972A-2003 504 11 (Made by Matsuo Electric Co., Ltd. — 200VAC rating)

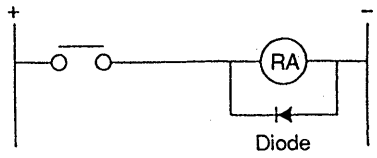
Rated Current AC(V)	C(μF)	R(Ω)	Test Voltage AC(V)
200	0.5	50(1W)	Across T-C 1000 (1 to 5s)

Outer dimensions diagram [Unit: mm]



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

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

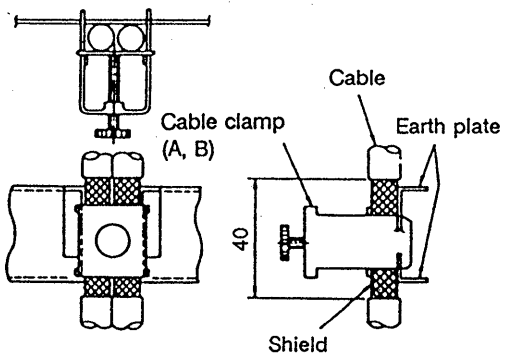


(3) Cable clamp fitting (AERSBAN-□SET)

The shield wire earth plate normally only needs to be connected to the connector's SD terminal. However, the effect can be increased by directly connecting the wire 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 shield, and insert that part into the earth plate with the cable clamp. If the cable is thin, clamp several cables in a bunch.

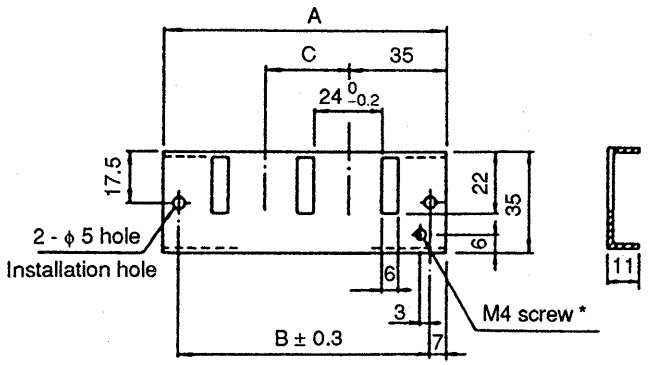
Please contact Mitsubishi when the cable clamp is required. The clamp comes as a set with the earth plate.



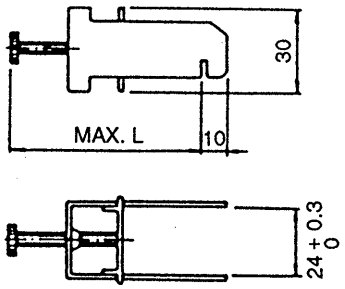
Clamp section diagram

- **Outer dimensions diagram [Unit: mm]**

Earth plate



Cable clamp



1) Always wire from the earth plate to the cabinet ground.

2) * Screw hole for wiring to cabinet ground.

	A	B	C	Enclosed fittings
AERSBAN-DSET	100	86	30	Fitting A: 2pcs.
AERSBAN-ESET	70	56	–	Fitting B: 1pc.

	L
Clamp A	70
Clamp B	45

(4) Line noise filter (FR-BLF, FR-BSF01)

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

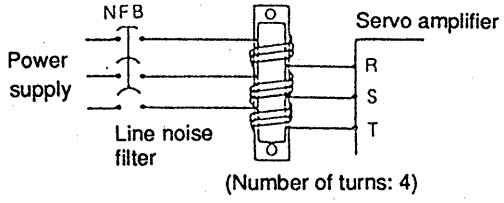
Connection chart

- Wind the wires connected to a three-phase power supply on equal number of times in the same direction, and insert the filter to the power supply side and the output side of the servo amplifier.
- The effect of the filter on the power supply side becomes higher as the number of winds becomes larger. The number of turns is generally four. On the output side, the number of turns must be four or less.

Note 1: Do not wind the grounding wire together with the three-phase power wires. The filter effect will decrease. Use caution when a four-core cable is used. Use a separate wire for grounding.

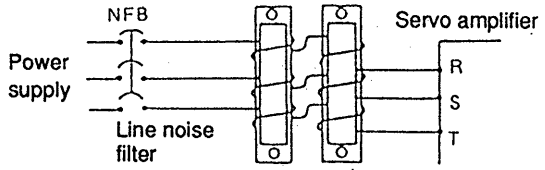
Note 2: If the wires are too thick to be wound, use two filters or more and the number of turns should be as mentioned above.

Example 1



(Number of turns: 4)

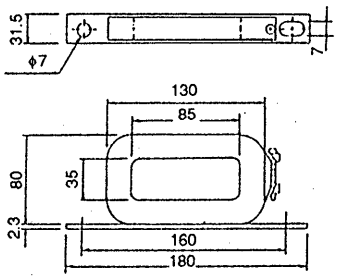
Example 2



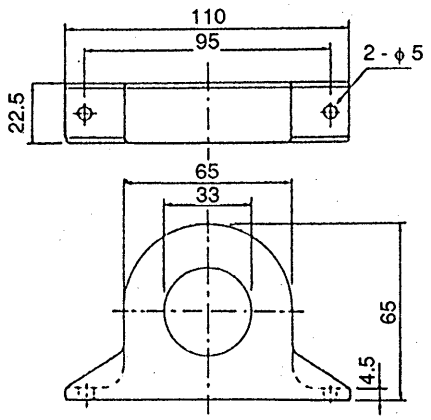
Two filters are used
(Total number of turns: 4)

Outside dimensions drawing (Unit: mm)

FR-BLF (for MR-J350□ an higher)



FR-BSF01 (for MR-J200□ and ower)

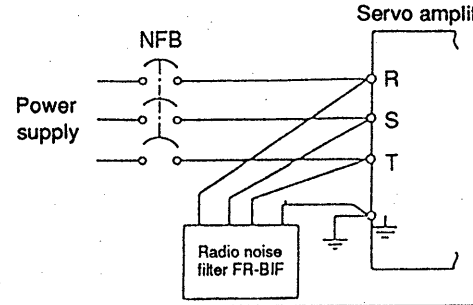


(5) Radio noise filter (FR-BIF)...exclusively for the input side

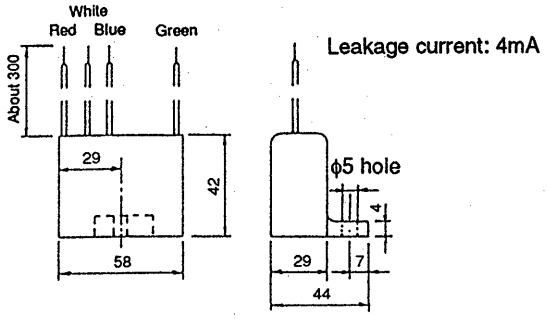
This filter is effective in suppressing noises radiated from the power supply side of the servo amplifier especially in 10MHz and lower radio frequency band. Exclusively for the input side and applicable to all types of servo amplifiers.

Connection chart

Make the connecting cables as short as possible.
Grounding is always required. (Class 3 or higher)



Outside dimensions drawing (Unit: mm)



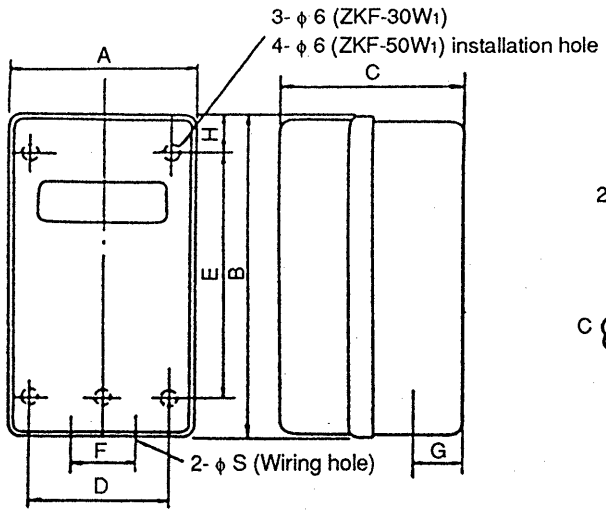
6-10 Selection of power supply and surge absorber for electromagnetic brake

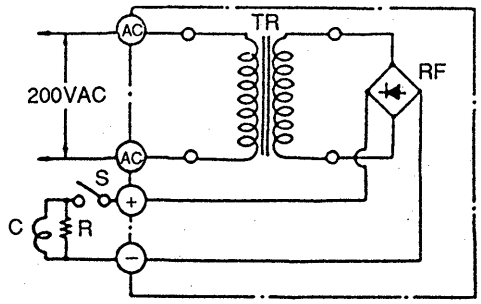
The following are available for servo motor with electromagnetic brakes.

(1) Power supply

This unit is used when the exciting power (24VDC) for the electromagnetic brake is abtained form a 200VAC source. Use the following power supply or equivalent.

(Ex.) ZKF-W_1 type power supply unit





TR: Transformer
RF: Rectifier
R : Protective resistor or barrister
C : Exciter coil for brake
S : Switch

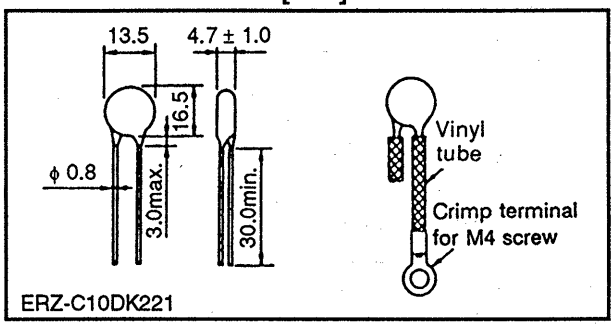
Outer dimensions of the ZKF-W_1 type power supply unit [mm]

Model	Power voltage AC (V)	Output voltage DC (V)	Output current (A)	A	B	C	D	E	F	G	H	S	Weight (kg)
ZKF-30W_1	200	24	0.9	104	170	110	76	140	50	30	15	22	2.6
ZKF-50W_1			1.8	135	225	130	95	165	50	45	30	28	3.8

(2) Surge absorber

When wiring the electromagnetic brake, always use a surge absorber. Use the following surge absorber or equivalent. Connect across the brake terminals in the servo motor terminal box. Insulate the wiring as shown in the diagram.

External dimensions [mm]



Maximum Rating					Maximum Limit Voltage		Static Capacity (Reference value)	Varistor Voltage Rating (Range) V_1mA
Permissible circuit voltage		Surge immunity	Energy immunity	Raged power				
AC (Vrms)	DC (V)	(A)	(J)	(W)	(A)	(V)	(pF)	(V)
140	180	500/time (Note)	5	0.4	25	360	300	220 (198 to 242)

Note: 1 time=8×20μsec

(Ex.) • ERZ-C10DK221 (Made by Matsushita Electric)

• TNR-12G21K (Marcon Electronics)

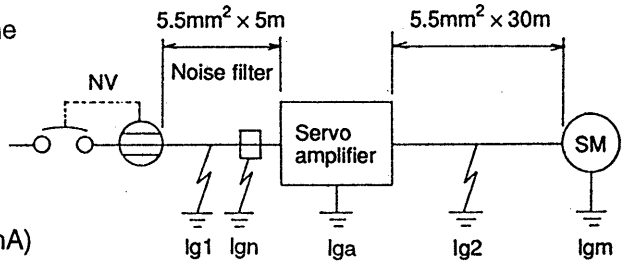
6-11 Leakage current breaker

High-frequency chopper current controlled by pulse width modulation flows in the AC servo circuit. Leakage current containing the harmonic contents is larger than that of a motor which is run with a commercial power supply. Leakage current during the low noise operation is larger than that during the non-low noise operation.
Select a leakage breaker as mentioned below, and ground the servo amplifier, servo motor, etc. securely. Make the input and output cables as short as possible, and also, make the grounding wire as long as possible (about 30cm) to minimize leak currents.

Selection

The amount of leakage current varies according to the cable and wire length, servo motor capacity and low noise/non-low noise operation. Select a leakage current breaker as mentioned below.

- Leakage current on the electric channel from the leakage current breaker to the input terminal of the servo amplifier: Ig1 (mA)
  (Obtain from Table 6-1.)
- Leakage current on the electric channel from the output terminal of the servo amplifier to the motor: Ig2 (mA)
  (Obtain from Table 6-1.)
- Leakage current when a filter is connected to the input side: Ign (mA)
  (4mA per one FR-BIF)
- Leakage current of the servo amplifier: Iga (mA)
  (Obtain from Table 6-3.)
- Leakage current of the servo motor: Igm (mA)
  (Obtain from Table 6-2.)



Rated sensitivity current ≥ 10 × {Ig1+Ign+Iga+K × (Ig2+Igm)}mA

K: Constant considering the harmonic contents
(varies according to the frequency characteristics of the leakage breaker)
Models provided with countermeasures against harmonics and surge (equivalent to MITSUBISHI NV-SF or FF): K=1
General models (equivalent to MITSUBISHI NV-CA, CS or SS): K=3

Table 6-1
Leakage current (Ig1, Ig2) when CV cable is laid in a metal conduit

Cable size (mm^2)	Leakage current per 1 km (mA)
2	13
3.5	17
5.5	33

Table 6-2
Leakage current of servo motor (Igm)

Servo motor		Leakage current (mA)
HA-ME HA-FE		0.03 or less
HA-SE	1kW or less	0.1
	1.2k to 2kW	0.2
	3k, 3.5kW	0.3

Table 6-3
Leakage current of servo amplifier

Servo amplifier capacity (kW)	Leakage current (mA)
0.1 to 0.6	0.1
0.7 to 3.5	0.15

Table 6-4
Leakage current breaker selection example

Model	Rated sensitivity current of leakage breaker
All servo amplifiers	15mA

Note: The above value assumes that the wiring distance is 5m.

6-12 External power for interface davices

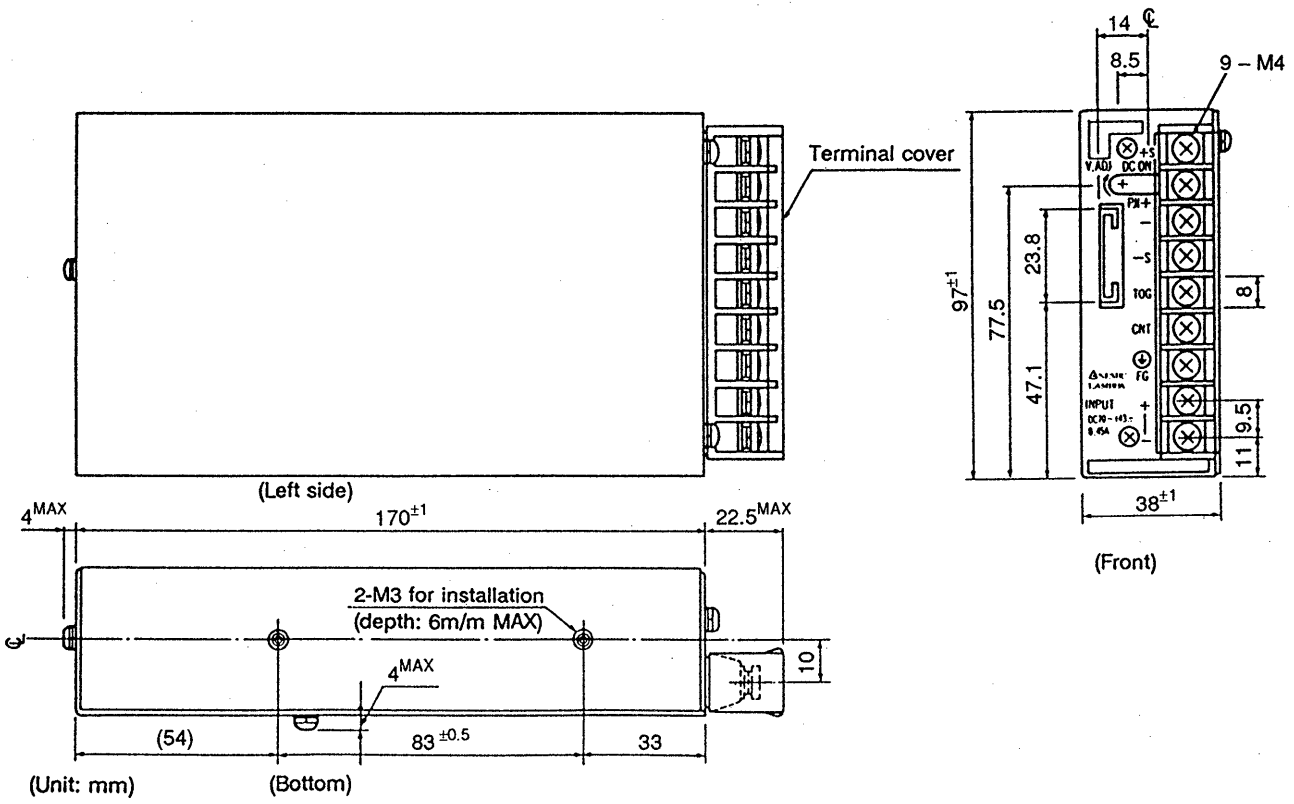
(1) Specifications

Use the following external power supply or equivalent.

Maker	Model	Input voltage (V)	Output voltage (V)	Variable voltage range (V)	Maximum output current (A)
TDK	FAW24-1R1	85 to 264	24	21.6 to 26.4	1.1
Nemic Lambda	SR20-24-110	70 to 143 (170 to 265)	24	21.6 to 26.4	0.9

Note: The SR20-24-110 does not allow the input power to be selected.

(2) Outer dimensions (for SR20-24-110) (unit :mm)



7-1 List of control variables

The following symbols and variables are used for selecting the correct servo.

T_a	:	Acceleration torque [N·m]	P_t	:	No. of feedback pulses in positioning servo [pulse/rev]
T_d	:	Deceleration torque [N·m]	f	:	Input pulse frequency in positioning servo [pps]
T_{Ma}	:	Servo motor torque necessary for acceleration [N·m]	fo	:	Input pulse frequency during fast feed in positioning servo [pps]
T_{Md}	:	Servo motor torque necessary for deceleration [N·m]	Tpsa	:	Acceleration time constant of frequency command in positioning servo [sec]
T_{LH}	:	Torque applied when the servo motor is stopping [N·m]	Tpsd	:	Deceleration time constant of pulse frequency command in positioning servo [sec]
T_L	:	Load torque converted into equivalent value on servo motor shaft [N·m]	Kp	:	Position loop gain [sec^{-1}]
T_{LM}	:	Load torque converted into equivalent value on servo motor shaft during stopping [N·m]	Tp	:	Position loop time constant (Tp=1/Kp) [sec]
T_U	:	Unbalance torque [N·m]	Kv	:	Speed loop gain [sec^{-1}]
T_F	:	Load friction torque [N·m]	Tv	:	Speed loop time constant (Tv=1/Kv) [sec]
T_{LO}	:	Load torque on load shaft [N·m]	$\Delta\ell$	:	Movement amount per feedback pulse in positioning servo [mm/pulse]
T_{rms}	:	Continuous effective load torque converted into equivalent value on servo motor shaft [N·m]	$\Delta\ell o$	:	Movement amount per command pulse in positioning servo [mm/pulse]
J_L	:	Load inertia converted into servo motor shaft [$kg\cdot cm^2$]	ℓ	:	Movement amount [mm]
J_{LO}	:	Load inertia on load shaft [$kg\cdot cm^2$]	P	:	Number of input command pulses in positioning servo [pulse]
J_M	:	Motor's rotor inertia [$kg\cdot cm^2$]	ts	:	Stop settling time in positioning servo [sec]
N	:	Motor speed [r/min]	to	:	Positioning time [sec]
N_O	:	Motor speed during fast feed [r/min]	tc	:	Time of constant rpm of servo motor in 1 cycle [sec]
N_{LO}	:	Load shaft speed during fast feed [r/min]	$t\ell$	:	Stopping time in 1 cycle [sec]
V	:	Motion part speed [mm/min]	$\Delta\varepsilon$	:	Positioning accuracy [mm]
V_O	:	Motion part speed during fast feed [mm/min]	ε	:	No. of droop pulses [pulse]
P_B	:	Ball screw lead [mm]	$\Delta\theta$	:	Load shaft rotation angle per pulse in positioning servo [degree/pulse]
Z_1	:	No. of gear teeth on servo motor shaft	e	:	Euler constant = 2.71828
Z_2	:	No. of gear teeth on load gear	ΔS	:	Movement amount per servo motor revolution [mm]
n	:	Gear ratio $n = \frac{Z_2}{Z_1}$ Speed reduced when n>1, Speed increased when n<1			

7

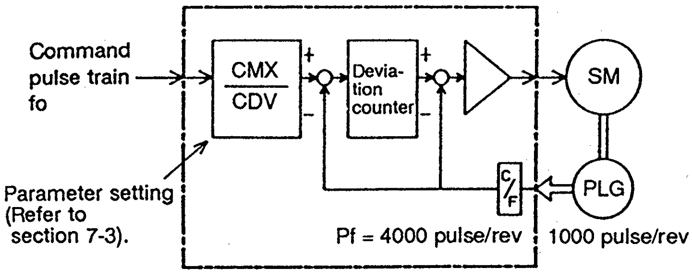
7-2 Position resolution and parameter setting

The position resolution (movement amount per feedback pulse $\Delta\ell$) is determined from the movement amount per servo motor revolution ΔS and number of detector feedback pulses Pf. The following equation shows this.

$$\Delta\ell = \frac{\Delta S}{P_f} \quad \cdots\cdots \quad (7\text{-}1)$$

$\Delta\ell$: movement amount per pulse [mm]
ΔS : movement amount per servo motor revolution [mm]
P_f : number of feedback pulses [pulse/rev]

The value for $\Delta\ell$ is related to the equation (7-1) and the value in the control system is fixed when the drive system and encoder are determined. However, the movement amount per command pulse can be set with parameters.



As shown above, the command pulse is multiplied by CMX/CDV to become the position control pulse. Therefore the movement amount per command pulse, $\Delta\ell_o$, is expressed with the following equation.

$$\Delta\ell_o = \frac{\Delta S}{P_f} \times \left[\frac{CMX}{CDV}\right] = \Delta\ell \times \left[\frac{CMX}{CDV}\right] \quad \cdots\cdots \quad (7\text{-}2)$$

Using the above relation, the movement amount for command pulse can be set to a number without fraction.

Setting example

Obtain the parameter value for $\Delta l = 0.01$ [mm] in the drive system with a ball screw lead $P_B = 10$ [mm], reduction ratio 1/n = 1.

The MR-FE encoder feedback pulse is Pf = 4000 [pulse/rev].

$\Delta S = 10$ [mm] so with equation (7-2), the following is obtained.

$$\left[\frac{CMX}{CDV}\right] = \Delta\ell_o \times \frac{Pf}{\Delta S} = 0.01 \times \frac{4000}{10} = 4$$

Therefore, the parameters are set as CMX=4 and CDV=1.

Relationship of position resolution $\Delta\ell$ and total accuracy

Total accuracy (machine's positioning accuracy) is the sum of the electrical difference and mechanical difference. Therefore, the electrical system difference is normally set so that it does not influence overall difference.

Refer to the equation below as a guideline.

$$\Delta\ell < \left[\frac{1}{5} \text{ to } \frac{1}{10}\right] \times \Delta\varepsilon \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \text{(7-3)}$$

Here: $\Delta\varepsilon$: positioning accuracy [mm]

7-3 Servo motor speed and command pulse frequency

The servo motor is commanded to run at a speed where the command pulse and feedback pulse are equivalent. Therefore, the command pulse frequency and feedback pulse frequency are equivalent, so the relation including the parameter command pulse multiplication (CMX, CDV) set value is shown below.

$$f_o \times \frac{CXM}{CDV} = 4000 \times \frac{N_o}{60} \quad \cdots\cdots (7\text{-}4)$$

Here: f_o : command pulse frequency [pps]
CMX : command pulse multiplication numerator
CDV : command pulse multiplication denominator
N_o : servo motor speed [r/min]

Use the above equation to obtain the command pulse multiplication and command pulse frequency for rotating the servo motor at No.

Setting example 1

Setting example for command pulse multiplication (CMX, CDV) when using AD71.
Obtain the command pulse multiplication to operate the servo motor at 3000 [r/min] with an input pulse train frequency of 200 [kpps].
With equation (7-4):

$$\left[\frac{CMX}{CDV}\right] = 4000 \times \frac{N_o}{60} \times \frac{1}{f_o} = 4000 \times \frac{3000}{60} \times \frac{1}{200 \times 10^3} = 1$$

Therefore, the parameter and set to CMX=1 and CDV=1.

Setting example 2

Obtain the command pulse frequency that sets the servo motor speed N_o to 3000 [r/min]. Here, the command pulse multiplication is CMX/CDV = 1.
With equation (7-4):

$$f_o = 4000 \times \frac{N_o}{60} \times \frac{CVD}{CMX} = 4000 \times \frac{3000}{60} \times 1 = 200 \times 10^3 \text{ [pps]} = 200\text{[kpps]}$$

When using HA-FE at 4000r/min, the input pulse is limited to 200kpps, so the electronic gear ratio is set to that below.

$$\left[\frac{CMX}{CDV}\right] = 4000 \times \frac{4000}{60} \times \frac{1}{200 \times 10^3} = \frac{4}{3}$$

Therefore, the parameter are set to CMX=4 and CDV=3.

7-4 Stopping characteristics of the servo motor

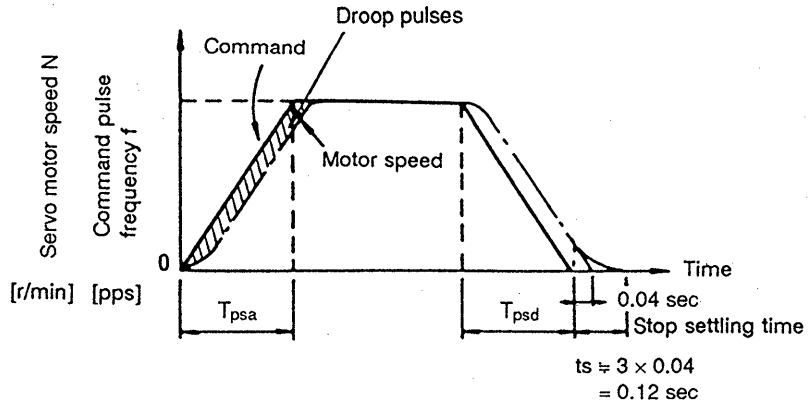
(1) Droop pulses (ε) (DEVIATION)

When operating the servo with a pulse train command, the encoder feedback pulses are delayed during acceleration. The difference between the command pulses and feedback pulses are called droop pulses. The droop pulses are accumulated in the servo amplifier's deviation counter. The following equation defines the relationship between the command frequency(f_o), the position loop gain(K_p), and the number of droop pulses(e).

$$\varepsilon = \frac{f_o}{K_p} \text{ [pulse]} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \text{(7-5)}$$

In the MELSERVO-J, K_p can be adjusted from 5 to 100 [sec^{-1}]. It is set to K_p=25 [sec^{-1}] at the factory. Here, if the command pulse frequency is 200 [kpps], the droop pulses will be the following, according to the above equation (7-5).

$$\varepsilon = \frac{200 \times 10^3}{25} = 8000 \text{ [pulse]}$$



(2) Stop settling time (ts) during linear deceleration

The servo amplifier during operation has droop pulses, so a stop settling time (ts) is required from the time the command reaches 0 to when the servo motor stops. The command positioning time and machine positioning time will differ.

Set the operation pattern while taking the stop settling time into consideration.

The ts value can be obtained from the next equation.

$$ts \fallingdotseq 3 \times T_P = 3 \times \frac{1}{K_P} \text{ [sec]} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \text{(7-6)}$$

* When the factory default setting Kp=25 [sec^{-1}] is used, ts ≒ 0.12 [sec]. Refer to above diagram.

(Note) The stop settling time (ts) indicates the time required for the servo motor to stop in the necessary position accuracy range. This does not always mean that the servo motor has stopped completely. Thus, at high cycle rates, a larger value than the value obtained in the equation (7- 6) must be considered when there is no allowance in the positioning accuracy for the movement amount per pulse ($\Delta\ell$).

The ts will differ depending on the moving part conditions. If the load friction torque is especially large, the movement may be unstable near the stopping position.

7-5 Servo motor selection

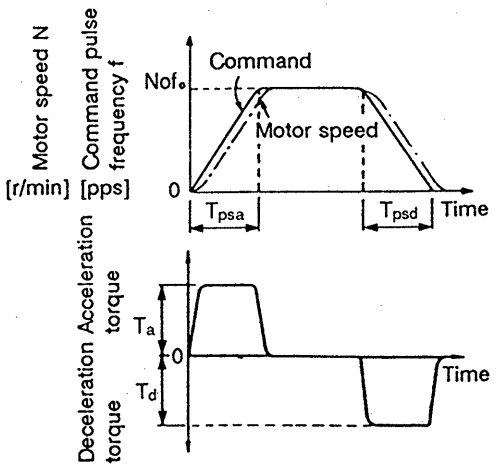
To select a servo motor, the load torque and inertia must first be calculated. Next, a motor is selected according to these initial calculations. Then, the load of the motor is included in further calculations to determine if the initial motor selected will provide the necessary performance.

(1) Initial selection of servo motor capacity

When the load torque (T_L) and load inertia (J_L) have been calculated. Select a servo motor using motor rated torque > T_L, servo motor inertia $J_M > J_L/3$ as a guideline. Find the torque for acceleration/deceleration, and the continuous effective load torque following the steps in (2) and then verify the selection.
For frequent positioning, the J_L value should be as small as possible. If positioning is infrequent, the J_L value can be slightly larger than the above conditions.

(2) Acceleration/deceleration torque

The equation for obtaining the acceleration/deceleration torque with the following pattern is shown.



• Acceleration torque

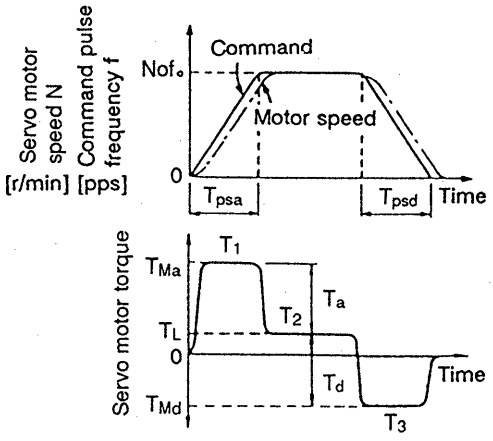
$$T_a = \frac{(J_L + J_M) \times No}{9.55 \times 10^4} \times \frac{1}{T_{psa}} \quad \cdots\cdots (7\text{-}7)$$

• Deceleration torque

$$T_d = \frac{(J_L + J_M) \times No}{9.55 \times 10^4} \times \frac{1}{T_{psd}} \quad \cdots\cdots (7\text{-}8)$$

(3) Torque required for operation

The highest torque is applied to the servo motor during acceleration. If the torque required for the servo motor during acceleration obtained in the following equation exceeds the maximum servo motor torque, acceleration will not be possible in the commanded time. Confirm that the calculated value is lower than the motor's maximum servo motor torque. Normally, a friction load is applied during deceleration, so only the acceleration torque needs to be considered.



$T_1 = T_{Ma} = T_a + T_L$ ..... (7-9)

$T_2 = T_L$ ..... (7-10)

$T_3 = T_{Md} = -T_d + T_L$ ..... (7-11)

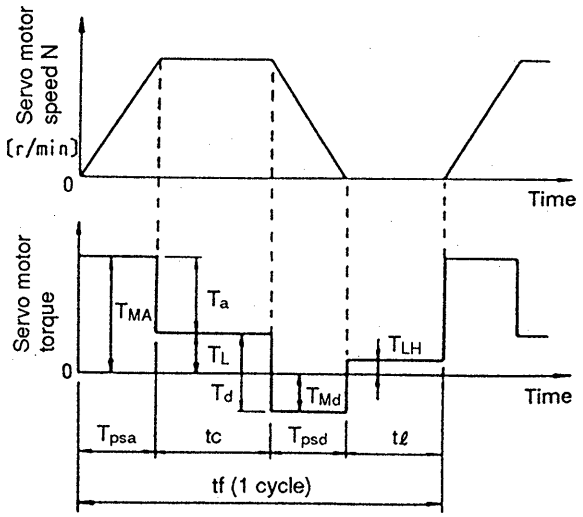
(Note)

The regenerative status will be indicated if the value obtained in the equation (7-11) is a negative value.

(4) Continuous effective load torque

If the torque required for the servo motor changes with the time, the continuous effective load torque obtained in the following equation must be lower than the servo motor's rated torque. Always confirm this torque and check that the servo motor does not overheat when carrying out frequent positioning.

There may be a servo motor torque delay at acceleration or deceleration due to a delay in the control system. But, to simplify the calculation, the calculation assumes that a constant acceleration/deceleration torque is applied during Tpsa and Tpsd. The equation for the continuous effective load torque for the following operation pattern is given below.



