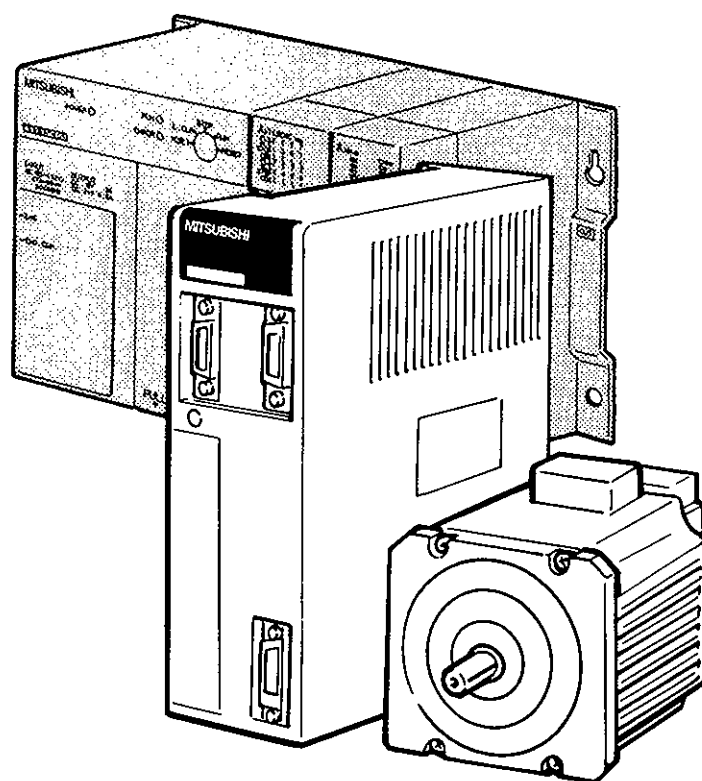


MITSUBISHI

Motion Controller AC Servo

MELSERVO-J-B

Specifications and Instruction Manual



 **MITSUBISHI
ELECTRIC**



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.

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Introduction

Thank you for choosing the Mitsubishi MELSERVO-J-B AC servo. When used with the Mitsubishi motion controller, the MR-J-B servo provides high performance and high functions. Though the MR-J-B has been designed for ease of use, incorrect use or operation will cause an unexpected fault. Before use, please read this manual carefully to use the equipment to its optimum.

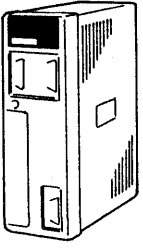
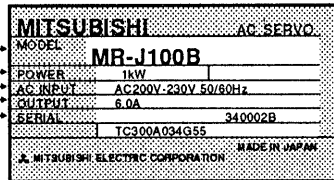
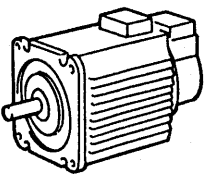
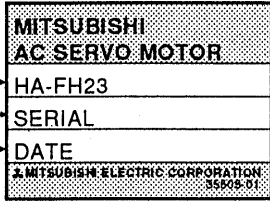
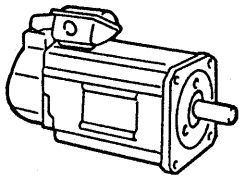
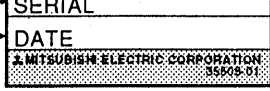
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1. HANDLING

1-1 Inspection at Delivery

Confirm the following items after unpacking.

Inspect the nameplate and confirm that the specifications are as ordered.

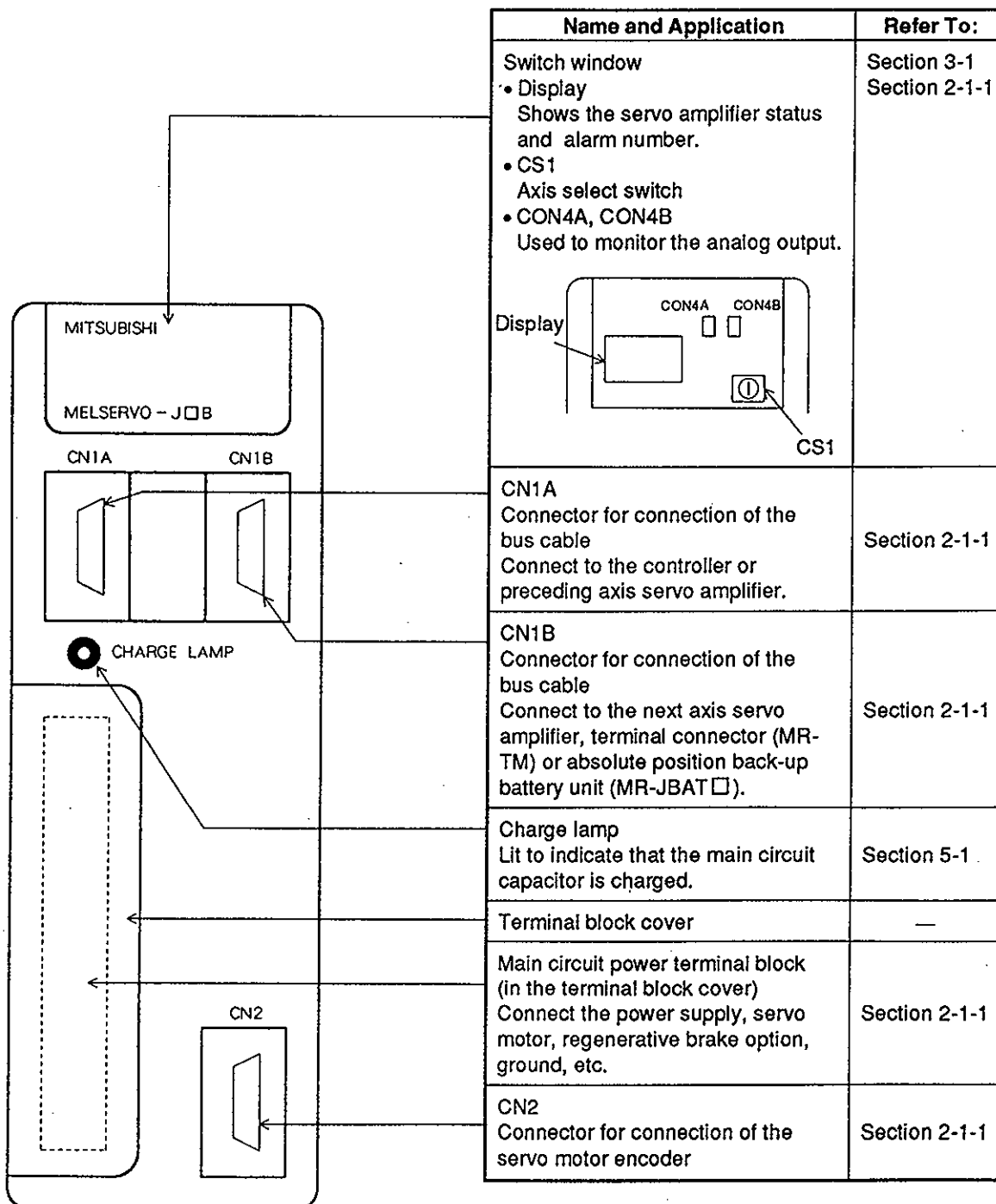
	Appearance	Information on Rating Plate	Information on Model																														
Servo amplifier	MR-J□B 	Applicable motor capacity Model  Serial number + current status Rated output current Applicable power supply	MR-J □ B MR-J-B series AC servo amplifier Standard <table border="1" data-bbox="1085 560 1436 806"> <thead> <tr> <th>Symbol</th> <th>Power (W)</th> </tr> </thead> <tbody> <tr> <td>10</td> <td>50, 100</td> </tr> <tr> <td>20</td> <td>200</td> </tr> <tr> <td>40</td> <td>300, 400</td> </tr> <tr> <td>60</td> <td>500, 600</td> </tr> <tr> <td>100</td> <td>850, 1000</td> </tr> <tr> <td>200</td> <td>1200, 1500, 2000</td> </tr> </tbody> </table>	Symbol	Power (W)	10	50, 100	20	200	40	300, 400	60	500, 600	100	850, 1000	200	1200, 1500, 2000																
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Servo motor	HA-FH□(B)(G) 	Model 	HA-FH □ 3 B G - □ HA-FH series AC servo motor Rated speed 3000r/min With reduction gear With brake <table border="1" data-bbox="1157 1030 1444 1142"> <thead> <tr> <th>Symbol</th> <th>Encoder</th> </tr> </thead> <tbody> <tr> <td>None</td> <td>Incremental</td> </tr> <tr> <td>Y</td> <td>Absolute value</td> </tr> </tbody> </table> <table border="1" data-bbox="941 1153 1444 1332"> <thead> <tr> <th>Symbol</th> <th>Rated Output (W)</th> <th>Symbol</th> <th>Rated Output (W)</th> </tr> </thead> <tbody> <tr> <td>05</td> <td>50</td> <td>3</td> <td>300</td> </tr> <tr> <td>1</td> <td>100</td> <td>4</td> <td>400</td> </tr> <tr> <td>2</td> <td>200</td> <td>6</td> <td>600</td> </tr> </tbody> </table>	Symbol	Encoder	None	Incremental	Y	Absolute value	Symbol	Rated Output (W)	Symbol	Rated Output (W)	05	50	3	300	1	100	4	400	2	200	6	600								
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1. HANDLING

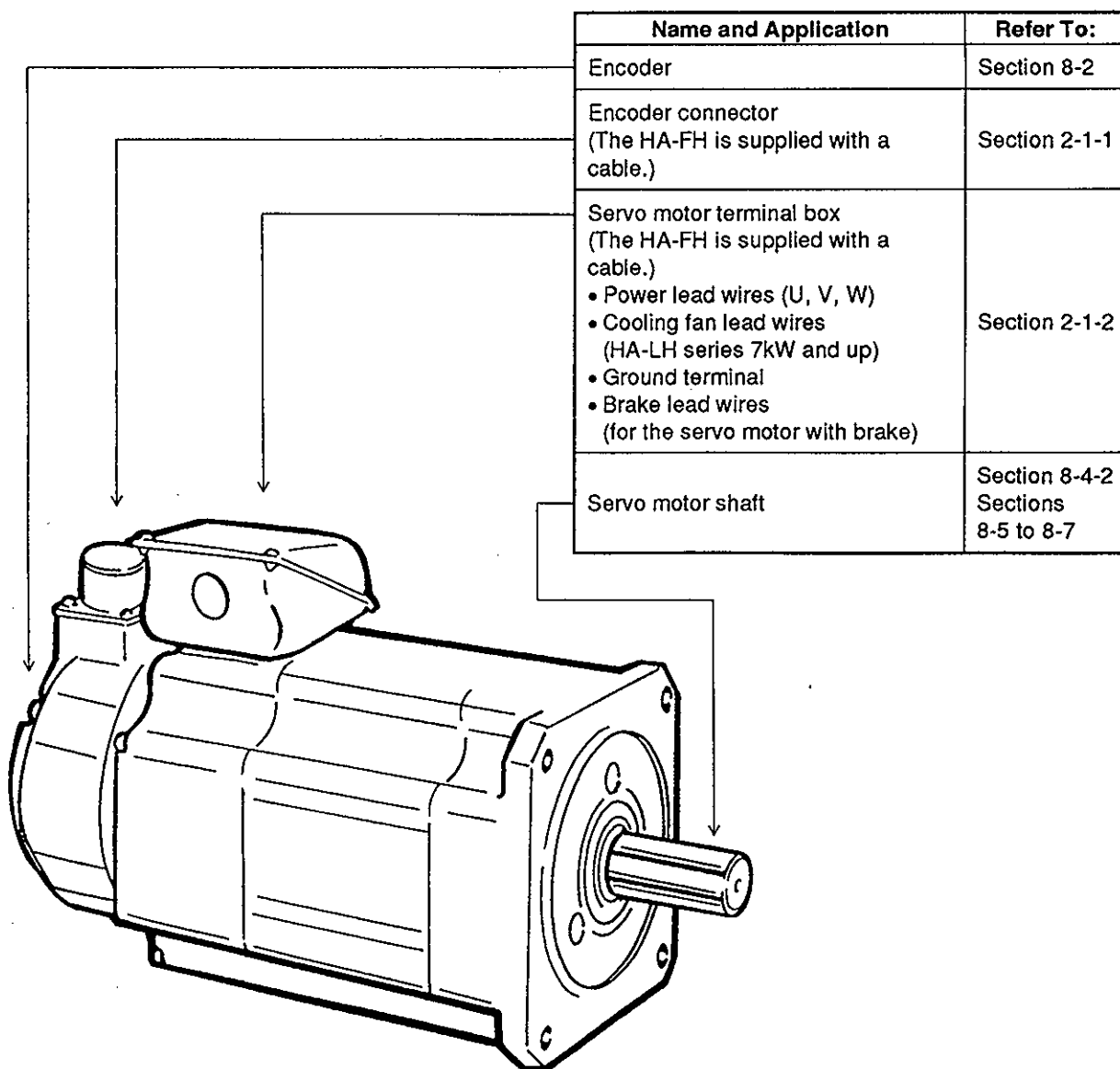
1-2 Structure

1-2-1 Servo amplifier



1. HANDLING

1-2-2 Servo motor



1

2. INSTALLATION AND WIRING

2-1 Terminals, Connectors and Switches


2-1-1 Servo amplifier

(1) Main circuit terminal block

- 1) Terminal layout 2) Terminals explanation

TE

R
S
T
C
P
U
V
W
⏏

Signal Name	Symbol	Function and Application
Main circuit power supply	R, S, T	Connect to the 3-phase commercial power supply 200 to 230VAC/50, 60Hz.
Servo motor output	U, V, W	Connect to the servo motor power terminals U, V, W. The servo motor is inoperative on a mismatch with the servo motor phases U, V, W.
Regenerative brake	C, P	Connect the regenerative brake option across P-C.
Ground		Ground at one point with the servo motor. Connected to the power filter capacitor and case. Must be grounded at one point with the servo motor ground terminal.

(2) Signal connectors

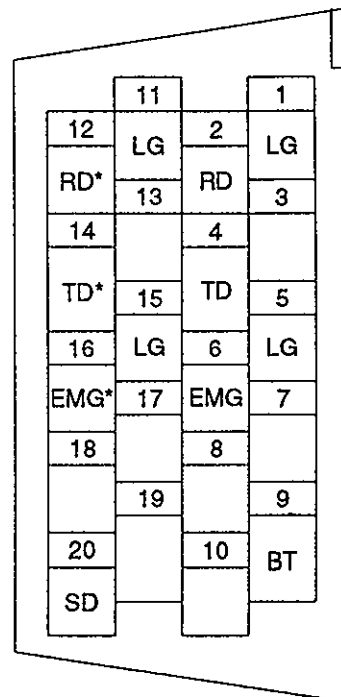
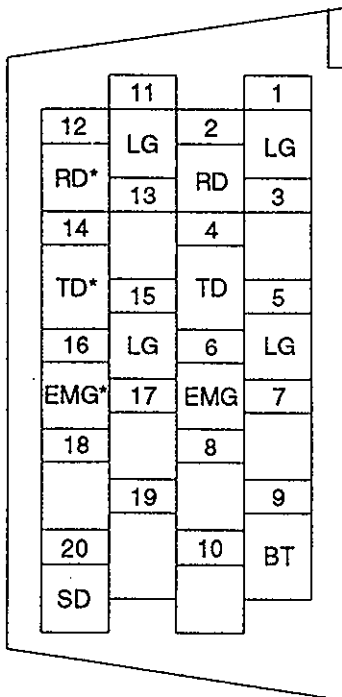
1) Connector pin-outs

a. CN1A

(for connection of the bus cable of the preceding axis)
Type PCR-S20FS (Honda Tsushin Kogyo)

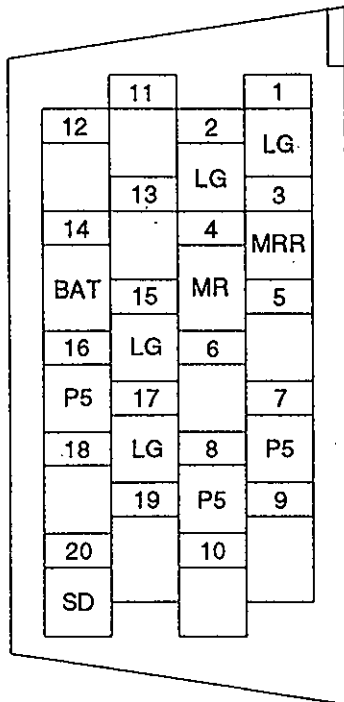
b. CN1B

(for connection of the bus cable of the next axis)
Type PCR-S20FS (Honda Tsushin Kogyo)



2. INSTALLATION AND WIRING

- c. CN2 (for PLG signals)
Type PCR-S20FS (Honda Tsushin Kogyo)



2) Connector pins explanation

Connector	Signal Name	Symbol
CN1A	For connection of the bus cable of the preceding axis	Connector for connection of the bus cable of the preceding axis Connect to the controller or preceding axis servo amplifier.
CN1B	For connection of the bus cable of the next axis	Connector for connection of the bus cable of the next axis Connect to the next axis servo amplifier, terminal connector or absolute position back-up battery unit.
CN2	Encoder signal	Connect the servo motor encoder.

2. INSTALLATION AND WIRING

(3) Axis select switch

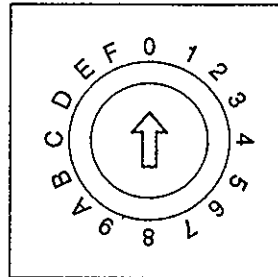
The servo amplifier allows up to eight axes to be connected in a single communication system.

Each servo amplifier has an axis select switch (CS1) for setting the axis number of the control axis.

Set the axis select switch correctly since it provides the only information on the axis number of the servo amplifier. Also note that if the same control axis number is set to the servo amplifiers connected with each other, they will not operate properly. Set the CS1 as indicated below.

No.	Description
0	First axis
1	Second axis
2	Third axis
3	Fourth axis
4	Fifth axis
5	Sixth axis
6	Seventh axis
7	Eighth axis
8	Not used.
9	Not used.
A	Not used.
B	Not used.
C	Not used.
D	Not used.
E	Not used.
F	Not used.

Rotary switch CS1



Match the servo amplifier axis setting with the motion controller axis setting. Each axis can be set independently of the connection sequence of the bus cables.

(4) Analog output monitor terminals

Used to monitor the analog output.

Terminal	Description
CON4A	Analog output HOT
CON4B	Common

2. INSTALLATION AND WIRING

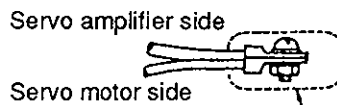
2-1-2 Servo motor

(1) Notes on connection

- 1) Always match the servo motor lead phases (U, V, W) with the servo amplifier output terminals (U, V, W). If the phases do not match, the servo motor does not rotate properly.

The servo motor may be demagnetized or burnt out if AC power is applied to the servo motor terminals (U, V, W).

- 2) Wind several layers of insulation tape around the connection. When putting the connection into the terminal box, exercise care not to damage the insulated area. Insufficient insulation might cause a ground fault.

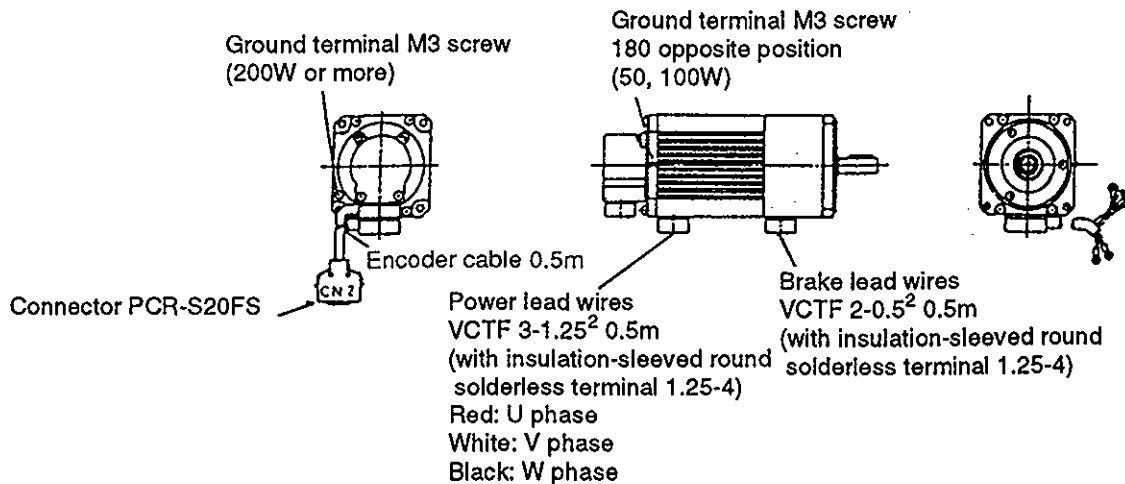


Wind 3 or 4 turns of insulating tape.

- 3) For grounding, connect the motor with the ground terminal of the servo amplifier so that the motor is earthed via the grounding plate in the control box. Refer to Section 2-3-3.
- 4) The user must supply a 24VDC power supply for brake lead of the servo motor with electromagnatic brake is used. (For the power supply capacity, see Section 7-3.)