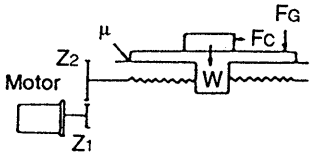
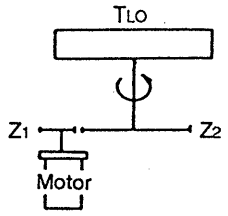
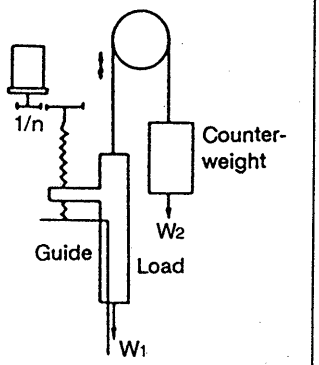
$$Trms = \sqrt{\frac{T_{Ma}^2 \times T_{psa} + T_L^2 \times tc + T_{Md}^2 \times T_{psd} + T_{LH}^2 \times t\ell}{t_f}} \quad \text{.....(7-12)}$$

Note: T_{LH} in the diagram shows the torque applied during stopping. A torque is applied to the servo motor especially when stopping during vertical operations. During vertical drive, the unbalanced torque T_U will be T_{LH}.

7-6 Load torque equations

The main load torque equations are shown in Table 7-1.

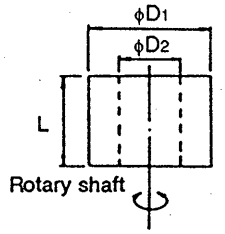
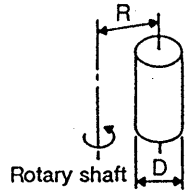
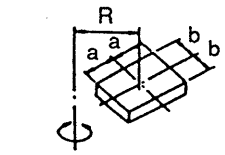
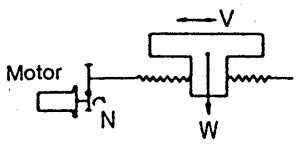
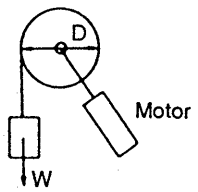
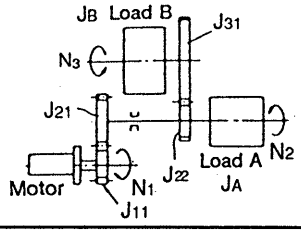
Table 7-1 Load torque equations

Type	Mechanism	Equation
Linear movement		$T_L = \frac{F}{2\times10^3\pi\eta} \times [\frac{V}{N}] = \frac{F\times\Delta s}{2\times10^3\pi\eta}$ .....(7-13) F: Shaft direction force of the machine in linear motion [N] η: Drive system efficiency F in the above equation is obtained with the equation (7-19) when moving a table, for example, as shown in the diagram. $F = F_C + \mu (W\times g + F_G)$ .....(7-14) Fc: Shaft direction force applied on moving part [N] FG: Tightening force of the table guide plate [N] W : Total weight of the moving part [kg] g : Acceleration of gravity [9.8m/s^2] μ : Friction coefficient
Rotary movement		$T_L = \frac{1}{n}\times\frac{1}{\eta}\times T_{LO} + T_F$ .....(7-15) TLO: Load torque on the load shaft [N·m] TF : Load friction torque co nverted into equivalent value on servo motor shaft [N·m]
Vertical movement		During rising $T_L = T_U + T_F$ .....(7-16) During lowering $T_L = -T_U\times\eta^2 + T_F$ .....(7-17) TU: Unbalanced torque [N·m] TF: Friction torque of the moving part [N·m] $T_U = \frac{(W_1 - W_2)\times g}{2\times10^3\pi\eta} \times [\frac{V}{N}] = \frac{(W_1 - W_2)\times g\times\Delta S}{2\times10^3\pi\eta}$ .....(7-18) $T_F = \frac{\mu\times(W_1+W_2)\times g\times\Delta S}{2\times10^3\pi\eta}$ .....(7-19) W1 : Load weight [kg] W2 : Counter weight [kg] η : Drive part efficiency μ : Friction coefficient

7-7 Load inertia equations

The main load inertia equations are shown in Table 7-2.

Table 7-2 Load inertia equations

Type	Mechanism	Equation
Cylinder	Rotary shaft is at cylinder center 	$J_{LO} = \frac{\pi \times \rho \times L}{32} \times (D_1^4 - D_2^4) = \frac{W}{8} \times (D_1^2 - D_2^2)$ .....(7-20) J_{LO} : Load inertia [kg·cm^2] ρ : Cylinder material density [kg·cm^3] L : Cylinder length [cm] D_1 : Cylinder outer diameter [cm] D_2 : Cylinder inner diameter [cm] W : Cylinder weight [kg] Reference data: material density Steel : 7.8×10^{-3} [kg/cm^3] Aluminum : 2.7×10^{-3} [kg/cm^3] Copper : 8.96×10^{-3} [kg/cm^3]
	When rotary shaft and cylinder shaft are off 	$J_{LO} = \frac{W}{8} \times (D^2 + 8R^2)$ .....(7-21)
Square block		$J_{LO} = W \times [\frac{a^2 + b^2}{3} + R^2]$ .....(7-22) a, b, R: Left diagram [cm]
Object which moves linearly		$J_L = W \times [\frac{v}{600\omega}] = W \times [\frac{1}{2\pi N} \times \frac{v}{10}]^2 = W \times [\frac{\Delta S}{20\pi}]^2$ .....(7-23) J_L : Load inertia converted into equivalent value on servo motor shaft [kg·cm^2] V : Speed of object moving linearly [mm/min] N : Servo motor speed [r/min] ΔS: Servo movement amount of object moving linearly per motor one rotation [mm]
Object that is hung with pulley		$J_L = W \times [\frac{D}{2}]^2 + J_P$ .....(7-24) J_P : Pulley inertia [kg·cm^2] D : Pulley diameter [cm]
Converted load		$J_L = J_{11} + (J_{21} + J_{22} + J_A) \times [\frac{N_2}{N_1}]^2 + (J_{31} + J_B) \times [\frac{N_3}{N_1}]^2$ .....(7-25) J_A, J_B : Load A, B inertia [kg·cm^2] J_{11} to J_{31} : Inertia [kg·cm^2] N_1 to N_3 : Speed of each shaft [r/min]

7-8 Procedure for setting the mechanical origin

To return the system to the origin with the MELSERVO-J, use a near-zero point dog or actuator. The method and precautions for setting the mechanical origin are given below.

In the following origin return, an actuator and the zero pulse signal of a servo motor encoder are used to set the mechanical origin.

When a general positioning module (e.g. AD71) is used, the sequence of events is as shown below.

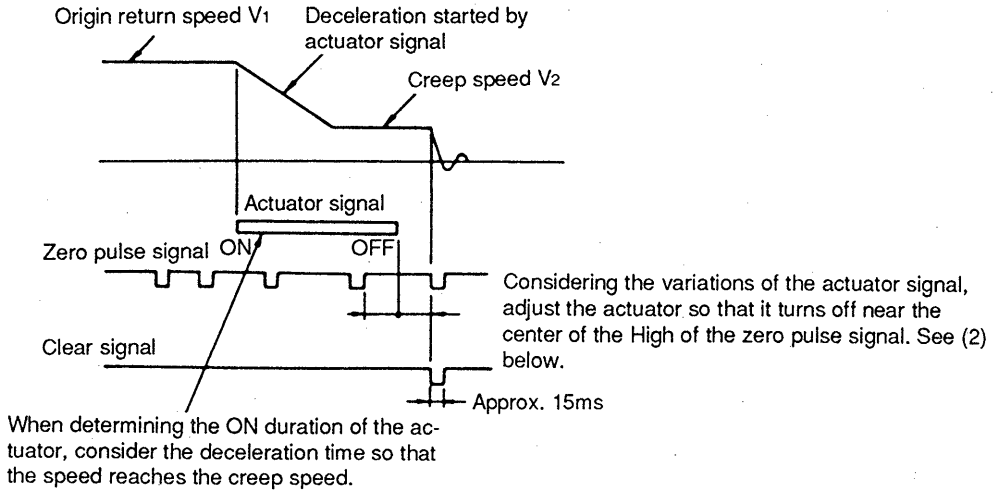
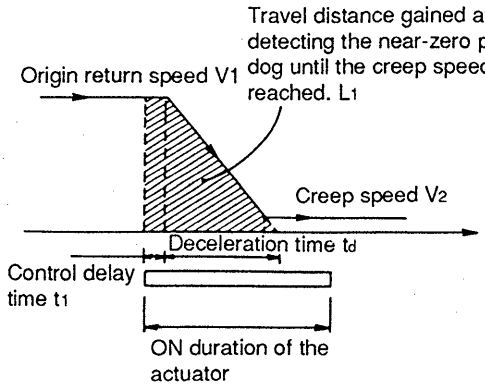


Fig. 7-1 Origin return using the actuator

(1) When determining the ON duration of the actuator, consider the delay time of the control and the deceleration time so that the creep speed is attained. If the near-zero point dog turns OFF during deceleration, precise origin return cannot be performed.



- Travel distance L_1 in the chart can be obtained by the general formula given below. ... Formula (7-26)
- ON duration of the actuator L_D [mm] must be longer than L_1 obtained by formula (7-26). ... Formula (7-27)

$$L_1 = \frac{1}{60} V_1 \times t_1 + \frac{1}{120} V_1 \times t_d \left\{ 1 - \left(\frac{V_2}{V_1} \right)^2 \right\} \quad \text{... (7-26)}$$

$$L_D > L_1 \quad \text{... (7-27)}$$

where,

V_1, V_2 : as shown in the chart [mm/min]

t_1, t_d : same as above [sec]

L_1 : same as above [mm]

L_D : same as above [mm]

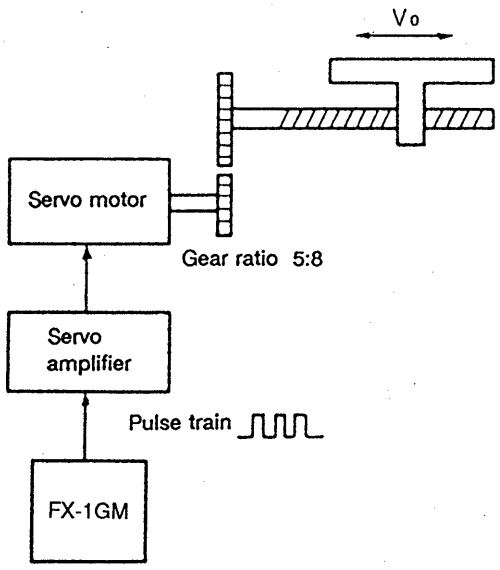
(2) Set the end (OFF position) of the actuator signal at the middle of two ON positions (Lows) of the zero pulse signal. If it is set near either ON position of the zero pulse signal, the positioning module is liable to misdetect the zero pulse signal. In this case, a fault will occur, e.g. the origin will shift by one revolution of the servo motor.
The zero pulse output position is shown on the 7-segment display of the servo amplifier.

(3) Set the creep speed so that the machine is not shocked when the operation comes to a stop. The operation instantly stops since a clear (CR) signal is given to the servo amplifier immediately when a zero pulse signal is detected.

7-9 Example of servo motor selection

Selection example 1

Machine specifications



— System configuration —

Speed of moving part during fast feed	Vo = 30000 mm/min
Movement amount per pulse	$\Delta\ell$ = 0.005 mm
Movement amount	ℓ = 400 mm
Positioning time	to = 1 sec or less
No. of feeds	40 times/min.
(Operation cycle	t_f = 1.5 sec.)
Gear ratio	n = 8/5
Moving part weight	W = 60 kg
Drive part efficiency	η = 0.8
Friction coefficient	μ = 0.2
Ball screw lead	P_B = 16 mm
Ball screw diameter	20 mm
Ball screw length	500 mm
Gear diameter (motor shaft)	25 mm
Gear diameter (load shaft)	40 mm
Gear teeth width	10 mm

(1) Selection of control parameter

a. Setting of electronic gears (pulse multiplication numerator, denominator)
The following relation is established between the multiplication setting and movement amount per pulse $\Delta\ell$.

$$\Delta\ell = \frac{\text{(Ball screw lead)}}{4000 \times \text{(Gear ratio)}} \times \left[\frac{CMX}{CDV}\right]$$

When the machine specification are substituted in the above equation:

$$\frac{CMX}{CDV} = 0.005 \times \frac{4000 \times 8/5}{16} = 2$$

OK if the $\frac{CMX}{CDV}$ ratio is within 1/50 to 20.

b. Input pulse train frequency f_o for fast feed

$$f_o = \frac{V_o}{60 \times \Delta\ell} = \frac{30000}{60 \times 0.005} = 100000 \text{ pps}$$

OK if f_o is 200kpps or less

(2) Servo motor speed

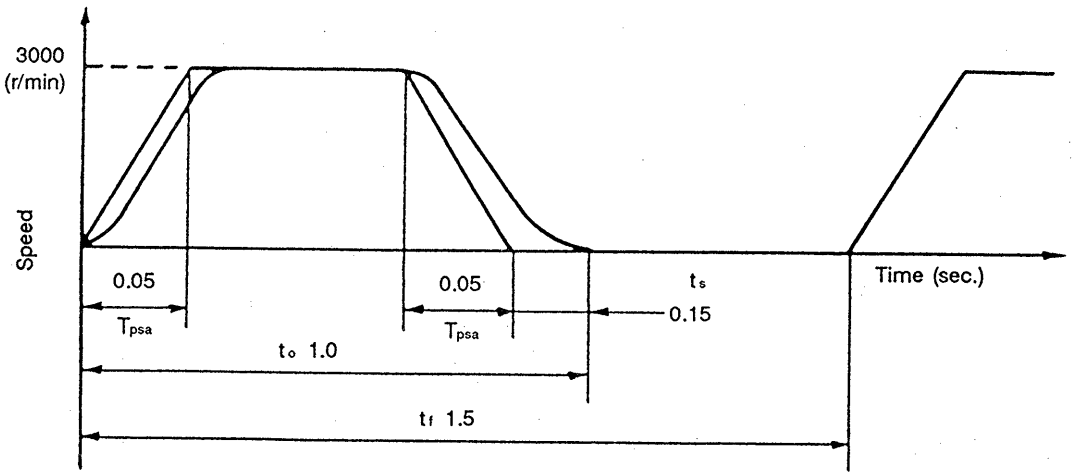
$$N_o = \frac{V_o}{P_B} \times n = 3000 \text{ r/min}$$

(3) Acceleration/deceleration time

$$T_{psa} = T_{psd} = t_o - \frac{\ell}{V_o/60} - ts = 0.05 \text{ sec.}$$

* ts: stop settling time. Here, this is assumed to be 0.15 sec.

(4) Operation pattern



(5) Load torque (converted into equivalent value on motor shaft)

Movement amount per motor revolution

$$\Delta S = P_B \times \frac{1}{n} = 10 \text{ mm}$$

$$T_L = \frac{\mu \times W \times g \times \Delta S}{2 \times 10^3 \pi \eta} = 0.23 \text{ N} \cdot \text{m}$$

For conventional system of units

$$T_L = \frac{\mu W \times \Delta S}{20 \pi \eta} = 2.4 \text{ kgf·cm}$$

(6) Load inertia (converted into equivalent value on servo motor shaft)

Moving part

$$L_{L1} = W \times [\frac{\Delta S}{20\pi}]^2 = 1.52 \text{ kg·cm}^2$$

Ball screw

$$J_{L2} = \frac{\pi \times \rho \times L}{32} \times D^4 \times \left[\frac{1}{n}\right]^2 = 0.24 \text{ kg·cm}^2$$

* $\rho = 7.8 \times 10^{-3}$ kg/cm^3 (iron)

Gear (servo motor shaft)

$$J_{L3} = \frac{\pi \times \rho \times L}{32} \times D^4 = 0.03 \text{ kg·cm}^2$$

Gear (load shaft)

$$J_{L4} = \frac{\pi \times \rho \times L}{32} \times D^4 \times \left[\frac{1}{n}\right]^2 = 0.08 \text{ kg·cm}^2$$

Full load inertia (converted into equivalent value on motor shaft)

$J_L = J_{L1} + J_{L2} + J_{L3} + J_{L4} = 1.9$ kg·cm^2

For conventional system of units

$GD^2 = 4 \times J = 7.6$ kgf·cm^2

(7) Temporary selection of servo motor

Selection conditions
Select HA-FE23 (200W) with:

1) Load torque < motor rated torque
2) Load inertia < 10 × motor inertia

(8) Acceleration/deceleration torque

Torque required for servo motor during acceleration

$$T_{Ma} = \frac{(J_L + J_M) \times N_o}{9.55 \times 10^4 \times T_{psa}} + T_L = 1.7 \text{ N·m}$$

For conventional system of units

$$T_{Ma} = \frac{(GD^2_L + GD^2_M) \times N_o}{37500 \times T_{psa}} + TL = 17.2 \text{ kgf·cm}$$

Torque required for servo motor during deceleration

$$T_{Md} = -\frac{(J_L + J_M) \times N_o}{9.55 \times 10^4 \times T_{psd}} + T_L = -1.2 \text{ N·m}$$

For conventional system of units

$$T_{Md} = -\frac{(GD^2_L + GD^2_M) \times N_o}{37500 \times T_{psd}} + TL = -12.4 \text{ kgf·cm}$$

The torque required for the motor during acceleration/deceleration must be lower than the servo motor maximum torque.

(9) Continuous effective load torque

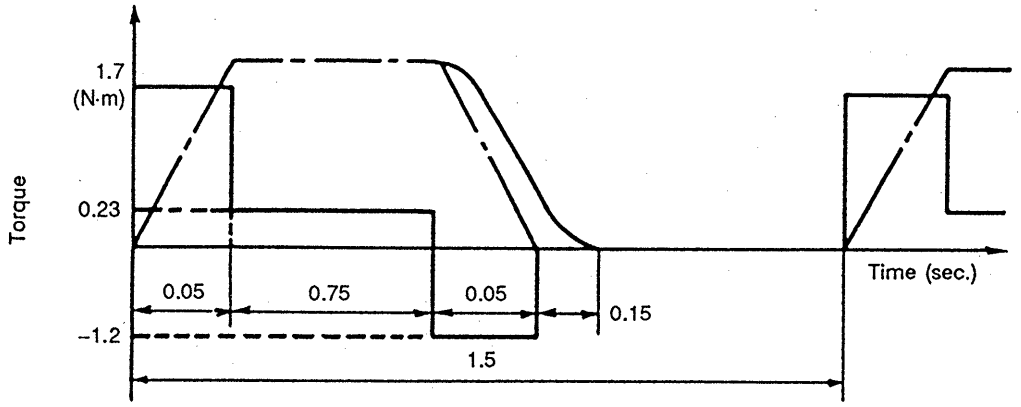
$$Trms = \sqrt{\frac{T_{Ma}^2 \times T_{psa} + T_L^2 \times tc + T_{Md}^2 \times T_{psd}}{t_f}} = 0.41 \text{ N·m}$$

For conventional system of units

4.2 kgf·cm

The continuous effective load torque must be lower than the servo motor rated torque.

(10) Torque pattern



(11) Selection results

Servo motor HA-FE23 and servo amplifier MR-J20A are selected with the above conditions.

a. Parameter setting value

Motor series and type	(MTY)	23
Servo loop type	(STY)	0000
Command pulse multiplication numerator	(CMX)	2
Command pulse multiplication denominator	(CDV)	1

b. During fast feed

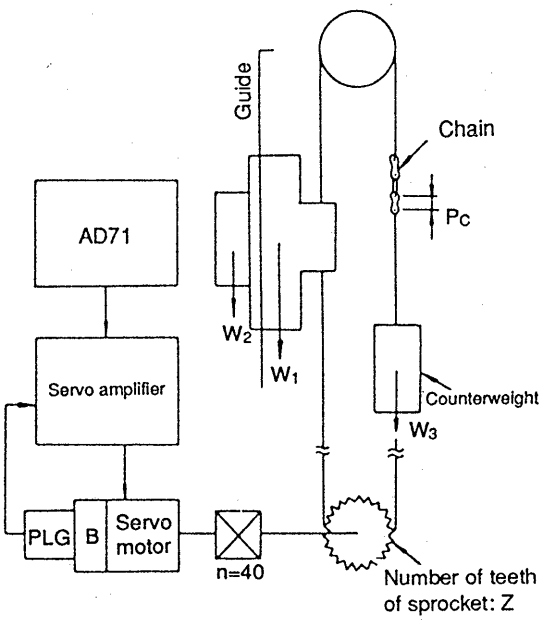
- Motor speed ..... N_o = 3000 r/min
- Input pulse train frequency ..... f_o = 100 kpps

c. Acceleration/deceleration time constant

$T_{psa} = T_{psd}$ = 0.05 sec

Selection example 2

Machine specifications



— System configuration —

Gear ratio	n = 40
Chain pitch	P_c = 25.4 (RS80) [mm]
Number of teeth of sprocket	Z = 45
Fast feed speed	V_O = 55000 [mm/min]
Head mass	W_1 = 400 [kg]
Workpiece mass	W_2 = 50 [kg]
Counterweight mass	W_3 = 350 [kg]
Chain mass	W_4 = 10 [kg]
Reduction gear inertia moment (converted into equivalent value on the servo motor shaft)	J_R = 12 [kg·cm²]
Sprocket inertia moment	J_S = 10000 [kg·cm²]
Feed amount per one time of positioning	ℓ = 700 [mm]
Positioning time	to = 1.2 [sec]
Number of times of positioning	fs = 10 × 2 [times/min]
Positioning accuracy	$\Delta\varepsilon$ = 0.1 [mm]
Driving unit efficiency	η = 0.7
Frictional coefficient	μ = 0.1
Feed amount per pulse	$\Delta\ell_0$ = 0.01 [mm/pulse]

(1) Parameter settings

(a) Servo amplifier electronic gear setting

$$\left(\frac{CMX}{CDX}\right) = \frac{Pf}{\Delta S} \times \Delta\ell = \frac{1600}{1143}$$

Setting CMX = 1600, CDV = 1143

(b) Command module AD71 setting

Motor speed during fast feed

$$N1 = \frac{Vo}{\Delta S} = \frac{55000}{25.4 \times 45/40} \fallingdotseq 1925 \text{ [r/min]}$$

When the unit of feed of AD71 is PULSE

- Positioning speed (positioning data No. 2)

$$f_0 = \frac{Vo}{\Delta\ell O} \times \frac{1}{60} = \frac{55000}{0.01} \times \frac{1}{60} \fallingdotseq 91667 \text{ [pps]}$$

(= 91.667 [kpps])

Setting 9167

- Positioning address (positioning data No. 3)

$$P = \frac{\ell}{\Delta\ell O} = \frac{700}{0.01} = 70000 \text{ [pulse]}$$

Setting 7000

When the unit of feed of AD71 is mm

- Travel amount per pulse (parameter No. 2)
  $\Delta\ell_o = 0.01$ [mm] Setting 100
- Positioning speed (positioning data No. 2)
  Vo = 55000 [mm/min] Setting 5500
- Positioning address (positioning data No. 3)
  $\ell = 700 \times 10^3$ [μm] Setting 700×10^4

(2) Calculation of load torque
Obtain the load torque from formulas (7-16) to (7-19) given in Section 7-6.

(a) When moving up
From formulas (7-16), (7-18) and (7-19), the following is obtained.

$$T_L = T_U + T_F$$

$$= \frac{(W_1 + W_2 - W_3)\cdot g\cdot \Delta S}{2\times 10^3 \pi\eta} + \frac{\mu(W_1 + W_2 + W_3 + W_4)\cdot g\cdot \Delta S}{2\times 10^3 \pi\eta}$$

$$= \frac{(400 + 50 - 350)\times 9.8 \times \frac{25.4\times 45}{40}}{2\times 10^3\pi\times 0.7} + \frac{0.1\times(400 + 50 - 350 + 10)\times 9.8\times \frac{25.4\times 45}{40}}{2\times 10^3\pi\times 0.7}$$

$$= 6.4 + 5.2$$

$$= 11.6 \text{ [N·m]}$$

(b) When moving down
From formulas (7-17), (7-18) and (7-19), the following is obtained.

$$T_L = -T_U\cdot\eta^2 + T_F = -3.1 + 5.2 = 2.1 \text{ [N·m]}$$

(3) Calculation of load inertia

(a) Inertia of movable object
Use formula (7-23) in Section 7-7 as follows.

- $$J_{L1} = (W_1 + W_2 + W_3 + W_4)\times\left(\frac{\Delta S}{20\pi}\right)^2$$
  $$= (400 + 50 + 350 + 10)\times\left(\frac{25.4\times 45/40}{20\pi}\right)^2 = 168 \text{ [kg·cm²]}$$

(b) Inertia moment of the sprocket converted to the equivalent value on the servo motor shaft

$$J_{L2} = J_S\times\left(\frac{1}{n}\right)^2$$

$$= 10000\times\left(\frac{1}{40}\right)^2 = 6.25 \text{ [kgÃcm²]}$$

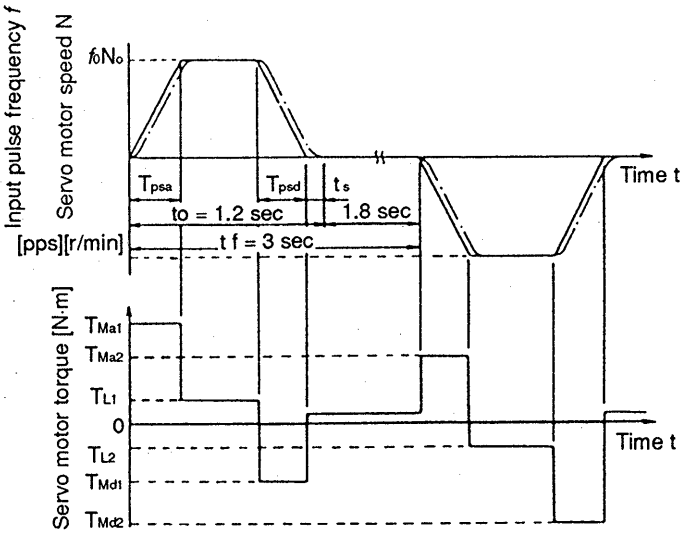
(c) Load inertia converted to the equivalent value on all servo motor shafts
This is obtained as the sum of (a) and (b) mentioned above and the reduction gear inertia.

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

$$= 168 + 6.25 + 12 = 186.25 \text{ [kg·cm²]}$$

(4) Provisional selection of servo motor
Considering the load values obtained in (2) and (3) above, provisionally select the HA-SE352 (with electromagnetic brake) (rated torque $T_M = 16.7$ [N·m] and the servo motor inertia $J_M = 131$ [kg·cm²].

(5) Calculation of the operation pattern
Since the operation is performed as up and down movements, the motor speed and torque patterns will be as shown below.



Calculate the acceleration and deceleration times required for positioning performed under the conditions of to = 1.2 (sec) or less and $\ell = 700$ (mm), shown in the figure above, as given below. To increase the stopping accuracy, determine ts as follows.

$$t_S = 5 \times T_P$$
$$= 5 \times 0.04 = 0.2 \text{ [sec]}$$

Calculate as follows.

$$T_{PSa} = to - ts - \frac{\ell}{Vo} \times 60$$
$$= 1.2 - 0.2 - \frac{700}{55000} \times 60 \fallingdotseq 0.24 \text{ [set]}$$

(6) Calculation of the acceleration and deceleration torque
Since $T_{psa} = T_{psd} = 0.24$ (sec) is substantially larger than $T_p = 0.04$ (sec), calculate the acceleration and deceleration torque using simplified formula (7-7).

$$T_a = T_d = \frac{(J_L + J_B + J_M) \times N_o}{9.55 \times 10^4} \times \frac{1}{T_{psa}}$$
$$= \frac{(186 + 5 + 131) \times 1925}{9.55 \times 10^4} \times \frac{1}{0.24} = 27.0 \text{ [N·m]}$$

Note: JB is the brake inertia moment of the motor with brake.

The servo motor torque values required during acceleration and deceleration are as follows.

When moving up
$T_{Ma1} = T_a + T_U + T_F = 38.6$ [N·m]
$T_{L1} = T_U + T_F = 11.6$ [N·m]
$T_{Md1} = -T_d + T_U + T_F = -15.4$ [N·m]

When moving down
$T_{Ma2} = T_a - T_U \cdot \eta^2 + T_F = 29.1$ [N·m]
$T_{L2} = -T_U \cdot \eta^2 + T_F = 2.1$ [N·m]
$T_{Md2} = -T_d - T_U \cdot \eta^2 + T_F = -24.9$ [N·m]

When stopping

Unbalance torque $T_U = 6.4$ [N·m]

The maximum torque values T_{Ma} and T_{Md} provisionally set with HA-SE352 are 50.1 [N·m] or less, which are allowable.

Since the maximum torque of the HA-SE352 selected provisionally is 50.1 [N·m] or less, both T_{Ma} and T_{Md} are acceptable.

(7) Calculation of continuous effective load torque

Confirm that the continuous effective load torque obtained from formula (7-12) using the operation pattern and required servo motor torque obtained in (2), (5) and (6) above is not larger than the servo motor's rated torque.

$$T_{rms} = \sqrt{\frac{38.6^2 \times 0.24 + 11.6^2 \times 0.52 + (-15.4)^2 \times 0.24 + 6.4^2 \times 2 \times 2 + 29.1^2 \times 0.24 + 2.1^2 \times 0.52 + (-24.9)^2 \times 0.24}{3 \times 2}}$$

$= 12.9$ [N·m]

This is less than the rated torque, 16.7 [N·m], of provisionally selected motor HA-SE352 and is therefore acceptable.

(8) Necessity of regenerative option

Inertia ratio $m = \frac{186 + 4.25}{131} = 1.45$ Note: Magnetic brake must be added to the load.

Number of times of positioning $f_S = 10 \times 2$ [times/min]

If a regenerative option is added externally, allowable brake duty is calculated as given in Section 9-4 as follows.

$$\text{Tolerable duty} = \frac{67}{m + 1} = \frac{67}{1.45 + 1} = 27.3 \text{ [times/min]}$$

And, this satisfies the specification value (20 times/min).

Regenerative option: Necessary

Note: If the brake duty on the machine side is not satisfactory even if a regenerative option is used, refer to Section 9-4 and calculate the regenerative energy and the allowable frequency.

(Example)

Calculate the regenerative energy by using the formula in Section 9-4 and required servo motor torque in respective operation section. The total of the regenerative energy is given in the table below.

Operation section	Required servo motor torque [N·m]	Energy E·[J]	Driving/Regenerative
(1)	38.6	934	Driving
(2)	11.6	1216	Driving
(3)	−15.4	-372	Regenerative
(4), (8)	6.4	0 (regenerative energy)	Driving
(5)	29.1	704	Driving
(6)	2.1	220	Driving
(7)	−24.9	-602	Regenerative
Total E of ⊖ energies at (1) to (8)		-974	

Regenerative power P_r is calculated as follows by using the total E of ⊖ energies, mentioned above, which is the total regenerative energy in one cycle (t_r = 6 [sec]).

$$P_r = \frac{E_r}{t_r} = \frac{833.2}{6} = 138\ [W] \quad \left(P_r = \frac{n \times E_S - E_A - E_C}{tr} = \frac{9 \times 974 - 7 \times 48 - 40}{6} \right)$$

The values shown above are larger than the values of the brake built in the servo amplifier given in a table in Section 9-4 and smaller than the values of the regenerative option.
Judging from the above, the operation is possible when a regenerative option is used.

(9) Motor's magnetic brake

Select a motor equipped with a magnetic brake to prevent object from falling at power failures or when the power is switched OFF.

Result of selection

- Servo motor (with magnetic brake) — HA-SE352B
- Servo amplifier — MR-J350A
- Regenerative option — MR-RB30
- Parameter settings

Servo loop type (STY)	0100
Command pulse multiplication numerator (CMX)	1600
Command pulse multiplication denominator (CDV)	1143

- Servo motor speed in fast feed — No = 1925 [r/min]
- Acceleration/deceleration time constant — $T_{PSa} = T_{PSd}$ = 0.24 [sec]
- Motor torque required during acceleration (maximum) — T_{Ma} = 38.6 [N·m]
- Servo motor torque required during deceleration (maximum) — T_{Md} = -24.9 [N·m]
- Continuous effective load torque — T_{rms} = 12.9 [N·m]

Calculation with customary units system

Specifications of the machine

Calculations with the SI units system are the same as those with customary units system except the following items.

Item		Conversion formula [unit]
Reduction gear	GD^2	$GD^2_R = 4 \times J_R = 48$ [kgf·cm²]
Sprocket	GD^2	$GD^2_S = 4 \times J_S = 40000$ [kgf·cm²]

Note: The same value applies to weight and mass.

(1) Parameter settings .... Same as in the SI units system.

(2) Calculation of load torque

(a) When moving up

$$T_L = T_U + T_F$$

$$= \frac{(W_1 + W_2 - W_3) \times \Delta S}{20\pi\eta} + \frac{\mu(W_1 + W_2 + W_3 + W_4) \times \Delta S}{20\pi\eta}$$

$$= \frac{(400 + 50 - 350) \times \frac{25.4 \times 45}{40}}{20\pi \times 0.7} + \frac{0.1 \times (400 + 50 - 350 + 10) \times \frac{25.4 \times 45}{40}}{20\pi \times 0.7}$$

$$= 6.50 + 5.26$$

$$= 117.6 \text{ [kgf·cm]}$$

(b) When moving down

$$T_L = -T_U \times \eta^2 + T_F = -31.9 + 52.6 = 20.7 \text{ [kgf·cm]}$$

(3) Calculation of GD^2

(a) GD^2 of movable object

$$GD^2_{L1} = 4 \times (400 + 50 + 350 + 10) \times \left(\frac{25.4 \times 45/40}{20\pi}\right)^2 = 670 \text{ [kgf·cm}^2\text{]}$$

(b) GD^2 of the sprocket converted to the equivalent value on the servo motor shaft

$$GD^2_{L2} = GD^2_S \times \left(\frac{1}{n}\right)^2 = 40000 \times \left(\frac{1}{40}\right)^2 = 25 \text{ [kgf·cm}^2\text{]}$$

(c) GD^2 of the sprocket converted to the equivalent value on all servo motor shafts

$$GD^2_L = GD^2_{L1} + GD^2_{L2} + GD^2_R = 670 + 25 + 48 = 743 \text{ [kgf·cm}^2\text{]}$$

(4) Provisional selection of servo motor

Torque and GD^2 values of the standard specification (Section 10-2) are given also in customary units system. Refer to those values and provisionally select the motor capacity. The result of provisional selection is the same as that with the SI units system.

(5) Calculation of the operation pattern .... Same as that with the SI units system.

(6) Calculation of the acceleration and deceleration torque

$$T_a = T_d = \frac{(GD^2_L + GD^2_B + GD^2_M) \times No}{37500 \times T_{PSa}} = \frac{(743 + 17 + 525) \times 1925}{37500 \times 0.24} \quad 275 \text{ [kgf·cm]}$$

The motor torque values required during acceleration and deceleration are as follows.

When moving up

$T_{Ma1} = T_a + T_U + T_F = 392.6$ [kgf·cm]

$T_{L1} = T_U + T_F = 117.6$ [kgf·cm]

$T_{Md1} = -T_d + T_U + T_F = -157.4$ [kgf·cm]

When moving down

$T_{Ma2} = T_a - T_U \cdot \eta^2 + T_F = 295.7$ [kgf·cm]

$T_{L2} = -T_U \cdot \eta^2 + T_F = 20.7$ [kgf·cm]

$T_{Md2} = -T_d - T_U \cdot \eta^2 + T_F = -254.3$ [kgf·cm]

When stopping

Unbalance torque T_U = 65.0 [kgf·cm]

Since the maximum torque of the HA-SE352 selected provisionally is 510 [kgf·m] or less, both T_{Ma} and T_{Md} are acceptable.

(7) Calculation of continuous effective load torque

$$T_{rms} = \sqrt{\frac{392.6^2 \times 0.24 + 117.6^2 \times 0.52 + (-157.4)^2 \times 0.24 + 65^2 \times 2 \times 2 \times 295.7^2 \times 0.24 + 20.7^2 \times 0.52 + (-254.3)^2 \times 0.24}{3 \times 2}}$$

= 131.5 [kgf·cm]

This is less than the rated torque 170 [kgf·cm] of provisionally selected servo motor HA-SE352 and is therefore acceptable.

(8) Necessity of regenerative option ... Same as that with the SI units system.

Note: When the regenerative energy is calculated to select a regenerative option, the formula for calculating the regenerative energy mentioned in Section 9-4 is as given below.

- During acceleration/deceleration $E_1 = 0.01027 \times No \times T_1 \times T_{PSa}$ [J]
- At constant speed $E_2 = \frac{2}{0.01027} \times No \times T_1 \times t_1$ [J]

* Torque values T_1 and T_2 are expressed in customary units system [kgf·cm].

8-1 Troubles shooting points

When the drive is not operating correctly, determine the status of the unit and consider the following items.

⚠CAUTION

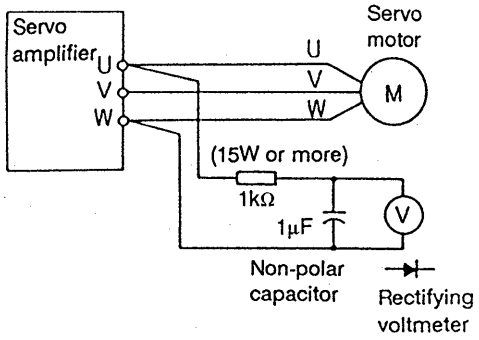
- The MELSERVO-J servo amplifier uses a large capacity, electrolyte capacitor. A voltage will remain in the unit for several minutes after turning the power off, so take care to prevent electrical shocks and short circuits.
- Because of its structure, the servo amplifier does not allow internal energization check. This check must not be made.
- Megger tests must not be conducted. Otherwise, the servo amplifier may be damaged.

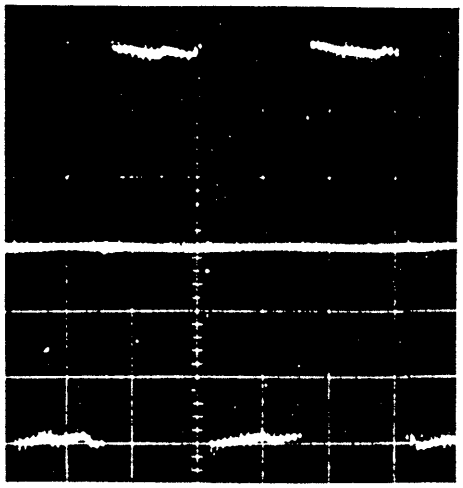
Items to consider when problems occor:

(1) What is the alarm code display?
(2) Does the error or trouble occur repeatedly? (Check alarm history.)
(3) Are the servo motor and servo amplifier temperatures and peripheral temperatures normal?
(4) Is the servo motor accelerating, decelerating, or at a constant speed? What is the speed?
(5) Is there a difference between the forward and reverse operation?
(6) Has an instantaneous power failure occurred?
(7) Does the trouble occur at a certain operation or command?
(8) How frequently does the trouble occur?
(9) Does the trouble occur when a load is applied or removed?
(10) Have parts been replaced or repaired?
(11) How many years has the unit been operating?
(12) Is the power voltage normal? Does it change greatly depending on the time?

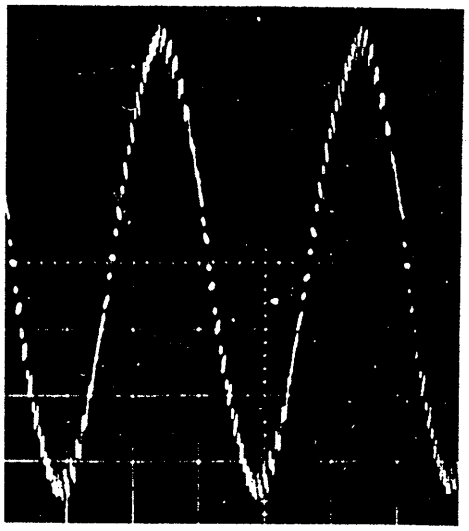
8-2 How to measure the voltage and current of the servo

(1) Measurement of servo motor voltage
The voltage output to the servo motor from the servo amplifier is PWM-controlled, and has a pulse type waveform. Depending on the meter type, the indicated value may differ greatly. Install the following filter when measuring, and use a rectifying voltmeter to measure.





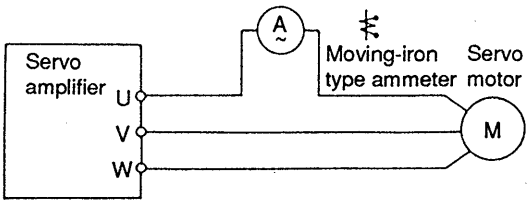
Waveform without filter installed



Waveform with filter installed

(2) Measurement of servo motor current
The pulse-shaped current is smoothed to a sinusoidal current with the servo motor reactance. Thus, a moving-iron type ammeter can be directly connected.

(3) Measurement of power
Measure with the three-wattmeter method using an electrodynamometer.



(4) Other testers
When using an oscilloscope or digital voltmeter, do not ground them. The tester's input current must not exceed 1mA.

8-3 Periodic inspection and maintenance

The servo amplifier is a static unit, and requires no daily inspection and maintenance. However, the unit must be inspected at least once a year. The servo motor is brush-less, and maintenance free, but should be inspected periodically to confirm that there are no abnormal sounds or vibrations.

(1) With power on:

1) When inspecting while the unit is operating, measure the voltage and current while referring to Section 8-2.

2) Check that the fan is operating properly.

3) Check that there are no abnormal sounds (servo motor bearing, brake, etc.).

(2) With power off:

1) Check to see if any dust or dirt is in the servo amplifier and clean when necessary.

2) Check terminal screws for looseness and retighten.

3) Check if there are any defects in the parts (discoloration due to overheating, damage, or broken wires, etc.)

4) Use a tester (high-resistance range) for the continuity test of the control circuit. Do no use a megger or buzzer.

5) Check that there are no scratches or cracks in the cables (especially the detector cable). Carry out the periodic inspection according to the usage conditions for the moving parts.

6) Inspect the servo motor shaft and coupling alignment and adjust when necessary.

(3) Parts replacement

The following parts may have mechanical wear or may deteriorate physically after years of use. These can contribute to decreased unit performance and trouble, so periodic maintenance and periodic replacement should be done to maintain performance.

1) Smoothing capacitor: The effectiveness will deteriorate because of effects from the ripple current. The life of the capacitor will differ greatly according to the ambient temperature and usage conditions. When operated under normal environmental conditions, the life should be approximately 10 years.
The deterioration of the capacitor will be sudden after a certain point is passed. Therefore, periodic inspections should be enforced at least once a year (once every six months when nearing the life of the unit).
The appearance inspection points are as follows:
a. State of the case: expansion of the case sides and bottom.
b. State of the sealing plate: visible warping and extreme cracks
c. State of the explosion-proof valve: remarkable expansion in the valve or value operated
Periodically check the capacitor for outer appearance, cracks, discoloration, and leakages.
When the measured capacity is below 85% of the rating, the life of the capacitor is judged to be expired.

2) Relays : Defective contacts may occur due to high switching current. The life of relay will differ depending on the power capacity, but the guideline for the life should be 100,000 cycles of operation.

3) Servo motor bearing : Replace the bearing after 20,000 to 30,000 hours of normal use under the rated speed and rated load. This will differ on the operation conditions, but the motor bearings should be replaced when abnormal sounds and vibrations are found.

4) Cooling fan : Life expectancy of the bearing is 10,000 to 35,000 hours of operation. If continuously operated, replace the cooling fan assembly every two or three years. The cooling fan assembly must be replaced if it makes abnormal sound or vibration. (This applies to MR-J200A and J350A.)

Standard replacement intervals of parts

Part name	Standard replacement interval	Replacement method, etc.
Cooling fan (Note 1)	2 or 3 years	Replace with new part. (Decide according to the result of examination.)
Smoothing capacitor	10 years	Replace the card. (Decide according to the result of examination.)
Relays (Note 1)	—	Same as above
Servo motor bearing	—	Decide according to the result of examination.

Note 1: Applies to MR-J200A and J350.

Table 8.1 Daily inspections and periodical inspections (1/2)

Inspection point	Inspection item	Inspection object	Inspection period: Daily	Inspection period: As specified	Inspection method	Judgment criteria	Instrument
General	Operating environment	Ambient temperature, humidity, dust, etc.	O		Refer to the precautions in Section 1-5.	Refer to Section 1-4 Installation.	Thermometer, hygrometer, recorder
	Storage environment	Ambient temperature, humidity, dust, etc.	O		Measure with a thermometer, hygrometer, etc.	Servo motor: -10°C to +70°C (Freezing is not allowed.) 90%RH or less (Dewing is not allowed.) Servo amplifier: -20°C to +65°C (Freezing is not allowed.) 90%RH or less (Dewing is not allowed.)	Thermometer, hygrometer, recorder
	Overall equipment	Abnormal vibration and sound	O		Visual and hearing check	No abnormality is allowed.	—
	Power supply voltage	Main circuit voltage	O		Measure the voltages between phases R, S and T at the servo amplifier terminal block.	Refer to Section 10-2 Standard specifications.	Digital multimeter

Table 8.1 Daily inspections and periodical inspections (2/2)

Inspection point	Inspection item	Inspection object	Inspection period: Daily	Inspection period: As specified	Inspection method	Judgment criteria	Instrument
Main circuit	General	(1) Looseness at tightened parts (2) Traces of overheat (3) Cleaning		O O	(1) Retighten loose parts. (2) Visual check	(1) Loose parts are not allowed. (2) No abnormality is allowed.	
	Connected conductors and wires	(1) Deformed conductor (2) Breaks of wire insulation		O O	(1) (2) Visual check	(1) (2) No abnormality is allowed.	
	Terminal block	Damages		O	Visual check	No abnormality is allowed.	
	Smoothing capacitor	(1) Fluid leak (2) Safety valve protruding, swelling (3) Static capacity measurement		O O	(1) (2) Visual check (3) Measure with a capacity meter.	(1) (2) No abnormality is allowed. (3) 85% or over of rated capacity	Capacity meter
	Relay	(1) Stick-slip noise at operation (2) Timer operation time (3) Damages at contacts		O O O	(1) Hearing check (2) Time from power ON to relay ON. (3) Visual check	(1) No abnormality is allowed. (2) Relay must operate in 0.1 to 0.15 sec. (3) No abnormality is allowed.	Universal counter
	Resistor	(1) Crack in the resistor insulation (2) Disconnection		O O	(1) Visual check. Cement resistors, coil resistors. (2) Remove connection on one end and measure with a multimeter.	(1) No abnormality is allowed. (2) Error must be within ± 10% of indicated resistance value.	Digital multimeter
Control circuit, protective circuit	Operation check	(1) Operate the servo amplifier without applying load and check the balance of voltage between phases. (2) Perform sequence protective operation and check the protective and display circuits.		O O	(1) Measure voltages between phases U, V and W of the servo amplifier output terminals. (2) Short the protective circuit output of the servo amplifier.	(1) Balance of the voltages between phases must be within 4V. (2) A sequence error must be generated.	Digital multimeter, rectifier voltmeter
Cooling system	Cooling fan	(1) Abnormal vibration and sound (2) Looseness of connecting parts	O	 O	(1) Turn the fan by hand when the power is not supplied. (2) Retighten.	(1) The fan must rotate smoothly. (2) No abnormality is allowed.	
Indication	Indication	Breaks of the charge lamp and the 7-segment LED indicator	O		Lamp and indicator on the servo amplifier	Make sure the indicators light.	
Servo motor	General	(1) Abnormal vibration and sound (2) Abnormal smell	O O		(1) Heating, touching and visual checks (2) Check for abnormal smell by overheat or damage.	(1) (2) No abnormality is allowed.	
	Detector	Abnormal vibration and sound	O		Hearing and touching	No abnormality is allowed.	
	Cooling fan	(1) Abnormal vibration and sound (2) Adhesion of mist and foreign material	O		(1) Turn the fan by hand when the power is not supplied. (2) Visual check	(1) Must rotate smoothly. (2) No abnormality is allowed.	
	Bearing	Abnormal vibration and sound	O		Hearing and touching	No abnormality is allowed.	

8-4 Alarms

When an alarm occurs, the trouble signal (ALM) in the servo amplifier will switch OFF. Therefore, the magnetic contactor (MC) installed before the input terminals (R, S, T) will switch OFF, and the servo amplifier power will be shut off. The alarm will be displayed for several seconds, but after that, will switch off. To confirm which alarm occurred, switch the power ON again, and check the alarm history. Alternatively preset the alarm code outputs in parameter No. 19. The DO output alarm code will then be read into the host controller when an alarm occurs.

LED display Alarm code	DO output alarm code CN1 pin No. 26	25	24	Alarm name	Alarm details	Alarm occurrence time	Possibility of reset alarm with reset signal	Cause	Points to check	Remedy
12	0	0	0	Memory error 1	RAM, ROM memory error	When power is switched ON	Not possible	Error in unit part	—	Replace unit.
15				Memory error 2	EEPROM memory error					
17				PCB error	CPU, part error					
37				Parameter error	Parameter value is wrong.			Parameter has been rewritten.		
10	0	1	0	Undervoltage	Power voltage has dropped. (200V class: 165V or less 100V class: 83V or less)	Alarm occurs when power is switched ON.	Possible	1. Power voltage is low. 2. Power was switched ON immediately after it was switched OFF.	Check the input terminal (R, S, T) voltage with tester or synchroscope.	Review the power supply.
						Alarm occurs during acceleration or when load is applied.		Insufficient power capacity		
						During operation		Instantaneous power failure (10 msec or more)	Check if the other units connected to the same power are affected by instantaneous power failure.	
16	0	1	1	Polarity detect error (RD)	The servo motor polarity cannot be detected normally.	Alarm occurs when power is switched ON.	Possible	Encoder connector is disconnected.	Visually check for disconnected connector.	Connect properly.
								Defective encoder cable connection	Check that the encoder signals (PU, PUR, PV, PVR, PW, PWR) are correctly connected.	

Continued on the next page.

LED display Alarm code	DO output alarm code CN1 pin No. 26	25	24	Alarm name	Alarm details	Alarm occurrence time	Possibility of reset alarm with reset signal	Cause	Points to check	Remedy
16	0	1	1	Polarity detect error (RD)	The servo motor polarity cannot be detected normally.	Alarm occurs when power is switched ON.	Possible	Defective encoder or servo amplifier	1. When other motors and amplifiers are used: alternate the servo motors and servo amplifiers to find the defective unit. 2. Check the signals in the connector: Check whether "H" or "L" occurs simultaneously in PU, PV and PW.	Replace unit.
						There is a bend in the cable that corresponds to the servo motor rotation Alarm occurs at specific position.		Is the cable broken?	Bend the cable and check for continuity.	Replace cable.
30	1	0	0	Over-regeneration (Note 1)	The regenerative transistor is continuously ON.	Alarm occurs when power is switched ON.	Reset is possible, but alarm occurs again immediately.	Regenerative transistor damage	If the alarm occurs immediately after power is switched ON, check the power voltage with a tester. The regenerative transistor is damaged if below 260VAC. Avoid switching the power ON after this. (The regenerative resistor will overheat (dangerous).)	Replace unit.
					The tolerable loss of the regenerative resistor is exceeded.	During operation (display status L90% or more)	Possible Leave for 3 to 5 min. and wait until display status drops to approx. 50%. Then, reset alarm with reset signal input.	Parameter setting error	Confirm the parameter set values (Pr. 1). (Refer to parameter list.)	Set properly.
								Frequent positioning (regenerative)	Check the regeneration frequency and regenerative resistor loss.	1. Lower the positioning frequency. 2. Increase the regenerative option capacity. 3. Lower the load.
31	1	0	1	Overspeed	The servo motor speed exceeds 115% of the maximum speed.	Alarm occurs other than during acceleration.	Possible	Encoder signal error or servo amplifier error	1. Check cable connection (PA, PAR, PB, PBR, PZ, PZR signals). 2. Alternately change the servo motor and servo amplifier.	Replace the cable. Replace the servo motor. Replace the servo amplifier.

Continued on the next page.

LED display Alarm code	DO output alarm code CN1 pin No. 26	25	24	Alarm name	Alarm details	Alarm occurrence time	Possibility of reset alarm with reset signal	Cause	Points to check	Remedy
31	1	0	1	Overspeed	The servo motor speed exceeds 115% of the maximum speed.	Alarm occurs during acceleration.	Possible	For position servo 1. For HA-SE servo motor: Pulse train command is 150kpps or more (electronic gear 1/1) 2. The electronic gear ratio is too large. (Pr. 2, 3)	1. Check parameter Pr. 2, 3 settings and command frequency. 2. Check the status display (r, n).	Set correctly.
								For speed servo: Speed command is too large.	The parameter Pr. 9 (speed during 10V command) and analog speed command voltage do not match.	Set correctly.
								Overshoot is too large.	The acceleration/deceleration time constant is too small in the position servo and the motor overshoots during acceleration. Check status display (b).	Review the acceleration/deceleration time constant.
								Overshoot is too large due to unstable servo system.	1. Try automatic tuning. 2. Adjust the servo gain. VGN: increase VIC: increase PGN: decrease 3. Check whether the alarm occurs when the speed is decreased.	Correctly adjust the gain.
32	0	0	1	Overcurrent	The current to the servo amplifier exceeds tolerable value.	Alarm occurs when servo is switched ON.	Possible	The servo amplifier's output terminals (U, V, W) are short circuited.	Check whether the output terminals are short circuited.	Correct the wiring.
								The servo amplifier's output terminals (U, V, W) are in ground fault.	Check insulation between the output terminals and case with a tester.	Correct the wiring.
						Alarm occurs at certain intervals during the operation or when servo is OFF.		External noise	Check the peripheral equipment (AL-32 occurs when the relay or valves are operating).	Enforce noise countermeasures.
						Alarm occurs when servo is switched ON.		Servo amplifier IPM defect	Disconnect the output cables (U, V, W) and switch the servo ON.	Replace the unit.

Continued on the next page.

LED display Alarm code	DO output alarm code CN1 pin No. 26	25	24	Alarm name	Alarm details	Alarm occurrence time	Possibility of reset alarm with reset signal	Cause	Points to check	Remedy
32	0	0	1	Overcurrent	A current exceeding the tolerable value is flowing to brake TR (MR- J100A and higher models).	Alarm occurs during servo motor deceleration.	Possible	Regenerative option installed is not proper.	Check that the regenerative option resistivity value matches the unit.	Replace the regenerative option.
33	1	0	0	Overvoltage (OV)	The converter's d.c. line voltage exceeds 400VDC.	Alarm occurs other than during servo motor deceleration.	Possible	Power supply voltage too large.	Check the power voltage with a tester.	Review the power.
								Power voltage distortion is too large (when regenerative option is not installed).	Measure power voltage waveform with an oscilloscope and check for power voltage distortion.	1. Install the FR-BAL. 2. Use a different power source from the equipment where distortion is occurring.
						Alarm occurs during servo motor deceleration.		Regenerative energy is too large (when regenerative option is not installed).	Check the regenerative energy.	Install the regenerative option.
								Broken wire in regenerative resistor	Check the regenerative resistor resistance value with a tester. MR-RBOO□ └ Resistance value 0: 13Ω 3: 52Ω 4: 26Ω	Replace the regenerative option.
								The regenerative resistor is incorrect (especially in models MR-J200A or upper).	Check that the regenerative option and unit match.	Replace the regenerative option.
35	1	0	1	Error in the command frequency	The pulse train command frequency exceeds 220Kpps (only in the position servo).	Alarm occurs during operation other than in high speed rotation.	Possible	Servo amplifier error	—	Replace unit.
						Alarm occurs during high speed rotation or acceleration.		Pulse train command exceeds 220Kpps.	1. Check the pulse train command frequency. 2. Decrease the pulse train command frequency by 1/2, set electronic gear to 2/1 and check if alarm occurs. 3. Check status display (n).	Review pulse train command frequency.

Continued on the next page.

LED display Alarm code	DO output alarm code CN1 pin No. 26	25	24	Alarm name	Alarm details	Alarm occurrence time	Possibility of reset alarm with reset signal	Cause	Points to check	Remedy
45	1	1	0	Main circuit element overheating	The servo amplifier's main circuit element (IPM) is overheating. (100°C to 120°C)	Alarm occurs when servo is ON and motor is not operating.	Possible (Reset alarm with reset input after main circuit element temperature has dropped.)	Servo amplifier error	—	Replace the unit.
								Cooling defect	1. Check whether the servo amplifier's fan is stopped (in models exceeding MR-J200A). 2. Check whether the ventilation is obstructed. 3. Check whether the temperature in the box is too high. 4. Check the status display (J).	Improve the cooling condition.
								Operation was performed so that AL-50 does not operate (power ON/OFF was repeated).	Is it operated by turning the power ON/OFF repeatedly?	Review operation methods.
50	1	1	0	Overload (Note 1)	A current exceeding the electronic thermal curve has flowed.	Alarm at servo ON.	Possible Reset with the reset input signal after 3 to 5 min. have passed from the alarm and the status display J has dropped to approx. 50% or below.	The servo amplifier output terminals (U, V, W) and servo motor terminals (U, V, W) do not match.	1. Check the U, V, W connections. 2. Check the status display J.	Connect properly.
								Hunting occurs due to unstable servo system.	Same as alarm code AL-31	
								Encoder signal defect	Same as alarm code AL-16 and 31	
						Alarm during operation		The machine struck something.	Same as alarm code AL-52	
								A load exceeding the servo capacity has been used.	Check status display J.	1. Review capacity. 2. Review operation pattern.
52	1	0	1	Excessive difference	The remaining pulses in the deviation counter exceed 65K pulses.	During positioning servo acceleration	Possible	The position loop gain (Pr. 5) is too small, and the overshoot during acceleration is too large.	1. Check parameter (Pr. 5). 2. Check acceleration time constant. 3. Check gain. 4. Try automatic tuning.	Review the parameters.
						When servo motor is stopped with servo ON.		The servo motor is rotated with external force.	1. Check status display (E, L). Check whether the status display (E, L) changes when servo motor is stopped. 2. Check torque limit command. Is the servo torque set to a small value with an external force? 3. Recheck the servo motor capacity.	1. Change the torque limit command. 2. Change the motor capacity.

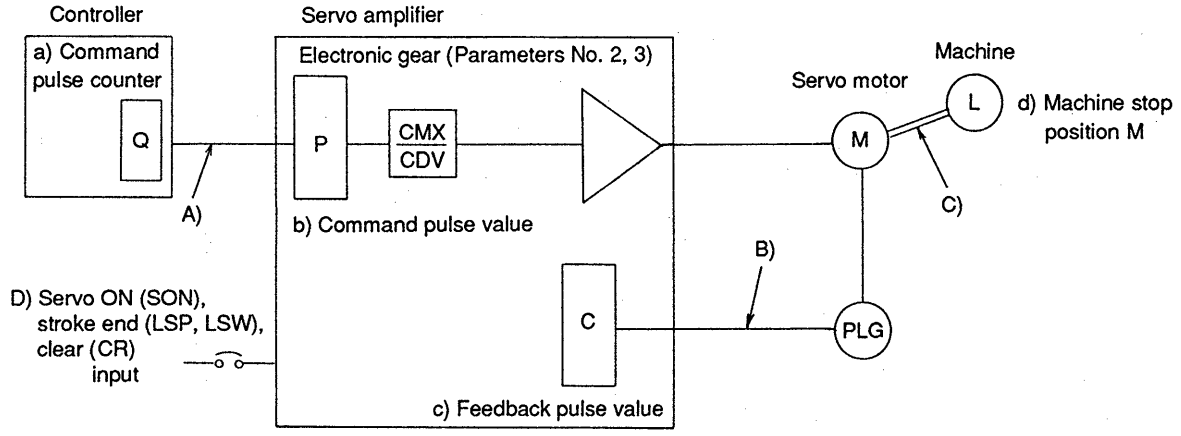
Continued on the next page.

LED display Alarm code	DO output alarm code CN1 pin No. 26	25	24	Alarm name	Alarm details	Alarm occurrence time	Possibility of reset alarm with reset signal	Cause	Points to check	Remedy
52	1	0	1	Excessive difference	The remaining pulses in the deviation counter exceed 65K pulses.	When positioning servo command is applied	Posiible	The machine struck something.	Check whether a machine has been contacted. (P in the status display has changed but L has not.)	Review the operation pattern.
								The output terminals (U, V, W) are not connected properly.	Check that the servo motor and servo amplifier (U, V, W) terminals match.	Correct the wiring.
								Encoder signal defect	Same as alarm code AL-16	
90	1	1	1	Switch to diagnosis display while servo is on.	Servo ON signal is ON when no-motor operation is set.	—	Possible	Servo ON signal is ON.	Check whether the servo ON signal is ON.	Set after turning servo-ON signal OFF.
	Alarm code is not output.				Servo ON signal is ON when switching to the do (output signal) check screen or test mode operation screen.		Possible	Same as above	Same as above	Same as above
CPU	Not defined			CPU error	CPU is not operating correctly.	—	Not possible	CPU is not operating correctly.	Try resetting the power.	Replace the unit.
CO	Alarm code is not output.			Communication error (the motor operates normally even when this alarm is output)	Communication error has occurred between servo CPU and display CPU.	—	Not possible	Servo amplifier defect	Unit error if not corrected when power is reset	Replace the unit.
								External noise	Same as alarm code AL-32	

(Note) Once alarm AL-30 or AL-50 occurs, its alarm status is stored in the EEPROM. Therefore, the time until the next alarm occurs after the power is reset is shortened. The status display J and L values will be approximately 80% when the power is reset after an alarm. To reset the stored alarm status, switch the servo-ON signal OFF, or stay in the non-load status for 3 to 5 minutes. Lower the status display J and L to approximately 40% or below.
Operation with an effective load of under 100% is possible even when the alarm status is stored.

8-5 Determining the cause of a position offset

- Position servo -



In the above diagram, (a) command pulse counter, b) command pulse value P display, c) feedback pulse value C display, and d) machine stop position represent points to be checked when a position offset occurs.
Also, A, B, C and D indicate places where position offset factors may occur. For example, A, indicates the wiring between the controller and servo amplifier where noise may be picked up. The noise may cause the mis-count of pulses.

In a normal operation without a position offset, the following relationships are established and maintained:

1) Q = P (command pulse counter value of the controller = servo amplifier command pulse value)

2) $P \times \frac{CMX\ (Pr.2)}{CDV\ (Pr.3)} = C$ (command pulse value × electronic gear ratio = feedback pulse value)

3) $C \times \Delta l = M$ (feedback pulse value × movement amount per feedback pulse = machine position)

When a position offset occurs, check the following situations:

1) When $Q \neq P$
   Noise picked up by the pulse train signal wiring between the controller and servo amplifier may have caused a pulse count error. (Factor A)

2) When $P \times \frac{CMX}{CDV} \neq C$
   The servo ON (SON) signal or forward/reverse run stroke end (LSP, LSN) signal may have switched off during operation, or the clear (CR) signal switched ON. (Factor D)

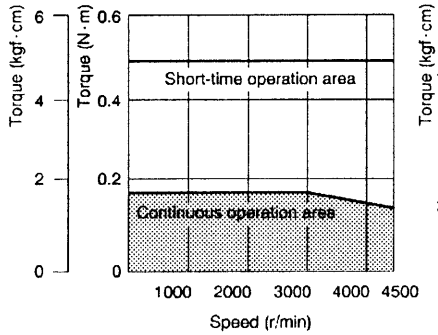
3) When $C \times \Delta l \neq M$
   Noised picked up by the encoder cable may have caused a count error, or mechanical slip may have occurred between the servo motor and machine.