(2) Detailed information on the I/O terminals

1) HA-FH series



2. INSTALLATION AND WIRING

2) HA-SH series

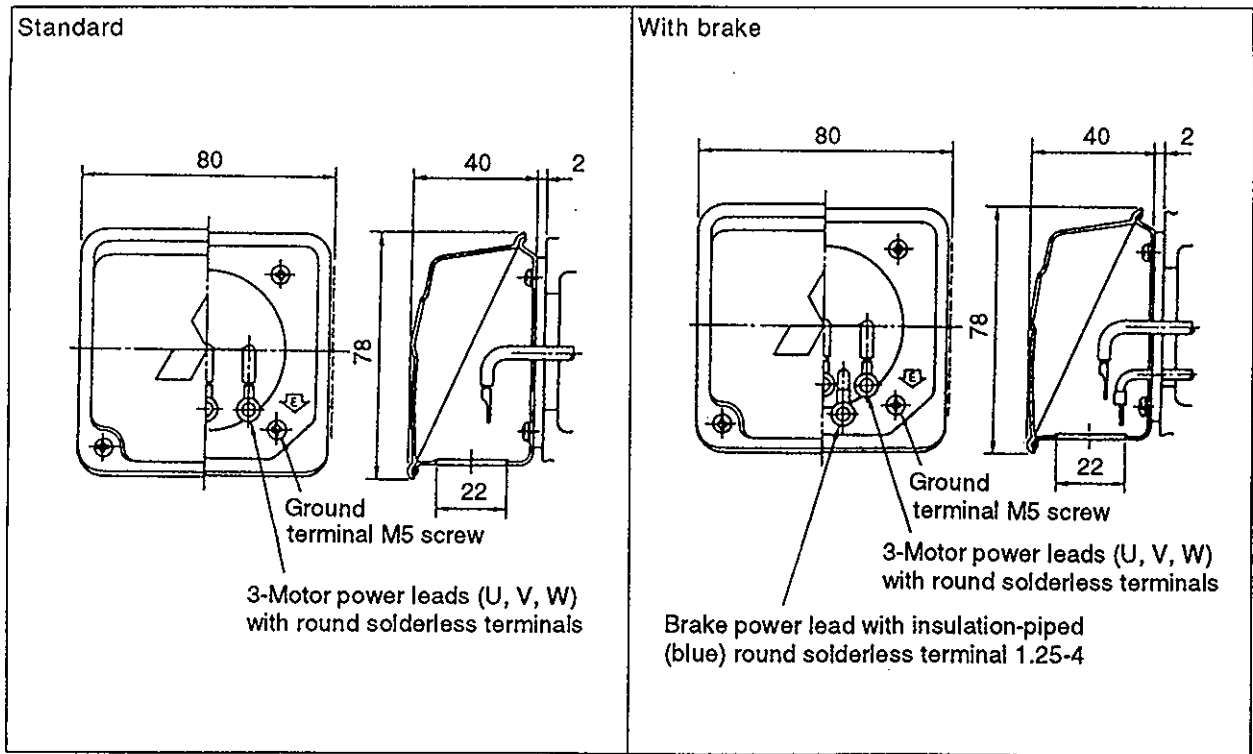


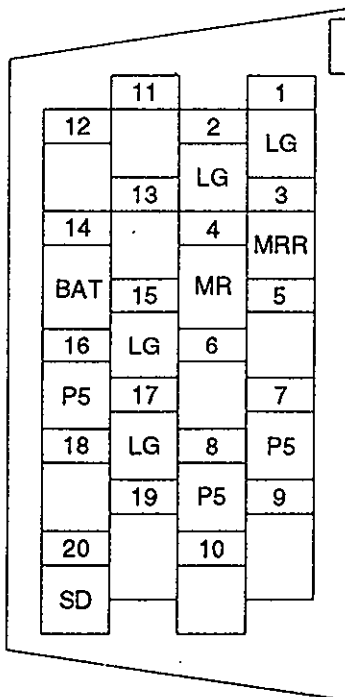
Fig. 2-1 Detailed Figure of Terminal Box

(3) Connector pin-outs of the encoder cable (servo motor side)

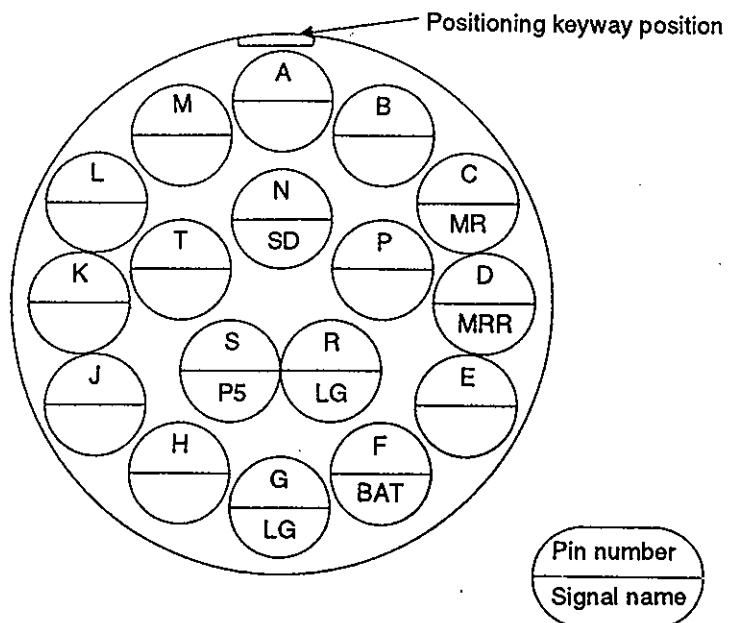
1) For the HA-FH series

2) For the HA-SH series

PCR-E20PMRS-SL



MS3106B20-29S



2. INSTALLATION AND WIRING

2-2 Installation

2-2-1 Servo amplifier

Incorrect handling might cause the servo amplifier to an unexpected accident or a fault. Install the servo amplifier properly in accordance with the instructions in this section.

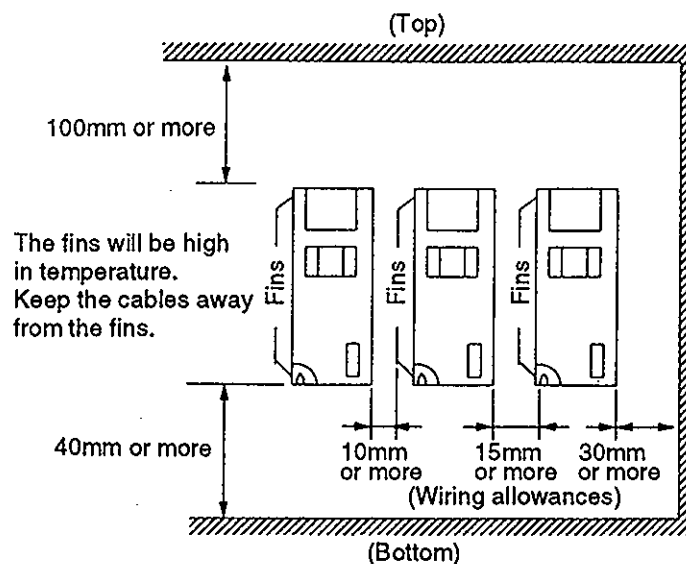
(1) Operating environmental conditions

Ambient temperature	0 to 55°C (non-freezing) (Note)
Ambient humidity	90%RH or less (non-condensing)
Vibration	5.9m/S ² (0.6G) or less

Note: To ensure servo amplifier long life and high reliability, the temperature of 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 amplifier so that the front cover is located at the front correctly in the vertical direction.
- When the amplifier is installed in an enclosed box, leave horizontal clear-ances of at least 10mm and vertical clearances of at least 40mm. Especially when two or more amplifiers are installed, leave an at least 100mm clearance above the amplifier or fit a fan or the like for adequate heat dissipation.
- When using regeneration units, install them away from the servo amplifier.



(3) Keep out foreign materials

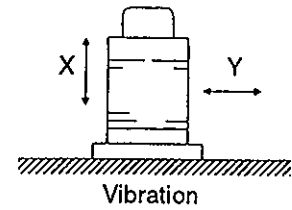
- When installing unit on a panel or inside and enclosure, prevent drill chips and wire fragments from entering the servo amplifier.
- Prevent oil, water, and metallic dust from entering the amplifier through openings in the enclosure.
- Provide positive pressure in control enclosure by forcing in clean,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

2. INSTALLATION AND WIRING

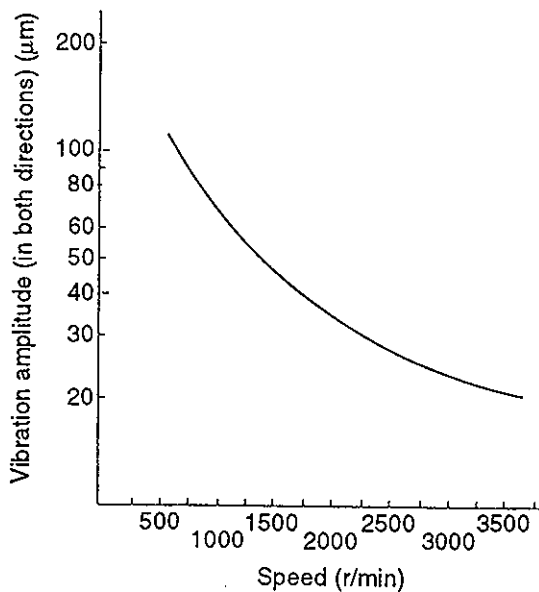
2-2-2 Servo motor

(1) Operating environmental conditions

Ambient temperature		0 to 40°C (non-freezing) (Note)
Ambient humidity		80%RH or less (non-condensing)
Vibration	HA-FH	X, Y: 19.6m/S ² (2G)
	HA-SH 1.5kW or less	X: 9.8m/S ² (1G), Y: 24.5m/S ² (2.5G)
	HA-SH 2kW	X: 19.6m/S ² (2G), Y: 49m/S ² (5G)

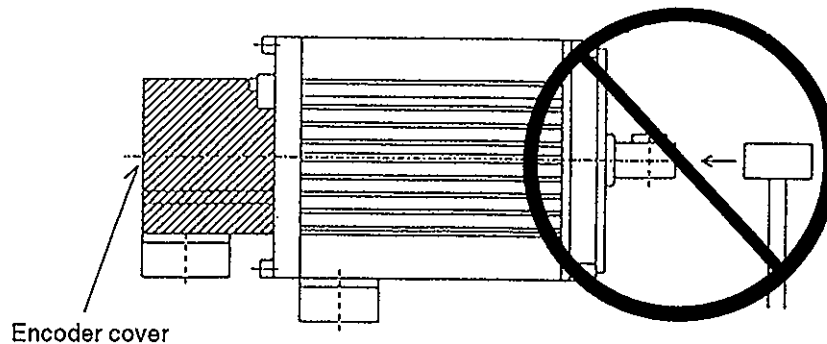


Graph of vibration servo amplifude VS. speed:



(2) Servo motor load-mounting precautions

- Use the screw hole on the end of the shaft when mounting a pulley. When the shaft does not have a keyway, use a friction coupling or the like.
- 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.)
- Orientation of the encoder on the servo motor cannot be changed.



2. INSTALLATION AND WIRING

(3) Permissible load of the shaft

- Use a flexible coupling which can accommodate misalignment or angular movement so that shaft off-center falls within the permissible radial load.
- When the pulley, sprocket and timing belt are used, select those that will satisfy the permissible radial load.

See the permissible shaft end load in Section 7-6.

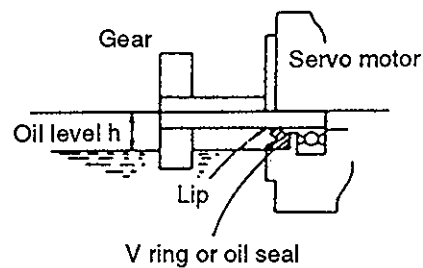
(4) Oil and water protection

1) The servo motor is not waterproof. Prevent oil and water from entering the servo motor.

- When the servo motor is installed to a gear box, set the oil level height from the servo motor shaft center in accordance with the following table.

Also, provide a breathing hole in the gear box to keep the internal pressure low.

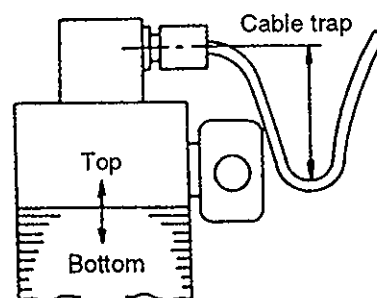
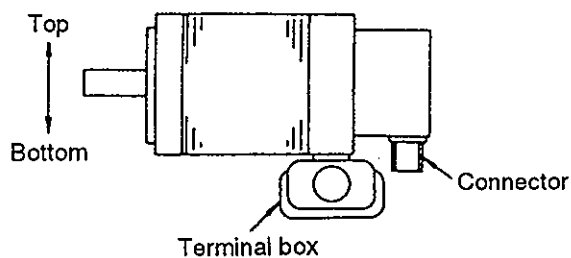
Servo Motor	Oil Level Height h (mm)
HA-FH053, 13	8
HA-FH23, 33	12
HA-FH43, 63	14
HA-SH52 to 152	20
HA-SH53 to 153	
HA-SH81	
HA-SH202	25
HA-SH203	
HA-SH121 to 201	



Note: The HA-FH servo motor with oil seal is available as an option.

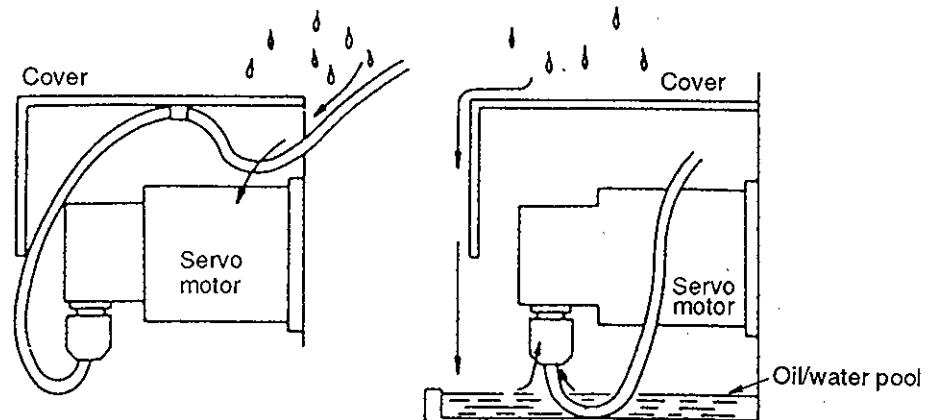
2) In any place where the servo motor is subjected to oil/water, provide measures, e.g. fit a cover.

- Route the lead wires downward to prevent oil/water from running into the servo motor through the lead wires.
- When the servo motor is installed vertically or obliquely, provide a trap for the cable.



2. INSTALLATION AND WIRING

- The cable may lead oil/water, adversely affecting the servo motor and encoder. Do not cause the cable to lead oil and/or water or to dip into an oil/water pool.
- When the servo motor is to be installed with the shaft end at top, provide measures on the machine side to prevent oil from entering the servo motor from the gear box, etc. In such a case, oil entry cannot be prevented by only the oil seal provided for the servo motor.



<Incorrect> Breathing action

<Incorrect> Capillary phenomenon

(5) Installation direction

1) Provide stress relief to cables. Prevent cable abrasion.

- The way of clamping the cable must be fully considered so that flexing stress and cable's own weight stress are not applied to the cable connection.
- In any application where the servo motor moves, determine the bending radius of the cable according to the required flex life and wire size. When the servo motor moves, e.g. the encoder cable and motor cables are contained in cable bearers, run the cable so that its flexing portion falls within the relay cable range and fix the accessory encoder cable and servo motor cables (for the HA-FH servo motor).
- Avoid any probability that the cable sheath might be cut by sharp chips, rubbed by a machine corner or stamped by workers or vehicles.

2) The servo motor may be installed horizontally or installed with its shaft end at top or bottom.

- The servo motor with electromagnetic brake can also be installed horizontally or installed with its shaft end at top or bottom. When the servo motor is installed with its shaft end at top, the brake plate may generate sliding noise but it is not a fault.
- The servo motor with reduction gear cannot be used in any position different from the outline drawing and must be used as specified in the outline drawing.

2. INSTALLATION AND WIRING

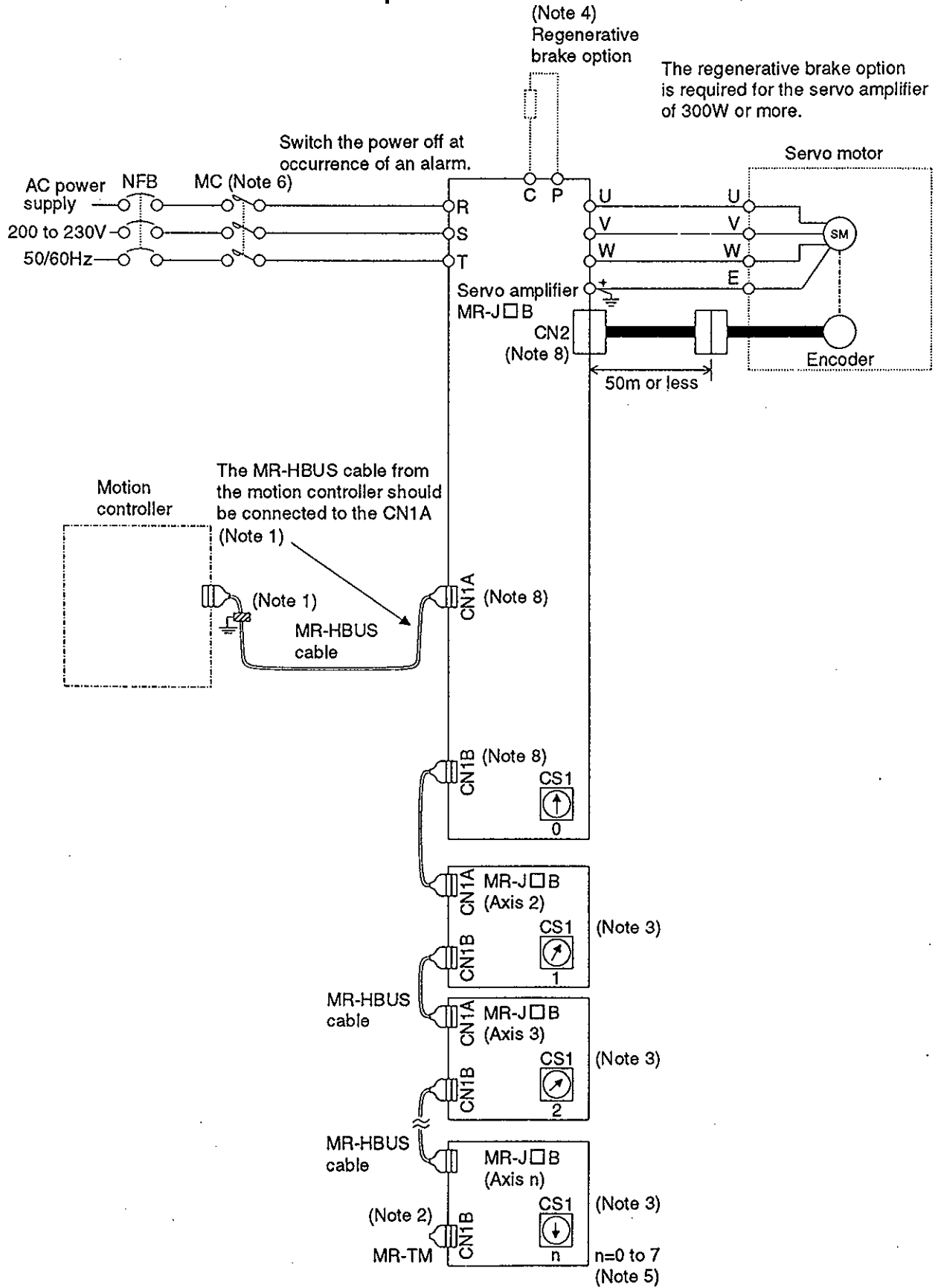
2-3 Wiring and Timing Chart

2-3-1 Wiring instructions

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

2. INSTALLATION AND WIRING

2-3-2 Standard connection example



2

2. INSTALLATION AND WIRING

Note: 1. Use the MR-HBUS cable within the overall distance of 30m.

To improve noise immunity, it is recommended to use a cable clamp or data line filters (3 or 4 filters connected in series) near the connector lead-out portion. (Refer to Section 4-2-3 (1), (3).)