Contents

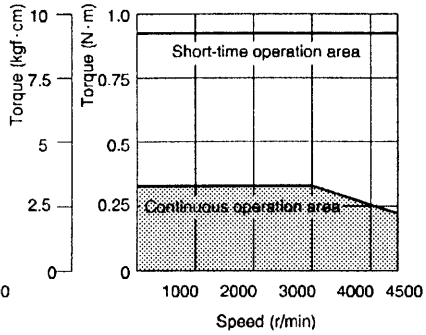
9-1 Torque characteristics

HA-ME Series

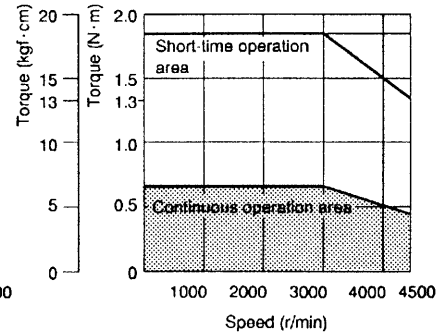
HA-ME053



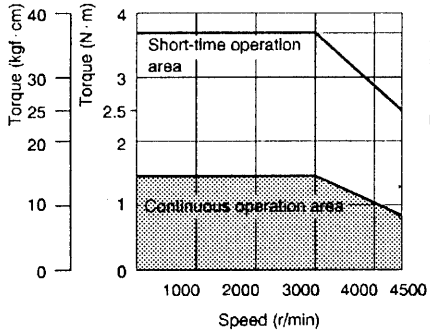
HA-ME13



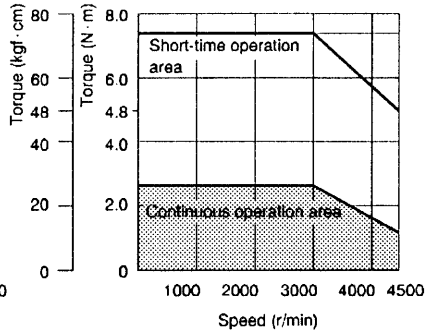
HA-ME23



HA-ME43

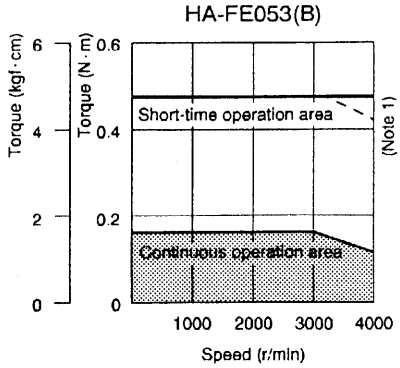


HA-ME73

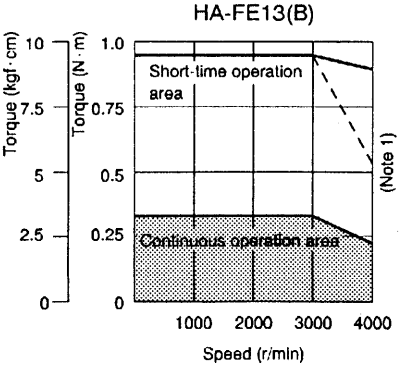


HA-FE Series

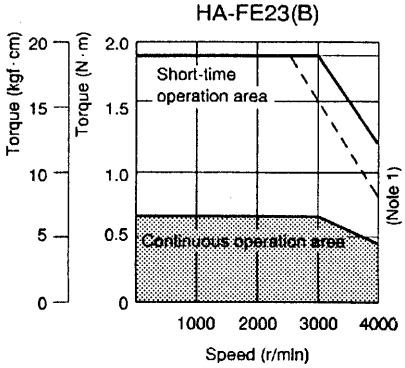
HA-FE053(B)



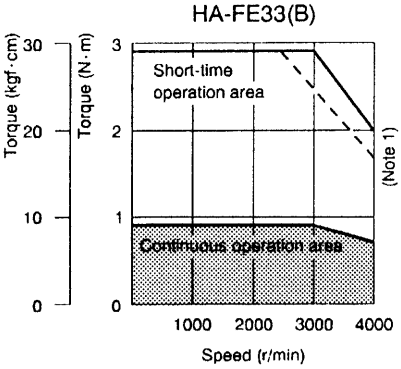
HA-FE13(B)



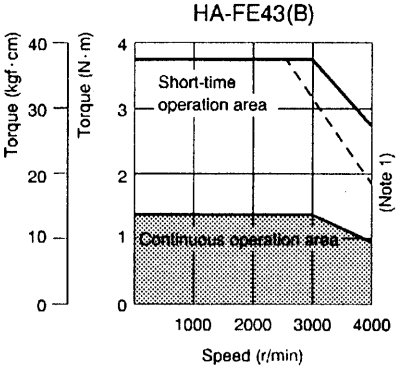
HA-FE23(B)



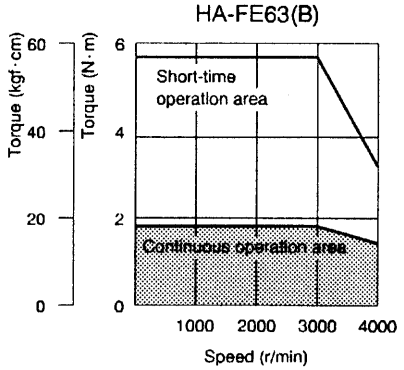
HA-FE33(B)



HA-FE43(B)

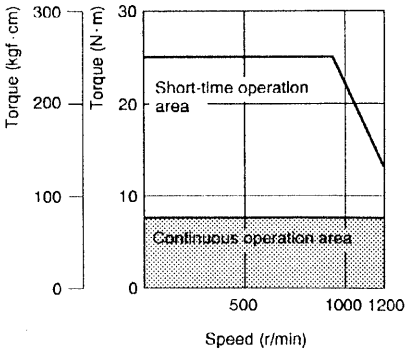


HA-FE63(B)

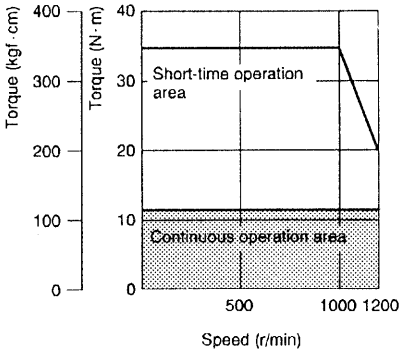


HA-SE1000 r/min Series

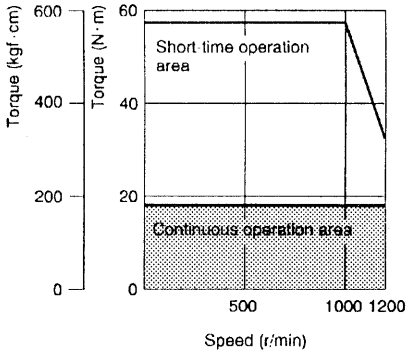
HA-SE81(B)



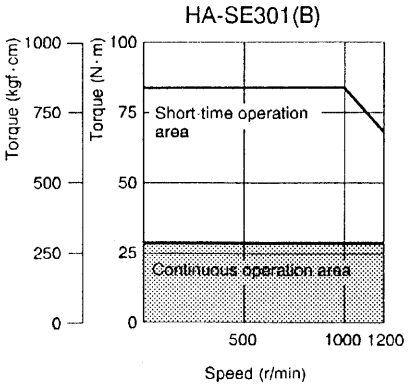
HA-SE121(B)



HA-SE201(B)

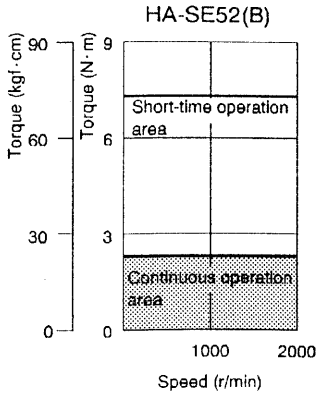


HA-SE301(B)

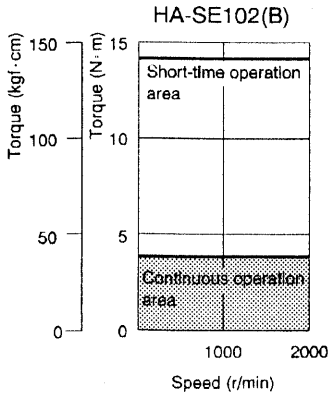


HA-SE2000 r/min Series

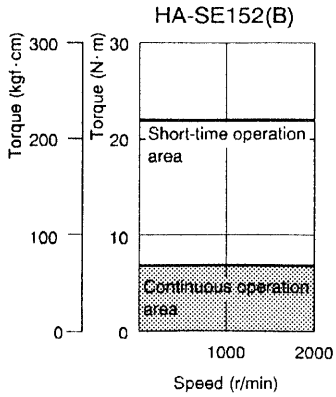
HA-SE52(B)



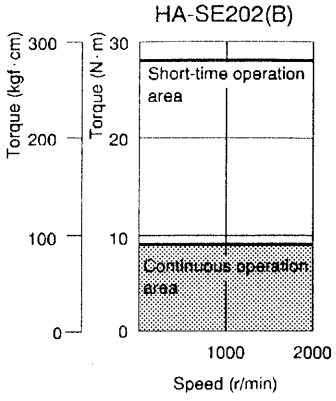
HA-SE102(B)



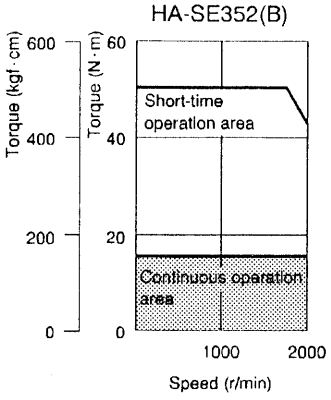
HA-SE152(B)



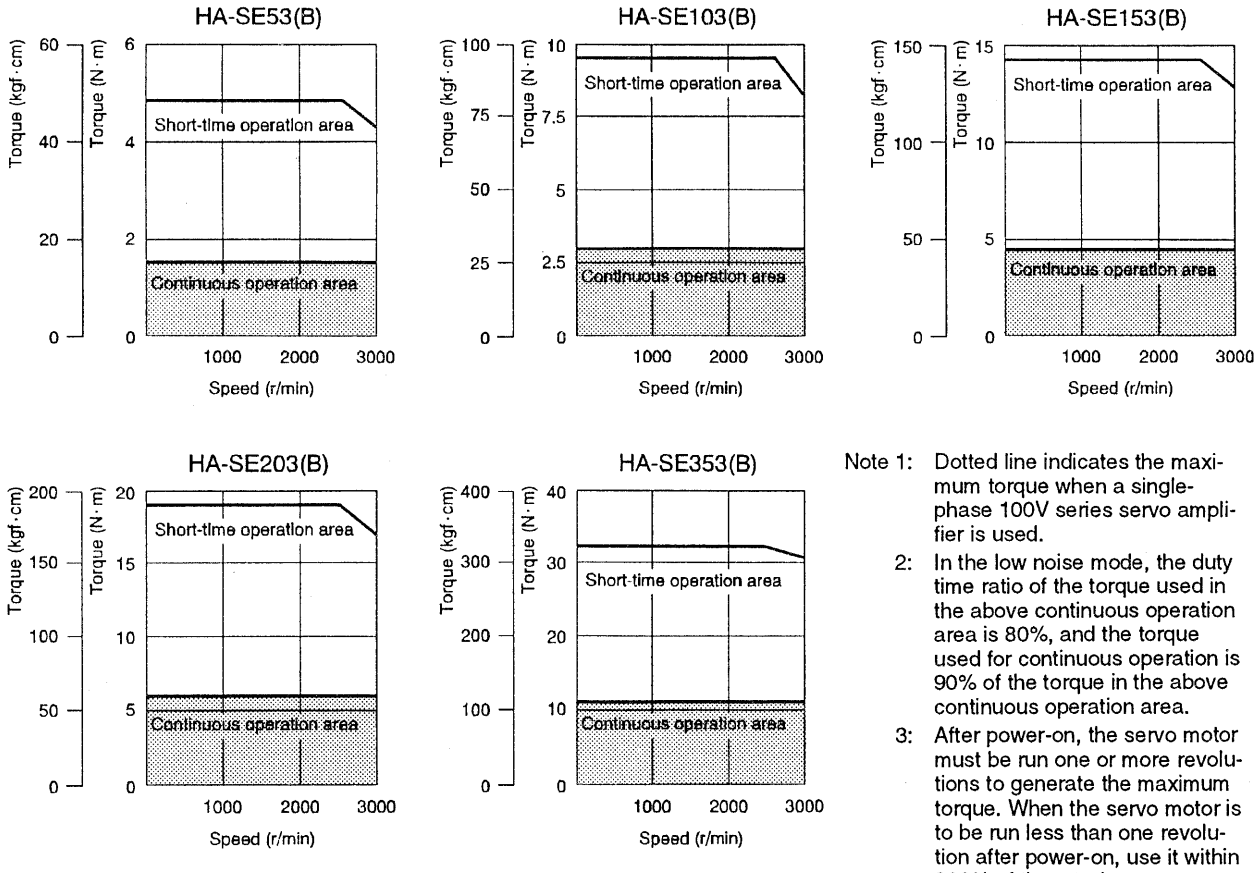
HA-SE202(B)



HA-SE352(B)



HA-SE3000 r/min Series



Note 1: Dotted line indicates the maximum torque when a single-phase 100V series servo amplifier is used.

2: In the low noise mode, the duty time ratio of the torque used in the above continuous operation area is 80%, and the torque used for continuous operation is 90% of the torque in the above continuous operation area.

3: After power-on, the servo motor must be run one or more revolutions to generate the maximum torque. When the servo motor is to be run less than one revolution after power-on, use it within 200% of the rated torque.

9-2 Servo amplifier overload protection characteristics

An electronic thermal relay is built into the servo amplifier to protect the servo motor and servo amplifier from overloads. The operation characteristics of the electronic thermal relay are shown at the right.

If the machine strikes something and the maximum current flows, the protective circuit will operate (alarm code 50) in the area on the right side of the solid line in the chart.

How to view the diagram:

The electronic thermal relay's overload protection characteristics will differ with each model. The characteristics A and B in Fig. 9-1 correspond to the following models. Values in parentheses indicate load ratios in the low acoustic noise mode.

A: HA-FE053, HA-ME13 servo motors

B: HA-FE13, 23, 43, 63 motors, HA-SE servo moters, HA-ME053, 23, 43, 73 servo motors

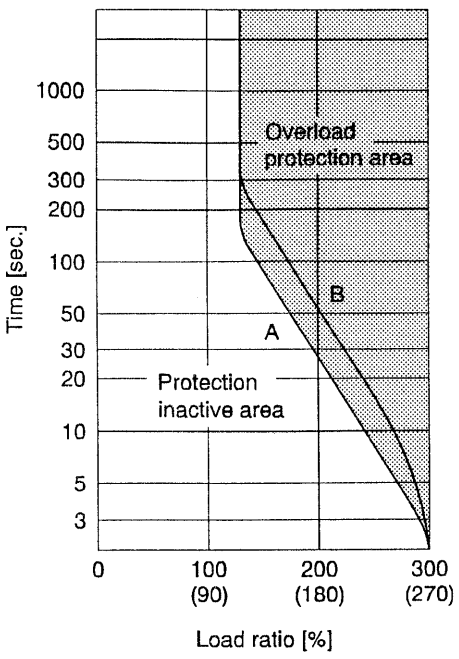


Fig. 9-1 Overload protection characteristics of electronic thermal relay

9-3 Losses generated in servo amplifier

(1) Amount of heat generated by servo amplifier

The losses generated during the servo amplifier's rated load operation, and power capacities are shown below. Use the size of closed-type control box under the worst usage conditions. The actual amount of generated heat will be a value between the rated output and zero torque according to the duty used. The motor's nominal output will decrease when the motor is not used at maximum speed. The power capacity will be lower than the values given below. However, the servo amplifier's generated heat will not change.

Table 9-1 Power capacity and generated heat amount per servo amplifier

Servo amplifier	Servo motor	Power facility capacity (kVA)	Servo amplifier's generated heat		Total surface area required for heat dissi-pation (m2)	Enclosure outline dimensions (mm)
			During rated output (W)	During zero torque (W)		
MR-J10MA MR-J10MA1	HA-ME053, 13	0.3	25	15	0.5	280W × 300D × 300H
MR-J20MA MR-J20MA1	HA-ME23	0.5	25	15	0.5	280W × 300D × 300H
MR-J40MA MR-J40MA1	HA-ME43	0.9	35	15	0.7	350W × 400D × 300H
MR-J70MA	HA-ME73	1.3	50	15	1.0	400W × 400D × 500H
MR-J10A MR-J10A1	HA-FE053, 13	0.3	25	15	0.5	280W × 300D × 300H
MR-J20A MR-J20A1	HA-FE23	0.5	25	15	0.5	280W × 300D × 300H
MR-J40A MR-J40A1	HA-FE33	0.7	35	15	0.7	350W × 400D × 300H
	HA-FE43	0.9	35	15	0.7	350W × 400D × 300H
MR-J60A	HA-FE63	1.1	40	15	0.8	400W × 400D × 300H
MR-J70A	HA-SE52, 53	1.0	40	15	0.8	400W × 400D × 300H
MR-J100A	HA-SE102, 103	1.7	50	15	1.0	400W × 400D × 500H
	HA-SE81	1.5	50	15	1.0	400W × 400D × 500H
	HA-SE121	2.1	50	15	1.0	400W × 400D × 500H
MR-J200A	HA-SE152, 153	2.5	90	20	1.8	400W × 400D × 1000H
	HA-SE202, 203	3.5	90	20	1.8	400W × 400D × 1000H
	HA-SE201	3.5	90	20	1.8	400W × 400D × 1000H
MR-J350A	HA-SE352, 353	5.5	130	20	2.7	400W × 400D × 1500H
	HA-SE301	4.8	120	20	2.7	400W × 400D × 1500H

Note: 1. The heat related power capacity (kVA) is as shown above. However, peak power that is 2 to 2.5 times higher than the rated will be required during the servo motor acceleration. Therefore, select a power supply which shows minimum voltage fluctuation so that the voltage range 180 to 253V for the 200V class or 95 to 127V for the the 100V class can be attained. The necessary power facility capacity will change according to the impedance.

2. When using multi-axes, add the power capacity per axis.
3. The heat generated during regeneration is not included in the servo amplifier's generated heat amount. The brake resistivity heat amount is shown with the following equation. Secure a heat dissipation area including this value when start/stop is frequent, and the resistor heat generation cannot be ignored.

$$P_{RB} = \frac{(J_M + J_L) \times N^2 \times fs}{1.37 \times 10^8} \text{ [W]}$$

Here: J_L : Load inertia converted into motor shaft [kgf•cm^2]
J_M : Servo motor inertia [kgf•cm2]
N : Servo motor speed [r/min]
fs : No. of decelerations [times/min]

(2) Heat dissipation area for enclosed servo amplifier

An enclosure for the servo amplifier should be desingned to operate in an ambient temperature of 40°C and allow no more than a temperature rise of 10°C. With a 5°C safety margin, the system should operate within a maximum 55°C limit. The necessary enclosure heat dissipation area can be calculated using the following equation.

$$A = \frac{P}{K \times \Delta T} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (9\text{-}1)$$

Here, A : Heat dissipation area [m^2]
P : Losses generated in storage box [W]
ΔT : Difference inside and ambient temperature [°C]
K : Heat dissipation coefficient (5 to 6)

The heat dissipation area calculated in equation (9-1) should be calculated so that P is the sum of all losses generated in the enclosure.
'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 into the enclosures surface area.
The required heat dissipation area will differ according to the conditions in the enclosure. If the convection in the enclosure is poor, and the heat builds up, effective heat dissipa-tion will not be possible. Therefore, arrangement of the equipment in the enclosure and the use of a fan should be considered .

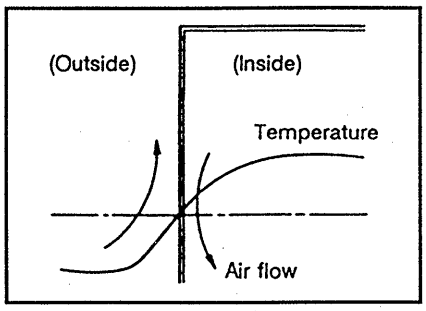


Fig. 9-2 Distribution of temperature in enclosure

If air is flowed along the outer wall of the enclosure, effective heat exchange will be possible, because the temperature slope inside and outside the enclosure will be large.

Table 9-1 lists the required enclosure surface area required for each servo amplifier when the servo amplifier is operated at rated load in an ambient of 40°C.

9-4 Regenerative brake characteristics

(1) Regenerative brake torque
The regenerative brake torque is applied by the regenerative resistor or capacitor regeneration.

	MR-J10A, 20A MR-J10A1, 20A1 MR-J10MA, 20MA MR-J10MA1, 20MA1	MR-J40A to 350A, MR-J40A1 MR-J40MA, 70MA, MR-J40MA1
Method	Capacitor regeneration	External installation of the regenerative resistor (The resistor is not built-in, so always install the regenerative option)
Regenerative option	Refer to the Regenerative option combination specifications in Section 6-1 Regenerative Option.	

(2) Regenerative brake duty

1) Tolerance duty for regenerative operation from rated speed to stopping
Tolerable duty for servo motor at no load ..... value noted in standard specifications (Section 10-2)
When a load is applied, the tolerable duty will change according to the inertia calculate the duty with the following equation.

$$\text{Tolerable duty } (n_1) = \frac{\text{Tolerable duty for servo motor at no load (value noted in Section 10 - 2)}}{(m+1)} \text{ [times/min]} \quad \ldots\ldots\ldots \quad (9\text{-}2)$$

Here, m = load inertia/servo motor inertia

2) Tolerable duty for regenerative operation from other than rated speed
When performing regenerative operation with a speed other than the rated speed, multiply the value in Section 10-2 by (rated speed/operation speed)^2.

- For servo motor with no load

$$\text{Tolerable duty} = (\text{Value noted in Section 10 - 2}) \times \left[\frac{\text{Rated speed}}{\text{Operation speed}}\right]^2 \text{ (times/min)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (9\text{-}3)$$

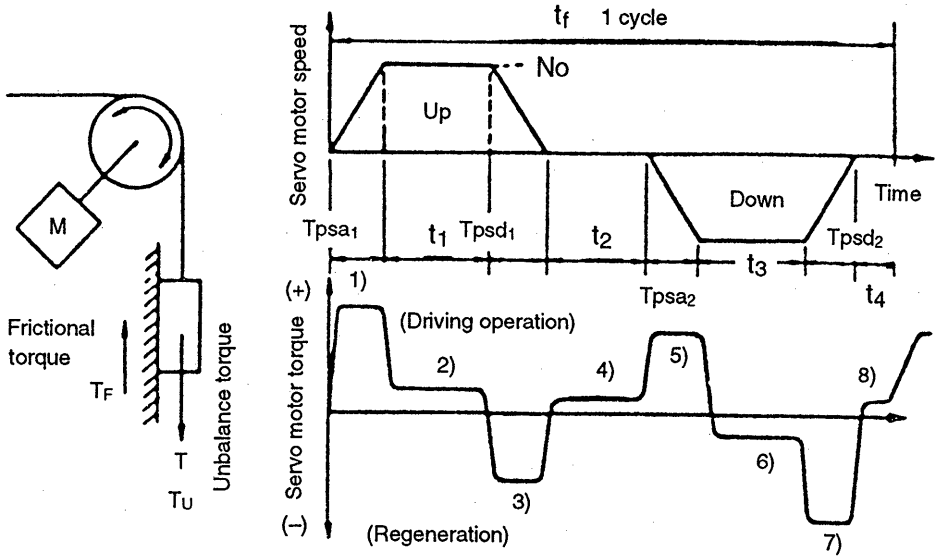
- When load is applied

$$\text{Tolerable duty} = \frac{(\text{Value noted in Section10 - 2})}{(m+1)} \times \left[\frac{\text{Rated speed}}{\text{Operation speed}}\right]^2 \text{ (times/min)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (9\text{-}4)$$

(3) Necessity of regenerative option
When the tolerable duty (equation 9-4) is greater than the required number of positioning times (cycles), then the regeneration option is not nessesary. However, if the number of cycles is greater or unknown, then the regeneration option must be used.

(4) Calculation of regenerative power

1) Calculation of regenerative energy
Calculate the regenerative energy according to the table shown below.



Example of the vertical drive shaft operation pattern

Calculation formulas for torque and energy in respective operation section

Operation section	Torque applied to the servo motor [N•m]	Energy [J]
1)	$T_1 = \frac{(J_L + J_M) \cdot No}{9.55 \times 10^4} \cdot \frac{1}{Tpsa_1} + T_U + T_F$	$E_1 = \frac{0.1047}{2} \cdot No \cdot T_1 \cdot Tpsa_1$
2)	$T_2 = T_U + T_F$	$E_2 = 0.1047 \cdot No \cdot T_2 \cdot t_1$
3)	$T_3 = -\frac{(J_L + J_M) \cdot No}{9.55 \times 10^4} \cdot \frac{1}{Tpsd_1} + T_U + T_F$	$E_3 = \frac{0.1047}{2} \cdot No \cdot T_3 \cdot Tspd_1$
4), 8)	$T_4 = T_U$	$E_4 \geq 0$ (no regeneration)
5)	$T_5 = \frac{(J_L + J_M) \cdot No}{9.55 \times 10^4} \cdot \frac{1}{Tpsa_2} - T_U + T_F$	$E_5 = \frac{0.1047}{2} \cdot No \cdot T_5 \cdot Tpsa_2$
6)	$T_6 = -T_U + T_F$	$E_6 = 0.1047 \cdot No \cdot T_6 \cdot t_3$
7)	$T_7 = -\frac{(J_L + J_M) \cdot No}{9.55 \times 10^4} \cdot \frac{1}{Tpsd_2} - T_U + T_F$	$E_7 = \frac{0.1047}{2} \cdot No \cdot T_7 \cdot Tpsd_2$
Total of regenerative energy E_s		Total of – energy in 1 to 8 E_s

2) Loss of the motor and amplifier in regenerative operation
Efficiency, etc. of the motor and amplifier in regenerative operation are listed below.

Servo motor	Reverse efficiency (%)	Amplifier loss (W)	C charging (J)	Servo motor	Reverse efficiency (%)	Amplifier loss (W)	C charging (J)
HA-FE053/ME053	35	5	11	HA-SE52	80	5	18
HA-FE13/ME13	55			HA-SE102	85		
HA-FE23/ME23	70			HA-SE152	85	7	33
HA-FE33	75			HA-SE202	85		
HA-FE43/ME43	85			HA-SE352	90		40
HA-FE63	85			HA-SE53	80	5	18
HA-ME73/SE81	80		18	HA-SE103	85		
HA-SE121	85			HA-SE153	85	7	33
HA-SE201	85	7	33	HA-SE203	85		
HA-SE301	90		40	HA-SE353	85		40

(1) Reverse efficiency (η) : Efficiency including the servo motor and part of the servo amplifier when the rated (regenerative) torque is generated at the rated speed. Since the efficiency varies according to the speed and generated torque, consider a 10% tolerance.

(2) Servo amplifier loss (EA) : Loss consumed within the servo amplifier. Conversion to the regenerative energy is as follows.

$$E_A \text{ (Joule)} = P \text{ (W)} \times t \text{ (sec)}$$

t: Regenerative operation time excluding the driving operation time

(3) C charging (E_C) : Energy charged to the electrolytic capacitors in the servo amplifier.

Heat generation of the regenerative option
The amount of energy obtained in 1) less the loss obtained in 2) gives the amount of energy consumed by the regenerative option.

$$E_R \text{ (Joule)} = \eta \times E_S - E_A - E_C$$

Calculate the power consumption of the regenerative option on the basis of a single operation cycle tf (sec), and select necessary options.

$$P_R \text{ (W)} = E_R/tf$$

9-5 Electromagnetic brake characteristics

An electromagnetic brake is used in vertical motion applications to hold the load when power is removed from the drive. It is also used in conjunction with dynamic braking during an emergency stop. Do not use this brake for any other stopping situations. The characteristics of the electromagnetic brake are shown in the table below.

(1) Characteristics

Table 9-2 Electromagnetic brake characteristics

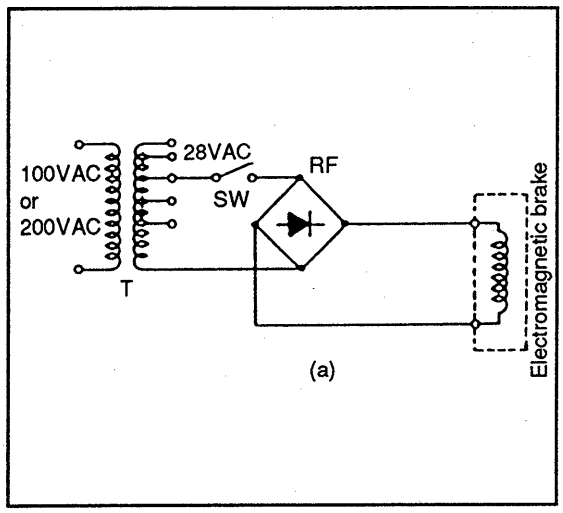
Item		HA-ME series			HA-FE series			HA-SE series	
		HA-ME053B HA-ME13B	HA-ME23B HA-ME43B	HA-ME73B	HA-FE053B HA-FE13B	HA-FE23B HA-FE33B	HA-FE43B HA-FE63B	HA-SE52B to 152B HA-SE53B to 153B HA-SE81B, 121B	HA-SE202B, 352B HA-SE203B, 353B HA-SE201B, 301B
(Note 2) Model		Spring braking type safety brake							
Rated voltage		24VDC							
Exciter coil resistance (Ω)	When cooled (20°C)	90	63	47	111	78	52	38	23
	When hot (95°C)	117	82	61	144	101	67	49	30
Capacity (W)		6.4	9.1	12.3	7	7.4	11	15	25
Brake release current (A) (Note 5)		0.12	0.15	0.22	0.15	0.2	0.3	0.25	0.4
Brake active current (A)		0.04	0.06	0.07	0.06	0.06	0.1	0.14	0.2
Static friction torque (TB) (N•m{kgf•cm})		0.32 {3.2}	1.3 {13}	2.4 {24}	0.39 {4}	1.18 {12}	2.3 {23.5}	7.84 {80}	29.5 {300}
(Note 3) Inertia moment J ($kg•cm^2$ {$kgf•cm^2$})		0.0031 {0.012}	0.04 {0.16}	0.2 {0.8}	0.02 {0.07}	0.13 {0.53}	0.34 {1.4}	0.68 {2.7}	4.25 {17}
(Note 4) Release delay time (t_2) (S)		0.03	0.03	0.04	0.03	0.03	0.03	0.07	0.10
Braking delay time (Note 4) (S)	AC off (Fig. a)	0.08	0.10	0.12	0.08	0.10	0.12	0.12	0.12
	DC off (Fig. b, c)	0.01	0.02	0.02	0.01	0.03	0.03	0.03	0.0.3
Tolerable braking amount (N.m {kgf.m})	Per braking	5.6 {0.6}	22 {2.2}	64 {6.5}	3.9 {0.4}	18 {1.8}	46 {4.7}	390 {40}	4400 {450}
	Per hour	56 {6}	220 {22}	640 {65}	39 {4.0}	180 {18}	460 {47}	3900 {400}	44000 {4500}
Degree of brake looseness in motor shaft (degree)		0.19 to2.2	0.12 to 1.01	0.088 to 1.01	0.3 to 3.5	0.2 to 2.0	0.2 to 1.3	0.2 to 0.6	
Brake life (Note 1) (cycles)		20,000 with 4 (N•m) braking amount per braking	20,000 with 15 (N•m) braking amount per braking	20,000 with 32 (N•m) braking amount per braking	30,000 with 4 (N•m) braking amount per braking	30,000 with 18 (N•m) braking amount per braking	30,000 with 47 (N•m) braking amount per braking	20,000 with 200 (N•m) braking amount per braking	20,000 with 2000 (N•m) braking amount per braking

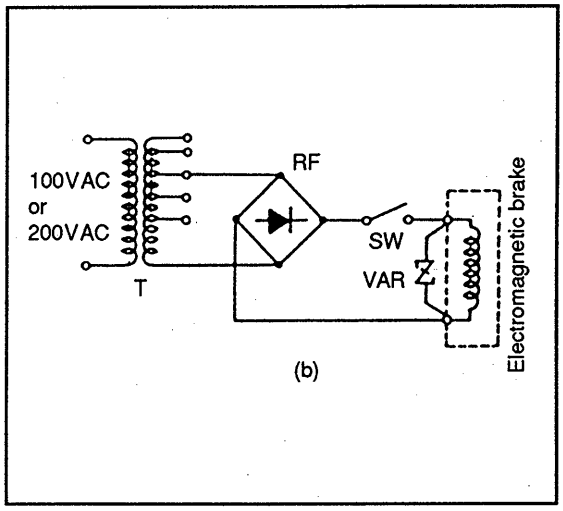
Note 1. The brake gap will increase due to the wear of the brake lining. The brake gap cannot be adjusted. The life of 20,000 cycles is equivalent to 5 cycles/day for 10 years.

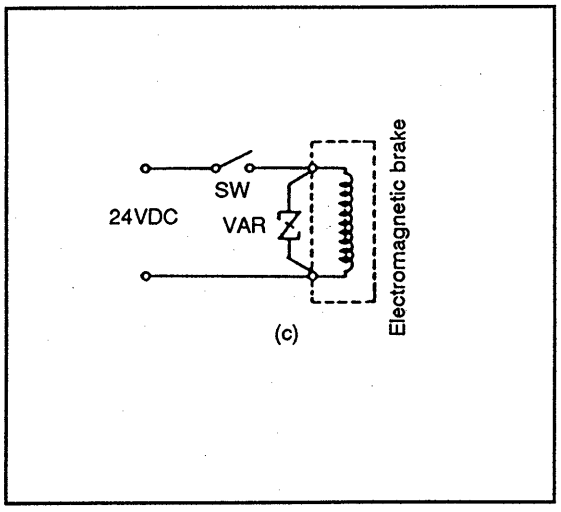
2. A manual release mechanism is not installed. When the servo motor shaft is required to turn for core alignment of the machine, etc., use a separate 24VDC power, and open the brake electrically.
3. For the servo motor with electromagnetic brake, this value is added to inertia moment of the servo motor without a brake.
4. The value for initial suction gap at 20°C (t_2).
5. The interface power in the servo amplifier's (VDD+24V) cannot be used. Always use a separate power source.
6. A leakage magnetic flux will occur at the shaft end of the servo motor with electromagnetic brake. (For HA-FE motor)
7. The brake lining may clatter during low-speed operation. However, this does not pose functional problems.

(2) External connections (Refer to Section 2-2.4)

1) Examples of connection of the brake power supply are shown in Fig. 9-3(a) to (c). (a) is for AC off, and (b) and (c) for DC off.
2) When the DC is off, the braking delay time will be shortened, but a surge absorber must be installed onto the brake terminal.
3) Use the ERZ-C10DK221 (Matsushita Electric Co., Ltd.) or equivalent as the surge absorber. (Refer to Section 6-10.)
4) Connect the lead (blue) of the magnetic brake to the power supply regardless of the polarity.







T : Transformer
RF : Rectifier
VAR: Surge absorber (Varister)

- Refer to Section 6-10 for selection of the peripheral equipment.

Fig. 9-3 Examples of connection

(3) Coasting distance

If the dynamic brake is used during emergency stop, the coasting distance will not be shortened even if the electromagnetic brake is used. If the dynamic brake does not operate due to trouble, the motor will decelerate with the following pattern. 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 with the following equation.
The effect of the load torque is great near the stopping area. When the load torque is large, the motor will stop faster than the value obtained in the equation.