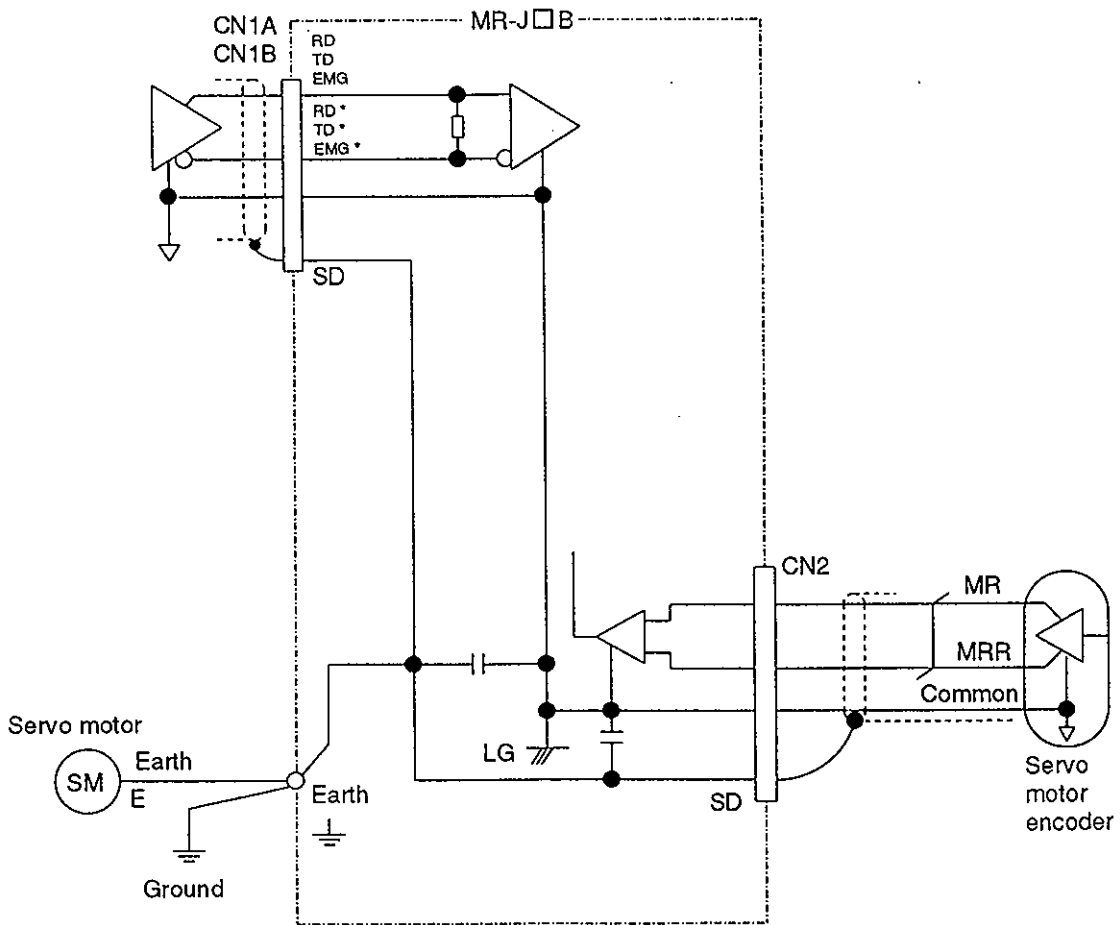
2. At the termination of the servo bus, the terminal connector (MR-TM) must be inserted into CN1B. In an absolute position detection system, connect the absolute position back-up battery unit (MR-JBAT□).
3. The servo motor side connections of the second and subsequent axes are omitted.
4. Connect when the regenerative brake option is used.
5. Up to eight axes ($n = 0$ to 7) can be connected. The MR-H-B servo can also be connected to the same bus.
6. Make up a sequence to switch off the magnetic contactor (MC) at the time of an alarm.
7. CN1A, CN1B and CN2 are connectors of the same type.
Connect the cables to correct connectors.

2. INSTALLATION AND WIRING

2-3-3 Common line diagram

The internal power supply 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.



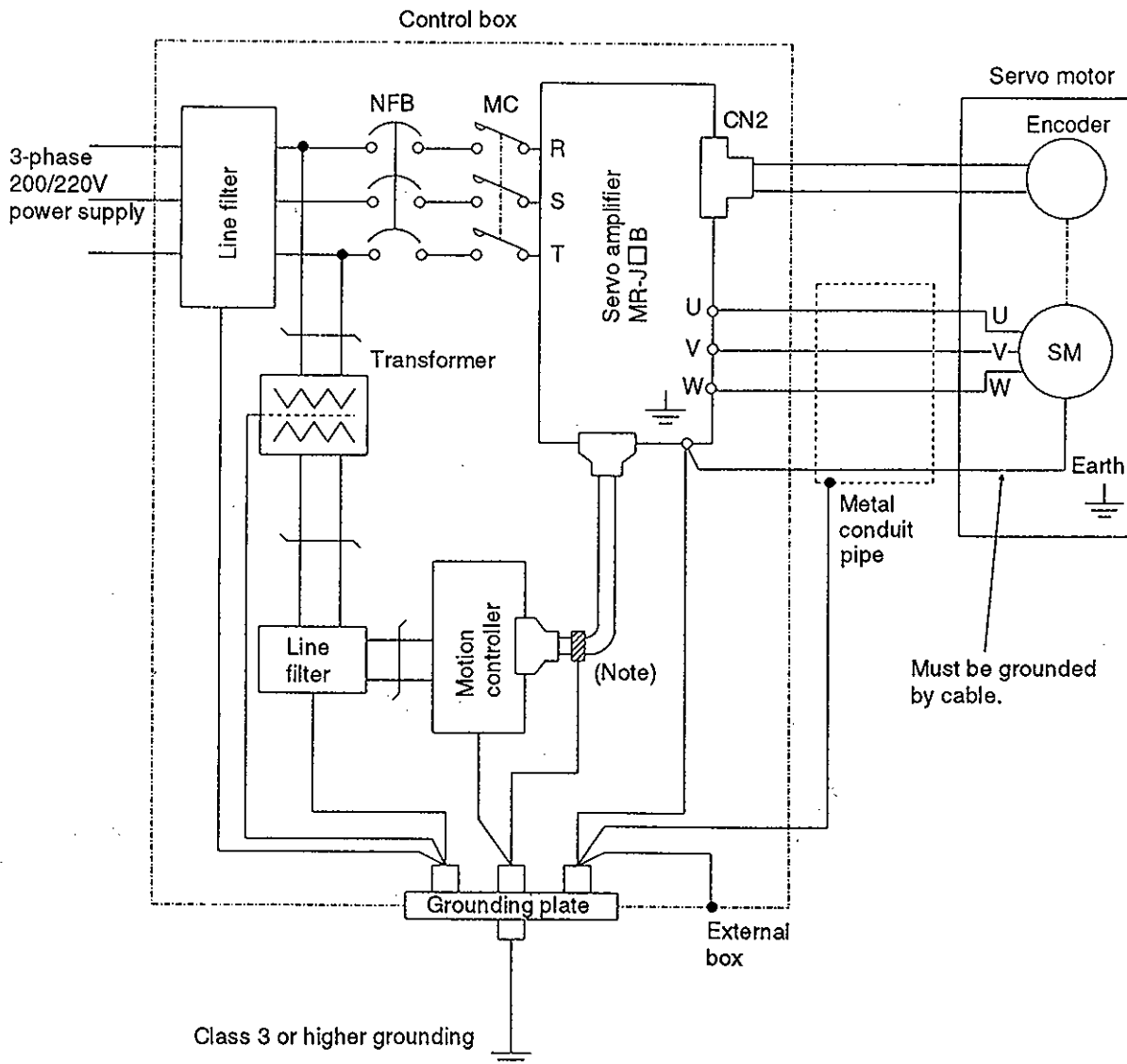
2. INSTALLATION AND WIRING

2-3-4 Grounding

The servo amplifier switches the power transistor to supply power to the servo motor. Depending on the way of wiring and ground cable routing, the servo amplifier may be affected by the switching noise (due to di/dt and dv/dt) of the transistor.

To prevent such a fault, follow the grounding and wiring instructions.

In accordance with the following diagram, run the ground cable, such as a flat mesh copper cable, which is as large as possible (3.5mm^2 or more is desirable).



Note: To minimize the influence of external noise, it is recommended to clamp the bus cable or fit three or four data line filters near the controller. (Refer to Section 4-2-3 (1), (3).)

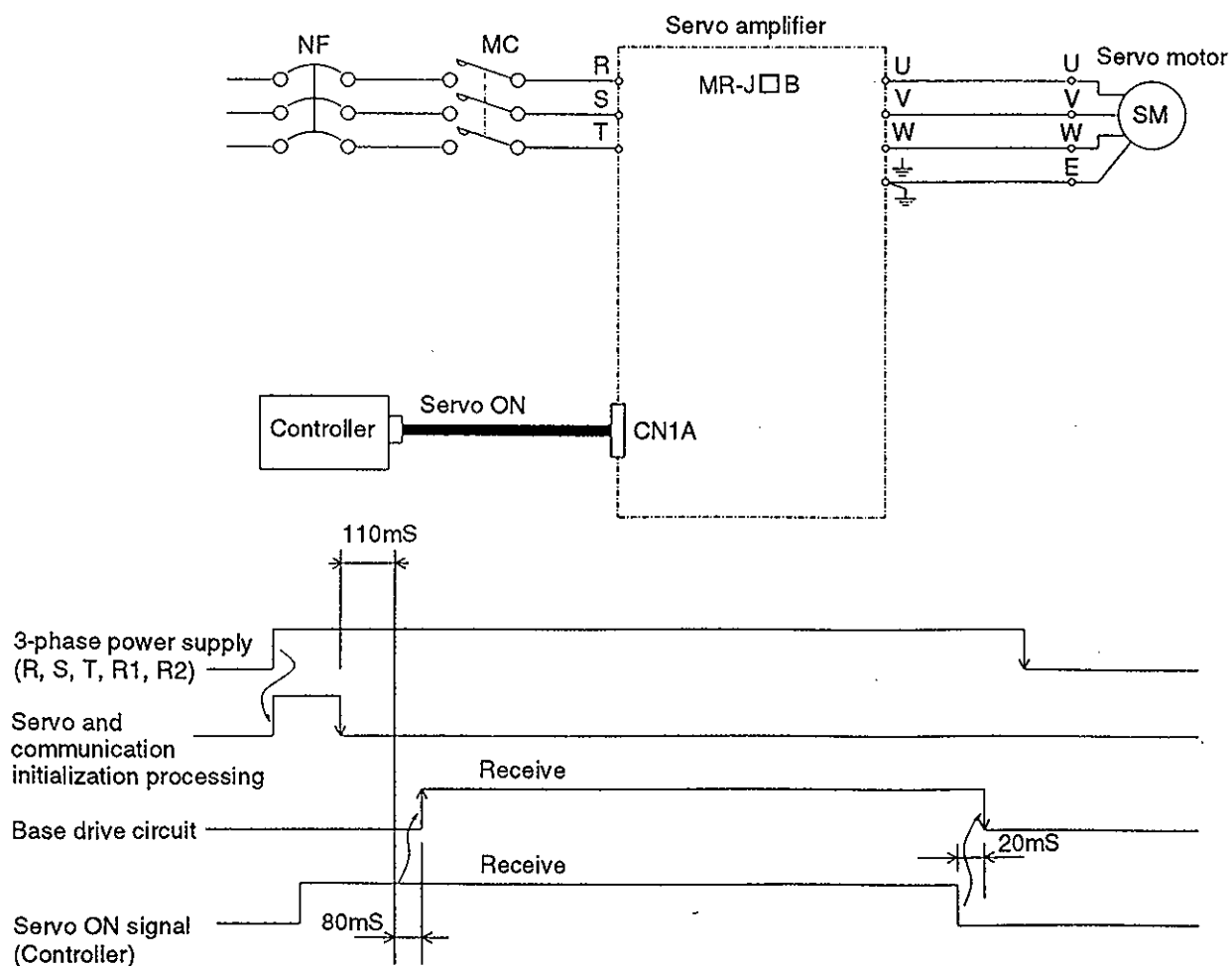
Grounding the MR-J□B Servo

2. INSTALLATION AND WIRING

2-3-5 Power supply circuit

(1) Power-on sequence

- 1) When wiring the power supply, a magnetic contactor must be connected to R, S, T as shown below. Make up the external sequence to switch off the magnetic contactor when an alarm occurs.
- 2) 110ms after the initialization processing, the servo amplifier is ready to receive the "servo ON" signal. Within 80ms after the receipt of the "servo ON" signal, the servo amplifier is ready to operate.



Note: The power and "servo ON" signal may be switched on at the same time.

Power-On Timing Chart

2. INSTALLATION AND WIRING

2-3-6 Timing chart at the time of alarm occurrence

When an alarm occurs in the servo amplifier, the base drive circuit is shut off, and at the same time, the dynamic brake is operated to bring the servo motor to a sudden stop. Reset the alarm by using the reset signal from the host controller or by switching the power off, then on. (The overload-related alarm cannot be reset by the reset signal.)

*The alarm is not reset by switching the servo off.

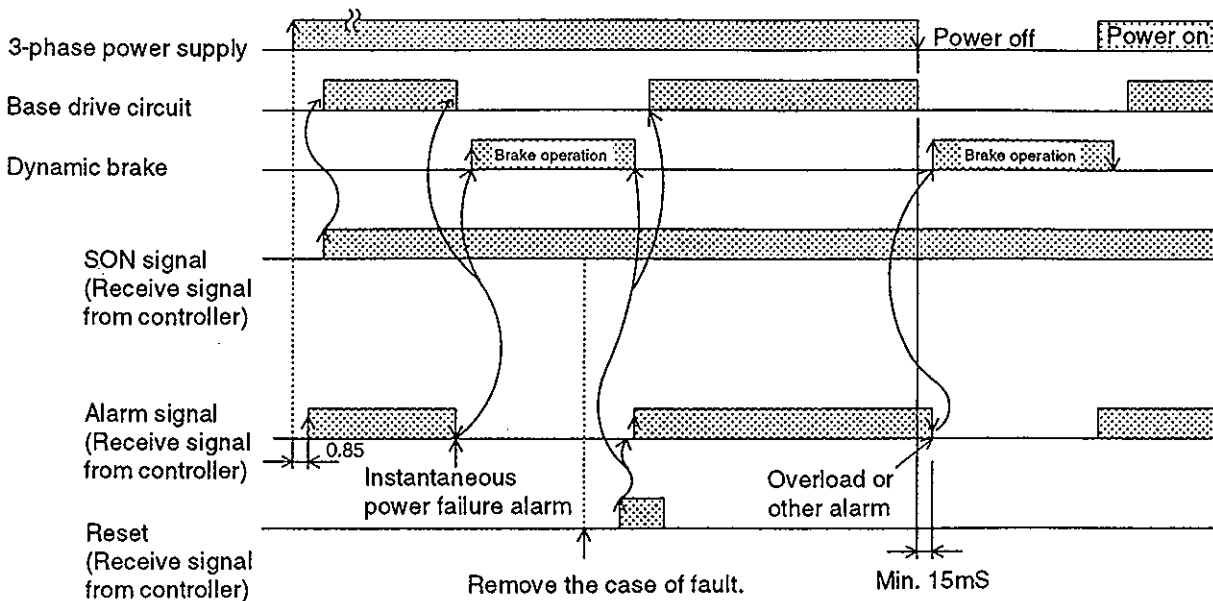


Fig. 2-5 Timing Chart at Occurrence of Alarm

Important

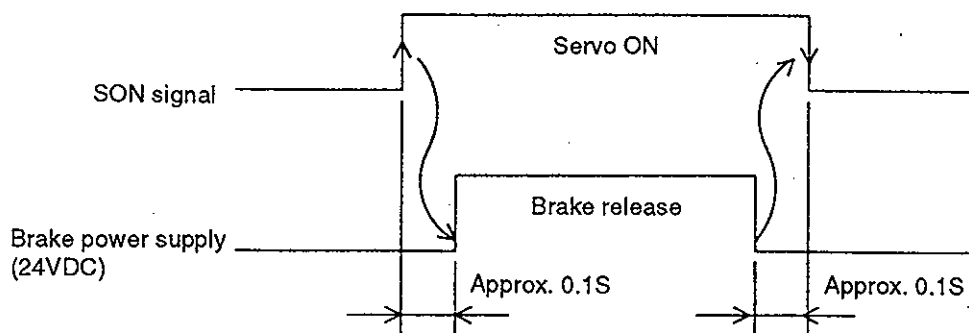
1. If operation is repeated by switching the power off, then on after the occurrence of overcurrent/overload-related alarm, without the cause of alarm being removed, the main circuit devices may be damaged due to temperature rise. Remove the cause of alarm completely and restart the operation after about 30 minutes have elapsed.
2. If operation is repeated by switching the power off, then on after the occurrence of regenerative alarm (AL30), the regenerative brake resistor will generate heat, resulting in a hazardous accident. Take special care to avoid this.
3. When an instantaneous power failure occurs for 15ms or more, the protective circuit is activated. If the power failure still persists for 20 to 30ms or more, the power is lost, the protective circuit is reset, and when the power is restored, the servo amplifier returns to the initial state.
4. At occurrence of alarm, the command position is not retained. Execute the home positioning at the time of restart.

2. INSTALLATION AND WIRING

2-3-7 Electromagnetic brake operation

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

- 1) The brake, which is a safety brake, operates when the power (24VDC) is switched off.
- 2) To operate the brake, the servo (SON signal) must be switched off.
- 3) To use the brake to prevent a drop in the vertical axis, make up a sequence which allows for a control delay.



* When it is difficult to make up a sequence which allows for a control delay at servo-off, switch DC off, and as soon as the brake power is switched off, switch the servo off to reduce the drop distance.

Control delay

AC off: approx. 0.1s

DC off: approx. 0.3s

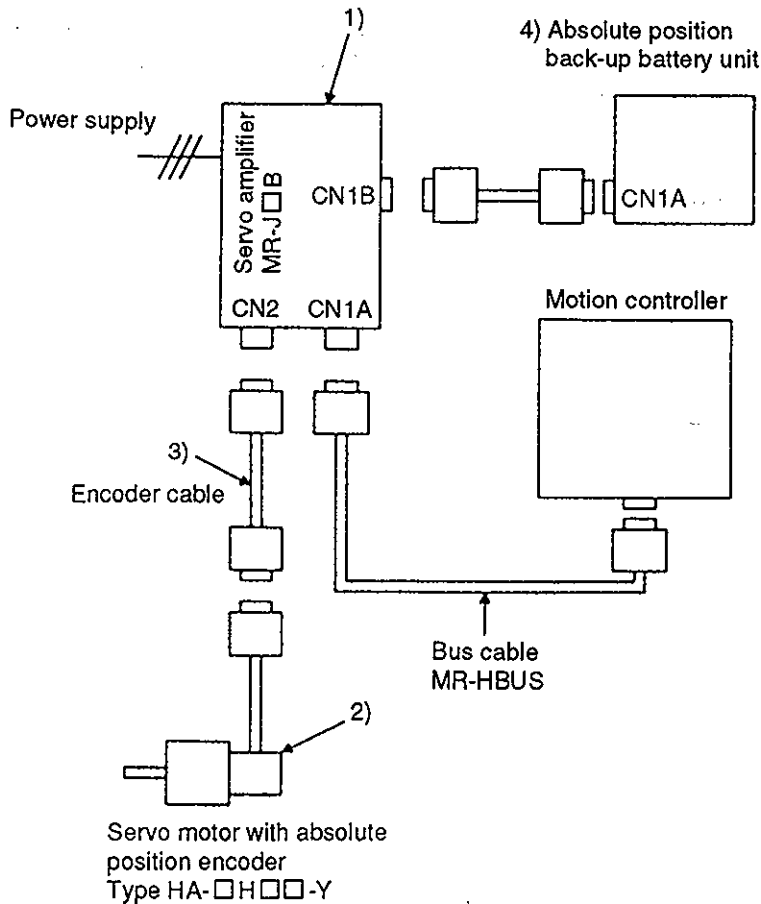
2. INSTALLATION AND WIRING

2-4 Absolute Position Detection Specifications

An absolute position detection system can be made up by a motion controller and the MR-J□B servo amplifier. Set 1 to AMP. SETTING on the basic parameter screen. This system does not require home positioning after power-off, such as an instantaneous power failure or emergency stop, facilitating restarting work on the field site. For the outline drawing and other data, refer to Section 4-1-5. When the MR-H□B servo amplifiers are used on the same bus, load the battery (MR-BAT or A6BAT) to each MR-H□B.

2-4-1 Structure

Item	Note	Refer To:
1) Servo amplifier MR-J□B	• All servo amplifiers are compatible with absolute position detection.	Section 8-2
2) Servo motor HA-□H□-Y	• Use a servo motor supplied with absolute position encoder.	Section 8-1 Section 8-2
3) Encoder cable	• Add the connection of the battery power supply (BAT, LG signals) to the wiring of the incremental encoder cable. • The option cable (MR-HCBL□M, MR-HSCBL□M) can be used with either the incremental or absolute position encoder.	Section 4-1-2 Section 4-1-4
4) Absolute position back-up battery unit MR-JBAT□	• Connect to CN1B of the final axis servo amplifier.	Section 4-1-5



2. INSTALLATION AND WIRING

2-4-2 Specifications

Item \ Motor Series	HA-FH Series	HA-SH Series
System	Electronically battery back-up system	
Battery	Use the MR-JBAT□ battery unit.	
Resolution	8192 pulses/rev	16384 pulses/rev
Maximum revolution range	Zero ± 32767	
Maximum speed at power failure	500r/min	
Nominal battery voltage	+3.6V	
Battery back-up time (Note 1)	About 10,000 hours (non-energized battery life)	
Accumulative revolution counter holding time (Note 2)	2 hours at delivery time, 1 hour 5 years later	10 hours at delivery time, 5 hours 5 years later
Battery life	5 years	

- Note: 1. Indicates the length of time when data can be held by the battery with the power off.
2. Indicates the length of time when data can be held by the super capacitor built in the encoder after the power is switched off with the battery voltage low. Change the battery within this period of time.