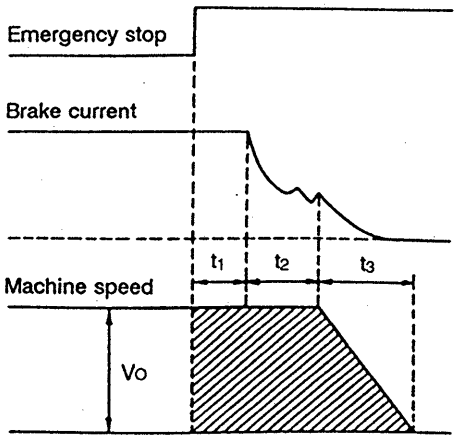


Fig. 9-4 Coasting distance during emergency stop

$$L_{max} = \frac{Vo}{60} \times (t_1 + t_2 + \frac{t_3}{2}) \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (9\text{-}5)$$

Here,

L_{max}	:	Maximum coasting distance	[mm]
Vo	:	Machine's fast feed speed	[mm/min]
t_1	:	Delay time of control section	[sec]
t_2	:	Braking delay time of brake *	[sec]
t_3	:	Braking time	[sec]

$$t_3 = \frac{(J_L + J_M) \times No}{9.55 \times 10^4 (T_L + 0.8T_B)}$$

J_L	:	Load inertia converted into equivalent value on servo motor shaft	[kg.cm^2]
J_M	:	Servo motor inertia	[kg.cm^2]
No	:	Servo motor 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 *	[N.m]

* t_2 and T_B are the values noted in Table 9-2 Characteristics.
J_M is the sum of the electromagnetic brake's inertia (Table 9-2) and the motor's inertia.

9-6 Dynamic brake characteristics

The servo motor coasts to a stop during a power failure or when an alarm occurs. If the motor must be stopped suddenly, use the dynamic brake option.

Table 9-3 Application of dynamic brake option

Servo amplifier	Dynamic brake option model
MR-J10A to 60A MR-J10A1 to 40A1 MR-J10MA to 40MA MR-J10MA1 to 40MA1	MR-SDBU-1C
MR-J100A, MR-J70A	MR-SDBU-1A
MR-J150A	MR-SDBU-2A
MR-J200A	
MR-J350A	

The coasting amount during dynamic brake is shown below. The maximum coasting distance Lmax at this time, is the area of the diagonal selection in the diagram, and can be calculated with the equation (9-6).

The effect of the load torque is greater near the stopping area. The larger the load torque is, the earlier the motor will stop than obtained value. The brake time constant, τ, in equation (9-6) will be the value shown in Table 9-4.

Refer to page 6-4 for the external wiring and operation sequence, etc.

$$L_{max} = \frac{V_o}{60} \times \left\{ te + \tau \left(1 + \frac{J_L}{J_M} \right) \right\} \ldots\ldots \text{(9-6)}$$

Here,

L_{max}	: Maximum coasting distance	[mm]
V_O	: Machine's fast feed speed	[mm/min]
J_L	: Load inertia converted into equivalent value on servo motor shaft	[kg·cm^2]
J_M	: Servo motor inertia	[kg·cm^2]
τ	: Brake time constant (Table 9-4)	[sec]
te	: Delay time of control section (diagram below) (The delay of the inner relay is approximately 15msec.)	[sec]

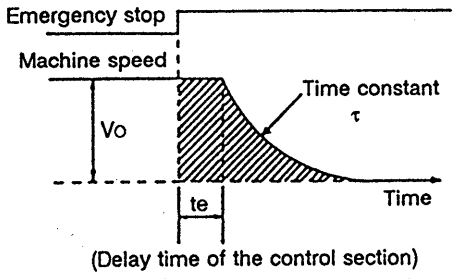


Fig. 9-5 Coasting distance during emergency stop

Table 9-4 Dynamic brake time constant

Servo motor	Brake time constant τ (sec)
HA-ME053	0.02
HA-ME13	0.03
HA-ME23	0.04
HA-ME43	0.06
HA-ME73	0.05
HA-FE053, 13	0.02
HA-FE23	0.05
HA-FE33	0.07
HA-FE43	0.09
HA-FE63	0.12
HA-SE52, 102, 152	0.06
HA-SE202	0.14
HA-SE53, 103, 153	0.1
HA-SE203	0.2

9-7 Mechanical characteristics of the servo motor

9-7-1 Vibration rank

The servo motor vibration rank is V-10 with the rated speed. The servo motor installation orientation and measurement position are shown on Section 1-4.

9-7-2 Flex life of the encoder cable

The flex life of the encoder cable supplied with the HA-FE type servo motors is approximately 20,000 bends with a bending radius of 25mm, and 30,000 bends at 50mm. When installed on a machine where the servo motor moves, the bending radius should be as large as possible. If the life poses a problem, use an extention cable, and replace the cable periodically. Special connector parts for the encoder cable are available.

9-8 Servo motor with reduction gear

Servo motors are available with integral gear reducers as listed below. Flange or foot mounting are possible.
The gear ratio is determined by the application. The installation position and lubrication methods may differ with each model. To select the correct motor and reducer, consider all mechanical requirements, then select the correct motor (HA-ME, HA-FE, or HA-SE) and reducer from the following charts.

9-8.1 HA-ME series

Reduction gear	For high precision			
Reduction ratio	1/5	1/9	1/20	1/29
Backlash	3 minutes or less			
Method of mounting	Flange mounting			
Output shaft rotating direction	The servo motor shaft and the reduction gear output shaft rotate in the same direction.			
Allowable speed (of the reduction gear input shaft)	3000 r/min			
Allowable load inertia moment ratio	25 times or less			
Lubrication method	Grease (Recommended grease: LDR101BV made by America Oil Center Research)			
Mounting direction	In any direction			

9-8.2 HA-FE series

Reduction ratio	1/5	1/10	1/30
HA-FE(B) series	O	O	O
Backlash	40 minutes to 1.5°		
Method of mounting	Flange mounting		
Output shaft rotating direction	The servo motor shaft and the reduction gear output shaft rotate in the same direction. However, the HA-FE053(B)G 1/30 and the HA-FE13(B)G 1/30 servo motors rotate in the direction opposite to that of the reduction gear output shaft.		
Allowable speed (of the reduction gear input shaft)	3000 r/min		
Allowable load inertia moment ratio	5 times or less		
Lubrication method	Grease (Recommended grease: BIHUCK UNIVERSAL No. 000 of Japan oil Note that Moricoat Grease is used for the HA-FH053G and 13G.)		
Mounting direction	In any direction		

The reduction ratios in the chart are nominal values. Actual values are listed below.

Motor model / Nominal reduction ratio	HA-FE053G	HA-FE13G	HA-FE23G	HA-FE33G	HA-FE43G	HA-FE63G
1/5	9/44		57/280	19/94		10/49
1/10	3/29		39/400	39/376		243/2401
1/30	144/4205		1/30	11/329		27/784

9-8.3 HA-SE series

Reduction gear		For high precision					For general industrial machines						
Reduction ratio		1/5	1/9	1/20	1/29	1/45	1/6	1/11	1/17	1/29	1/35	1/43	1/59
Applicable motor type	HA-SE52(B)G to 202(B)G	O	O	O	O	O	O	O	O	O	O	O	O
	HA-SE352(B)G	O	O	O	—	—	O	O	O	O	O	O	O
Backlash		3 minutes or less					40 minutes to 2°						
Method of mounting		Flange mounting					As in (1) and (2) of this section						
Output shaft rotating direction		The servo motor shaft and the reduction gear output shaft rotate in the same direction.					The servo motor shaft and the reduction gear output shaft rotate in the opposite directions.						
Allowable speed (of the reduction gear input shaft)		2000 r/min											
Allowable load inertia moment ratio		5 times or less					3 times or less						
Lubrication method		Grease (Recommended grease: LDR101BJ made by America Oil Center Research)					As in (1) and (3) of this section						
Mounting direction		In any direction					As in (1) of this section						

Note: O in the table indicates that the motor is available.

(1) Lubrication methods for reduction gears for general industrial machines

Mounting direction	Shaft vertical				Shaft downward			Shaft upward		
Reduction gear type / (Note 1) Reduction gear frame No.	HM	HMS	HMV	HMF	VMH	VM	VMF	WMH	WMV	WMF
210	Grease									
211	Grease									
213	Oil or grease							Grease		
216	Oil or grease				Grease		Oil or grease	Grease		
217	Oil							X		

Note: 1. The reduction gear frame numbers are as follows:

Motor type	Reduction ratio						
	1/6	1/11	1/17	1/29	1/35	1/43	1/59
HA-SH52(B)G	210			211			213
HA-SH102(B)G	211				213	216	
HA-SH152(B)G	211			213	216		
HA-SH202(B)G	211			216			
HA-SH352(B)G	213			217			

2. The oil lubrication method cannot be used in applications where the servo motor moves. For such applications, specify grease lubrication.

(2) Mounting of servo motors with reduction gears for general industrial machines

Reduction gear type	HM	HMS	VMH	WMH	HMV	VM	WMV	HMF	VMF	WMF
Mounting	Foot mounting				Mounting base			Flange mounting		

(3) Recommended lubricants

1) Grease:Albania grease RA of Showa Shell Sekiyu
(Changing interval: 20000 hours or 4 to 5 years)

2) Lubricating oil

Ambient temperature (°C)	COSMO OIL	Japan Oil	IDEMITSU KOSAN CO., LTD	GENERAL OIL	Showa Shell Sekiyu	ESSO OIL	Mobil Oil	MITSUBISHI OIL	Japan Energy
-10 to 5	COSMO GEAR SE 68	BONNOC SP 68	DAPHNE CE 68S DAPHNE SUPER GEAR OIL 68		Omala Oils 68	SPARTAN EP 68	Mobilgear 626 (ISO VG68)	DIAMOND GEAR LUBE SP 68	JOMO Reductus 68
0 to 35	COSMO GEAR SE 100, 150	BONNOC SP 100, 150	DAPHNE CE 100S, 150S DAPHNE SUPER GEAR OIL 100, 150	GENERAL SP GEAROL 100, 150	Omala Oils 100, 150	SPARTAN EP 150	Mobilgear 629 (ISO VG150)	DIAMOND GEAR LUBE SP 100, 150	JOMO Reductus 100, 150
30 to 50	COSMO GEAR SE 200, 320, 460	BONNOC SP 200 to 460	DAPHNE CE 220S to 460S	GENERAL SP GEAROL 220 to 460	Omala Oils 220 to 460	SPARTAN EP 220 to 460	Mobilgear 630 to 634 (ISO VG 220 to 460)	DIAMOND GEAR LUBE SP 220 to 460	JOMO Reductus 220 to 460

Lubrication amount

Reduction gear frame number		213	216	217
Lubrication amount	Horizontal type	0.7	1.4	1.9
	Vertical type	1.1	1.0	1.9

9-9 Servo motor with tapered shaft

The standard servo motor shaft has a straight shaft without key groove. A tapered shaft motor with the dimensions shown in Fig. 9-7 can be manufactured as special order for the 0.5 to 1.0kW servo motors. The dimensions other than the servo motor shaft end are the same as the standard specifications. Since the radial load capacity differs between the tapered shaft and straight shaft, determine the loading before using.

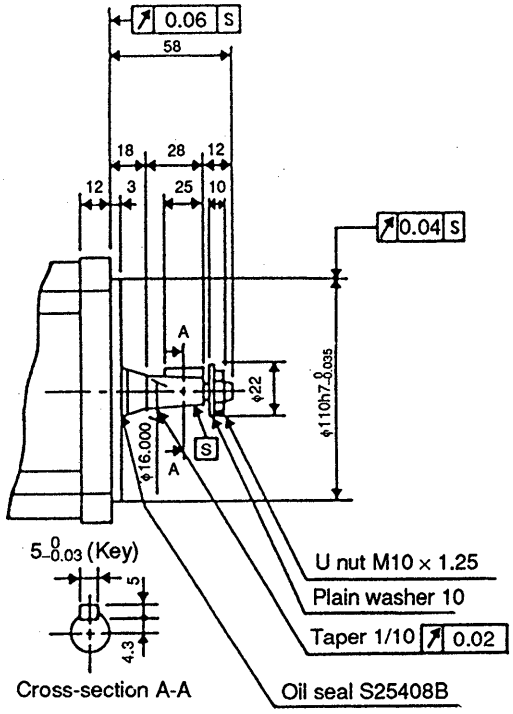
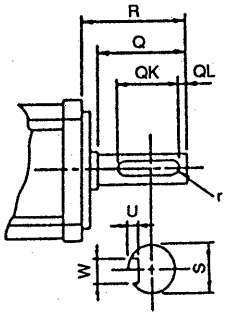


Fig. 9-6 Tapered shaft dimension diagram

9-10 Servo motor with special shaft

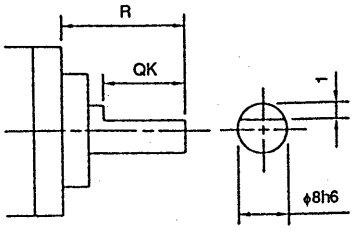
The standard servo motor shaft has a straight shaft without a key groove. The following dimensions are for the servo motor shaft with key groove.
This is not appropriate for applications where the servo motor is started and stopped frequently. For these applications, use a compression coupling.

Unit: mm



Servo motor (kW)		Variable dimensions							
		S	R	Q	W	QK	QL	U	r
HA-SE	0.5 to 1.5	24h6	55	50	$8^{0}_{-0.036}$	36	5	$4^{+0.2}_{0}$	4
	2.0, 3.5	$35^{+0.01}_{0}$	79	—	$10^{0}_{-0.036}$	55	5	$5^{+0.2}_{0}$	5
HA-ME	0.2, 0.4	14h6	30	27	5	20	3	3	2.5
	0.7	19h6	40	37	6	25	5	3.5	3

Note: The key is not included, and must be supplied by the user.

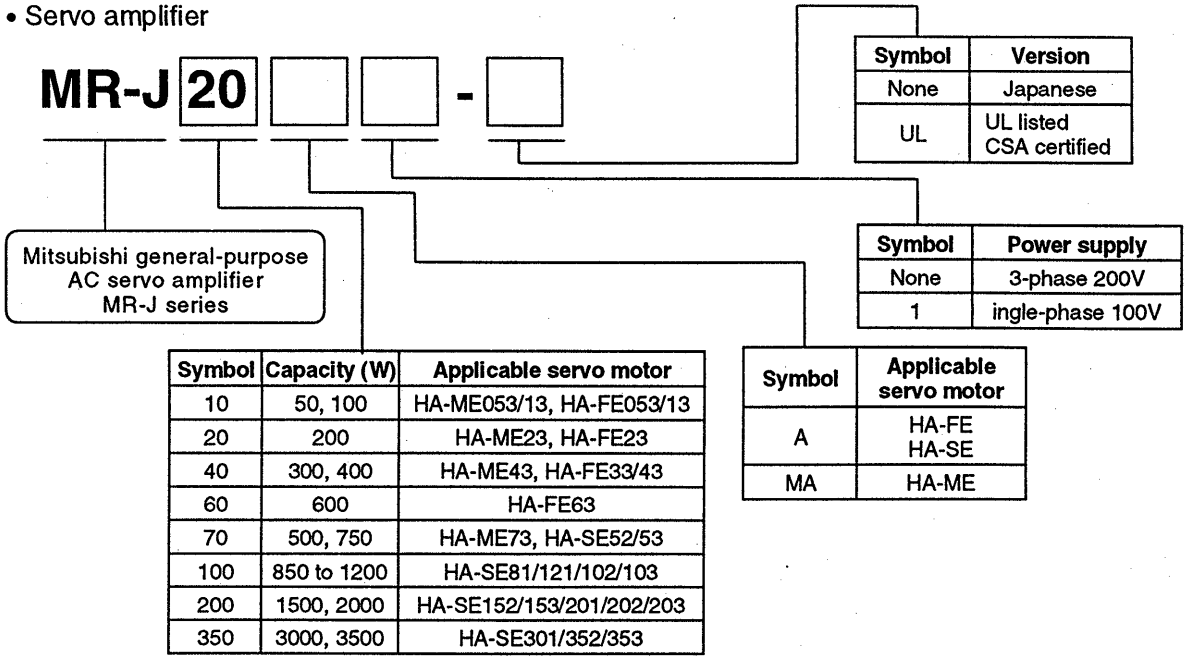


Unit: mm

Servo motor (kW)	Variable dimensions	
	R	QK
HA-ME 0.05, 0.1	25	20.5
HA-FE 0.05, 0.1	30	25.5

10-1 Model configuration

• Servo amplifier



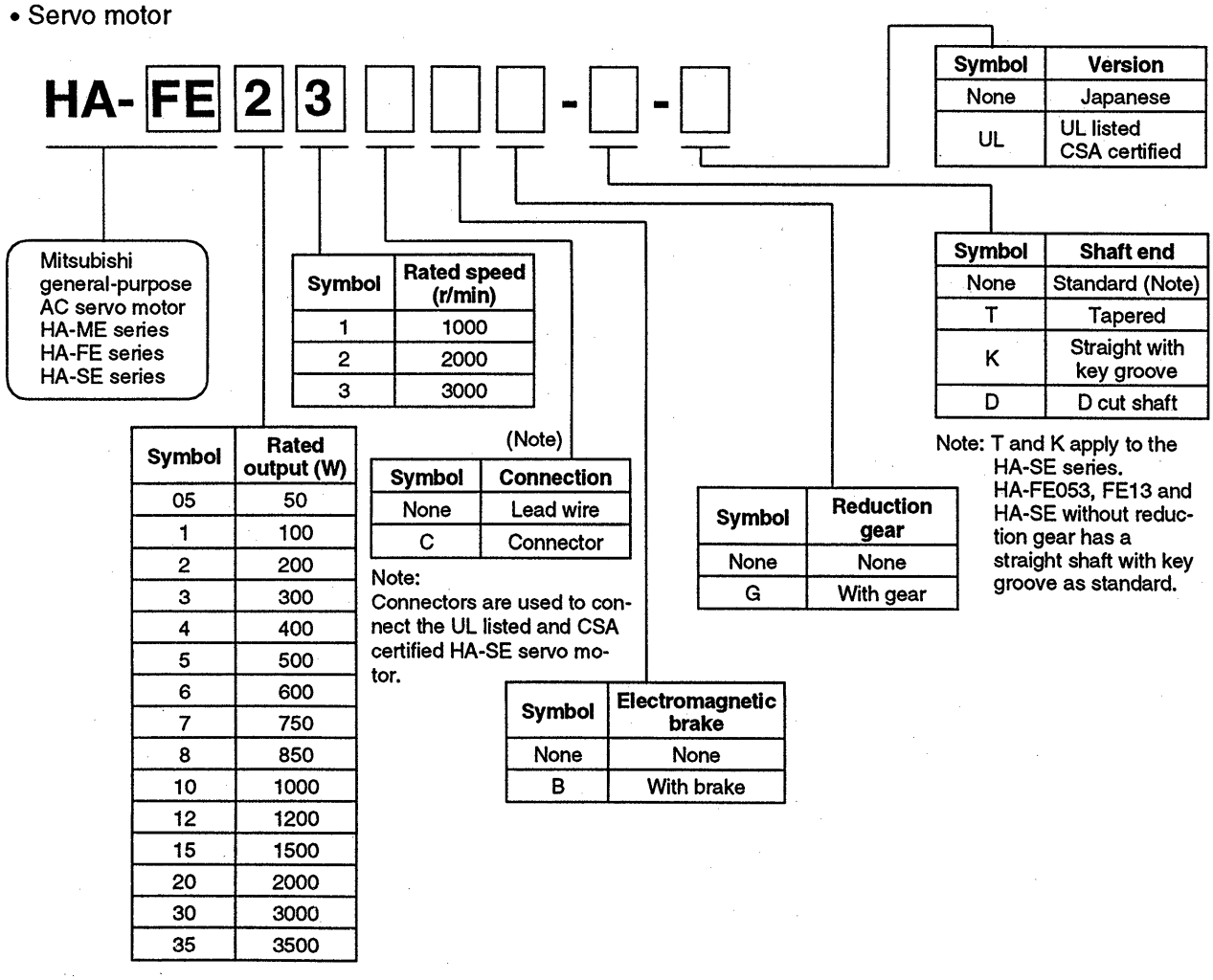
Symbol	Version
None	Japanese
UL	UL listed CSA certified

Symbol	Power supply
None	3-phase 200V
1	ingle-phase 100V

Symbol	Capacity (W)	Applicable servo motor
10	50, 100	HA-ME053/13, HA-FE053/13
20	200	HA-ME23, HA-FE23
40	300, 400	HA-ME43, HA-FE33/43
60	600	HA-FE63
70	500, 750	HA-ME73, HA-SE52/53
100	850 to 1200	HA-SE81/121/102/103
200	1500, 2000	HA-SE152/153/201/202/203
350	3000, 3500	HA-SE301/352/353

Symbol	Applicable servo motor
A	HA-FE HA-SE
MA	HA-ME

• Servo motor



Symbol	Version
None	Japanese
UL	UL listed CSA certified

Symbol	Shaft end
None	Standard (Note)
T	Tapered
K	Straight with key groove
D	D cut shaft

Note: T and K apply to the HA-SE series. HA-FE053, FE13 and HA-SE without reduction gear has a straight shaft with key groove as standard.

Symbol	Rated speed (r/min)
1	1000
2	2000
3	3000

Symbol	Rated output (W)
05	50
1	100
2	200
3	300
4	400
5	500
6	600
7	750
8	850
10	1000
12	1200
15	1500
20	2000
30	3000
35	3500

(Note)

Symbol	Connection
None	Lead wire
C	Connector

Note: Connectors are used to connect the UL listed and CSA certified HA-SE servo motor.

Symbol	Reduction gear
None	None
G	With gear

Symbol	Electromagnetic brake
None	None
B	With brake

10-2 Standard specifications (3-phase 200V series)

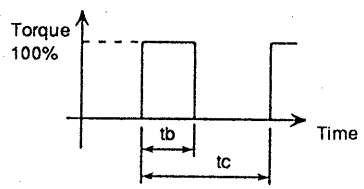
Specifications \ Model		Servo motor series	HA-ME Series					HA-FE Series					
		Servo motor model	HA-ME053	HA-ME13	HA-ME23	HA-ME43	HA-ME73	HA-FE053	HA-FE13	HA-FE23	HA-FE33	HA-FE43	HA-FE63
		Servo amplifier model	MR-J10MA		MR-J20MA	MR-J40MA	MR-J70MA	MR-J10A		MR-J20A	MR-J40A		MR-J60A
Servo motor (Note 1)	Continuous	Rated output (W)	50	100	200	400	750	50	100	200	300	400	600
		Rated torque (N·m {kg·cm})	0.16 {1.62}	0.32 {3.25}	0.64 {6.49}	1.3 {13.0}	2.4 {24.4}	0.16 {1.62}	0.32 {3.25}	0.64 {6.5}	0.95 {9.7}	1.3 {13.0}	1.9 {19.3}
	Max. torque (N·m {kgf·cm})		0.48 {4.86}	0.95 {9.74}	1.9 {19.5}	3.8 {39.0}	7.2 {73.1}	0.48 {4.86}	0.95 {9.74}	1.9 {19.5}	2.9 {29.2}	3.8 {39.0}	5.7 {58.5}
	Rated speed (r/min)		3000										
	Max. speed (r/min)		4500					4000					
	Absolute maximum speed (r/min)		5400					4600					
	Power rate (kW/s)		12.19	29.25	37.23	93.88	78.24	4.0	10.2	11.7	18.1	17.2	30.1
	Moment of inertia	J (kg·cm^2)	0.021	0.035	0.11	0.18	0.73	0.063	0.10	0.35	0.50	0.98	1.2
		GD^2 (kgf·cm^2)	0.084	0.14	0.44	0.72	2.92	0.25	0.38	1.4	2.0	3.9	4.8
	Speed/position encoder		Encoder 1000 P/rev.										
	Accessories		Encoder					Encoder, V-ring					
	Structure		Totally enclosed, natural air cooling										
	Ambient temperature		0 to 40°C										
	Weight (kg)		0.4	0.55	1.2	1.8	3.5	1.3	1.5	2.3	2.6	4.2	4.8
Servo amplifier (Note 2)	Power (Note 3)	Voltage/frequency	3-phase 200 to 230VAC 50/60Hz										
		Tolerable voltage fluctuation	170 to 253V										
		Tolerable frequency fluctuation	Less than ±5%										
		Power facility capacity (kVA)	0.3	0.3	0.5	0.9	1.3	0.3	0.3	0.5	0.7	0.9	1.1
	Control method		Sinusoidal PWM control, current controlled method										
	Rated output current (A)		1.2	1.2	1.7	2.8	5.3	0.6	1.1	1.3	1.9	2.5	3.6
	Max. output current (A)		3.6	3.6	5.1	8.4	15.9	1.8	3.3	3.9	5.7	7.5	10.8
	Regenerative brake duty (Note 4) (times/min) Δ: Those of 200W or less are not provided with a restriction on the regenerative frequency if the effective torque is smaller than the rated torque. ×: Impossible combination	MR-RB013	Δ	Δ	Δ	803	197	Δ	Δ	Δ	315	145	120
		MR-RB033	Δ	Δ	Δ	2410	592	Δ	Δ	Δ	945	440	360
		MR-RB064 Serial two	Δ	Δ	Δ	1250	1200	Δ	Δ	Δ	1818	1250	1200
		MR-RB064	×	×	×	×	×	×	×	×	×	×	×
		MR-RB10 Serial two	×	×	×	×	×	×	×	×	×	×	×
		MR-RB30 Serial two	×	×	×	×	×	×	×	×	×	×	×
		MR-RB10	×	×	×	×	×	×	×	×	×		×
		MR-RB30	×	×	×	×	×	×	×	×	×	×	×
		MR-RB50	×	×	×	×	×	×	×	×	×	×	×
	Tolerable load inertia ratio (Note 5)		Under 30 times					Under 10 times					
	Protective functions		Overcurrent shut off, regenerative overvoltage shut off, overload shut off (electronic thermal relay), undervoltage protection, regenerative brake resistor overheating protection, overspeed protection, excessive difference protection										
	Torque limit command input		0 to +10VDC (+10V/Max. current)										
	Speed control specifications	Speed control range	1:1000										
		Speed command input	0 to ±10VDC										
		Speed fluctuation ratio	-0.03% or less (load fluctuation 0 to 100%) ±0.02% or less (power fluctuation ±10%) ±0.2% or less (ambient temperature 25°C±10°C) Only for external speed setting										
	Position control specifications	Max. input pulse frequency	Max. 200 kpps										
		Positioning feedback pulses	4000 p/rev servo motor revolution										
		Command pulse multiplication	Electronic gear A, B: 1 to 9999 1/50<A/B<20 (input pulse frequency after multiplication is 200 kpps or less)										
		Positioning complete width setting	0 to ±9999 pulse										
		Excessive difference	±65K pulse										
	Structure		Opened										
	Environment	Ambient temperature	0 to ±55°C (with no freezing), storage -20 to +65°C										
		Ambient humidity	90%RH or less (with no dew condensation)										
		Atmosphere	With no corrosive gases or dust										
		Altitude	1000m or lower										
		Vibration	5.9 m/s^2 (0.6G) or less										
	Weight (kg)		0.8			1.0	1.5	0.8			1.0		

Note:
1. Special specifications will be required when using the motor in a site where oil or rain may contact the motor.
2. The output torque and rated speed are not guaranteed during power voltage drops. The current values are the rated and maximum output currents of the servo amplifiers.
3. The necessary power facility capacity will differ according to the impedance.
4. The regenerative brake duty is for the servo motor at no load, and indicates the tolerable duty for decelerating and stopping from the rated speed. There are no limits to the regenerative duty for the models below 200W if the effective torque is not more than the rated torque. When load is applied, the value becomes 1/(m+1) of the value in the table. (m = load inertia moment/motor inertia moment) If the speed exceeds the rated speed, the allowable number of times is in inverse proportion to the square of (operation speed/rated speed). When the operation speed frequently varies or when the regeneration state is constantly used as in up and down motions, calculate the amount of regenerative heat generated during the operation. The amount of heat generation must not be larger than the allowable value.
5. Please consult Mitsubishi when exceeding the tolerable load inertia ratio.