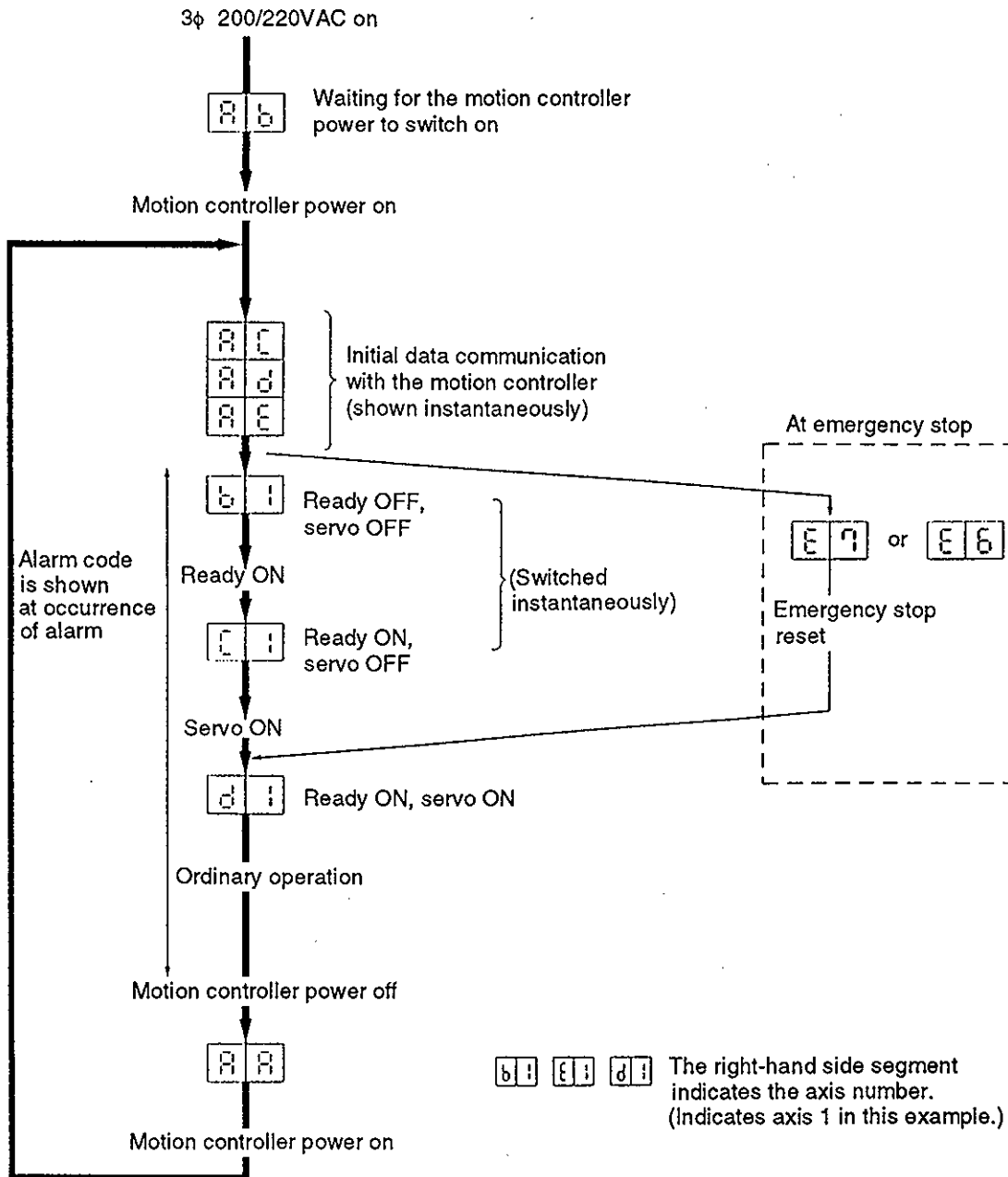
2

3. DISPLAY AND OPERATION

3-1 Servo Amplifier Display

3-1-1 Display sequence

Look at the display (2-digit, 7-segment display device) on the front of the servo amplifier to check the state of communication with the motion controller at power-on, to confirm the axis number, or to diagnose a fault at the occurrence of an alarm.



3. DISPLAY AND OPERATION

3-1-2 Display explanation

The seven-segment display on the front of the servo amplifier shows the servo amplifier status. At occurrence of an alarm, the alarm number is shown.

Servo Amplifier Status Display List

Display	Description
AA	Initializing; waiting for the motion controller power to switch on (when the motion controller power is switched on, then off)
Ab	Initializing (note 4); waiting for the motion controller power to switch on (when the servo amplifier power is switched off, then on and the motion controller power is off)
Ac	Initializing; start of communication between the motion controller and servo amplifier
Ad	Initializing; initial parameter receive complete
Ae	Initialization complete
b # (Note 1)	Ready OFF
[# (Note 1)	Servo OFF; the controller gives the servo OFF instruction.
d # (Note 1)	Servo ON
E * (Note 2)	Warning
S * (Note 2)	Warning
** (Note 3)	Alarm
...	CPU error
☼	Decimal point flickers; test run mode

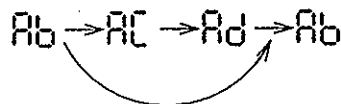
Note: 1. # indicates the axis number (1 to 8: axis number, 0: test run).

2. * indicates the warning number.

3. ** indicates the alarm number.

4. When Ab remains displayed, it indicates the servo amplifier is waiting for the controller to power up or any of the following causes:

- 1) Axis number setting fault...Set the servo axis select switch correctly. Positions "0" to "7" of the servo axis select switch correspond to axes 1 to 8, respectively.
- 2) Card or communication fault...Change the card or cable.



In this case, the display advances to Ad instantly, then returns to Ab again.

- 3) Bus cable fault
- 4) Controller fault

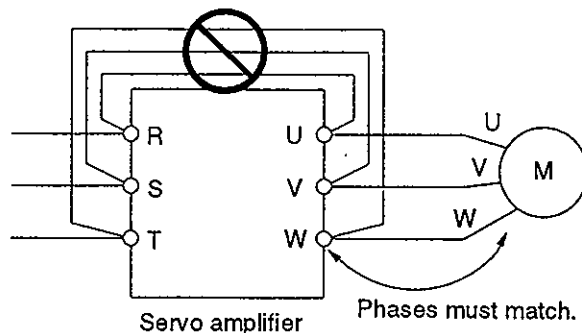
3. DISPLAY AND OPERATION

3-2 Operation Procedure

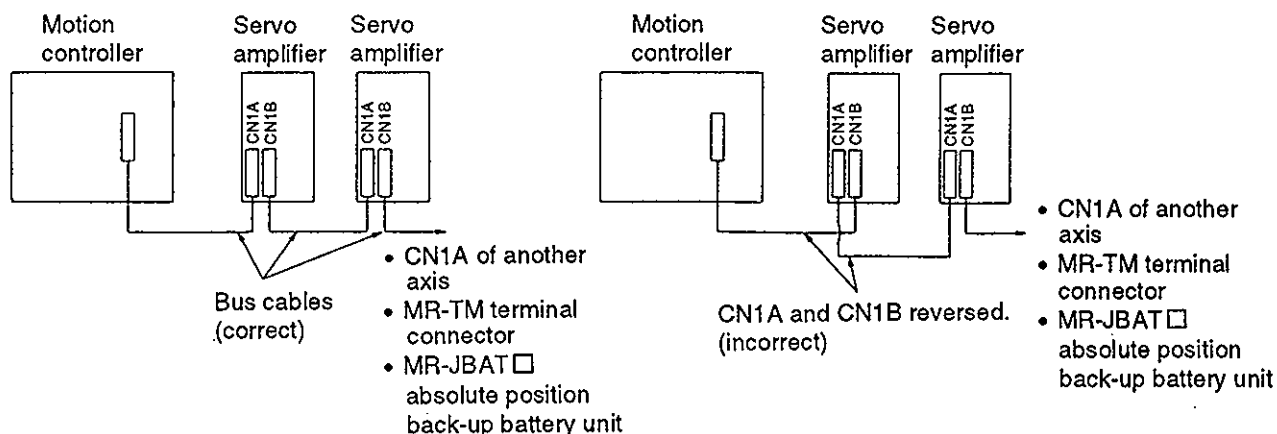
3-2-1 Pre-operation checks

When installation and wiring are over, make the following checks before starting operation.

- (1) Check the wiring again for wrong connections. Especially make sure that:
 - 1) 200V class cables are connected to the power supply terminals (R, S, T). When the power supply is 400V class or more, the voltage has been dropped to 200V class.
 - 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) For the wiring of the regenerative brake option, twisted cables are used.
- 5) The cable from the encoder is connected to the CN2 connector properly.
- 6) The cable from the motion controller or the cable from CN1B of another axis is connected to CN1A. The cable from CN1A of another axis, the MR-TM terminal connector or the absolute position back-up battery unit (MR-JBAT) is connected to CN1B.



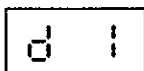
The terminal connector must be inserted into the CN1B connector of the final axis.

- (2) Match the CS1 (axis number setting) with the motion controller setting.
- (3) Set the servo parameters properly on the motion controller screen.
- (4) Check for shorts caused by wire debris, chips, etc.
- (5) Check for loose screws in the connections and mounting areas. Retighten if found.
- (6) Check for excessive force applied to the wiring.
- (7) Check that the servo motor and load (machine) are ready to operate.

3. DISPLAY AND OPERATION

3-2-2 Power on

When the input power is switched on, the servo amplifier display shows the following to indicate that the amplifier is ready to operate (servo ON).



Amplifier display (for axis 1)

Note that when the motion controller power is not on, the servo amplifier is not placed in the "servo ON" state. If an alarm or warning occurs, refer to Chapter 6 and return to normal.

Take the following precautions for the absolute position detection system:

- (1) When the power is switched on for the first time, alarm "25" (battery fault) occurs and the servo amplifier is not placed in the "servo ON" state. This alarm occurs due to the fact that the voltage of the super capacitor in the detector is $2.3V \pm 0.2V$ or less at power-on and does not indicate the fault of the detector or option card.

Reset the alarm in the following procedure:

- 1) With the alarm kept displayed, leave the power on for some time (about three minutes).
- 2) After about three minutes have elapsed, switch the power off once, then on again.

The alarm is reset. If it is not reset, repeat steps 1) and 2).

- (2) A fault (e.g. position offset) may occur if the power of the servo amplifier or controller is switched on or the controller CPU is reset during rotation (500r/min or more) of the servo motor.

When a slip occurs in the vertical axis due to an imbalanced load or when the above operation is performed for a synchronous tracking axis, etc., take preventive measures in the external sequence or the like, e.g. apply brakes.

3-2-3 Ordinary operation

When the servo starts normal operation under actual load, look at the status display to check the load condition.

- 1) Regenerative load factor
- 2) Effective load factor
- 3) Peak load factor

Perform operation at the load factors 1) and 2) of not more than 100% with a little allowance given for the factors (about 80%). If the factors are more than 100%, take measures: (I) reduce the load; (II) increase the acceleration/deceleration time; or (III) reduce the frequency of starts. Normally, the initial settings provide fully stable operation. When an unfavorable phenomenon, such as vibration or noise during movement, occurs due to a large load inertia or the like, or when it is desired to achieve the best performance according to the machine, set the corresponding parameters from the controller. (Refer to Section 3-4.)

3-2-4 Stop

Any of the following operations will cause the servo to interrupt or stop running.

Operation of the motion controller

- 1) Servo OFF..... Brings the servo amplifier to base drive circuit shut-off and coasts the servo motor to a stop.
- 2) Stroke end OFF... Brings the servo motor to a sudden stop and servo-locks the servo motor shaft. The servo motor can be moved in the opposite direction.
- 3) Alarm..... The occurrence of an alarm shuts off the base drive circuit and operates the dynamic brake to bring the servo motor to a sudden stop.
- 4) Emergency stop... Brings the servo amplifiers of all axes to base drive circuit shut-off simultaneously and operates the dynamic brakes to bring the servo motors to a sudden stop.

3. DISPLAY AND OPERATION

3-3 Auto Tuning

This function automatically sets optimum values to the position loop gain, speed loop gain and speed integral compensation parameters for a load coupled with the servo motor shaft. auto tuning provides stable operation. For more information on the parameters, refer to the motion controller instruction manual.

(1) Parameter setting

After setting J-SERVO RESPONSE SET on the basic parameter screen, set "1" to I-AUTO-TUNING on the same screen. Perform jog operation, etc. to make acceleration/deceleration once. AUTO-TUNING changes to "2" to indicate that the auto tuning is complete. To change the response setting, repeat the above operation.

AUTO-TUNING

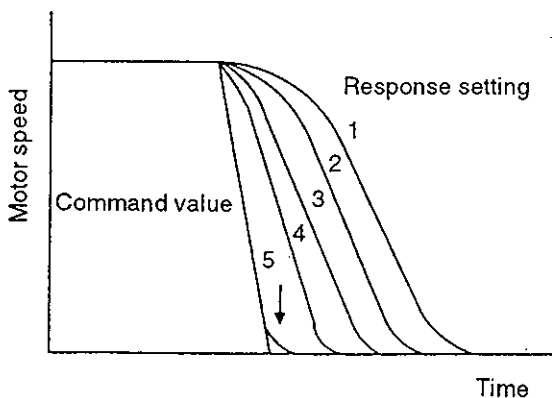
Setting	Auto tuning
1	Executed
2	Not executed

(2) Setting method

Look at the vibration and setting of the servo motor and machine immediately before they stop and increase the value in sequence, beginning with the slower response setting. If machine resonance occurs at this time, decrease the set value. When the load inertia is five or more times greater than the servo motor inertia, set 1 or a higher value.

SERVO RESPONSE SET

Setting	Response
1	Slower
2	↓
3	
4	
5	Faster

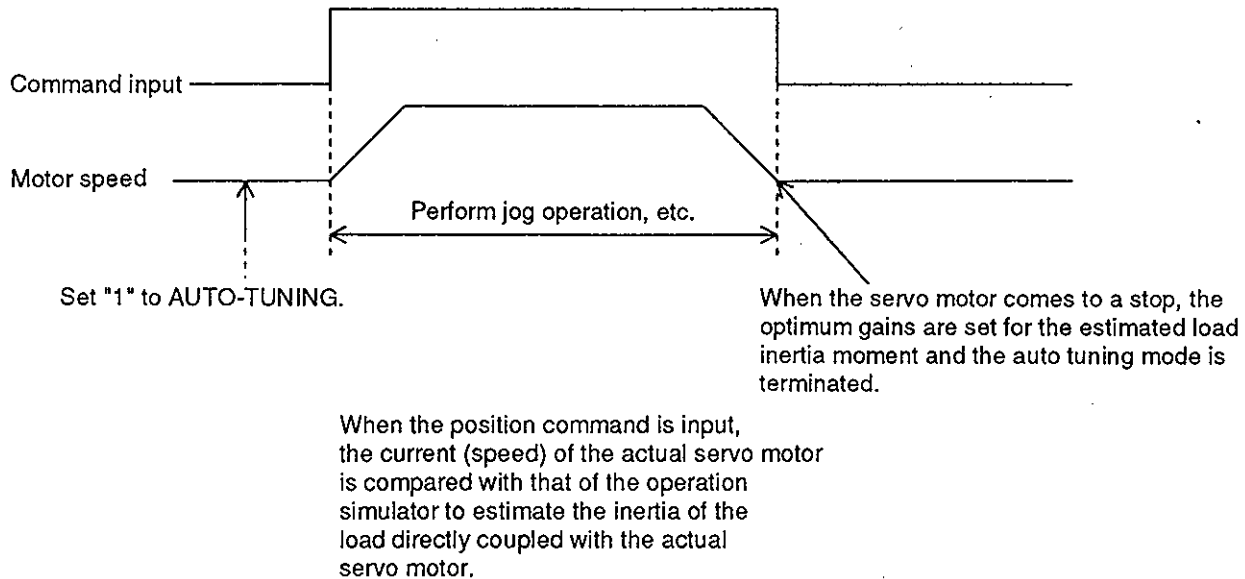


Changes of Motor Response by Response Setting

If mechanical sound and/or vibration still persists after auto tuning, refer to Section 3-4 and set the gains manually.

3. DISPLAY AND OPERATION

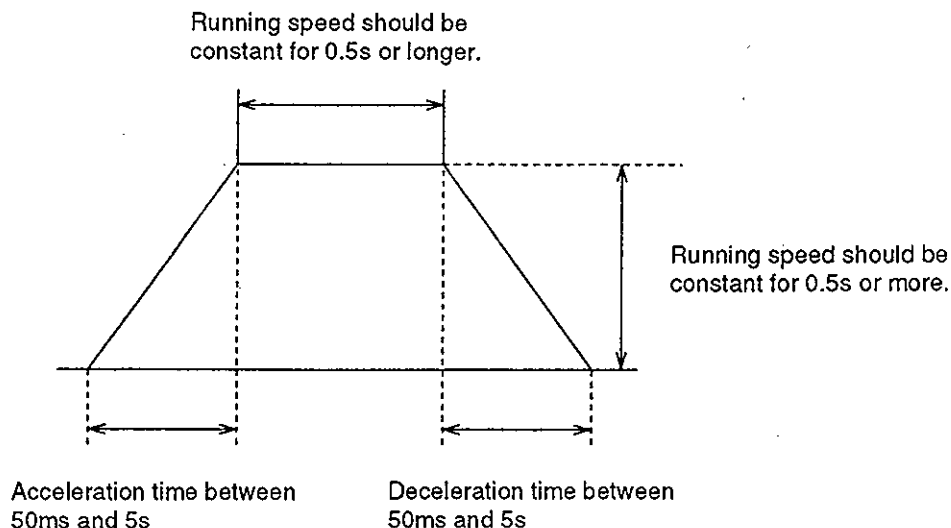
(3) Timing chart



Note 1. Change the response setting while the servo motor is at a stop.

(4) Auto tuning

- 1) The acceleration/deceleration time is 50ms to 5s (acceleration and deceleration times may be different from each other).
Within this range, the acceleration/deceleration torque of the actual servo motor should be not more than the maximum torque.
- 2) Trapezoidal acceleration/deceleration at the running speed of 500r/min or higher.
- 3) The running speed is constant for 0.5s or more.



(5) Machine conditions for auto tuning

For the following machines, auto tuning may not provide excellent characteristics:

- 1) Machines which vary in load inertia or load torque
- 2) Machines having large backlash
- 3) Machines which are low in rigidity and are apt to cause resonance

3. DISPLAY AND OPERATION

3-4 Manual Adjustment of Servo Loop Gain

If stable motor rotation is not achieved by the auto tuning, make the auto tuning invalid and adjust the gain and other parameters by manual setting.

(1) Preparations

Set "2" to I-AUTO-TUNING on the basic parameter screen.

(2) Basic adjustments

In the manual gain adjustment, first adjust the following two gains:

1) LOAD INERTIA RATIO (A- on adjustment parameter screen)

Set the ratio of the load inertia to the servo motor inertia.

$$\text{Load inertia ratio} = \frac{\text{load inertia}}{\text{motor inertia}}$$

2) VEL.LOOP GAIN 2 (E- on adjustment parameter screen)

Vibration may be generated on a low-rigidity machine, a machine having large backlash, etc. First, set the parameter according to the load inertia ratio using the following table as a guideline. If vibration still persists, reduce the parameter value until vibration is not generated.

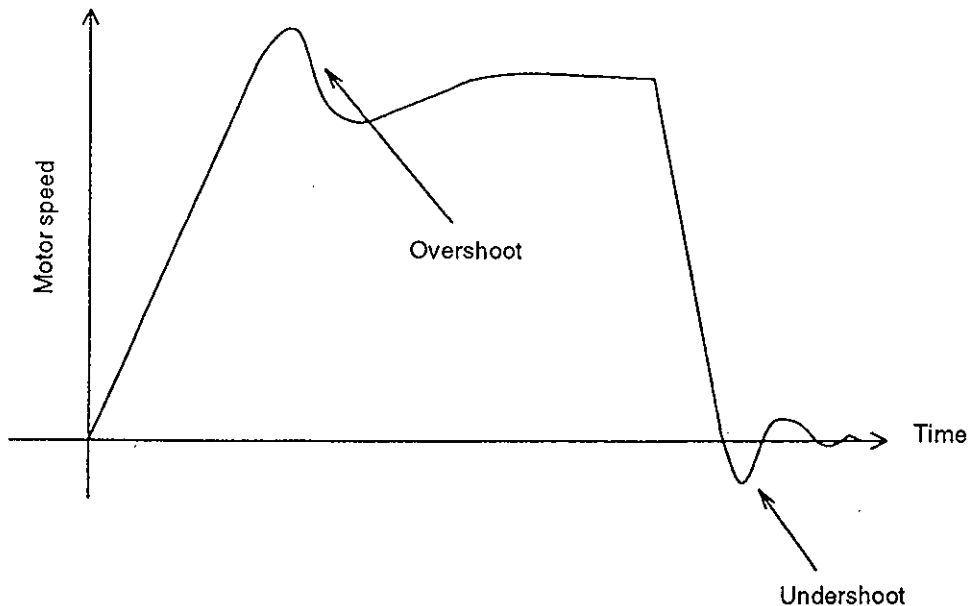
Load inertia moment ratio	1	3	5	10	20	30 or more
Set value	800	1000	1500	2000	2000	2000

(3) Application adjustments

If the desired operation is not achieved after the basic adjustments, adjust the following gains:

1) POS.LOOP GAIN 1 (B- on adjustment parameter screen)

Increase the value of this parameter to reduce the setting time. If this value is too large, overshoot will occur. Set this value within the range where overshoot and undershoot do not take place.



3. DISPLAY AND OPERATION

- 2) VEL.LOOP GAIN 1 (C- on adjustment parameter screen)
Set this parameter to increase tracking performance in response to a command.
- 3) POS.LOOP GAIN 2 (D- on adjustment parameter screen)
Calculate and set this parameter using the load inertia ratio and speed control gain 2.

$$\text{Position gain 2} = \frac{\text{speed gain 2}}{1 + \text{load inertia}} \times \frac{1}{10}$$

- 4) VEL.INTGRL COMPS. (F- on adjustment parameter screen)
Set this parameter when rotation is not uniform due to load torque. Set the parameter according to the load inertia moment ratio using the following table as a guideline:

Load inertia ratio	1	3	5	10	20	30 or more
Set value	20	30	40	60	100	200

3-5 Low Acoustic Noise Mode

By making parameter setting from the controller, select the low acoustic noise mode to improve motor-generated, audible-frequency magnetic noise about 20dB.

Setting method

Use M-OPTIONAL FUNC.2 (CARRIER FREQ.SEL) on the adjustment parameter screen.

Setting	Description
0	2.25 (Non-low acoustic noise mode)
3	9 (Low acoustic noise mode)

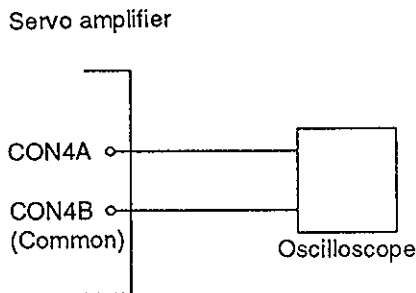
3. DISPLAY AND OPERATION

3-6 Analog Output

The operating status of the servo amplifier can be output as analog data in real time. The operating status can be checked by using an oscilloscope.

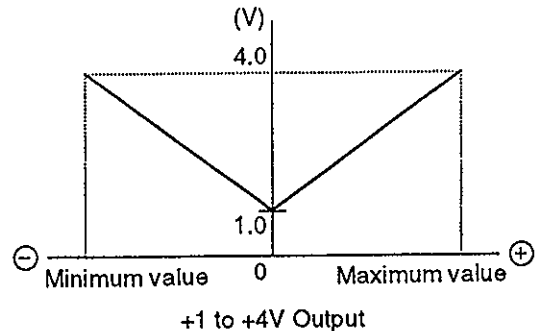
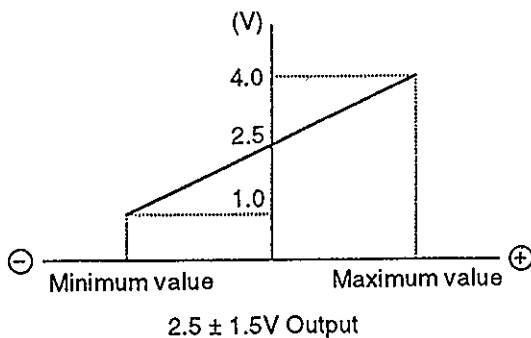
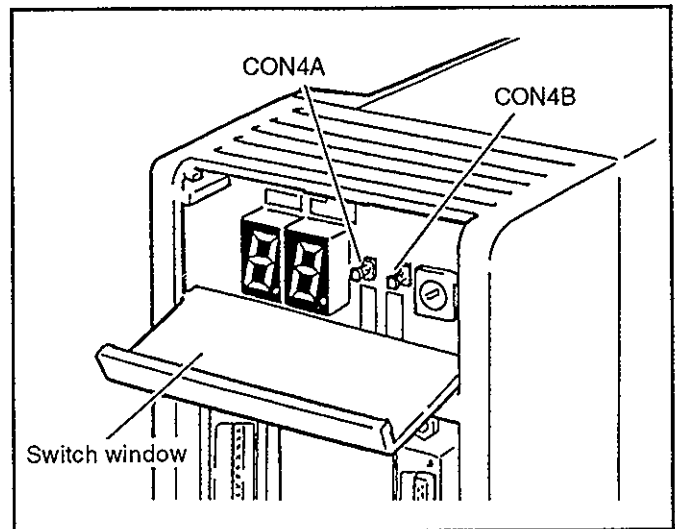
Setting method

Set the mode to be output to K-MON. OUT MODE (MON1) on the adjustment parameter screen. Connect an oscilloscope across analog output terminals CON4A-CON4B to monitor the operating status.



Setting of monitor output mode (monitor 1)

Setting	Monitor Output
0	Servo motor speed (2.5 ± 1.5V/maximum speed)
1	Torque (2.5 ± 1.5V/maximum torque)
2	Servo motor speed (+1V to +4V/maximum speed)
3	Torque (+1V to +4V/maximum torque)
4	Current command output (2.5 ± 1.5V/maximum current)
5	Command pulse frequency (2.5 ± 1.5V/400kpps)
6	Droop pulse value 1/1 (2.5 ± 1.5V/2048 pulses)
7	Droop pulse value 1/4 (2.5 ± 1.5V/8192 pulses)
8	Droop pulse value 1/16 (2.5 ± 1.5V/32768 pulses)
9	Droop pulse value 1/32 (2.5 ± 1.5V/65536 pulses)



3

4. AUXILIARY EQUIPMENT AND OPTIONS

4-1 Dedicated Options

4-1-1 Regenerative brake option

Use the regenerative brake option. The regenerative brake resistor is not built in the servo amplifier.

(1) Selection

1) Judging whether the regenerative brake option is required or not

In principle, use the regenerative brake option for 300W or more. Note that if regenerative power calculated can be absorbed by only the charging energy of the electrolytic capacitor, the regenerative brake option is not required. (Refer to (3) in this section.)

2) Regenerative brake characteristics

a. Regenerative brake torque

For the brake torque in the regenerative mode, maximum torque can be generated independently of whether the regenerative brake option exists or not.

b. Regenerative brake duty

When the servo motor is run alone in the regenerative mode from running speed to a stop, the permissible duty is as indicated in the standard specifications (Table 8-1). When a load is connected, the permissible duty changes according to the inertia of the load and can be calculated by the following expression:

$$\text{Permissible duty} = \frac{\text{permissible duty for operation of the servo motor alone (value indicated in Table 8-1)}}{(m + 1)} \times \left(\frac{\text{rated speed}}{\text{running speed}} \right)^2 [\text{times / minute}] \dots \dots \dots (4-1)$$

where m = load inertia moment/motor inertia

Judging whether the regenerative brake option is required or not

From the permissible duty, find whether the regenerative brake option is required or not. If the following condition is satisfied:

Permissible duty (Expression 4-1)

> number of positioning times n1 [times/minute]

and the number of positioning times n1 [times/minute] in the machine specifications can be attained, the regenerative brake option is not required, and if n1 cannot be attained, the regenerative brake option is required.

(2) Specifications of combined regenerative brake options

Servo Amplifier	Regenerative Brake Option Specifications			
	Model	Qty	Resistor	Regenerative power (W)
MR-J10B to MR-J100B	MR-RB013	1	52Ω	10
	MR-RB033	1	52Ω	30
	MR-RB064	2	52Ω	100 (2 resistors connected in series)
	MR-RB32	1	40Ω	300
MR-J200B	MR-RB064	1	26Ω	60
	MR-RB34	1	26Ω	300
	MR-RB54	1	26Ω	500



4. AUXILIARY EQUIPMENT AND OPTIONS

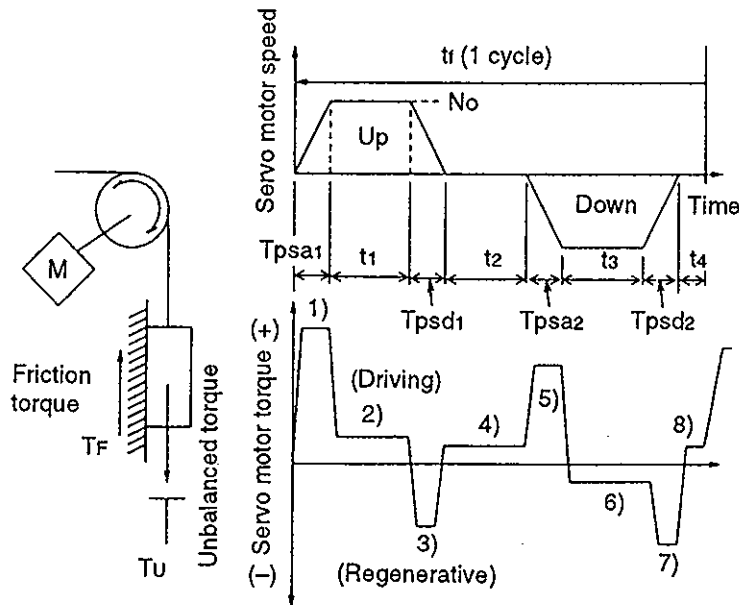
(3) Calculation of regenerative power

1) Calculation of regenerative energy

Use the following table to calculate regenerative energy.

Expressions for Calculating Torque and Energy in Each Operation

Operation Region	Torque Applied to Motor T [N·m]	Energy E [J]
1)	$T_1 = \frac{(J_L + J_M) \cdot N_0}{9.55 \times 10^4} \cdot \frac{1}{T_{psa1}} + T_U + T_F$	$E_1 = \frac{0.1047}{2} \cdot N_0 \cdot T_1 \cdot T_{psa1}$
2)	$T_2 = T_U + T_F$	$E_2 = 0.1047 \cdot N_0 \cdot T_2 \cdot t_1$
3)	$T_3 = \frac{(J_L + J_M) \cdot N_0}{9.55 \times 10^4} \cdot \frac{1}{T_{dsd1}} + T_U + T_F$	$E_3 = \frac{0.1047}{2} \cdot N_0 \cdot T_3 \cdot T_{psd1}$
4), 8)	$T_4 = T_U$	$E_4 \geq 0$
5)	$T_5 = \frac{(J_L + J_M) \cdot N_0}{9.55 \times 10^4} \cdot \frac{1}{T_{psa2}} - T_U + T_F$	$E_5 = \frac{0.1047}{2} \cdot N_0 \cdot T_5 \cdot T_{psa2}$
6)	$T_6 = T_U + T_F$	$E_6 = 0.1047 \cdot N_0 \cdot T_6 \cdot t_3$
7)	$T_7 = \frac{(J_L + J_M) \cdot N_0}{9.55 \times 10^4} \cdot \frac{1}{T_{psd2}} - T_U + T_F$	$E_7 = \frac{0.1047}{2} \cdot N_0 \cdot T_7 \cdot T_{psd2}$
Sum total of regenerative energies E_s		Sum total of - energies in 1 to 8 E_s



Vertical Drive Axis Operation Pattern

4. AUXILIARY EQUIPMENT AND OPTIONS

2) Losses of servo motor and servo amplifier in regenerative mode

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

Servo Motor	Inverse Efficiency (%)	Amplifier Loss (W)	Capacitor Charging	Servo Motor	Inverse Efficiency (%)	Amplifier Loss (W)	Capacitor Charging
HA-FH053	35	5	11	HA-SH52	80	5	18
HA-FH13	55			HA-SH102	85		
HA-FH23	70			HA-SH152	85	7	33
HA-FH33	75			HA-SH202	85		
HA-FH43	85		18	HA-SH53	80	5	18
HA-FH63	85			HA-SH103	85		
HA-SH81	80			HA-SH153	85	7	33
HA-SH121	85			HA-SH203	85		
HA-SH201	85	7	33				

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

Servo amplifier loss (EA) : Loss consumed in the servo amplifier.
Convert this loss into regenerative energy in accordance with the following expression:

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

where t = regenerative operation time, not including driving time

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

Heat generated by the regenerative brake option

Subtract the servo amplifier loss from the inverse efficiency to calculate the energy consumed by the regenerative brake option.

$$ER \text{ (Joule)} = \eta \times Es - EA - EC$$

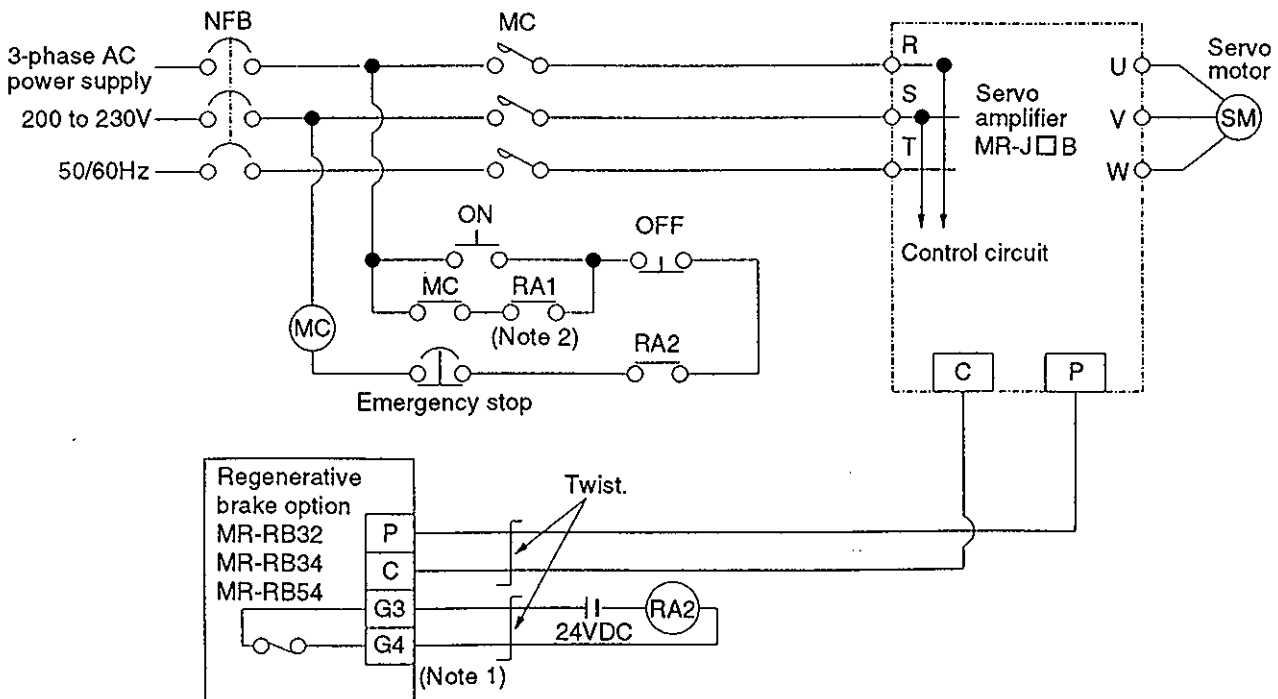
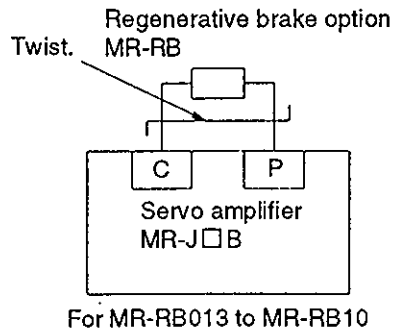
Calculate the consumption power of the regenerative brake option on the basis of single-cycle operation period t_f (sec) to select the regenerative brake option.

$$PR \text{ (W)} = ER/t_f$$

4. AUXILIARY EQUIPMENT AND OPTIONS

(4) Connection of the regenerative brake option

The regenerative brake option used should be connected as shown below:



For MR-RB32, MR-RB34, MR-RB54

Note: 1. When two MR-RB30s are connected in series, also connect terminals G3 and G4 directly.

Do not apply 200VAC to terminals G3 and G4 of the MR-RB32, MR-RB34 and MR-RB54.

2. Open RA1 at occurrence of an alarm in the motion controller.

Connection of the Regenerative Brake Unit

Notes on use

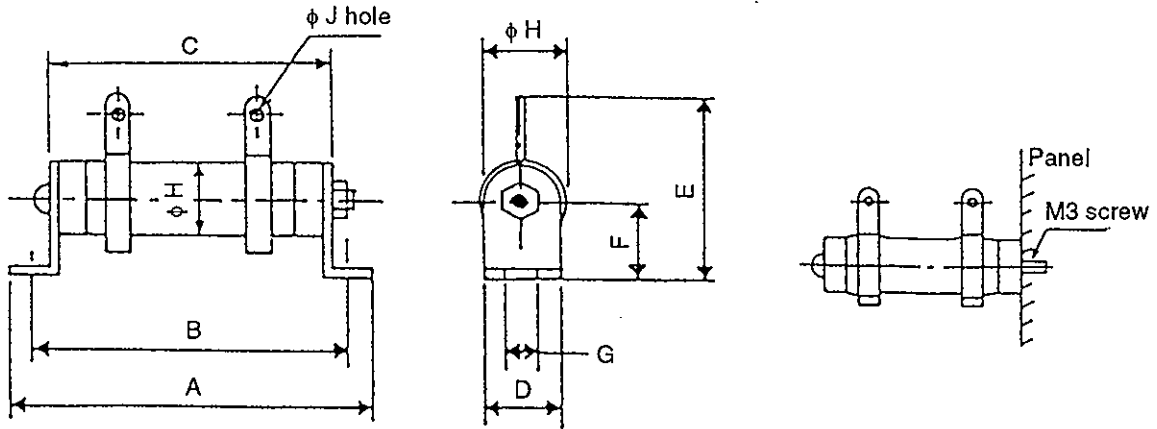
1. Twisted cables must be used for the wiring of the regenerative brake option and run as short as possible (5m max.).
2. The regenerative brake option, which will generate heat of about 100 degrees, should not be installed directly to a wall surface easily affected by heat. Use fire-retardant cables or make the cables fire-retardant (silicone tubing, etc.) and run the cables away from the regenerative brake option to avoid contact.

4. AUXILIARY EQUIPMENT AND OPTIONS

(5) Outside dimensions of the regenerative brake options

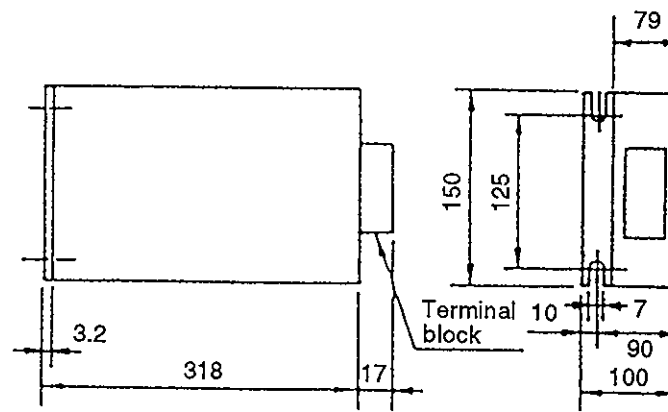
Model: MR-RB013, 033, 064

By removing the mounting brackets, the MR-RB013 can be installed as shown below.