10. Specifications

	HA-SE 1000 r/min Series				HA-SE 2000 r/min Series					HA-SE 3000 r/min Series				
	HA-SE81	HA-SE121	HA-SE201	HA-SE301	HA-SE52	HA-SE102	HA-SE152	HA-SE202	HA-SE352	HA-SE53	HA-SE103	HA-SE153	HA-SE203	HA-SE353
	MR-J100A		MR-J200A	MR-J350A	MR-J70A	MR-J100A	MR-J200A		MR-J350A	MR-J70A	MR-J100A	MR-J200A		MR-J350A
	850	1200	2000	3000	500	1000	1500	2000	3500	500	1000	1500	2000	3500
	8.12 {82.8}	11.5 {117}	19.1 {195}	28.6 {292}	2.4 {24.4}	4.8 {48.7}	7.16 {73.1}	9.5 {97.4}	16.7 {170}	1.59 {16.2}	3.18 {32.5}	4.78 {48.7}	6.37 {65.0}	11.1 {114}
	24.4 {248}	34.4 {351}	57.3 {585}	85.9 {877}	7.16 {73.1}	14.4 {146}	21.6 {219}	28.5 {292}	50.1 {510}	4.77 {48.7}	9.55 {97.4}	14.3 {146}	19.1 {195}	33.4 {341}
	1000				2000					3000				
	1200				2000					3000				
	1380				2300					3450				
	22.3	19.3	27.8	42.6	5.8	11.8	17.6	13.2	21.3	2.6	5.2	7.7	5.9	9.4
	29.5	68.5	131	192	9.80	19.6	29.5	68.5	131	9.80	19.6	29.5	68.5	131
	118	274	525	768	39.2	78.4	118	274	525	39.2	78.4	118	274	525
	Encoder 1000 P/rev.													
	Encoder, oil seal													
	Totally enclosed, natural air cooling													
	0 to 40°C													
	16	21	32	43	8.8	12	16	21	32	8.8	12	16	21	32
	3-phase 200 to 230VAC 50/60Hz													
	170 to 253V													
	Less than ±5%													
	1.5	2.1	3.5	4.8	1.0	1.7	2.5	3.5	5.5	1.0	1.7	2.5	3.5	5.5
	Sinusoidal PWM control, current controlled method													
	4.5	6	9.5	14	3	5.5	8	10	16	3	5	8	9	16
	13.5	18	28.5	42	9	16.5	24	30	48	9	15	24	27	48
	43	18	×	×	33	16	×	×	×	14	7	×	×	×
	130	55	×	×	100	48	×	×	×	44	22	×	×	×
	438	188	×	×	330	160	×	×	×	147	73	×	×	×
	×	×	55	×	×	×	67	29	×	×	×	27	11	×
	×	×	139	×	×	×	159	69	×	×	×	69	29	×
	×	×	417	×	×	×	348	199	×	×	×	154	88	×
	×	×	×	60	×	×	×	×	23	×	×	×	×	9
	×	×	×	180	×	×	×	×	67	×	×	×	×	29
	×	×	×	300	×	×	×	×	110	×	×	×	×	48
	Under 5 times													
	Overcurrent shut off, regenerative overvoltage shut off, overload shut off (electronic thermal relay), undervoltage protection, regenerative brake resistor overheating protection, overspeed protection, excessive difference protection													
	0 to +10VDC (+10V/Max. current)													
	1:1000													
	0 to ±10VDC													
	–0.03% or less (load fluctuation 0 to 100%) ±0.02% or less (power fluctuation ±10%) ±0.2% or less (ambient temperature 25°C±10°C) Only for external speed setting													
	Max. 200 kpps													
	4000 p/rev servo motor revolution													
	Electronic gear A, B: 1 to 9999 1/50<A/B<20 (input pulse frequency after multiplication is 200 kpps or less)													
	0 to ±9999 pulse													
	±65K pulse													
	Opened													
	0 to ±55°C (with no freezing), storage –20 to +65°C													
	90%RH or less (with no dew condensation)													
	With no corrosive gases or dust													
	1000m or lower													
	5.9 m/s^2 {0.6G} or less													
	1.5		3.3	3.6	1.5		3.3		3.6	1.5		3.3		3.6

80%ED: Operation time at the rated torque is 80% of one operation cycle time and the no-load operation time is remaining 20%.



tb < 60 seconds (continuous operation time)

$$\%ED = \frac{tb}{tc} \times 100$$

10

Standard specifications (single-phase 100V series)

Model			HA-ME053	HA-ME13	HA-ME23	HA-ME43	HA-FE053	HA-FE13	HA-FE23	HA-FE33	HA-FE43
Specifications	Servo amplifier model		MR-J10MA1		MR-J20MA1	MR-J40MA1	MR-J10A1		MR-J20A1	MR-J40A1	
Servo motor (Note 1)	Continuous	Rated output (W)	50	100	200	400	50	100	200	300	400
		Rated torque (N·m {kgf·cm})	0.16 {1.62}	0.32 {3.25}	0.54 {6.49}	1.3 {13.0}	0.16 {1.62}	0.32 {3.25}	0.64 {6.5}	0.95 {9.7}	1.3 {13.0}
	Max. torque (N·m {kgf·cm})		0.48 {4.86}	0.95 {9.74}	1.9 {19.5}	3.8 {39.0}	0.48 {4.86}	0.95 {9.74}	1.9 {19.5}	2.9 {29.2}	3.8 {39.0}
	Rated speed (r/min)		3000				3000				
	Max. speed (r/min)		4500				4000				
	Absolute maximum speed (r/min)		5400				4600				
	Power rate (kW/s)		12.19	29.25	37.23	93.88	4.0	10.2	11.7	18.1	17.2
	Moment of inertia	J (kg·cm^2)	0.021	0.035	0.11	0.18	0.063	0.10	0.35	0.50	0.98
		GD^2 (kgf·cm^2)	0.084	0.14	0.44	0.72	0.25	0.38	1.4	2.0	3.9
	Speed/position encoder		Encoder 1000 P/rev.								
	Accessories		Encoder				Encoder, V-ring				
	Structure		Totally enclosed, natural air cooling								
	Ambient temperature		0 to 40°C								
	Weight (kg)		0.4	0.55	1.2	1.8	1.3	1.5	2.3	2.6	4.2
Servo amplifier (Note 2)	Power (Note 3)	Voltage/ frequency: Japanese	Single-phase AC100 to 115V 50/60Hz								
		Voltage/ frequency: UL listed CSA certified	Single-phase AC100 to 120V 50/60Hz								
		Tolerable voltage fluctuation	85 to 127V								
		Tolerable frequency fluctuation	Less than ±5%								
		Power facility capacity (kVA)	0.3	0.3	0.5	0.9	0.3	0.3	0.5	0.7	0.9
	Control method		Sinusoidal PWM control, current controlled method								
	Rated output current (A)		1.2	1.2	1.7	2.8	0.6	1.1	1.3	1.9	2.5
	Max. output current (A)		3.6	3.6	5.1	8.4	1.8	3.3	3.9	5.7	7.5
	Regenerative brake duty (times/min) (Note 4)	MR-RB013	Δ	Δ	Δ	803	Δ	Δ	Δ	315	145
		MR-RB033	Δ	Δ	Δ	2410	Δ	Δ	Δ	945	440
		MR-RB064 Serial two	Δ	Δ	Δ	1250	Δ	Δ	Δ	1818	1250
	Tolerable load inertia ratio (Note 5)		Under 30 times				Under 10 times				
	Protective functions		Overcurrent shut off, regenerative overvoltage shut off, overload shut off (electronic thermal relay), undervoltage protection, regenerative brake resistor overheating protection, overspeed protection, excessive difference protection								
	Torque limit command input		DC 0 to +10V (+10V/Max. current)								
	Speed control specifications	Speed control range	1:1000								
		Speed command input	DC 0 to ±10V								
		Speed fluctuation ratio	−0.03% or less (load fluctuation 0 to 100%) ±0.02% or less (power fluctuation ±10%) ±0.2% or less (ambient temperature 25°C ± 10°C) Only for external speed								
	Position control specifications	Max. input pulse frequency	Max. 200 kpps								
		Positioning feedback pulses	4000 p/per servo motor revolution								
		Command pulse multiplication	Electronic gear A, B: 1 to 9999 1/50<A/B<20 (input pulse frequency after multiplication is 200 kpps or less)								
		Positioning complete width setting	0 to ±9999 pulse								
		Excessive difference	±65K pulse								
	Structure		Opened								
	Environment	Ambient temperature	0 to ±55°C (with no freezing), storage −20°C to +65°C								
		Ambient humidity	90%RH or less (with no dew condensation)								
		Atmosphere	With no corrosive gases or dust								
		Altitude	1000m or lower								
		Vibration	5.9 m/s^2 (0.6G) or less								
	Weight (kg)		0.8			1.0	0.8			1.0	

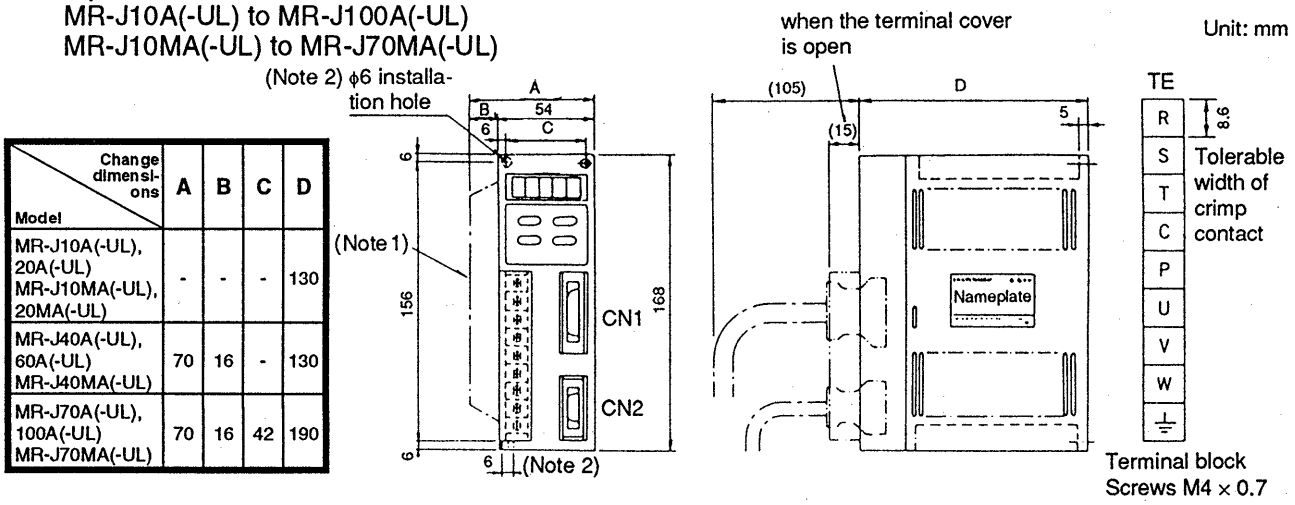
Note: 1. Special considerations will be required when using the motor in a site where oil or rain may contact the motor.
2. The output torque and rated speed are not guaranteed during power voltage drops. The current values are the rated and maximum output currents of the amplifiers.
3. The necessary power facility capacity will differ according to the impedance.
4. The regenerative brake duty is for the motor at no load, and indicates the tolerable duty for decelerating and stopping from the rated speed. There are no limits to the regenerative duty for the models below 200W if the effective torque is not more than the rated torque.
When load is applied, the value becomes 1/(m+1) of the value in the table. (m = load inertia moment/motor inertia moment)
If the speed exceeds the rated speed, the allowable number of times is in inverse proportion to the square of (operation speed/rated speed). When the operation speed frequently varies or when the regeneration state is constantly established as in up and down motions, calculate the amount of regenerative heat generated during the operation. The amount of heat generation must not be larger than the allowable value.
5. Please consult Mitsubishi when exceeding the tolerable load inertia moment ratio.

10-3 Outer dimensions of servo amplifier

- 3-phase 200V series
  MR-J10A(-UL) to MR-J100A(-UL)
  MR-J10MA(-UL) to MR-J70MA(-UL)

Unit: mm

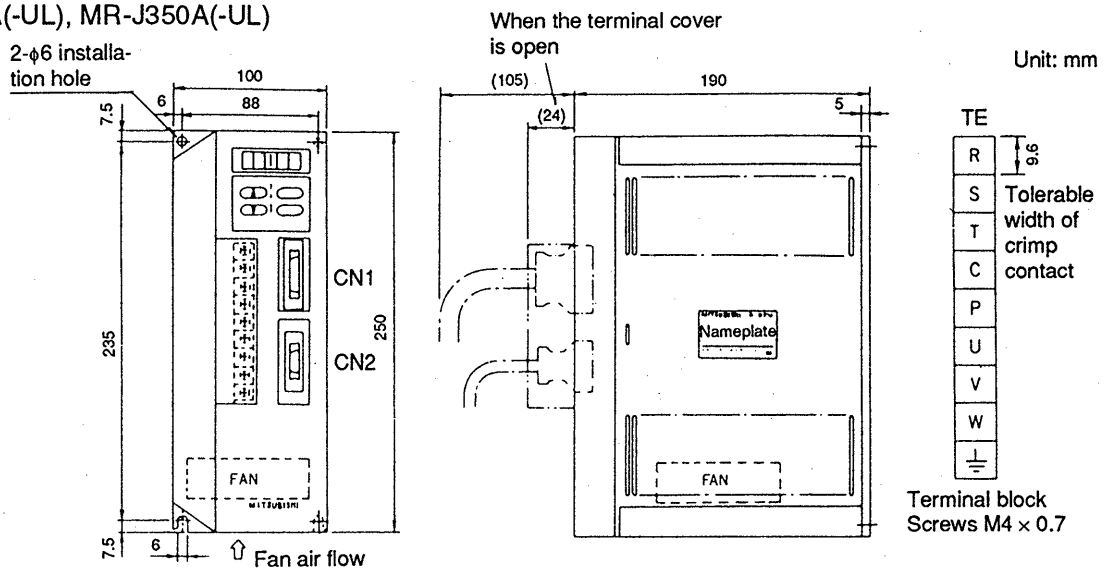
Change dimensions / Model	A	B	C	D
MR-J10A(-UL), 20A(-UL) MR-J10MA(-UL), 20MA(-UL)	-	-	-	130
MR-J40A(-UL), 60A(-UL) MR-J40MA(-UL)	70	16	-	130
MR-J70A(-UL), 100A(-UL) MR-J70MA(-UL)	70	16	42	190



Note: 1. MR-J40□A(-UL), J60A(-UL) , J70MA(-UL) and J100A(-UL) have a cooling fan.
2. The mounting holes for the MR-J10□A and J20□A are at two places indicated by the arrows.

MR-J200A(-UL), MR-J350A(-UL)

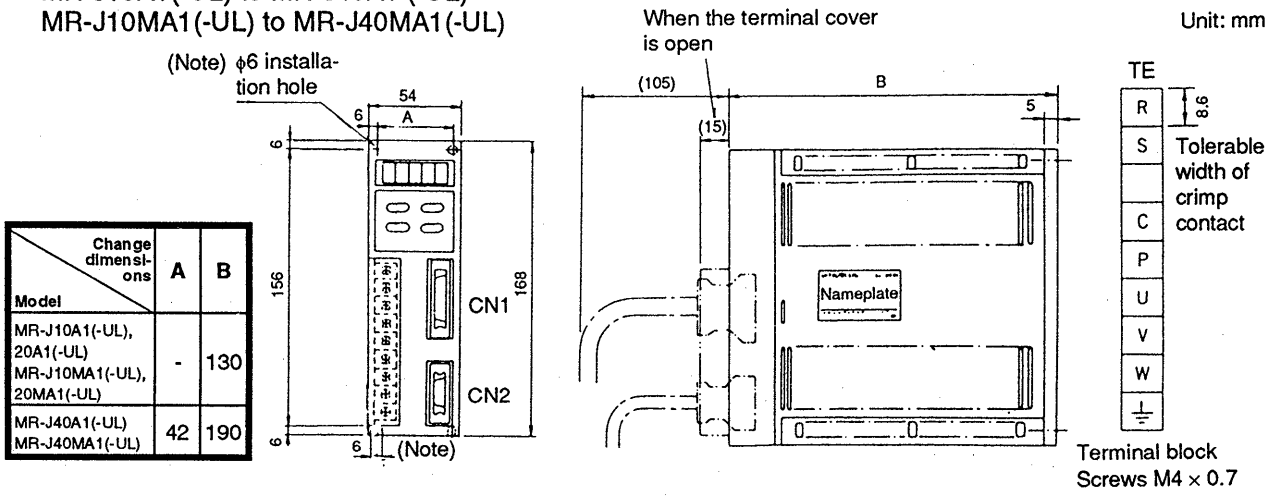
Unit: mm



- Single-phase 100V series
  MR-J10A1(-UL) to MR-J40A1 (-UL)
  MR-J10MA1(-UL) to MR-J40MA1(-UL)

Unit: mm

Change dimensions / Model	A	B
MR-J10A1(-UL), 20A1(-UL) MR-J10MA1(-UL), 20MA1(-UL)	-	130
MR-J40A1(-UL) MR-J40MA1(-UL)	42	190



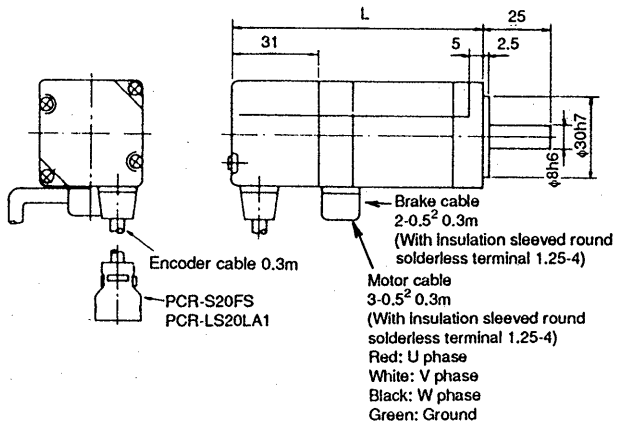
Note: The mounting holes for the MR-J10□A(-UL) 1 and J20□A(-UL) 1 are only at two places indicated by the arrows.

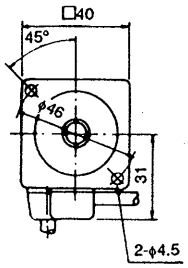
10-4 Outer dimensions of servo motor

Standard HA-ME servo motor series

- HA-ME053(B)G, HA-ME13(B)

(Unit: mm)

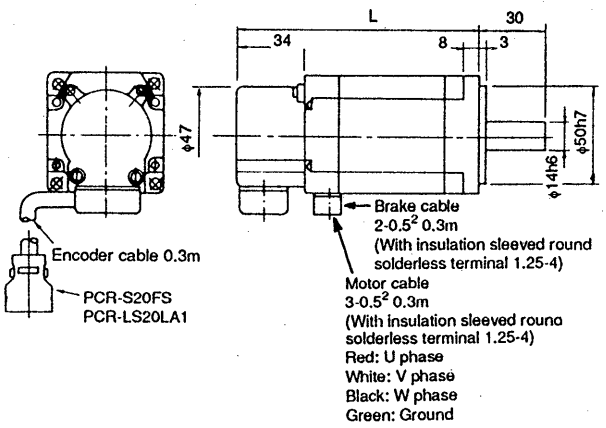


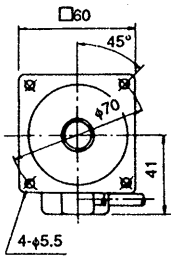


Model	Variable dimension L
HA-ME053(B)	76.5 (105.5)
HA-ME13(B)	94.5 (123.5)

- HA-ME23(B), HA-ME43(B)

(Unit: mm)

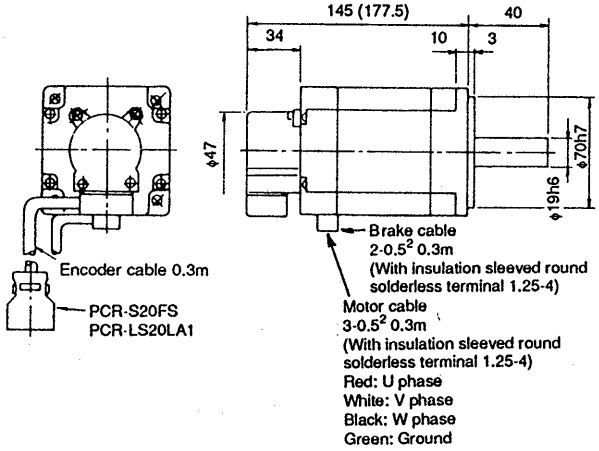


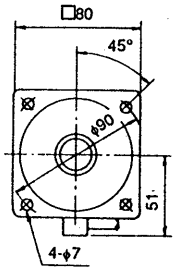


Model	Variable dimension L
HA-ME23(B)	96.5 (129)
HA-ME43(B)	124.5 (157)

- HA-ME73(B)

(Unit: mm)

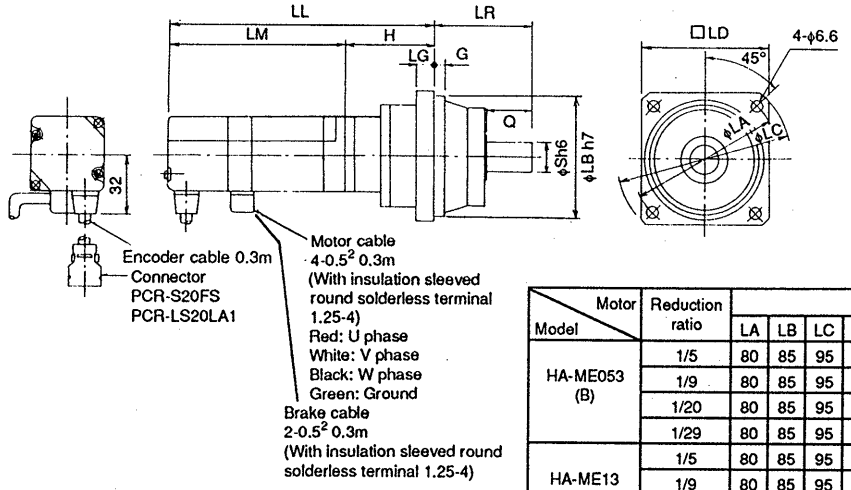




Note: 1. The dimensions in parentheses apply when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

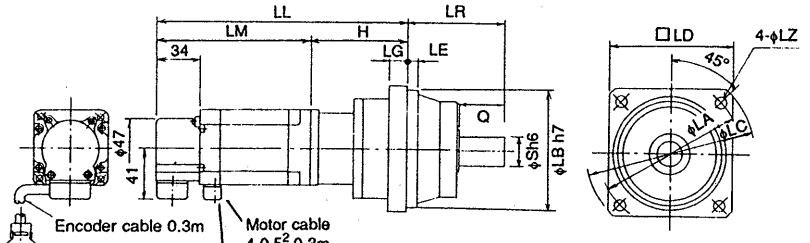
HA-ME servo motor series with reduction gear

- HA-ME053(B)G, HA-ME13(B)G



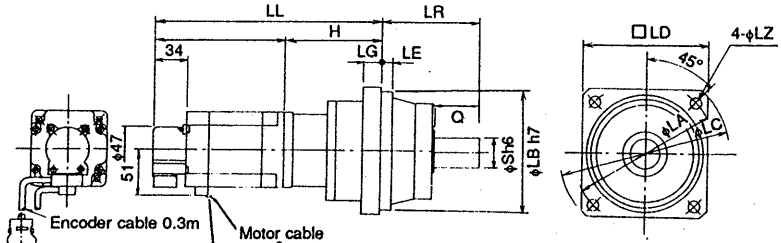
Model \ Motor	Reduction ratio	Variable dimension L										
		LA	LB	LC	LD	LG	LL	LR	LM	H	Q	S
HA-ME053 (B)	1/5	80	85	95	70	8	124.5 (153.5)	55	76.5 (105.5)	48	25	18
	1/9	80	85	95	70	8	140.5 (168.5)	55		64	25	18
	1/20	80	85	95	70	8	140.5 (169.5)	55		64	25	18
	1/29	80	85	95	70	8	140.5 (169.5)	55		64	25	18
HA-ME13 (B)	1/5	80	85	95	70	8	142.5 (171.5)	55	94.5 (123.5)	48	25	18
	1/9	80	85	95	70	8	158.5 (187.5)	55		64	25	18
	1/20	100	80	115	85	10	164.5 (193.5)	75		70	25	20
	1/29	100	80	115	85	10	164.5 (193.5)	75		70	25	20

- HA-ME23(B)G, HA-ME43(B)G



Model \ Motor	Reduction ratio	Variable dimension L												
		LA	LB	LC	LD	LE	LG	LL	LR	LM	LZ	H	Q	S
HA-ME23G (B)	1/5	80	65	95	70	8	8	153.5 (186)	55	98.5 (129)	8.8	57	25	18
	1/9	100	80	115	85	8	10	171.5 (204)	75		8.8	75	35	20
	1/20	115	95	135	100	8	10	175.5 (209)	85		9	80	40	25
	1/29	115	95	135	100	8	10	175.5 (209)	85		9	80	40	25
HA-ME43G (B)	1/5	100	80	115	85	8	10	183.5 (218)	75	124.5 (157)	8.8	59	35	20
	1/9	115	95	135	100	8	10	204.5 (237)	85		9	80	40	25
	1/20	135	110	155	115	8	12	210.5 (243)	100		11	88	50	32
	1/29	135	110	155	115	8	12	210.5 (243)	100		11	88	50	32

- HA-ME73(B)G

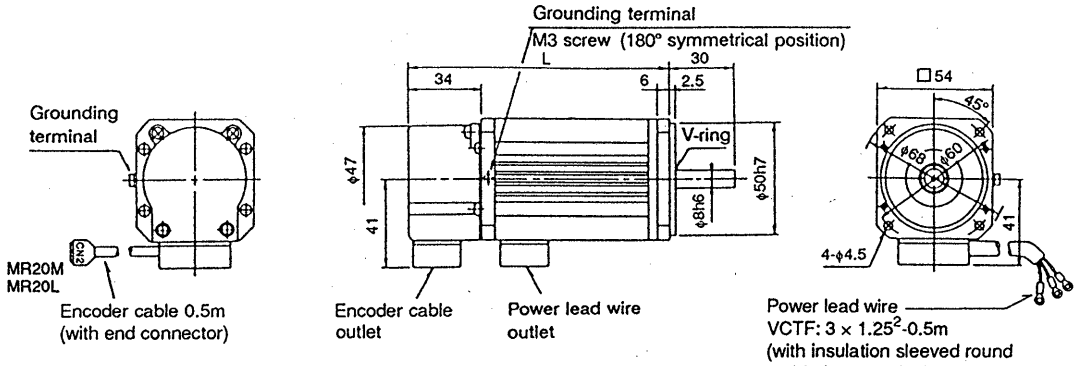


Model \ Motor	Reduction ratio	Variable dimension L												
		LA	LB	LC	LD	LE	LG	LL	LR	LM	LZ	H	Q	S
HA-ME73G (B)	1/5	115	95	135	100	8	10	215 (247.5)	85	145 (177.5)	9	70	40	25
	1/9	135	110	155	115	8	12	251 (283.5)	100		11	106	50	32
	1/20	150	125	175	130	10	15	251 (283.5)	115		14	106	60	40
	1/29	150	125	175	130	10	15	251 (283.5)	115		14	106	60	40

Note: 1. The reduction gear shaft rotation direction is the same as the motor rotation direction.
2. Backlash is 3 minutes.
3. The dimensions in parentheses apply when the electromagnetic brake is provided.
4. Use a compression coupling for connection with the load.

Standard HA-FE servo motor series

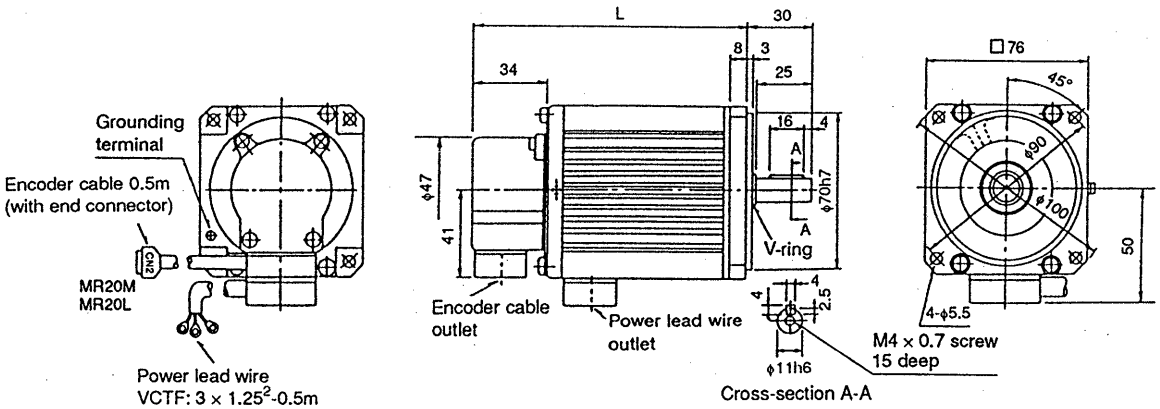
- HA-FE053(B), HA-FE13(B)



Model \ Changed dimensions	L
HA-FE053(B)	101 (136)
HA-FE13(B)	118 (153)

Unit: mm

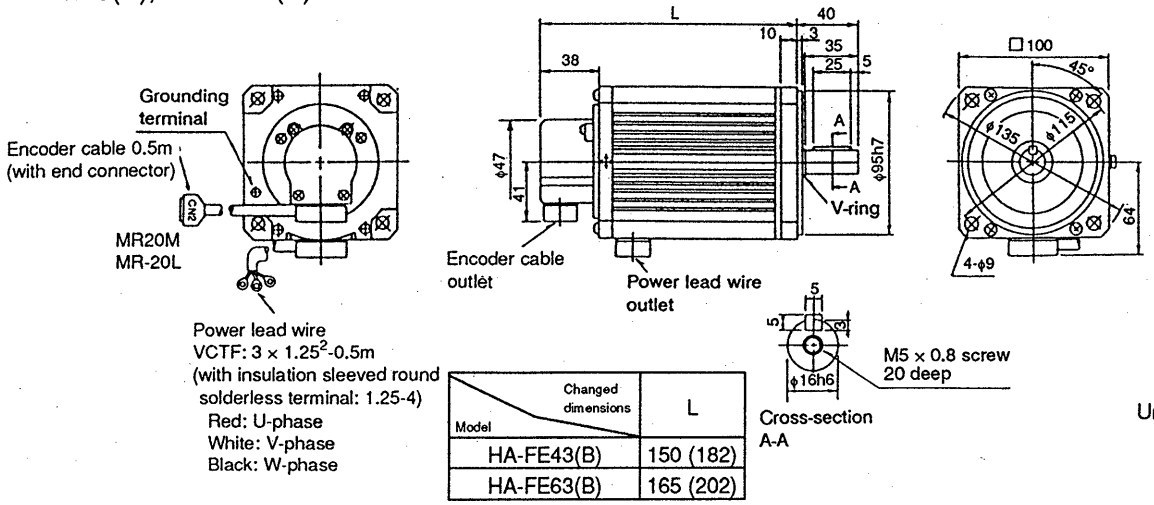
- HA-FE23(B), HA-FE33(B)



Unit: mm

Model \ Changed dimensions	L
HA-FE23(B)	126 (163)
HA-FE33(B)	143 (181)

- HA-FE43(B), HA-FE63(B)



Unit: mm

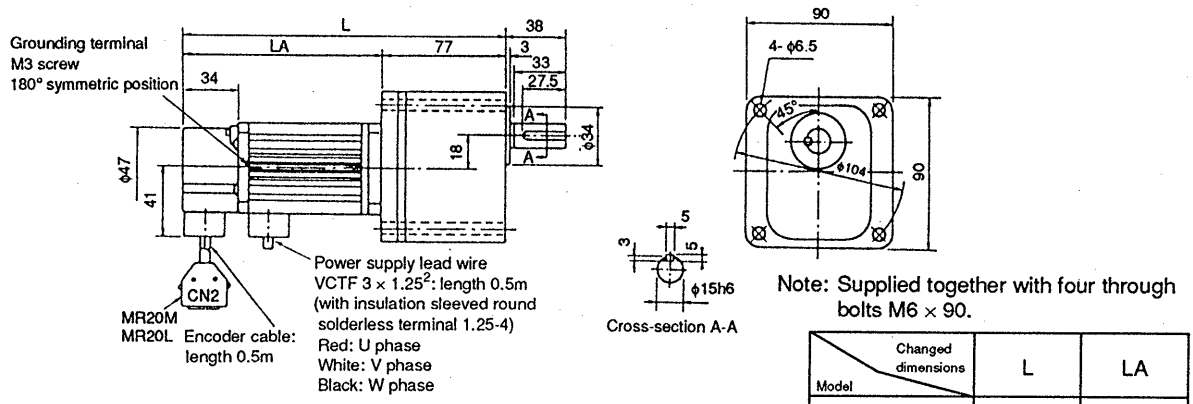
Model \ Changed dimensions	L
HA-FE43(B)	150 (182)
HA-FE63(B)	165 (202)

Note: 1. The dimensions in parentheses apply when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

HA-FE servo motor series with reduction gear

• HA-FE053(B)G (1/5, 1/10, 1/30), HA-FE13(B)G (1/5, 1/10, 1/30)

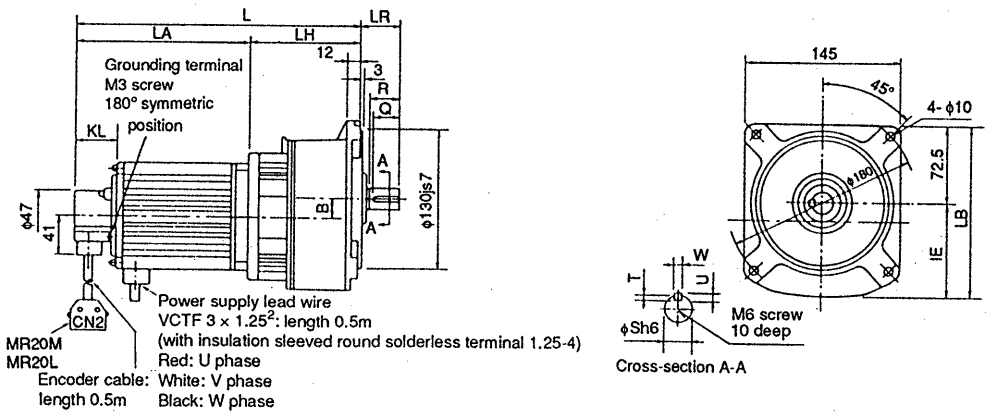
Unit: mm



Model \ Changed dimensions	L	LA
HA-FE053(B)G	178 (213)	101 (136)
HA-FE13(B)G	195 (230)	118 (153)

• HA-FE23(B)G (1/5, 1/10, 1/30), HA-FE33(B)G (1/5, 1/10, 1/30), HA- FE43(B)G (1/5, 1/10, 1/30)

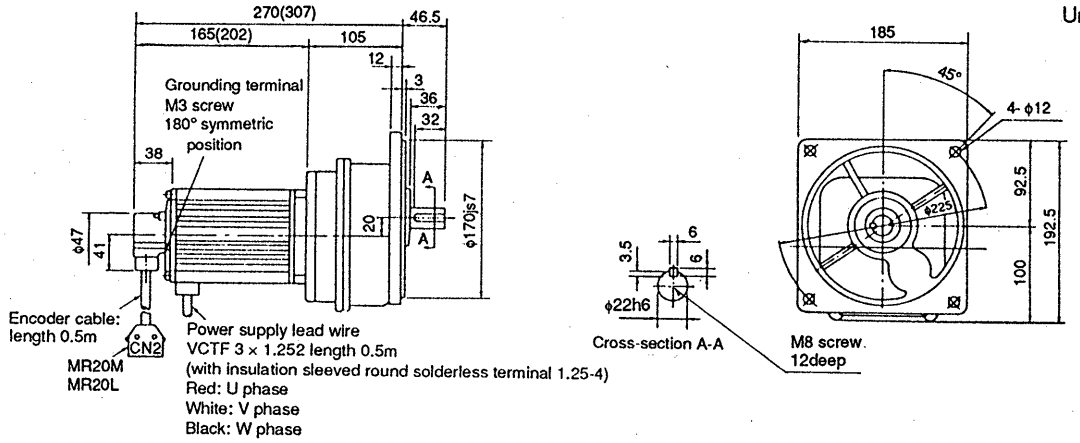
Unit: mm



Model \ Changed dimensions	L	LA	LH	LR	IE	LB	B	KL	R	Q	S	T	U	W
HA-FE23(B)G	210 (247)	126 (163)	84	32.5	77.5	150	15	34	25	24	16	3	5	5
HA-FE33(B)G	245 (283)	143 (181)	102	37.5	87.5	160	18	34	28	25	19	3.5	6	6
HA-FE43(B)G	254 (291)	150 (187)	104	37.5	87.5	160	18	38	28	25	19	3.5	6	6

• HA-FE63(B)G (1/5, 1/10, 1/30)

Unit: mm

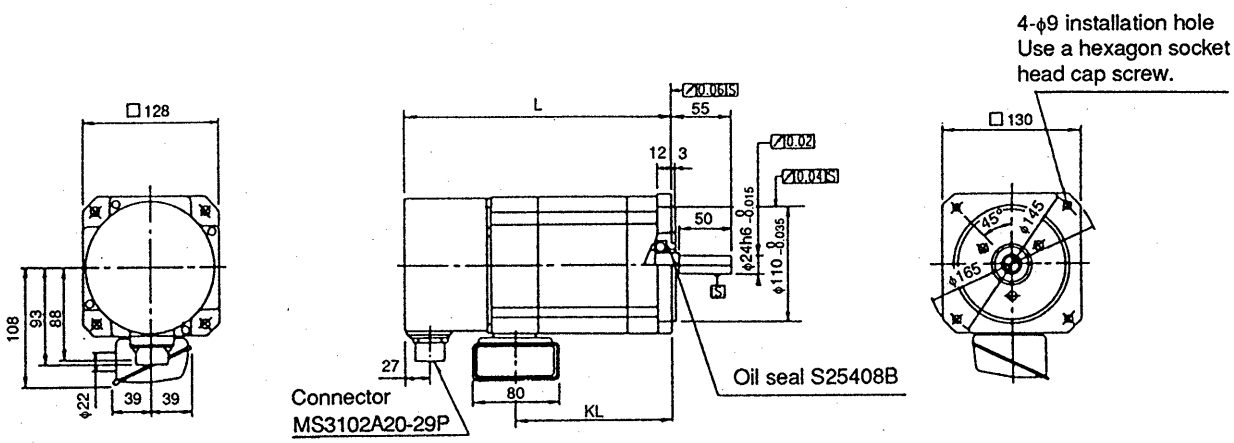


Note: 1. The reduction ratios in the charts are nominal values and are slightly different from actual values.
2. The reduction gear shaft rotation direction is the same as the servo motor rotation direction. However, HA-FE053(B)G 1/30 and HA-FE13(B)G 1/30 rotate in the direction opposite to the servo motor rotation direction.
3. Backlash is 40 minutes to 1.5.
4. The dimensions in parentheses apply when the electromagnetic brake is provided.
5. Use a compression coupling for connection with the load.