Regenerative Brake Option Model	Regenerative Power	Variable Dimensions mm								
		A	B	C	D	E	F	G	H	J
MR-RB013	10W	110	101	85	18	35	16	4.5	18	3.2
MR-RB033	30W	192	173	152	26	54	22	6	26	3.2
MR-RB064	60W	306	287	266	26	54	22	6	26	4.3

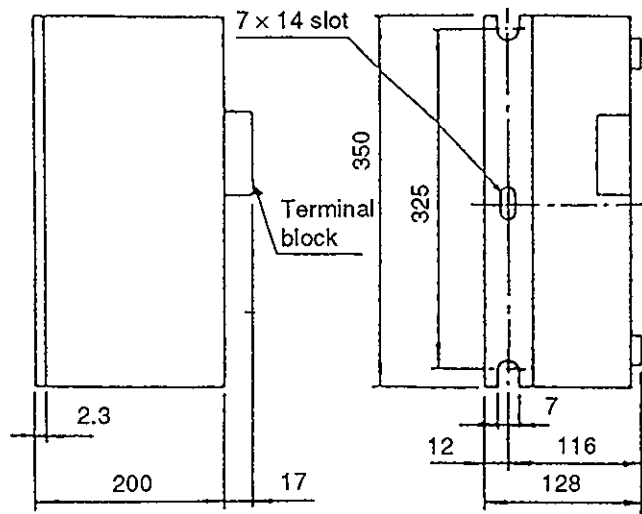
Model: MR-RB32, MR-RB34



Model	Regenerative Power (W)
MR-RB32	300
MR-RB34	300

4. AUXILIARY EQUIPMENT AND OPTIONS

Model: MR-RB54

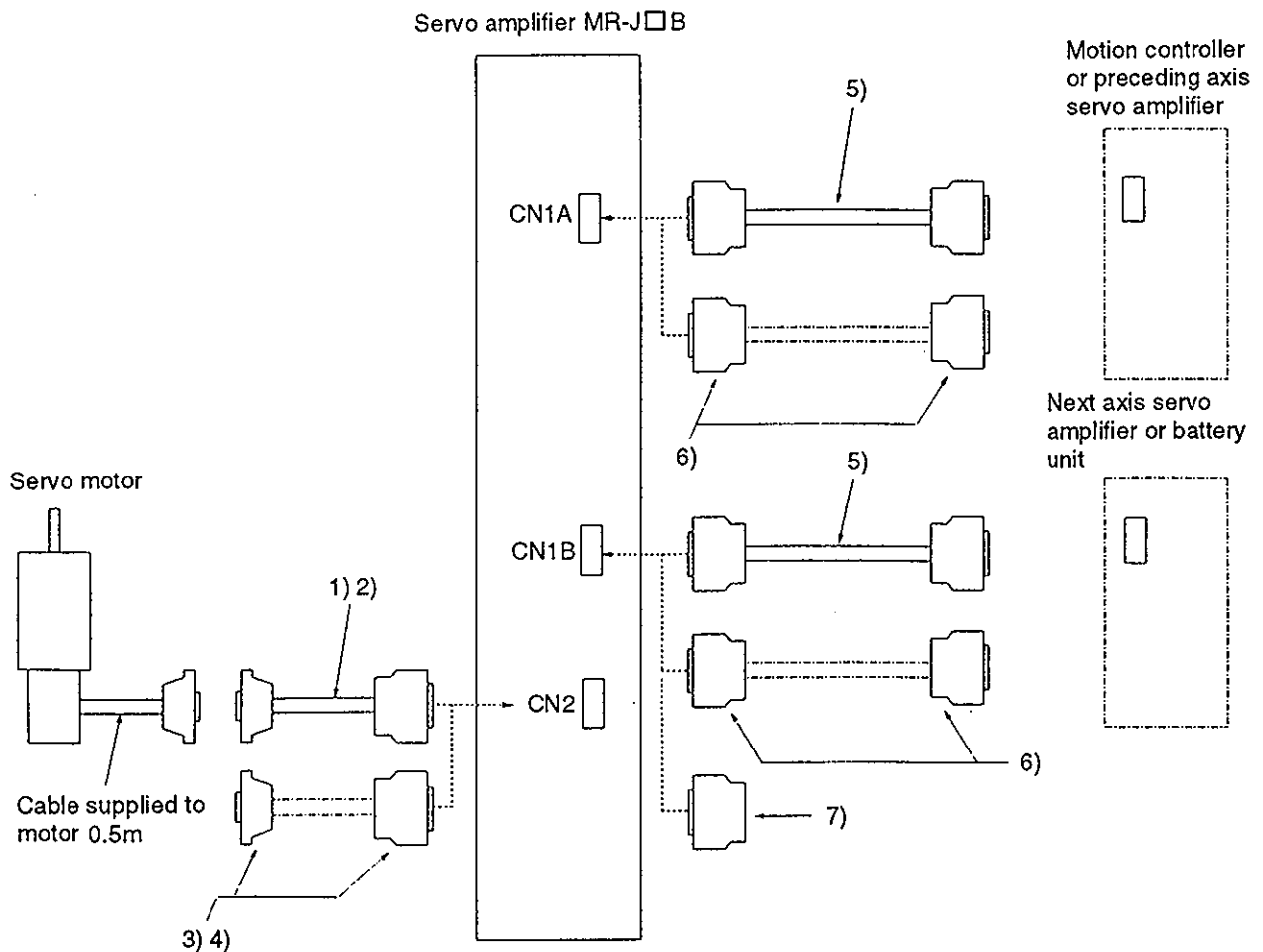


Model	Regenerative Power (W)
MR-RB54	500

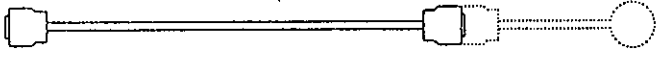
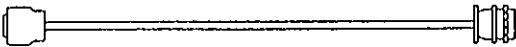


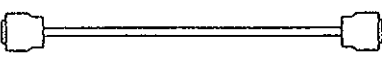


4. AUXILIARY EQUIPMENT AND OPTIONS

4-1-2 Cable connectors

- When the cable for connection of the servo motor detector and servo amplifier is to be purchased as an option, specify the encoder cable (1 or 2 in the figure below) after checking the servo motor series and required wiring length. When the encoder cable is to be fabricated by yourself, check the servo motor series, specify the detector connector set (3 or 4 in the figure below), and fabricate the encoder cable with reference to Section 4-1-4.
- When purchasing the bus cable, check the required wiring and specify the servo bus cable 5. To fabricate the servo bus cable by yourself, specify the servo bus connector 6 and refer to Section 4-1-3.



4. AUXILIARY EQUIPMENT AND OPTIONS

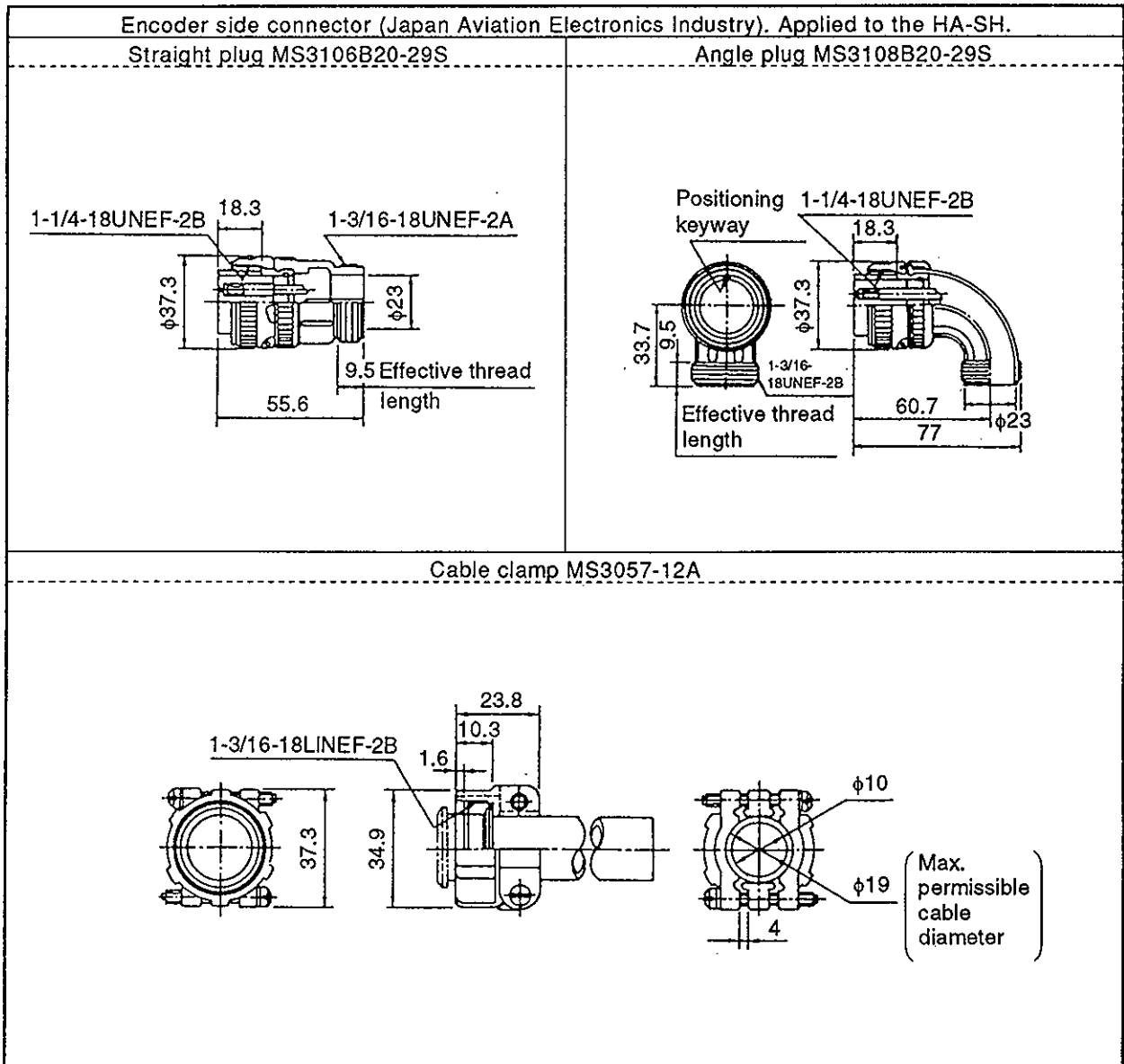
	Model	Name	Description	
Select any of those for CN2	1) MR-HCBL□M □ indicates cable length: 2, 5, 10, 20, 30m.	Encoder cable for the HA-FH series motor (50W to 600W)	Servo amplifier side connector (CN2) (Honda Tsushin Kogyo) PCR-S20FS, PCR-LS20LA1	Junction connector, Motor encoder (Honda Tsushin Kogyo) PCR-E20PMRS-SL, PCR-S20PLA2
				
	2) MR-HSCBL□M □ indicates cable length: 2, 5, 10, 20, 30m.	Encoder cable for the HA-SH/LH/UH series motor (0.5kW to 7kW)	Servo amplifier side connector (CN2) PCR-S20FS, PCR-LS20LA1 (Honda Tsushin Kogyo)	Encoder side connector (Japan Aviation Electronics Industry) MS3106B20-29S, MS3057-12A
				
	3) MR-HCNS	Encoder connector set for the HA-FH series motor	Servo amplifier side connector (CN2) PCR-S20FS...Connector PCR-LS20LA1...Case (Honda Tsushin Kogyo)	Junction connector PCR-E20PMRS-SL...Connector PCR-S20PMLA2...Case (Honda Tsushin Kogyo)
				
	4) MR-JSCNS	Encoder connector set for the HA-SH/LH/UH series motor	Servo amplifier side connector (CN2) PCR-S20FS...Connector PCR-LS20LA1...Case (Honda Tsushin Kogyo)	Encoder side connector MS3106B20-29S...Connector MS3057-12A...Case (Japan Aviation Electronics Industry)
				
Select either one for CN1A and CN1B	5) MR-H-BUS□M □ indicates cable length: 0.5, 5m.	Bus cable	PCR-S20FS, PCR-LS20LA1 (Honda Tsushin Kogyo)	PCR-S20FS, PCR-LS20LA1 (Honda Tsushin Kogyo)
				
	6) MR-H-BCNS	Connector set for bus cable	PCR-S20FS...Connector PCR-LS20LA1...Case (Honda Tsushin Kogyo)	PCR-S20FS...Connector PCR-LS20LA1...Case (Honda Tsushin Kogyo)
				
For CN1B	7) MR-TM	Terminal connector		Must be connected to CN1B of the final servo amplifier connected to the bus.

4. AUXILIARY EQUIPMENT AND OPTIONS

(1) Connectors

Outline drawing

Use the following connectors for connection of the signal cable. (Unit: mm)



4. AUXILIARY EQUIPMENT AND OPTIONS

Amplifier side connector (Honda Tsushin Kogyo) CN2, CN1A, CN1B			Encoder side junction connector (Honda Tsushin Kogyo) for HA-FH		
Number of Pins	Casing	Connector	Number of Pins	Casing	Connector
20	PCR-LS20LA1	PCR-S20FS (soldering type)	20	PCR-S20PMLA2	PCR-E20PMRS-SL (soldering type)
		PCR-S20F (crimping type)			
Number of Pins	Casing	Connector	Number of Pins	Casing	Connector
20	PCR-LS20LA1W	PCR-S20FS (soldering type)	20	PCR-S20PMLA2	PCR-E20PMRS-SL (soldering type)
		PCR-S20F (crimping type)			
Crimping tool: FHAT-0002A					

4. AUXILIARY EQUIPMENT AND OPTIONS

(2) Cables

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

1) 4-pair shielded cable

Applied to the MR-HCBL5M and MR-HSCBL5M

Type	Number of Cores, Size (mm)	Finishing OD (mm)	Characteristics of Single Cable	
			Structure (wires/mm)	Conductor resistance (Ω /km)
A14B2339	4 pairs x 0.2	7.2	40/0.08	105 or less

2) 6-pair shielded cable

Applied to the MR-HCBL10M to MR-HCBL30M, MR-HSCBL10M to MR-HSCBL30M and MR-HBUS05M to MR-HBUS5M

Type	Number of Cores, Size (mm)	Finishing OD (mm)	Characteristics of Single Cable	
			Structure (wires/mm)	Conductor resistance (Ω /km)
A14B2343	6 pairs x 0.2	7.9	40/0.08	105 or less

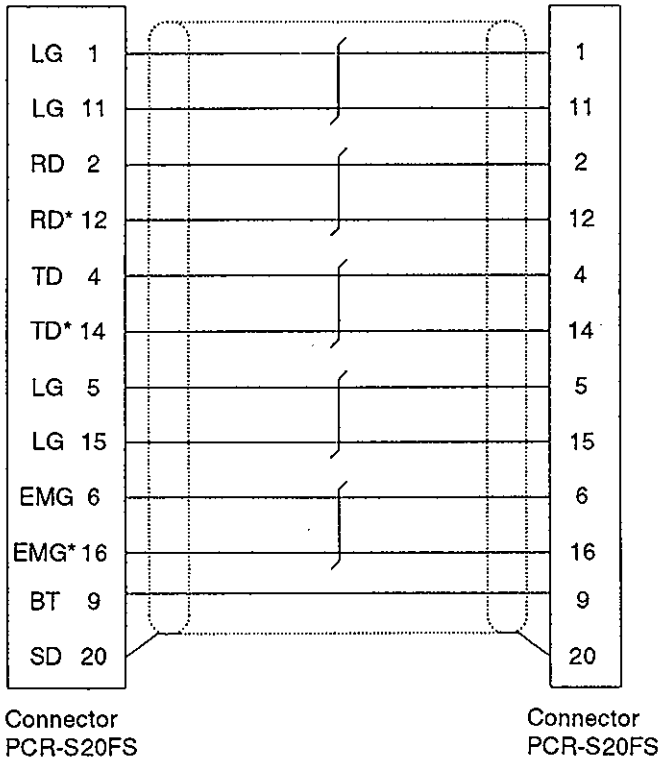
Manufacturer: Junkosha, agent: Toa Denki Kogyo

4. AUXILIARY EQUIPMENT AND OPTIONS

4-1-3 Detailed information on connection of the bus cable

The following is the connection diagram of the bus cable for connection of the servo amplifier with the controller or another servo amplifier.

MR-HBUS□M



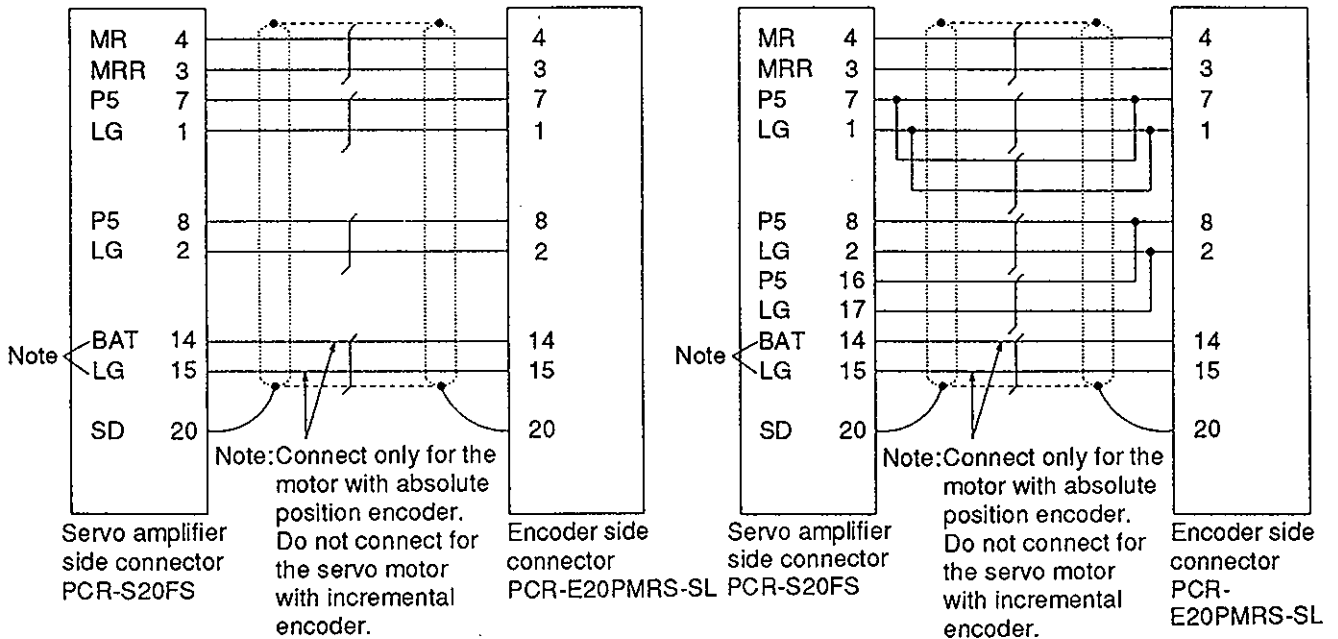
4. AUXILIARY EQUIPMENT AND OPTIONS

4-1-4 Detailed information on connection of the encoder cable

The following is the assembling diagram of the cables for connection of the servo motor encoder and controller. When purchasing the cables, specify the type of the cable set corresponding to the required wiring length. It is not recommended to connect two cables for cable extension because it will be the cause of noise generation.

The cables of 10m or more are turned out on order.

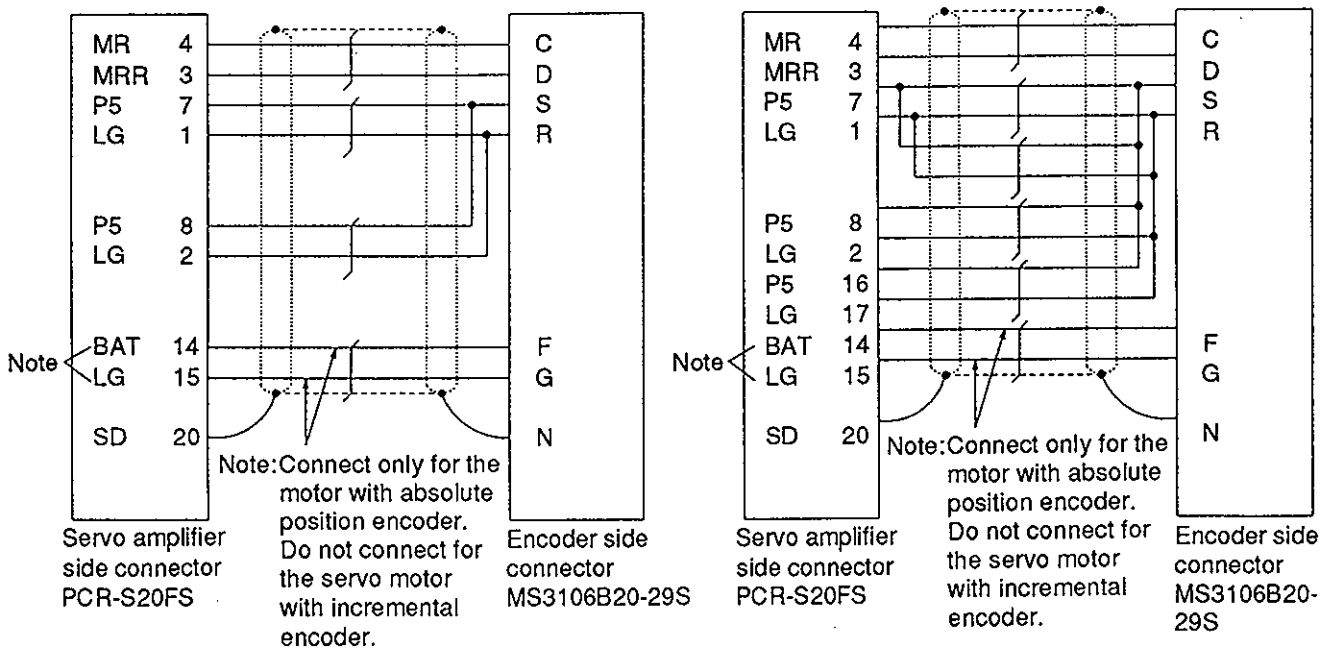
(1) MR-HCBL□M (Applied to the HA-FH series servo motor)



MR-HCBL5M (less than 10m)

MR-HCBL10M to MR-HCBL30M (10m to 50m)

(2) MR-HSCBL□M (Applied to the HA-SH series servo motor)



MR-HSCBL5M (less than 10m)

MR-HSCBL10M to MR-HSCBL30M (10m to 50m)

4. AUXILIARY EQUIPMENT AND OPTIONS

4-1-5 Battery unit

When configuring an absolute position detection system, use the MR-JBAT□ absolute position back-up battery unit.