Standard HA-SE servo motor series

- HA-SE81(B), HA-SE52(B) to HA-SE152(B), HA-SE53(B) to HA-SE153(B)

Unit: mm



With electromagnetic brake
(Non-excitation operation safety brake, 24VDC, 7.8N·m)

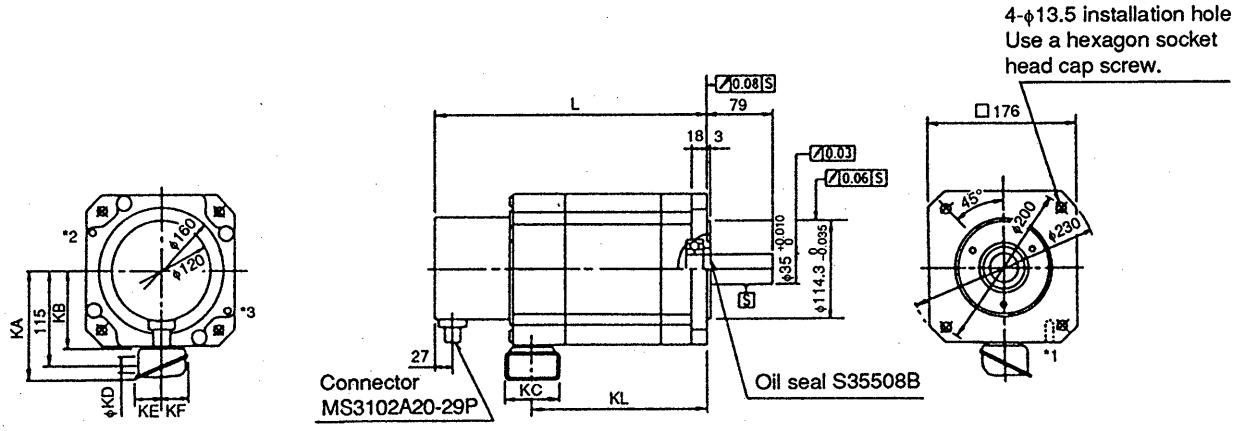
Note:
Use a compression coupling for connection with the load.

Model: Changed dimensions			L	KL
1000 r/min series	2000 r/min series	3000 r/min series		
—	HA-SE52(B)	HA-SE53(B)	223 (273)	124
—	HA-SE102(B)	HA-SE103(B)	263 (313)	164
HA-SE81(B)	HA-SE152(B)	HA-SE153(B)	303 (353)	204

Note: The L dimension in () parentheses applies when the electromagnetic brake is provided.

- HA-SE121(B) to HA-SE301(B), HA-SE202(B), HA-SE352(B), HA-SE203(B), HA-SE353(B)

Unit: mm



With electromagnetic brake
(Non-excitation operation safety brake, 24VDC, 29.4N·m)

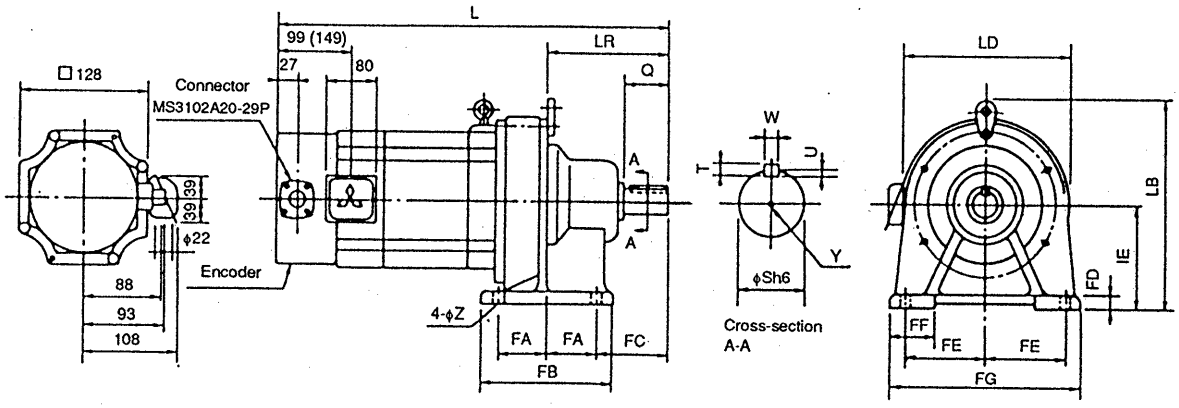
Model: Changed dimensions			L	KA	KB	KC	KD	KE	KF	KL
1000 r/min series	2000 r/min series	3000 r/min series								
HA-SE121(B)	HA-SE202(B)	HA-SE203(B)	271 (338)	135	115	80	22	39	39	168
HA-SE201(B)	HA-SE352(B)	HA-SE353(B)	339 (406)							236
HA-SE301(B)	—	—	407 (474)	144	119	93	27	61	43	301

Note: The L dimension in () parentheses applies when the electromagnetic brake is provided.

Note:
1. Use a compression coupling for connection with the load.
2. *1 to *3 are screw holes (M8) for the hangers. Use *1 and *3 for horizontal suspension.

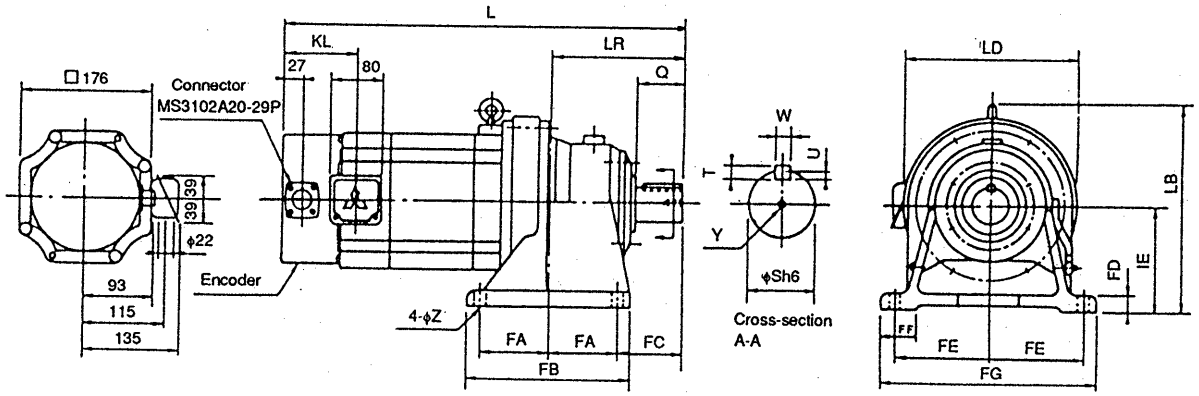
HA-SE servo motor series with reduction gear (for general industrial machines, foot mounting type)

- HA-SE52(B)G to HA-SE152(B)G



Model	Changed dimensions / Gear ratio	Motor L	LB	LD	LR	IE	Z	FA	FB	FC	FD	FE	FF	FG	Shaft End Q	S	T	U	W	Y
HA-SE 52(B)G	1/6 to 1/17	404 (454)	215	150	105	100	11	45	135	60	12	75	40	180	35	28	7	4	8	—
	1/29 to 1/43	429 (479)	257	204	139.5	120	14	57.5	155	82	15	95	55	230	55	38	8	5	10	
	1/59	480 (530)	300	230	172.5	150	18	72.5	195	100	22	145	65	330	70	50	9	5.5	14	M10 screw 18 deep
HA-SE 102(B)G	1/6 to 1/29	469 (519)	257	204	139.5	120	14	57.5	155	82	15	95	55	230	55	38	8	5	10	—
	1/35	520 (570)	300	230	172.5	150	18	72.5	195	100	22	145	65	330	70	50	9	5.5	14	M10 screw 18 deep
	1/43 to 1/59	598 (648)	310	300	214	160		75	238	139	25	185	75	410	90	60	11	7	18	
HA-SE 152(B)G	1/6 to 1/17	509 (559)	257	204	139.5	120	14	57.5	155	82	15	95	55	230	55	38	8	5	10	—
	1/29	560 (610)	300	230	172.5	150	18	72.5	195	100	22	145	65	330	70	50	9	5.5	14	M10 screw 18 deep
	1/35 to 1/59	638 (688)	310	300	214	160		75	238	139	25	185	75	410	90	60	11	7	18	

- HA-SE202(B)G to HA-SE352(B)G

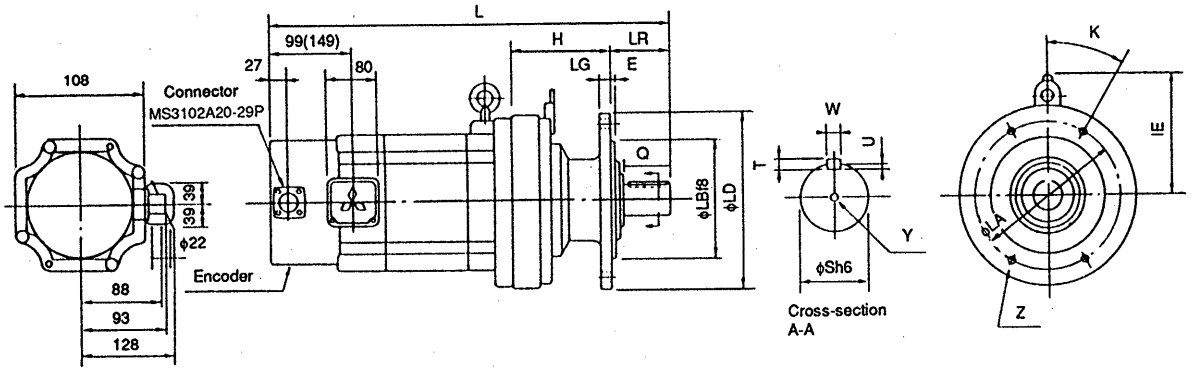


Model	Changed dimensions / Gear ratio	Motor L	LB	LD	LR	IE	Z	FA	FB	FC	FD	FE	FF	FG	Shaft End Q	S	T	U	W	Y
HA-SE 202(B)G	1/6 to 1/17	471 (538)	261.5	204	139.5	120	14	57.5	155	82	15	95	55	230	55	38	8	5	10	—
	1/29 to 1/59	588 (655)	341	300	214	160	18	75	238	139	25	185	75	410	90	60	11	7	18	M10 screw 18 deep
HA-SE 352(B)G	1/6 to 1/17	592 (659)	300	230	172.5	150		72.5	195	100	22	145	65	330	70	50	9	5.5	14	
	1/29 to 1/59	707 (774)	380	340	262.5	200	22	137.5	335	125	30	190	64	430	90	70	12	7.5	20	M10 screw 4 deep

Note: 1. The dimension in () parentheses applies when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

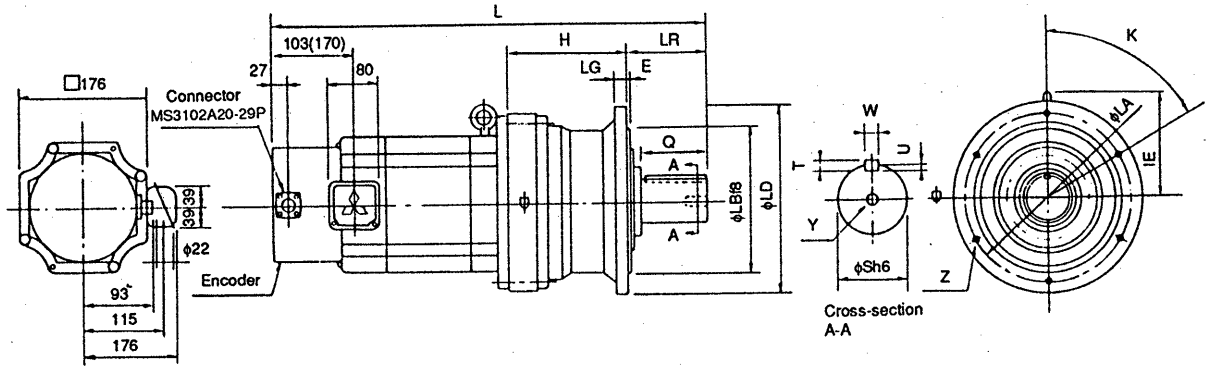
HA-SE servo motor series with reduction gear (for general industrial machines, flange mounting type)

- HA-SE52(B)G to HA-SE152(B)G



Model	Changed dimensions: Gear ratio	Motor: L	LA	LB	LD	LG	LR	IE	Z	K	E	H	Shaft End: Q	S	T	U	W	Y
HA-SE 52(B)G	1/6 to 1/17	404 (454)	134	110	160	9	48	115	4-φ11	45	3	108	35	28	7	4	8	—
	1/29 to 1/43	429 (479)	180	140	210	13	69	137	6-φ11	30	4	117	55	38	8	5	10	
	1/59	480 (530)	230	200	260	15	76	150		60		164	70	50	9	5.5	14	M10 screw 18 deep
HA-SE 102(B)G	1/6 to 1/29	469 (519)	180	140	210	13	69	137		30		117	55	38	8	5	10	—
	1/35	520 (570)	230	200	260	15	76	150		60		164	70	50	9	5.5	14	M8 screw 18 deep
	1/43 to 1/59	598 (648)	310	270	340	20	89	224				219	80	60	11	7	18	
HA-SE 152(B)G	1/6 to 1/17	509 (559)	180	140	210	13	69	137		30		117	55	38	8	5	10	—
	1/29	560 (610)	230	200	260	15	76	150		60		164	70	50	9	5.5	14	M8 screw 18 deep
	1/35 to 1/59	638 (688)	310	270	340	20	89	224				219	80	60	11	7	18	

- HA-SE202(B)G to HA-SE352(B)G

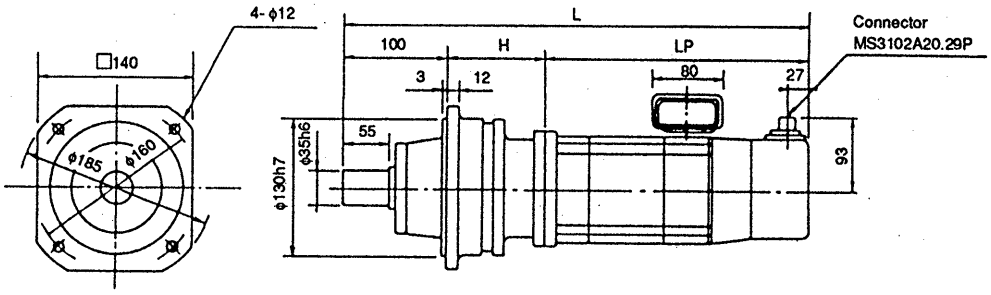


Model	Changed dimensions: Gear ratio	Motor: L	LA	LB	LD	LG	LR	IE	Z	K	E	Shaft End: Q	S	T	U	W	Y
HA-SE 202(B)G	1/6 to 1/17	471 (538)	180	140	210	13	69	141.5	6-φ11	30	4	55	38	8	5	10	—
	1/29 to 1/59	588 (655)	310	270	340	20	89	181		60		80	60	11	7	18	M8 screw 18 deep
HA-SE 352(B)G	1/6 to 1/17	592 (659)	230	200	260	15	76	150				70	50	9	5.5	14	
	1/29 to 1/59	707 (774)	360	316	400	22	94	239	68-φ14	22.5	5	84	70	12	7.5	20	M12 screw 24 deep

Note: 1. The dimension in () parentheses applies when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

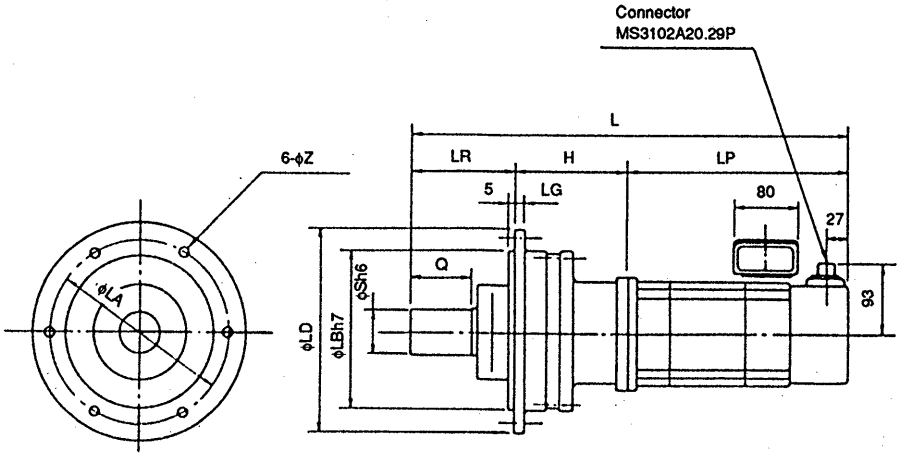
HA-SE servo motor series with reduction gear (for high precision operation)

- HA-SE52(B)G 1/5 to 1/20, HA-SE102(B)G 1/5, 1/9, HA-SE152(B)G 1/5



Model	Changed dimensions / Gear ratio	Motor L	Motor H	Motor LP
HA-SE52(B)G	1/5	479 (529)	156	223 (273)
	1/9	491 (541)	168	
	1/20	512 (562)	189	
HA-SE102(B)G	1/5	519 (569)	156	263 (313)
	1/9	531 (581)	168	
HA-SE152(B)G	1/5	559 (609)	156	303 (353)

- HA-SE52(B)G 1/29, 1/45, HA-SE102(B)G 1/20 to 1/45, HA-SE152(B)G 1/9 to 1/45, HA-SE202(B)G 1/5 to 1/45, HA-SE352(B)G 1/5 to 1/20



Model	Changed dimensions / Gear ratio	Motor L	LA	LB	LD	LG	H	Z	LP	Shaft End LR	Q	S
HA-SE52(B)G	1/29	580 (630)	220	190	245	15	217	12	223 (273)	140	75	50
	1/45	586 (636)					223					
HA-SE102(B)G	1/20, 1/29	620 (670)	220	190	245	15	217	12	263 (313)	140	75	50
	1/45	667 (717)	280	240	310	18	244	14		160	90	60
HA-SE152(B)G	1/9	652 (702)	220	190	245	15	209	12	303 (353)	140	75	50
	1/20	660 (710)					217					
	1/29	704 (754)	280	240	310	18	241	14		160	90	60
	1/45	707 (757)					244					
HA-SE202(B)G	1/5	614 (681)	220	190	245	15	203	12	271 (338)	140	75	50
	1/9	641 (708)					230					
	1/20 to 1/29	693 (760)	280	240	310	18	262	14		160	90	60
	1/45	696 (763)					265					
HA-SE352(B)G	1/5	722 (789)					223		339 (406)			
	1/9	754 (821)					255					
	1/20	761 (828)					262					

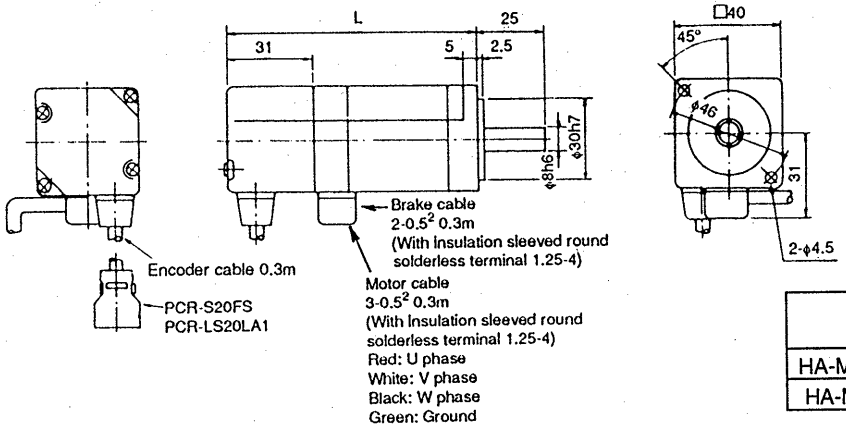
Note: 1. The dimension in ( ) parentheses applies when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

10-5 Outer dimensions of UL listed and CSA certified servo motor

Standard HA-ME servo motor series

• HA-ME053(B)-UL, HA-ME13(B)-UL

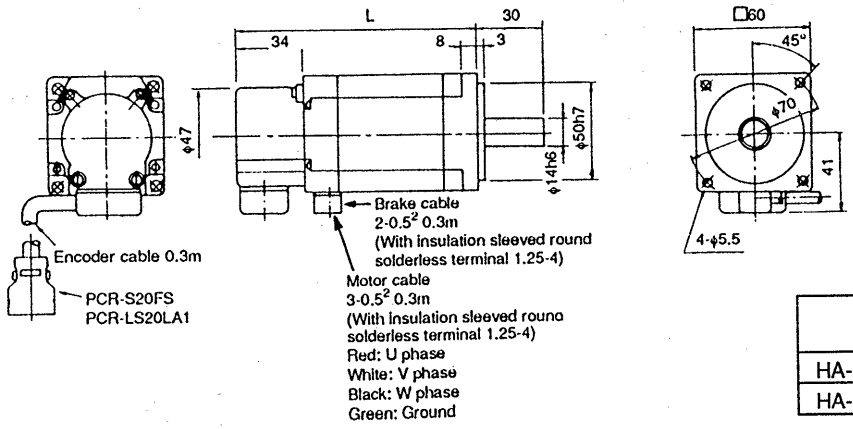
(Unit: mm)



Model	Variable dimension L
HA-ME053(B)-UL	76.5 (105.5)
HA-ME13(B)-UL	94.5 (123.5)

• HA-ME23(B)-UL, HA-ME43(B)-UL

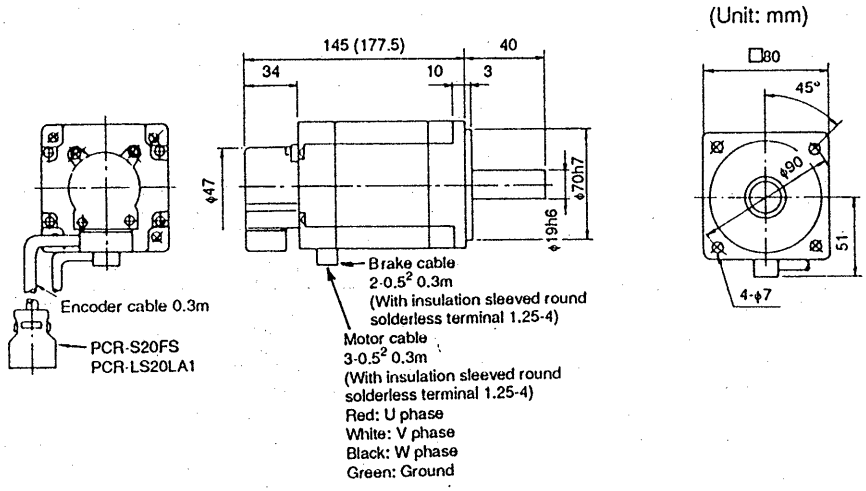
(Unit: mm)



Model	Variable dimension L
HA-ME23(B)-UL	96.5 (129)
HA-ME43(B)-UL	124.5 (157)

• HA-ME73(B)-UL

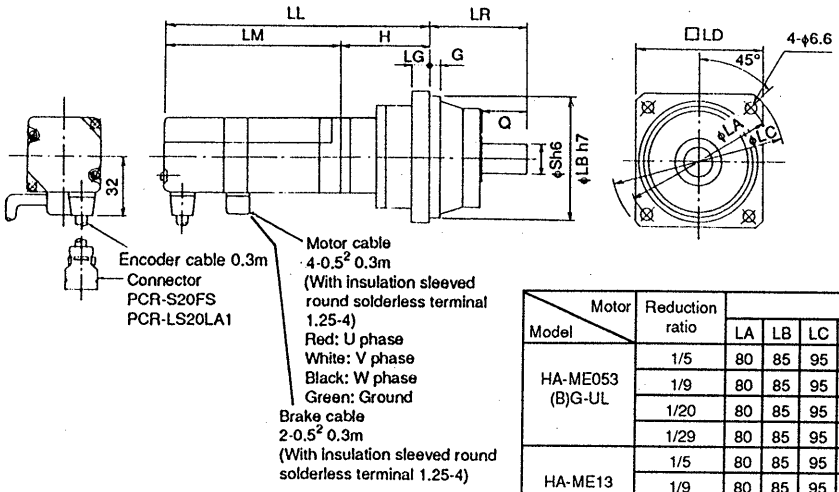
(Unit: mm)



Note: 1. The dimensions in parentheses apply when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

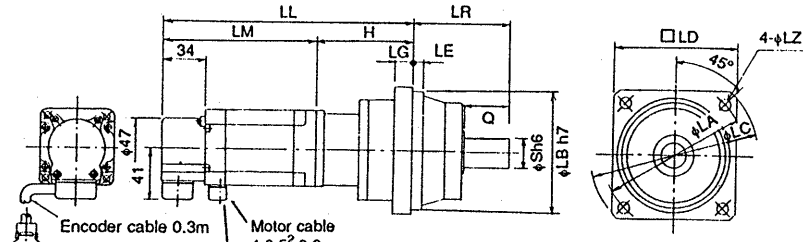
HA-ME servo motor series with reduction gear

- HA-ME053(B)G-UL, HA-ME13(B)G-UL



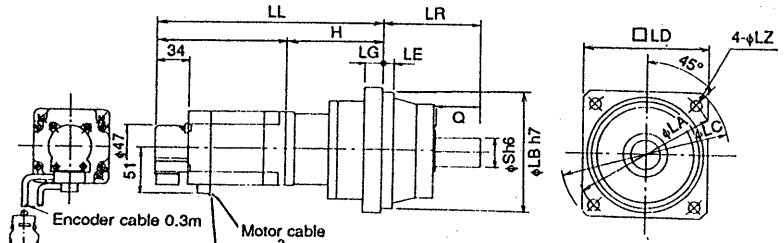
Model \ Motor	Reduction ratio	Variable dimension L											
		LA	LB	LC	LD	LG	LL	LR	LM	H	Q	S
HA-ME053 (B)G-UL	1/5	80	85	95	70	8	124.5 (153.5)	55	76.5 (105.5)	48	25	18
	1/9	80	85	95	70	8	140.5 (168.5)	55		64	25	18
	1/20	80	85	95	70	8	140.5 (169.5)	55		64	25	18
	1/29	80	85	95	70	8	140.5 (169.5)	55		64	25	18
HA-ME13 (B)G-UL	1/5	80	85	95	70	8	142.5 (171.5)	55	94.5 (123.5)	48	25	18
	1/9	80	85	95	70	8	158.5 (187.5)	55		64	25	18
	1/20	100	80	115	85	10	164.5 (193.5)	75		70	25	20
	1/29	100	80	115	85	10	164.5 (193.5)	75		70	25	20

- HA-ME23(B)G-UL, HA-ME43(B)G-UL



Model \ Motor	Reduction ratio	Variable dimension L												
		LA	LB	LC	LD	LE	LG	LL	LR	LM	LZ	H	Q	S
HA-ME23 (B)G-UL	1/5	80	65	95	70	8	8	153.5 (186)	55	98.5 (129)	8.8	57	25	18
	1/9	100	80	115	85	8	10	171.5 (204)	75		8.8	75	35	20
	1/20	115	95	135	100	8	10	175.5 (209)	85		9	80	40	25
	1/29	115	95	135	100	8	10	175.5 (209)	85		9	80	40	25
HA-ME43 (B)G-UL	1/5	100	80	115	85	8	10	183.5 (218)	75	124.5 (157)	8.8	59	35	20
	1/9	115	95	135	100	8	10	204.5 (237)	85		9	80	40	25
	1/20	135	110	155	115	8	12	210.5 (243)	100		11	88	50	32
	1/29	135	110	155	115	8	12	210.5 (243)	100		11	88	50	32

- HA-ME73(B)G-UL

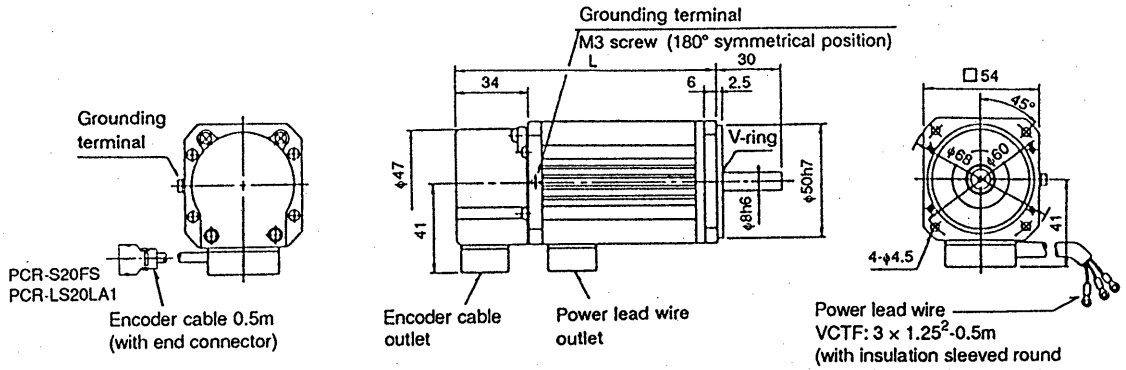


Model \ Motor	Reduction ratio	Variable dimension L												
		LA	LB	LC	LD	LE	LG	LL	LR	LM	LZ	H	Q	S
HA-ME73 (B)G-UL	1/5	115	95	135	100	8	10	215 (247.5)	85	145 (177.5)	9	70	40	25
	1/9	135	110	155	115	8	12	251 (283.5)	100		11	106	50	32
	1/20	150	125	175	130	10	15	251 (283.5)	115		14	106	60	40
	1/29	150	125	175	130	10	15	251 (283.5)	115		14	106	60	40

Note: 1. The reduction gear shaft rotation direction is the same as the servo motor rotation direction.
2. Backlash is 3 minutes.
3. The dimensions in parentheses apply when the electromagnetic brake is provided.
4. Use a compression coupling for connection with the load.

Standard HA-FE servo motor series

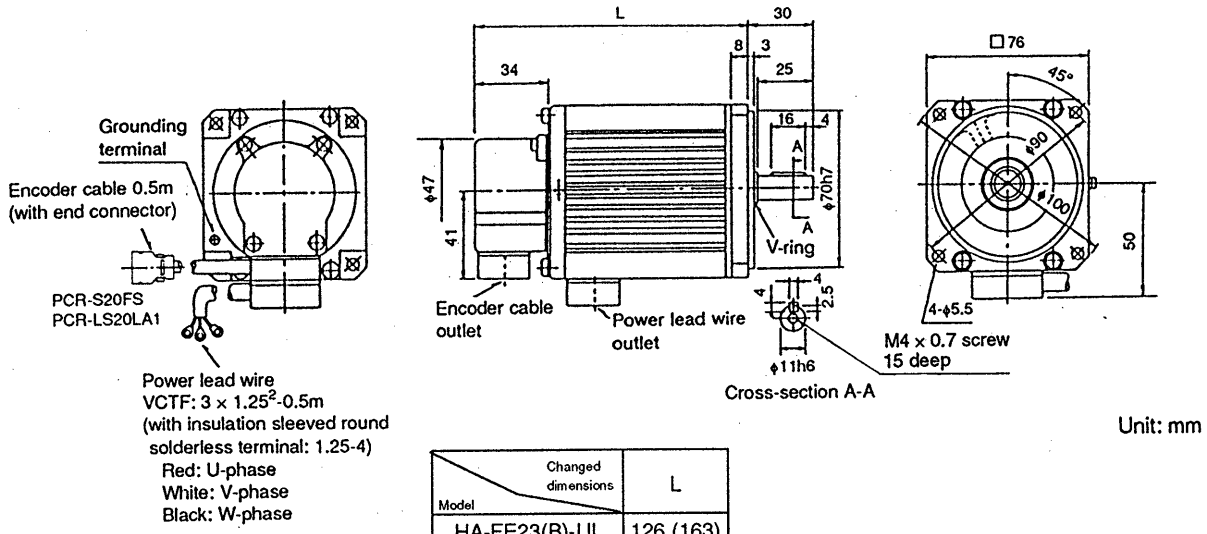
- HA-FE053(B)-UL, HA-FE13(B)-UL



Model \ Changed dimensions	L
HA-FE053(B)-UL	101 (136)
HA-FE13(B)-UL	118 (153)

Unit: mm

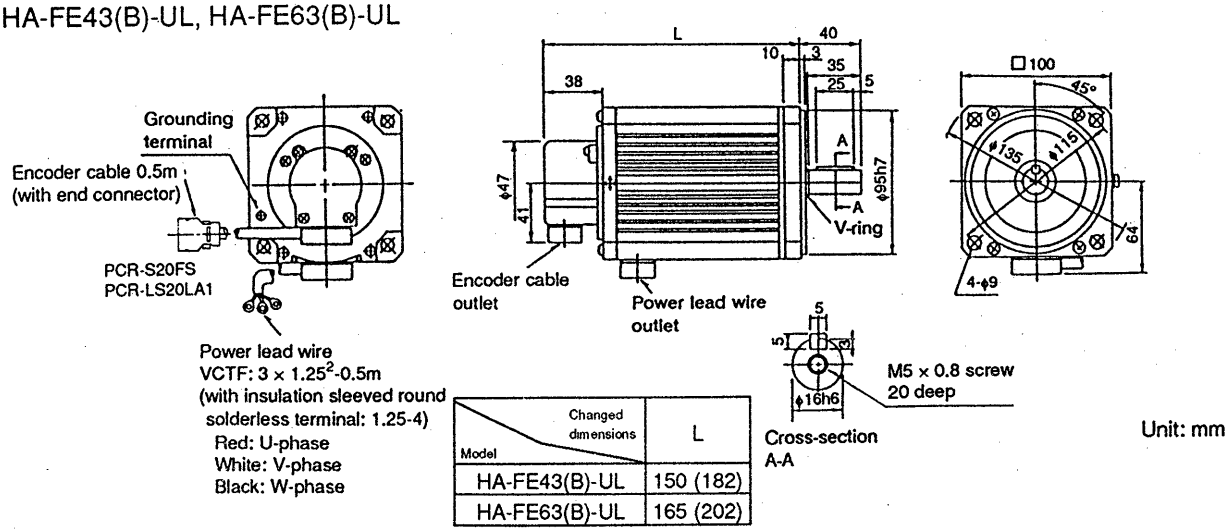
- HA-FE23(B)-UL, HA-FE33(B)-UL



Unit: mm

Model \ Changed dimensions	L
HA-FE23(B)-UL	126 (163)
HA-FE33(B)-UL	143 (181)

- HA-FE43(B)-UL, HA-FE63(B)-UL



Unit: mm

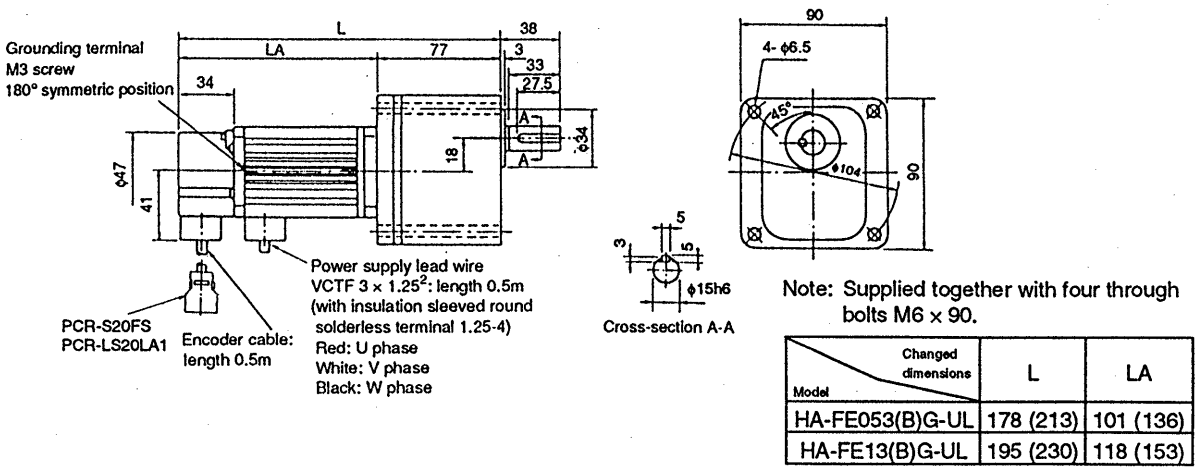
Model \ Changed dimensions	L
HA-FE43(B)-UL	150 (182)
HA-FE63(B)-UL	165 (202)

Note: 1. The dimensions in parentheses apply when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

HA-FE servo motor series with reduction gear

• HA-FE053(B)G-UL (1/5, 1/10, 1/30), HA-FE13(B)G-UL (1/5, 1/10, 1/30)

Unit: mm

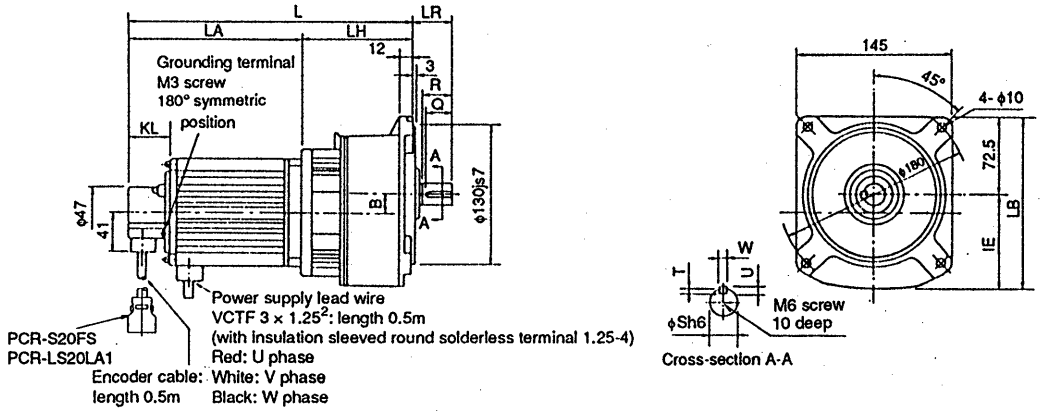


Note: Supplied together with four through bolts M6 x 90.

Model \ Changed dimensions	L	LA
HA-FE053(B)G-UL	178 (213)	101 (136)
HA-FE13(B)G-UL	195 (230)	118 (153)

• HA-FE23(B)G-UL (1/5, 1/10, 1/30), HA-FE33(B)G-UL (1/5, 1/10, 1/30), HA- FE43(B)G-UL (1/5, 1/10, 1/30)

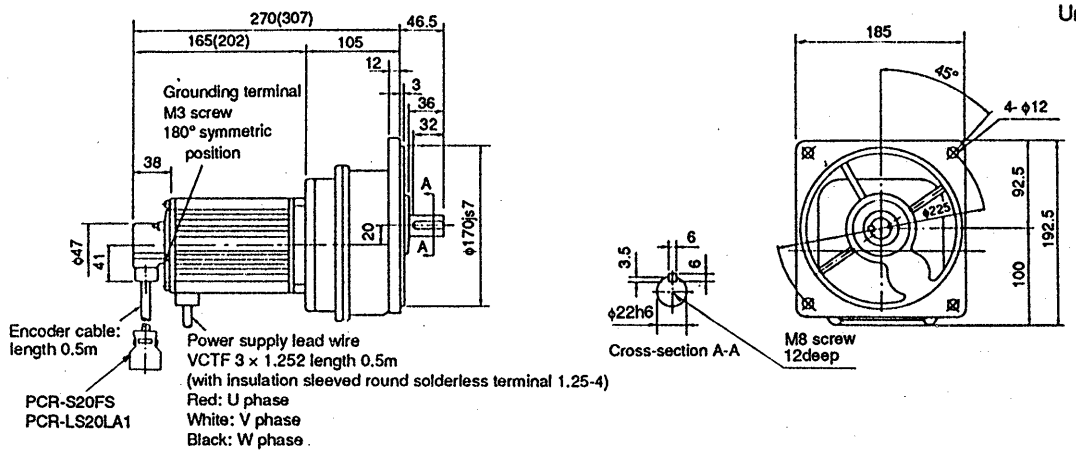
Unit: mm



Model \ Changed dimensions	L	LA	LH	LR	IE	LB	B	KL	R	Q	S	T	U	W
HA-FE23(B)G-UL	210 (247)	126 (163)	84	32.5	77.5	150	15	34	25	24	16	3	5	5
HA-FE33(B)G-UL	245 (283)	143 (181)	102	37.5	87.5	160	18	34	28	25	19	3.5	6	6
HA-FE43(B)G-UL	254 (291)	150 (187)	104	37.5	87.5	160	18	38	28	25	19	3.5	6	6

• HA-FE63(B)G-UL (1/5, 1/10, 1/30)

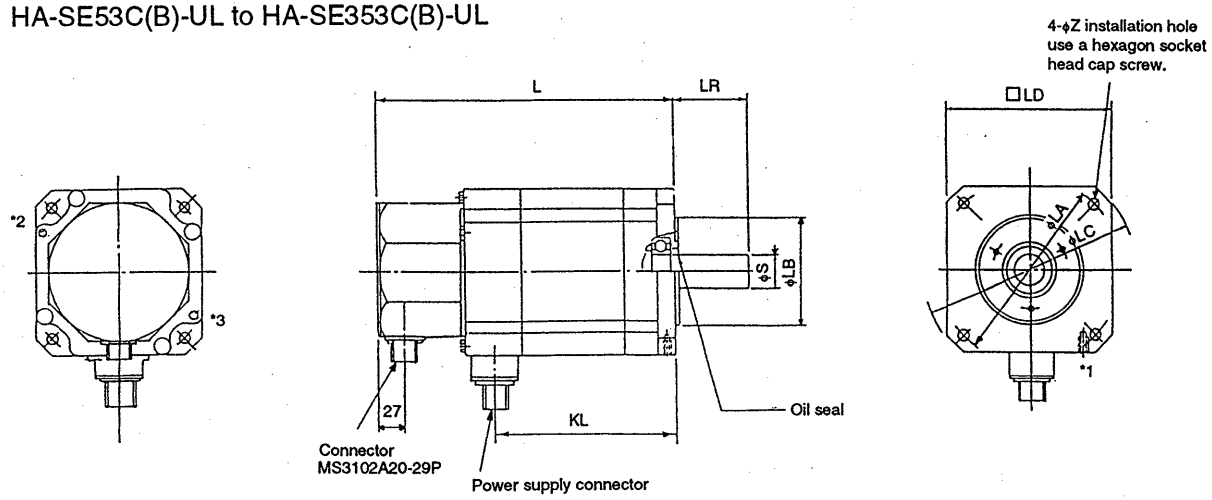
Unit: mm



Note: 1. The reduction ratios in the charts are nominal values and are slightly different from actual values.
2. The reduction gear shaft rotation direction is the same as the servo motor rotation direction. However, HA-FE053(B)G 1/30 and HA-FE13(B)G 1/30 rotate in the direction opposite to the servo motor rotation direction.
3. Backlash is 40 minutes to 1.5.
4. The dimensions in parentheses apply when the electromagnetic brake is provided.
5. Use a compression coupling for connection with the load.

Standard HA-SE servo motor series

- HA-SE81C(B)-UL to HA-SE301C(B)-UL
  HA-SE52C(B)-UL to HA-SE352C(B)-UL
  HA-SE53C(B)-UL to HA-SE353C(B)-UL

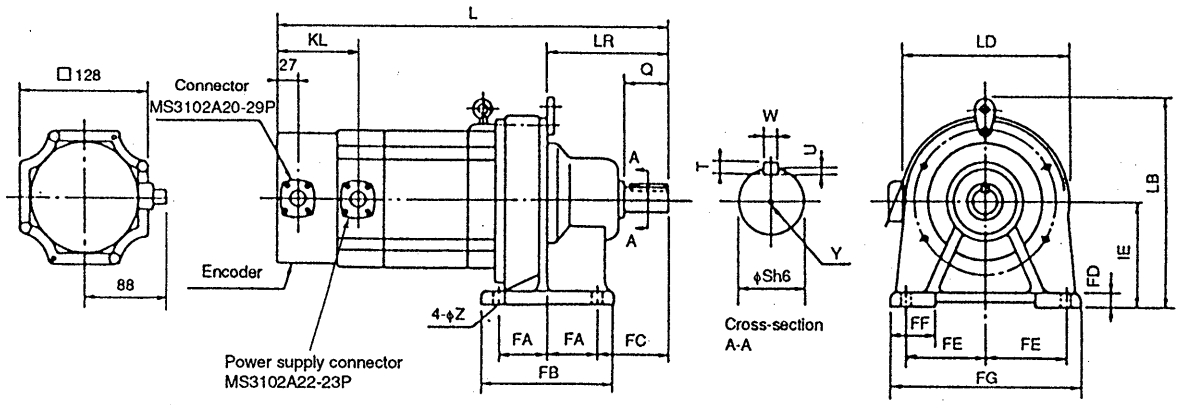


1000 r/min series	2000 r/min series	3000 r/min series	L	LA	LB	LC	LD	KL	Z	LR	S	Oil seal	Power supply connector
———	HA-SE52C(B)-UL	HA-SE53C(B)-UL	223 (273)	145	110	165	130	124	9	55	24h6	S25408B	MS3102A22-23P
———	HA-SE102C(B)-UL	HA-SE103C(B)-UL	263 (313)					164					
HA-SE81C(B)-UL	HA-SE152C(B)-UL	HA-SE153C(B)-UL	303 (353)					204					
HA-SE121C(B)-UL	HA-SE202C(B)-UL	HA-SE203C(B)-UL	271 (338)	200	114.3	230	176	168	13.5	79	$35^{+0.010}_{0}$	S35508B	MS3102A24-10P
HA-SE201C(B)-UL	HA-SE352C(B)-UL	HA-SE353C(B)-UL	339(406)					236					
HA-SE301C(B)-UL	———	———	407(474)					301					

Note: 1. The L dimension in ( ) parentheses applies when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.
3. For HA-SE121C(B)-UL to HA-SE301C(B)-UL, HA-SE202C(B)-UL or more and HA-SE203C(B)-UL or more, *1 to *3 are screw holes (M8) for the hangers. Use *1 and for horizontal suspension.

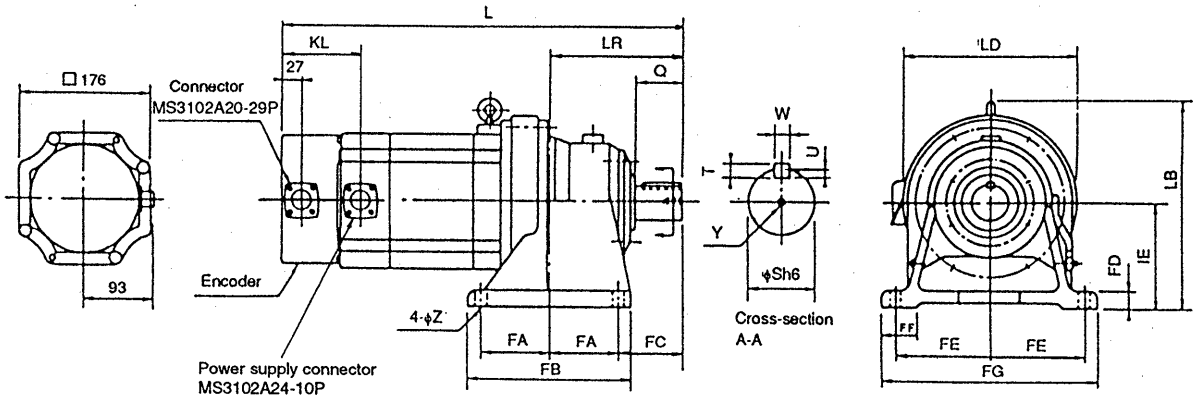
HA-SE servo motor series with reduction gear (for general industrial machines, foot mounting type)

- HA-SE52C(B)G-UL to HA-SE152C(B)G-UL



Model	Changed dimensions: Gear ratio	Motor: L	LB	LD	LR	IE	Z	FA	FB	FC	FD	FE	FF	FG	KL	Shaft End: Q	S	T	U	W	Y
HA-SE 52C(B)G -UL	1/6 to 1/17	404 (454)	215	150	105	100	11	45	135	60	12	75	40	180	99 (149)	35	28	7	4	8	—
	1/29 to 1/43	429 (479)	257	204	139.5	120	14	57.5	155	82	15	95	55	230		55	38	8	5	10	
	1/59	480 (530)	300	230	172.5	150	18	72.5	195	100	22	145	65	330		70	50	9	5.5	14	M10 screw 18 deep
HA-SE 102C(B)G -UL	1/6 to 1/29	469 (519)	257	204	139.5	120	14	57.5	155	82	15	95	55	230		55	38	8	5	10	—
	1/35	520 (570)	300	230	172.5	150	18	72.5	195	100	22	145	65	330		70	50	9	5.5	14	M10 screw 18 deep
	1/43 to 1/59	598 (648)	310	300	214	160		75	238	139	25	185	75	410		90	60	11	7	18	
HA-SE 152C(B)G -UL	1/6 to 1/17	509 (559)	257	204	139.5	120	14	57.5	155	82	15	95	55	230		55	38	8	5	10	—
	1/29	560 (610)	300	230	172.5	150	18	72.5	195	100	22	145	65	330		70	50	9	5.5	14	M10 screw 18 deep
	1/35 to 1/59	638 (688)	310	300	214	160		75	238	139	25	185	75	410		90	60	11	7	18	

- HA-SE202C(B)G-UL to HA-SE352C(B)G-UL

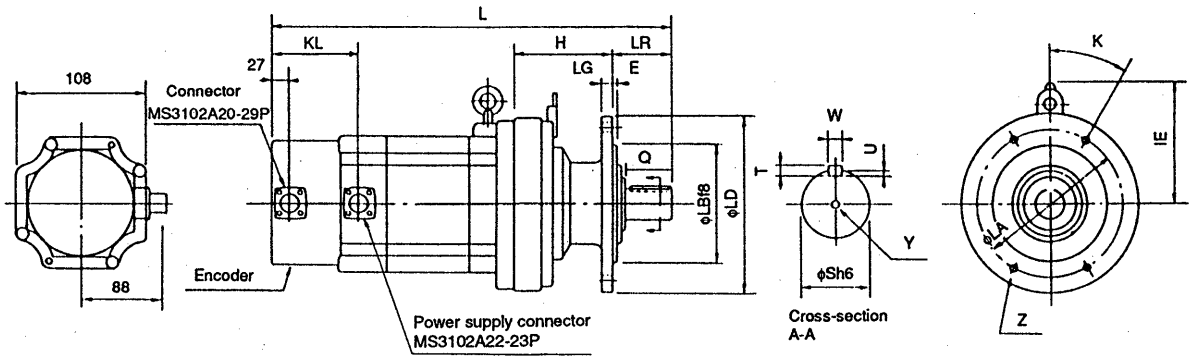


Model	Changed dimensions: Gear ratio	Motor: L	LB	LD	LR	IE	Z	FA	FB	FC	FD	FE	FF	FG	KL	Shaft End: Q	S	T	U	W	Y
HA-SE 202C(B)G -UL	1/6 to 1/17	471 (538)	261.5	204	139.5	120	14	57.5	155	82	15	95	55	230	103 (170)	55	38	8	5	10	—
	1/29 to 1/59	588 (655)	341	300	214	160	18	75	238	139	25	185	75	410		90	60	11	7	18	M10 screw 18 deep
HA-SE 352C(B)G -UL	1/6 to 1/17	592 (659)	300	230	172.5	150		72.5	195	100	22	145	65	330		70	50	9	5.5	14	
	1/29 to 1/59	707 (774)	380	340	262.5	200	22	137.5	335	125	30	190	64	430		90	70	12	7.5	20	M10 screw 4 deep

Note: 1. The dimension in () parentheses applies when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

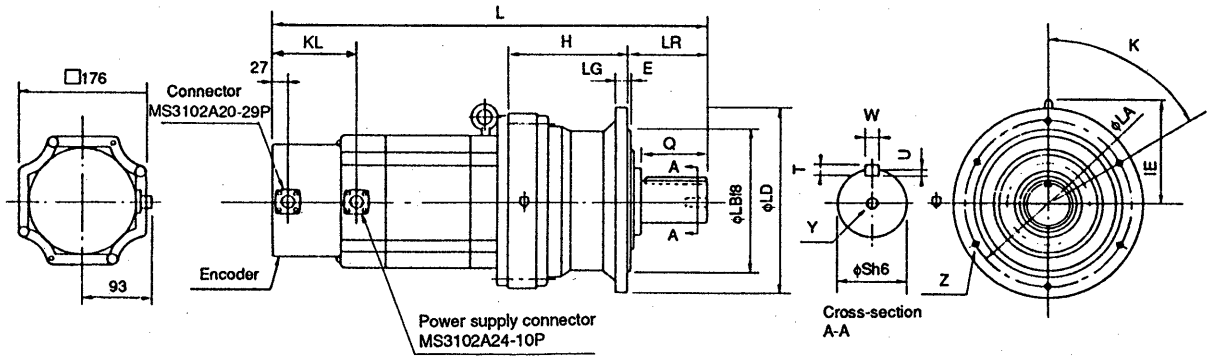
HA-SE servo motor series with reduction gear (for general industrial machines, flange mounting type)

- HA-SE52C(B)G-UL to HA-SE152C(B)G-UL



Model	Changed dimensions / Gear ratio	Motor L	LA	LB	LD	LG	LR	IE	Z	K	E	H	KL	Shaft End Q	S	T	U	W	Y
HA-SE 52C(B)G -UL	1/6 to 1/17	404 (454)	134	110	160	9	48	115	4-φ11	45	3	108	99 (149)	35	28	7	4	8	—
	1/29 to 1/43	429 (479)	180	140	210	13	69	137	6-φ11	30	4	117		55	38	8	5	10	
	1/59	480 (530)	230	200	260	15	76	150		60		164		70	50	9	5.5	14	M10 screw 18 deep
HA-SE 102C(B)G -UL	1/6 to 1/29	469 (519)	180	140	210	13	69	137		30		117		55	38	8	5	10	—
	1/35	520 (570)	230	200	260	15	76	150		60		164		70	50	9	5.5	14	M8 screw 18 deep
	1/43 to 1/59	598 (648)	310	270	340	20	89	224				219		80	60	11	7	18	
HA-SE 152C(B)G -UL	1/6 to 1/17	509 (559)	180	140	210	13	69	137		30		117		55	38	8	5	10	—
	1/29	560 (610)	230	200	260	15	76	150		60		164		70	50	9	5.5	14	M8 screw 18 deep
	1/35 to 1/59	638 (688)	310	270	340	20	89	224				219		80	60	11	7	18	

- HA-SE202C(B)G-UL to HA-SE352C(B)G-UL

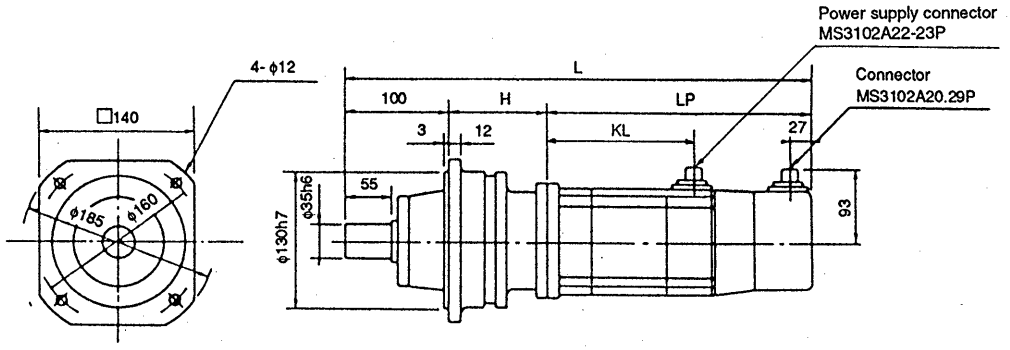


Model	Changed dimensions / Gear ratio	Motor L	LA	LB	LD	LG	LR	IE	Z	K	E	KL	Shaft End Q	S	T	U	W	Y
HA-SE 202C(B)G -UL	1/6 to 1/17	471 (538)	180	140	210	13	69	141.5	6-φ11	30	4	103 (170)	55	38	8	5	10	—
	1/29 to 1/59	588 (655)	310	270	340	20	89	181		60			80	60	11	7	18	M8 screw 18 deep
HA-SE 352C(B)G -UL	1/6 to 1/17	592 (659)	230	200	260	15	76	150					70	50	9	5.5	14	
	1/29 to 1/59	707 (774)	360	316	400	22	94	239	68-φ14	22.5	5		84	70	12	7.5	20	M12 screw 24 deep

Note: 1. The dimension in () parentheses applies when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

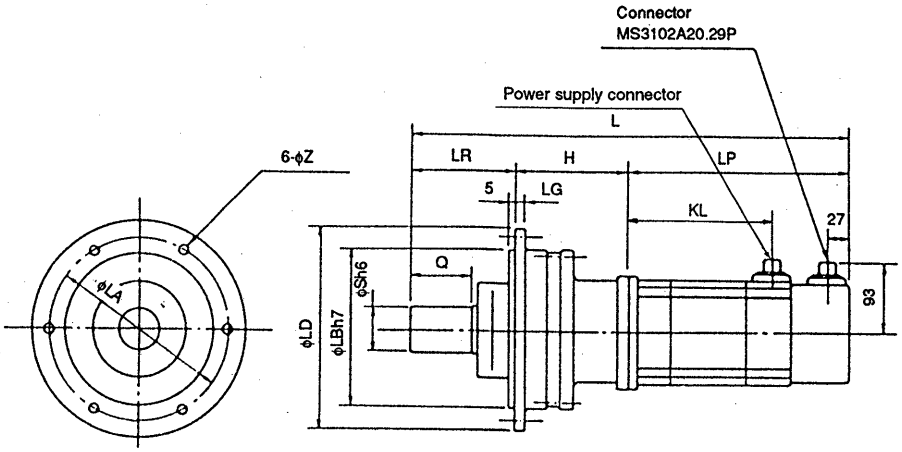
HA-SE servo motor series with reduction gear (for high precision operation)

- HA-SE52C(B)G-UL 1/5 to 1/20, HA-SE102C(B)G-UL 1/5, 1/9, HA-SE152C(B)G-UL 1/5



Model	Changed dimensions / Gear ratio	Motor L	H	LP	KL
HA-SE52C(B)G-UL	1/5	479 (529)	156	223 (273)	124
	1/9	491 (541)	168		
	1/20	512 (562)	189		
HA-SE102C(B)G-UL	1/5	519 (569)	156	263 (313)	164
	1/9	531 (581)	168		
HA-SE152C(B)G-UL	1/5	559 (609)	156	303 (353)	204

- HA-SE52C(B)G-UL 1/29, 1/45, HA-SE102C(B)G-UL 1/20 to 1/45, HA-SE152C(B)G-UL 1/9 to 1/45, HA-SE202C(B)G-UL 1/5 to 1/45, HA-SE352C(B)G-UL 1/5 to 1/20



Model	Changed dimensions / Gear ratio	Motor L	LA	LB	LD	LG	H	Z	LP	KL	Shaft End LR	Q	S	Power supply connector
HA-SE52C(B)G-UL	1/29	580 (630)	220	190	245	15	217	12	223 (273)	124	140	75	50	MS3102A22-23P
	1/45	586 (636)					223							
HA-SE102C(B)G-UL	1/20, 1/29	620 (670)	220	190	245	15	217	12	263 (313)	164	140	75	50	
	1/45	667 (717)	280	240	310	18	244	14			160	90	60	
HA-SE152C(B)G-UL	1/9	652 (702)	220	190	245	15	209	12	303 (353)	204	140	75	50	
	1/20	660 (710)					217							
	1/29	704 (754)	280	240	310	18	241	14			160	90	60	
	1/45	707 (757)					244							
HA-SE202C(B)G-UL	1/5	614 (681)	220	190	245	15	203	12	271 (338)	168	140	75	50	MS3102A24-10P
	1/9	641 (708)					230							
	1/20 to 1/29	693 (760)	280	240	310	18	262	14			160	90	60	
	1/45	696 (763)					265							
HA-SE352C(B)G-UL	1/5	722 (789)					223		339 (406)	236				
	1/9	754 (821)					255							
	1/20	761 (828)					262							

Note: 1. The dimension in ( ) parentheses applies when the electromagnetic brake is provided.
2. Use a compression coupling for connection with the load.

10-6 Protective functions

The following protective functions are built into the servo amplifier to protect the servo motor and servo amplifier. When a protective function is triggered, the transistor base current is switched of, and the drive coasts to a stop.
To reset the alarm, eliminate the cause, then either reset by closing the contact to terminals RES and SG, or switch off, then on the external contol power.

Alarm code	Potective function	Operation details
AL 10	Undervoltage	If the power voltage drops below a certain level or if an instantaneous power failure occurs, this function will operate. This will also operate if the power is switched OFF and then ON before the display goes out.
AL 12	Memory error 1	This operates if a memory error is detected when the power is switched ON.
AL 15	Memory error 2	This operates if a memory error is detected during operation.
AL 16	Polarity detection error	This operates if an error is found in the PLG servo motor polarity detection signal when the power is switched on.
AL 17	Card error 3	This operates if a card error is detected when the power is switched ON.
AL 30	Over-regeneration	This operates if overheating of the regenerative brake option is detected due to frequent regeneration.
AL 31	Overspeed	This operates if the servo motor speed exceeds allowable speed.
AL 32	Overcurrent	This operates if an overcurrent is detected due to grounding or short-circuit problems.
AL 33	Overvoltage	This operates if an excessive converter voltage is detected due to insufficient regeneration capacity.
AL 35	Command frequency error	This operates if the command pulse frequency is too high.
AL 37	Parameter setting error	This operates if a setting error is detected during parameter setting.
AL 45	Fin overheating	This operates when the servo amplifier's cooling fin overheats.
AL 50	Overload	This operates if an overload is detected in the servo motor or servo amplifier.
AL 52	Excessive difference	This operates if the difference between the input pulse and feedback pulse is 65K pulses or more during position control mode operation.
AL 90	Screen changed during servo ON	This displays if the diagnosis screen has been selected when the servo is ON, and erroneous operation is anticipated. This will appear when the SET key is pressed in the TEST 1, H3 screen with the servo ON.
AL CPU	CPU error	This operates if an error in the servo amplifier CPU is detected.
AL Co	Communication error	This operates when a communication error occurs between the cards in the servo amplifier. (Note) An alarm is not output, and the servo motor will operate correctly .

REVISIONS

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

Print Date	*Manual Number	Revision
Jun., 1992	IB (NA) 67138-A	First edition Translated from IB67105-D
Jan., 1994	IB (NA) 67138-B	Partial Correction Section 1-4: Explanation of air purging added. Section 3-7 and 4-24: Detailed explanation of phase relationships of the pulse train output interface added. Section 4-5.2: Effective load ratio and relationship diagram in the table added. Section 4-5.5: Explanation of presence/absence of servo lock added for Pr. 7. Chapter 5: Expressions used for operating methods corrected. Section 6-9: Correction: data line filter changed from a model made by Mitsubishi Electric to one made by TDK. Section 7-1: Specification symbols added. Section 8-3: Tables for daily and periodic inspections added. Section 9-1: Figure for point of inflection added to torque characteristic graph. Section 9-8: Allowable speed and allowable moment of load inertia added to the specifications for the motor with reduction gear. Section 10-4: Incorrect servo motor external dimensions corrected. Section 10-6: List of makers from which peripheral devices were purchased added. Section 10-6.1: List of List of makers from which peripheral devices were purchased added. Revised to conform to IB-67105-D
Dec., 1994	IB (NA) 67138-C	● CAUTION added. Servo amplifiers for HA-ME servo motors added. MR-J10MA, 20MA, 40MA, 100MA, 10MA1, 20MA1, 40MA1 HA-ME servo motors added HA-ME053, 13, 23, 43, 73 UL listed and CSA certified servo amplifiers added MR-J□-UL UL listed and CSA certified servo motors added HA-ME□-UL, HA-FE□-UL, HA-SE□-UL Section 1-3: UL listed and CSA certified models added. Section 2-1.4: Wiring the servo amplifier terminal block added. Chapter 5: Adjustments and Application Operations; chapter name and make-up changed. Section 5-1.1: Start-up adjustment sequence added. Section 5-1.4: Clever usage of the ultracompact HA-ME servo motor added. Section 6-1: Regenerative option models and definition added.

Print Date	*Manual Number	Revision
		Section 6-4.2: Connectors, cases and power supply connector made by Honda added. Section 6-4.5: MR-JMCBL□M option cables added Section 6-10: TNR-12G221K (Marcon Electronics) added as a surge absorber. Section 8-5: Checking the cause of a position offset added. Section 10-5: Outer demensions of UL listed and CSA certified servo motor added. In addition, corrections have been made to errors in writing. Revised to conform to IB-67105-E