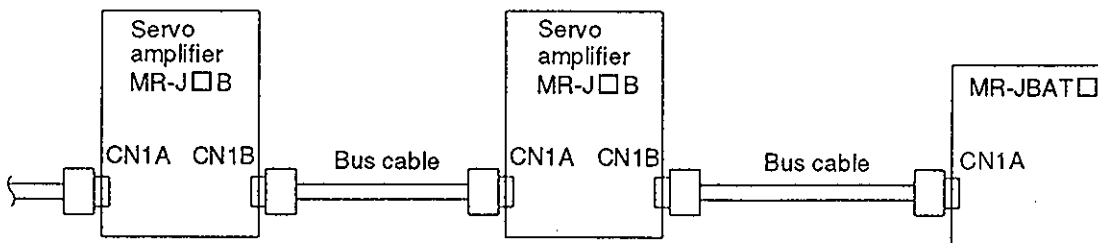
(1) Specifications

Model	Number of Servo Amplifiers Backed Up	Battery Back-Up Time ^(Note)	Battery Life
MR-JBAT4	Max. 4	Approx. 10,000 hours (for use of 4 servo amplifiers)	5 years
MR-JBAT8	Max. 8	Approx. 10,000 hours (for use of 8 servo amplifiers)	

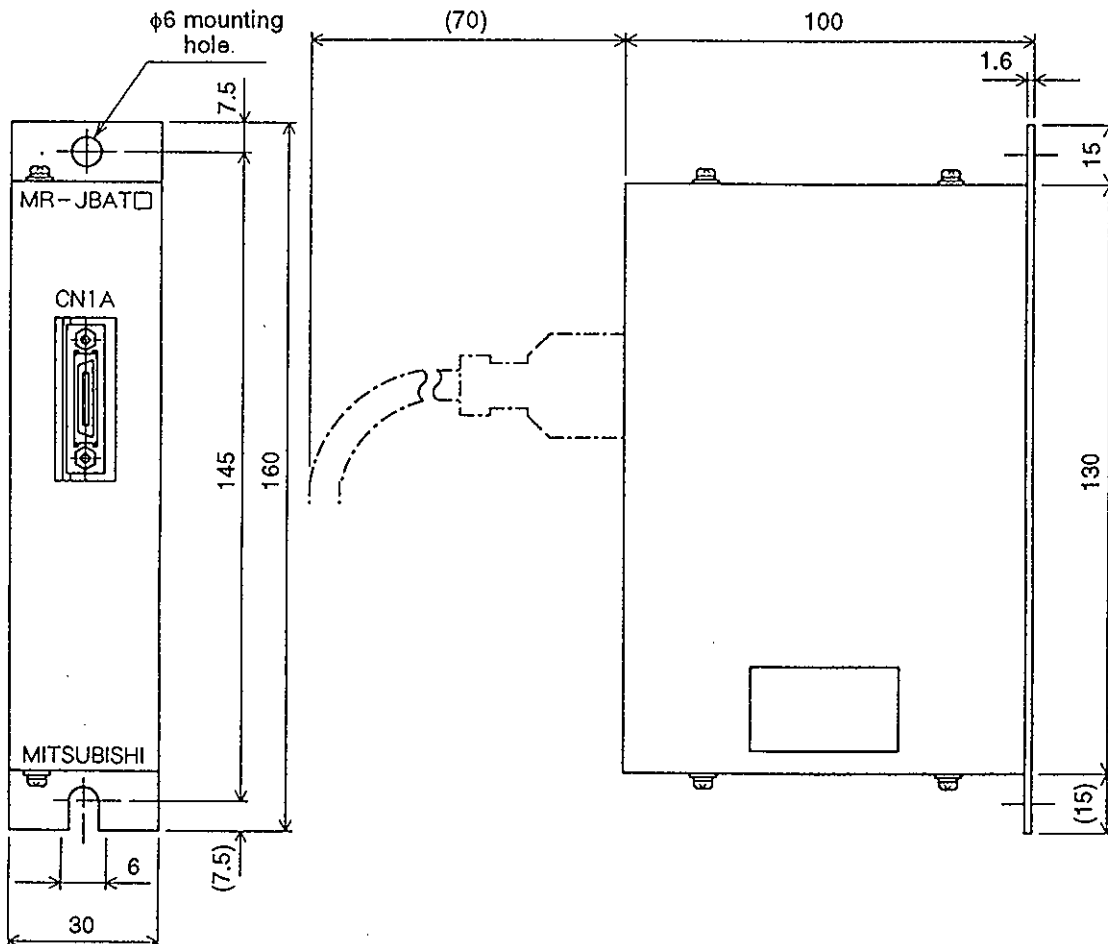
Note: Length of time when data can be stored by the battery with the power off.

(2) Connection diagram

Connect the battery unit to the last bus cable.



(3) Outline drawing



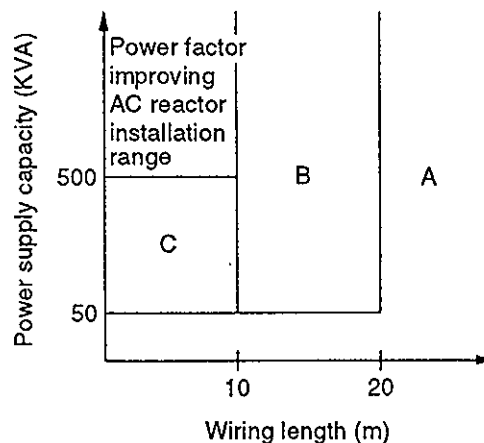
4. AUXILIARY EQUIPMENT AND OPTIONS

4-2 Peripherals

4-2-1 Cables, no-fuse breakers, magnetic contactors, power factor improving reactors

Select and use the main circuit cables and magnetic contactor with reference to the following table:

- Select the NFB in consideration of the power supply capacity and cable size.
- Provide the AC input power supply with a magnetic contactor (MC) according to the power supply capacity and wiring length so that the power is shut off at occurrence of an alarm.
- The reference cable size is 30cm.
- When the servo amplifier is connected near a large-capacity power supply transformer (500kVA or more and wiring length of 10m or less), an excessive current may flow at power-on, damaging the converter section. In such a case, fit the FR-BAL (option) to suppress the current.



Servo Amplifier Model	No-Fuse Breaker (NFB)	Magnetic Contactor (MC)			Cables (mm ²)			Power Factor Improving Reactor FR-BAL
		A	B	C	Terminal R, S, T ⏚	Terminal U, V, W	Terminal P, C	
MR-J10B, 20B	Type NF30 5A	S-K18	S-K21	S-K21	2	2	2	FR-BAL-0.4K
MR-J40B	Type NF30 10A	S-K18	S-K21	S-K21	2	2	2	FR-BAL-0.75K
MR-J60B	Type NF30 15A	S-K18	S-K21	S-K21	2	2	2	FR-BAL-1.5K
MR-J100B	Type NF30 15A	S-K18			2	2	2	FR-BAL-2.2K
MR-J200B	Type NF30 20A	S-K18			3.5	3.5	2	FR-BAL-3.7K

4

4. AUXILIARY EQUIPMENT AND OPTIONS

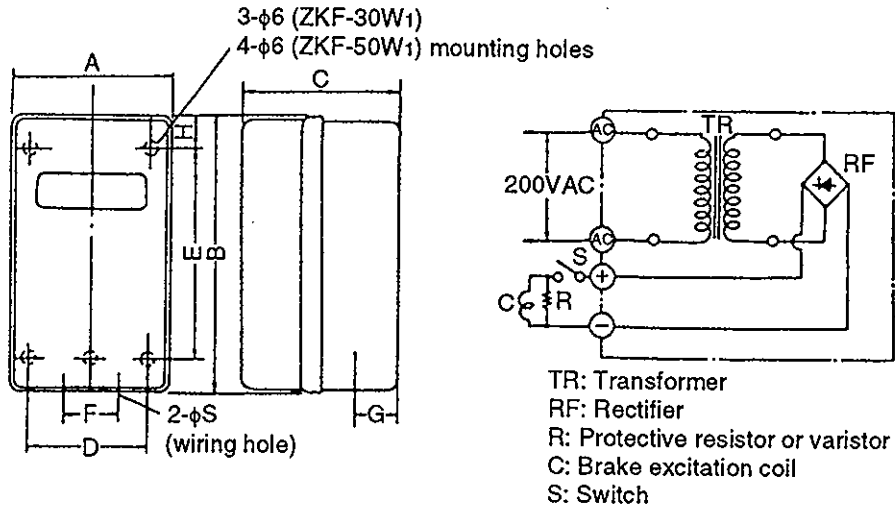
4-2-2 Power supply and surge absorber for electromagnetic brake

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 obtained from a 200VAC source. Use the following power supply or equivalent.

(Ex.) ZKF-W₁ type power supply unit



Type ZKF-W₁ power supply apparatus outline dimensions

Type	Power Supply Voltage AC (V)	Output Voltage DC (V)	Output Voltage (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

4. AUXILIARY EQUIPMENT AND OPTIONS

(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.

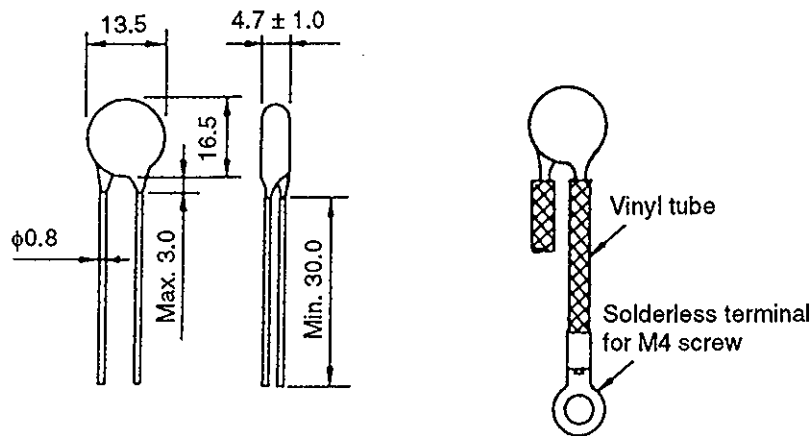
Maximum Rating					Max. Limit Voltage		Static Capacity (Reference value)	Varistor Voltage Rating (Range) V_{1mA}
Permissible circuit voltage		Surge immunity	Energy immunity	Rated power				
AC (Vrms)	DC (V)	(A)	(J)	(W)	(A)	(V)	(pF)	(V)
140	180	500/time (Note)	5	0.4	25	360	300	220 (198 to 242)

Note: 1 time = $8 \times 20\mu\text{sec}$

Example: ERZ-C10DK221 (Matsushita Electric)

TNR12G221K (MARCON ELECTRONICS)

Outline drawing [mm] (ERZ-C10DK221)



4. AUXILIARY EQUIPMENT AND OPTIONS

4-2-3 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 an 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).

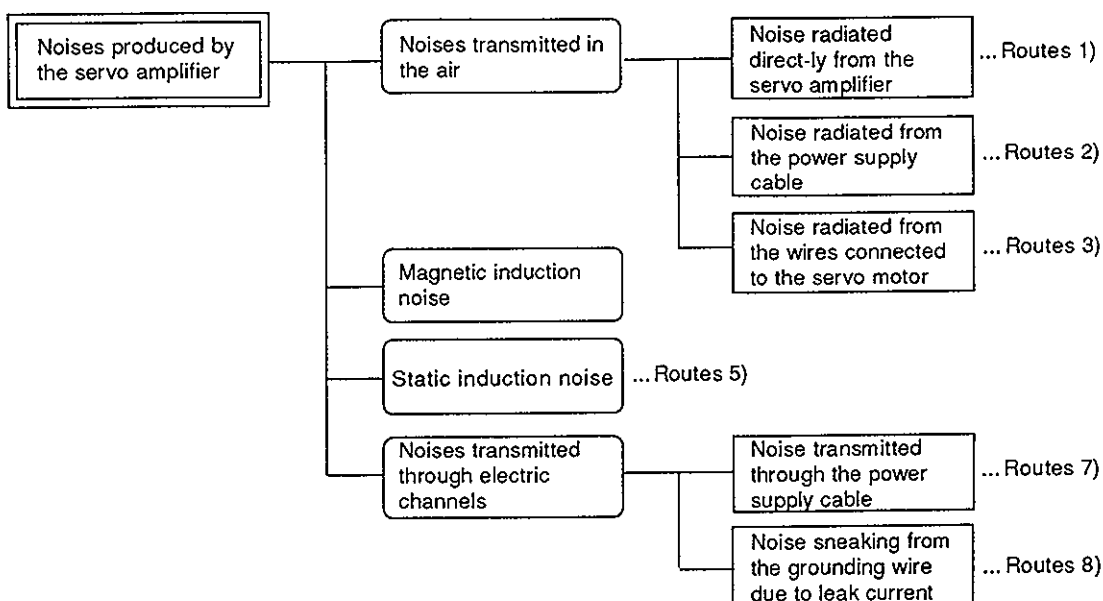
2) Reduction techniques for external noises that cause the servo amplifier to malfunction

If there are noise sources (such as magnetic contactor, electromagnetic 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.

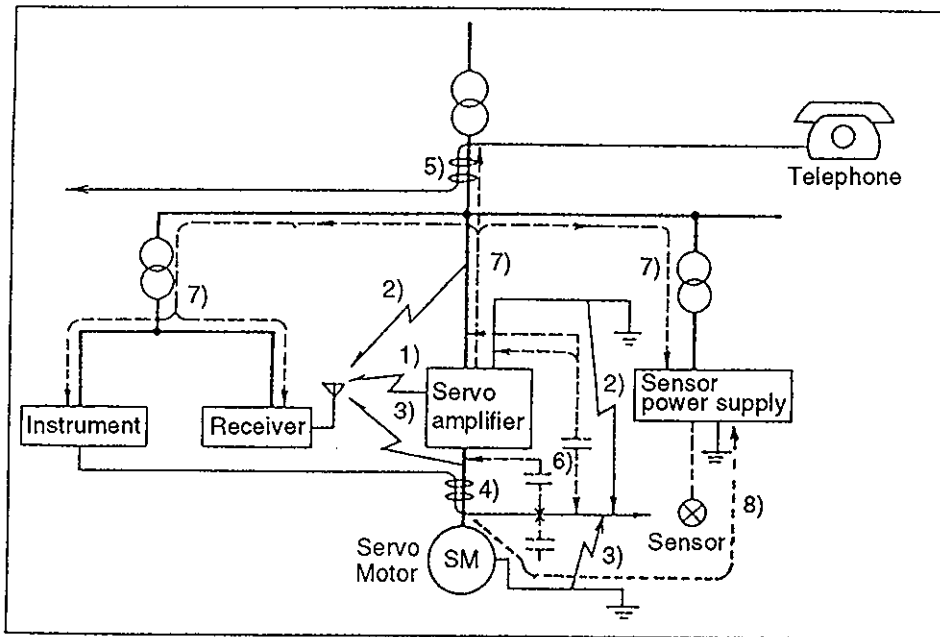
- Provide surge absorbers on the noise sources to suppress noises.
- Attach data line filters to the signal cables.
- Ground the shields of the encoder connecting wire and the control signal cables with cable clamp fittings.

3) Techniques for noises radiated by the servo amplifier that cause 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.



4. AUXILIARY EQUIPMENT AND OPTIONS



Noise transmission route	Countermeasures
1) 2) 3)	<p>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.</p> <ol style="list-style-type: none"> (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)	<p>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.</p> <ol style="list-style-type: none"> (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)	<p>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.</p> <ol style="list-style-type: none"> (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)	<p>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.</p>

4. AUXILIARY EQUIPMENT AND OPTIONS

(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.

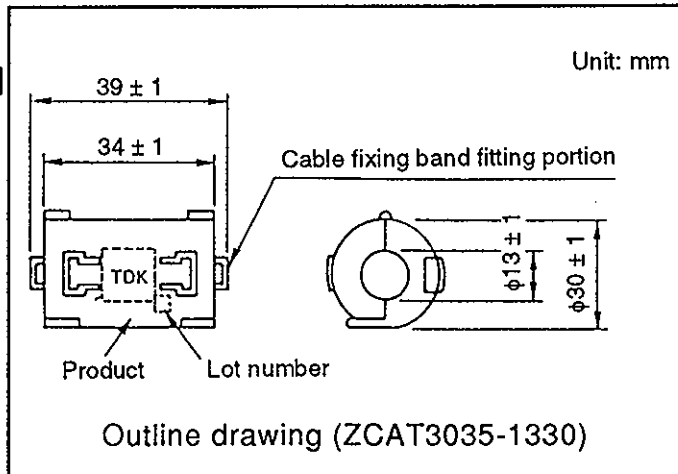
Ex: Data line filter: ZCAT3035-1330
 [Made by TDK]
 ESD-SR-25
 [Made by Tokin]

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

Impedance specifications (ZCAT3035-1330)

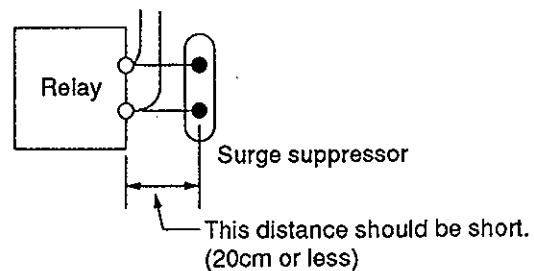
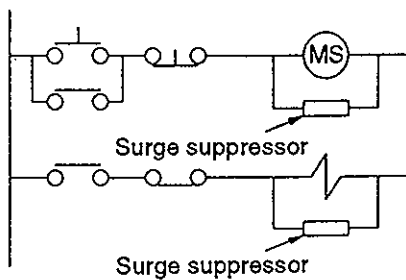
Impedance (Ω)	
10 to 100MHz	100 to 500MHz
80	150

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



(2) Surge suppressor

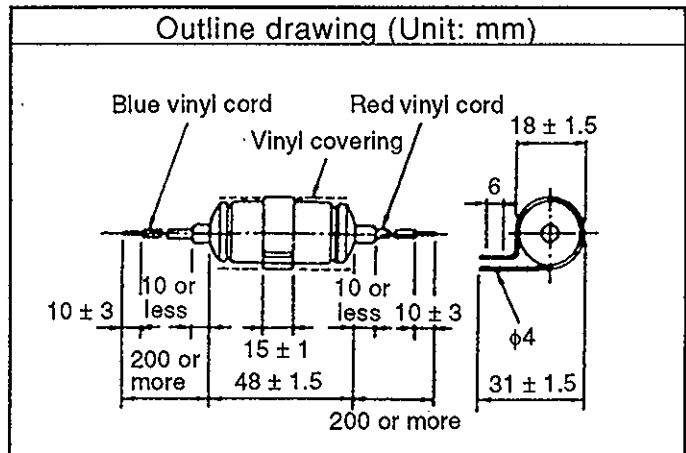
The recommended surge suppressor for installation an AC relay, AC valve, AC electro-magnetic brake or the like in the vicinity of the servo amplifier is shown below. Use this product or equivalent.



4. AUXILIARY EQUIPMENT AND OPTIONS

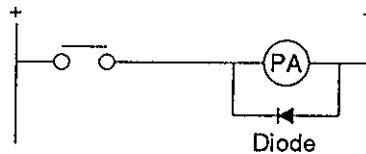
Example: 972A-2003 504 11 (Matsuo Electric
...200VAC rating)

Rated Voltage AC(V)	C (μ F)	R (Ω)	Test Voltage AC (V)
200	0.5	50 (1W)	Across T-C 1000 (1 to 5S)



Maximum voltage: Not less than 4 times greater than the relay or other drive voltage
Maximum current: Not less than 2 times greater than the relay or other drive current

Note that diodes should be fitted to the DC relay, DC valve, etc.



4

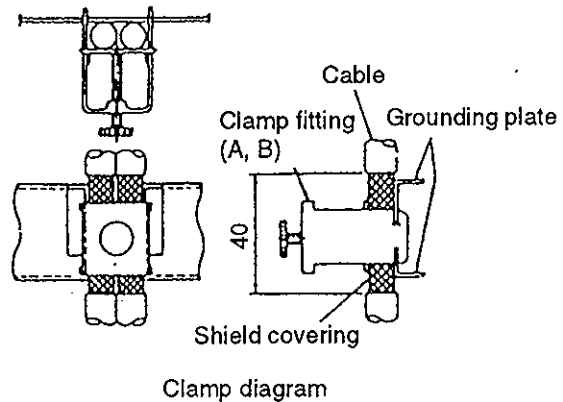
4. AUXILIARY EQUIPMENT AND OPTIONS

(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.

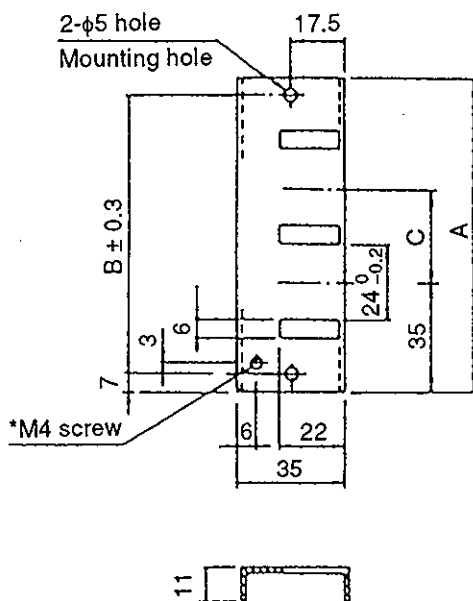
Install the earth plate near the servo amplifier for the encoder cable. Peel part of the cable sheath to expose the shield, and insert that part into the earth plate with the cable clamp. If the cable is thin, clamp several cables in a bunch.

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

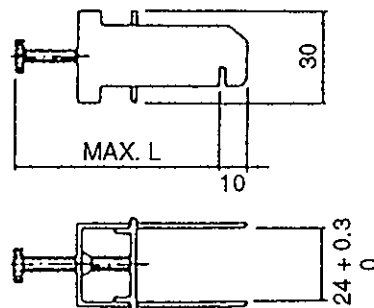


• Outline drawing

Grounding plate



Clamp fitting



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

2) * Screw hole for wiring to cabinet ground.

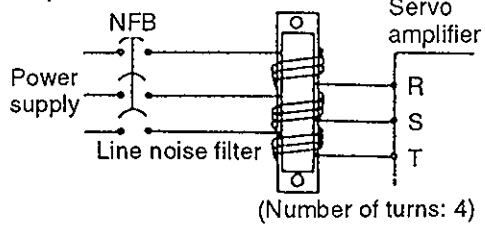
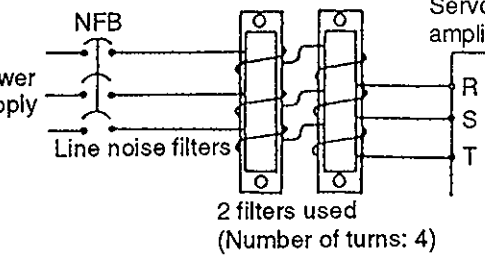
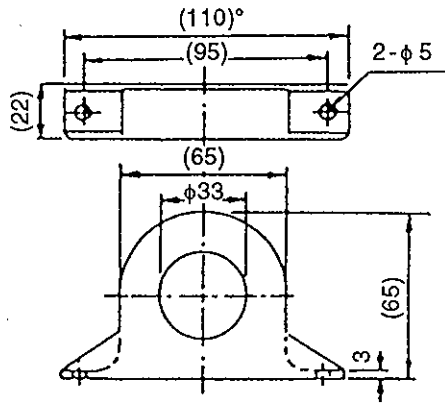
	A	B	C	Enclosed fittings
AERSBAN-DSET	100	86	30	Fitting A: 2pcs.
AERSBAN-ESET	70	56	-	Fitting B: 1pc.

	L
Clamp A	70
Clamp B	45

4. AUXILIARY EQUIPMENT AND OPTIONS

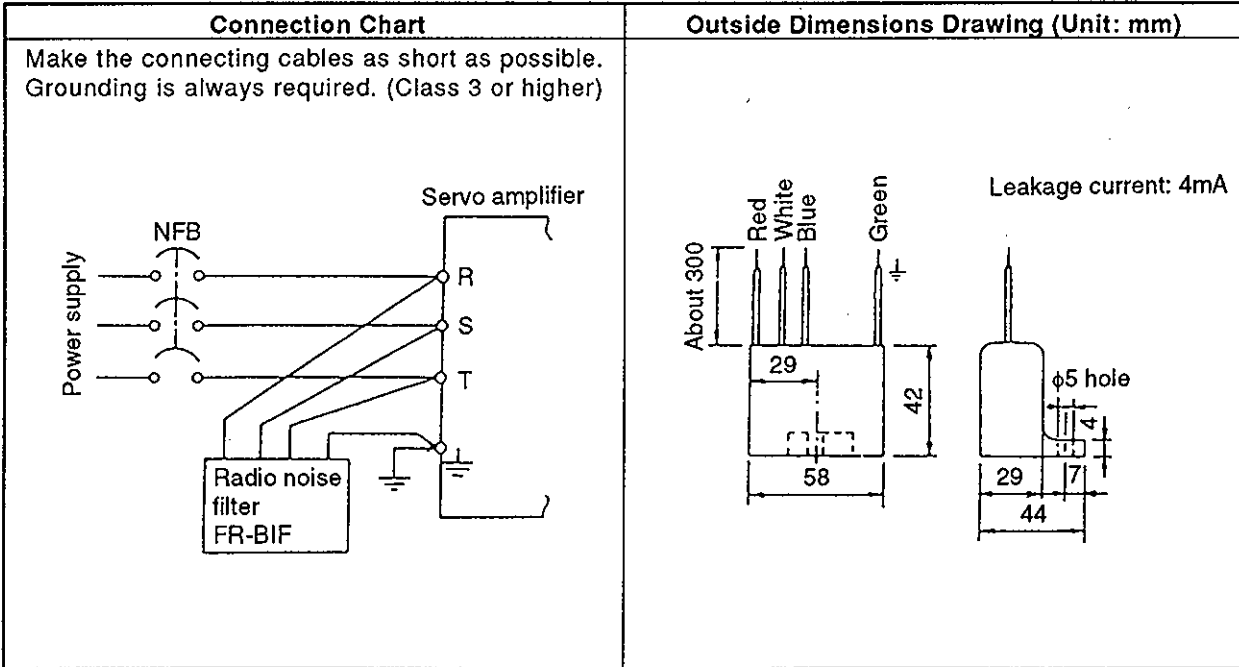
(4) Line noise filters (FR-BSF01)

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	Outside Dimensions Drawing (Unit: mm)
<ul style="list-style-type: none"> • 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. <p>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.</p> <p>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.</p> <p>Example 1</p>  <p>(Number of turns: 4)</p> <p>Example 2</p>  <p>2 filters used (Number of turns: 4)</p>	<p>FR-BSF01</p> 

4. AUXILIARY EQUIPMENT AND OPTIONS

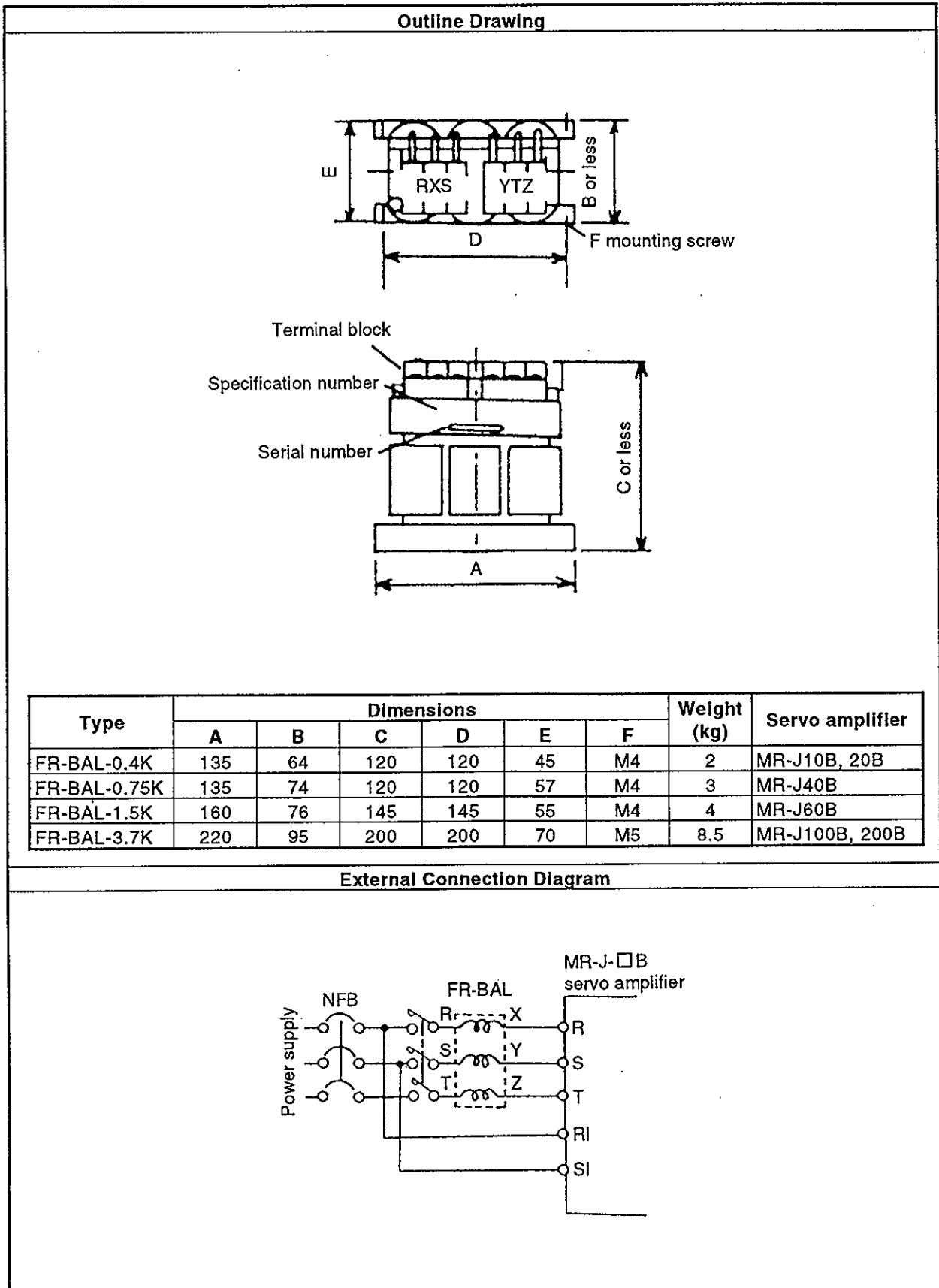
- (5) Radio noise filter (FR-BIF)...exclusively for the input side
 This filter is effective in suppressing noises radiated from the power supply side of the servo amplifier especially in 10MHz and lower radio frequency band. Exclusively for the input side and applicable to all types of servo amplifiers.



4. AUXILIARY EQUIPMENT AND OPTIONS

4-2-4 Power factor improving reactor

This reactor improves the power factor of the servo amplifier to reduce the power supply capacity.



4. AUXILIARY EQUIPMENT AND OPTIONS

4-2-5 Leakage current breaker

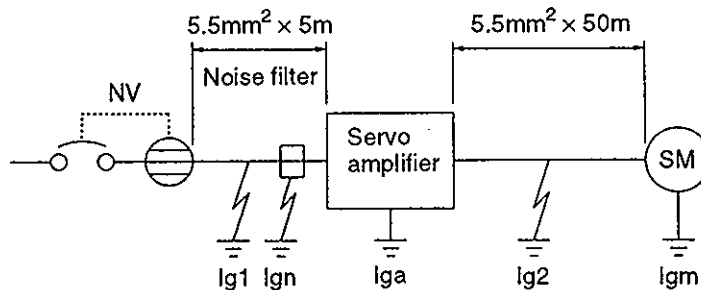
High-frequency chopper current controlled by pulse width modulation flows in the AC servo circuit. Leakage current containing the harmonic contents is larger than that of a servo motor which is run with a commercial power supply. Leakage current during the low noise operation is larger than that during 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: I_{g1} (mA)
(Obtain from Table 6-1.)
- Leakage current on the electric channel from the output terminal of the servo amplifier to the motor: I_{g2} (mA)
(Obtain from Table 6-1.)
- Leakage current when a filter is connected to the input side: I_{gn} (mA)
(4.4mA per one FR-BIF)
- Leakage current of the servo amplifier: I_{ga} (mA)
(Find using Table 4-3)
- Leakage current of the servo motor: I_{gm} (mA)
(Find using Table 4-2)



$$\text{Rated sensitivity current} \geq 10 \times \{I_{g1} + I_{gn} + I_{ga} + K \times (I_{g2} + I_{gm})\} \text{mA}$$

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): $K=3$

4. AUXILIARY EQUIPMENT AND OPTIONS

Table 4-1 Leakage Current Example over CV Cable Run in Metal Conduit (I_{g1}, I_{g2})

Cable Size (mm ²)	Leakage Current per 1km (mA)
2	13
3.5	17
5.5	33

Table 4-2 Leakage Current Example of Servo Motor (I_{gm})

Motor Capacity (kW)	Leakage Current (mA)
0.05 to 1.0	0.1
1.2 to 2.0	0.2

Table 4-3 Leakage Current Example 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 4-4 Earth Leakage Current Breaker Selection Example

Model	Rated Sensitivity Current of Earth Leakage Circuit Breaker
All servo amplifiers	15mA

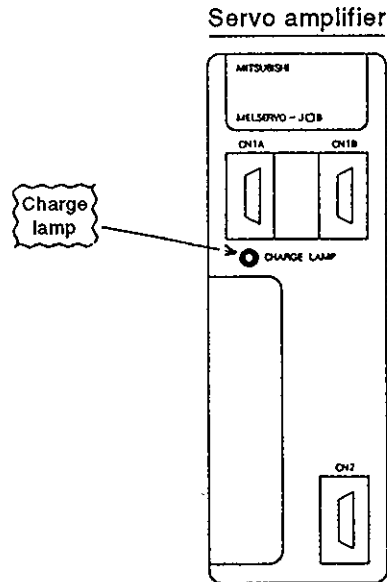
Note: The above value assumes that the wiring distance is 5m.

5. MAINTENANCE AND INSPECTION

5-1 Instructions

The MR-J□B servo amplifier uses a large-capacitance electrolytic capacitor. Before repair or inspection, check the red charge lamp as shown below. This lamp is lit to indicate that the voltage remains.

Before internal inspection, etc., check that the lamp is off.



5-2 Measurement of the Main Circuit Voltages, Currents and Powers

Since the voltages and currents on the power supply and output sides of the servo amplifier include harmonics, accurate measurement depends on the instruments used and circuits measured.

When instruments for commercial frequency are used for measurement, measure the circuits in Fig. 5-1 using the instruments in Table 5-1.

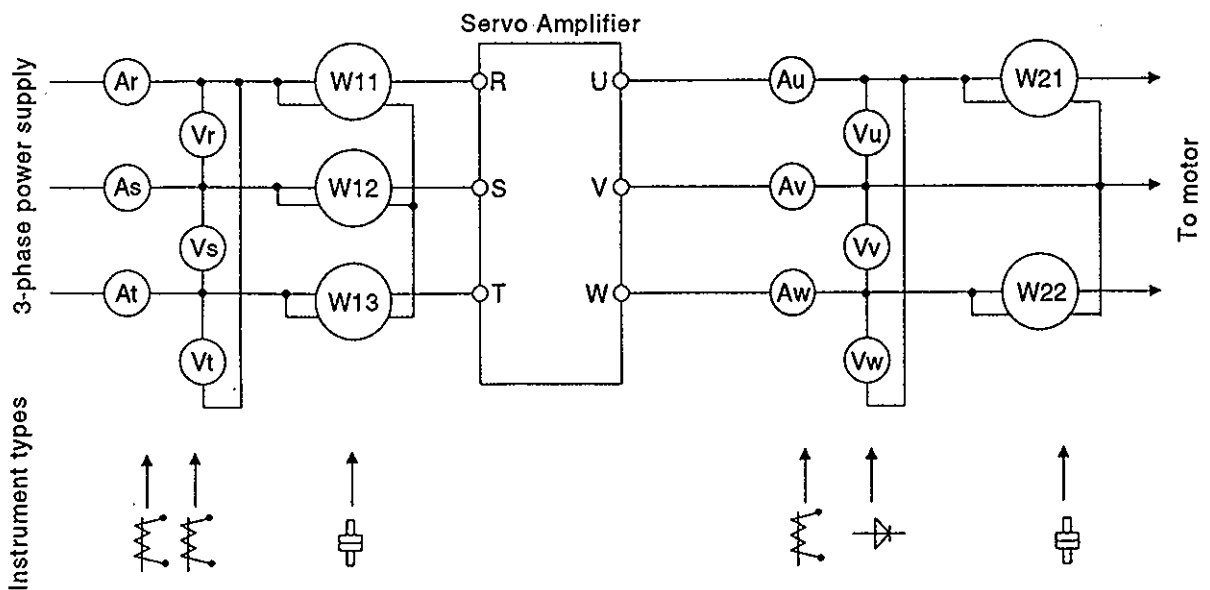


Fig. 5-1 Typical Measuring Points and Instruments

5. MAINTENANCE AND INSPECTION

Table 5-1 Measuring Points and Instruments

Item	Measuring Point	Measuring Instrument	Remarks (Reference Measured Value)
Power supply voltage V_1	Across R-S, S-T and T-R	Moving-iron type	Commercial power supply See the standard specifications (Section 8-2).
Power supply side current I_1	R, S and T line currents	Moving-iron type	
Power supply side power P_1	At R, S and T, and across R-S, S-T and T-R	Electrodynamic type	$P_1=W_{11}+W_{12}+W_{13}$ (3-wattmeter method)
Output side voltage V_2	Across U-V, V-W and W-U	Rectifier type (not moving-iron type)	Difference between phases is within $\pm 1\%$ of maximum output voltage.
Output side current I_2	U, V and W line currents	Moving-iron type	Current should be equal to or less than rated servo amplifier current. Difference between phases is 10% or less.
Output side power P_2	At U, V and W, and across U-V and V-W	Electrodynamic type	$P_2=W_{21}+W_{22}$ 2-wattmeter method (or 3-wattmeter method)

5. MAINTENANCE AND INSPECTION

5-3 Inspection

Perform inspection periodically in accordance with Table 5-2. Do not test the servo amplifier with a megger. Otherwise, the amplifier may become faulty.

Table 5-2 Daily and Periodic Inspection (1/2)

Area of Inspection	Inspection Item	Description	Instrument		Interval	Method	Criterion
			Daily	Periodic			
General	Surrounding environment	Check ambient temperature, humidity, dust, dirt, etc.	○		Refer to note in Section 2-2.	Refer to Section 2-2 Installation.	Thermometer, hygrometer, recorder
	Storage environment	Check ambient temperature, humidity, dust, dirt, etc.	○		Measure using thermometer, hygrometer, etc.	Servo motor: -10°C to +70°C (non-freezing) 90% or less (non-condensing) Servo amplifier: -20°C to +65°C (non-freezing) 90% or less (non-condensing)	Thermometer, hygrometer, recorder
	Overall unit	Check for unusual vibration and noise.	○		Visual and auditory checks.	No fault.	—
	Power supply voltage	Check that main circuit voltage is normal.	○		Measure voltage across servo amplifier terminals R-S-T.	See Section 8-2 Standard Specifications.	Tester, digital multimeter
Main circuit	Main circuit	(1) Check for loose connections. (2) Check for overheat on each part. (3) Clean.	○	○	(1) Retighten. (2) Visual check.	(1) Connections are tight. (2) No fault.	
	Conductors, cables	(1) Check conductors for distortion. (2) Check cable sheaths for breakage.	○	○	(1), (2) Visual check.	(1), (2) No fault.	
	Terminal block	Check for damage.	○		Visual check	No fault	
	Inverter module Converter module	Check resistance across terminals.	○		Disconnect cables from the servo amplifier and measure across terminals R, S, T↔P, N, and across U, V, W↔P, N with tester ×1Ω range.	—	Analog tester
	Smoothing capacitor	(1) Check for liquid leakage. (2) Check for safety valve projection and bulge. (3) Measure electrostatic capacity.	○	○	(1), (2) Visual check. (3) Measure with capacity meter.	(1), (2) No fault. (3) 85% or more of rated capacity.	Capacity meter

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5. MAINTENANCE AND INSPECTION

Table 5-2 Daily and Periodic Inspection (2/2)

Area of Inspection	Inspection Item	Description	Instrument		Interval	Method	Criterion
			Daily	Periodic			
Main circuit	Relay	(1) Check for chatter during operation. (2) Check the timer switch-on time. (3) Check for rough surface on contacts.		○	(1) Auditory check. (2) Time between power on and relay on. (3) Visual check.	(1) No fault. (2) Timer should be switched on in 0.1 to 0.15 seconds. (3) No fault.	Universal counter
	Resistor	(1) Check for crack in resistor insulation. (2) Check for open cable.		○	(1) Visual check. Cement resistor, wire-wound resistor. (2) Disconnect one end and measure with tester.	(1) No fault. (2) Error should be within $\pm 10\%$ of indicated resistance value.	Tester, digital multimeter
Control circuit Protective circuit	Operation check	(1) Check balance of output voltages across phases during no load operation.		○	(1) Measure voltages across servo amplifier output terminals U-V-W.	(1) Phase-to-phase voltage balance within 4V.	Digital multimeter, rectifier type voltmeter
Cooling system	Cooling fan	(1) Check for unusual vibration and noise. (2) Check for loose connections.	○	○	(1) Turn by hand with power off. (2) Retighten.	(1) Smooth rotation. (2) Connections are tight.	
Display	Display	Check for blown charge lamp and 7-segment LED display.	○		Indicate the lamp and display on the amplifier panel.	Check that the lamp and display are lit.	
Servo motor	General	(1) Check for unusual vibration and noise. (2) Check for unusual odor.	○	○	(1) Auditory, sensory, visual checks. (2) Check for unusual odor due to over-heat, damage, etc.	(1), (2) No fault	
	Insulation resistance	Check with megger (across terminals and ground terminal).		○	Disconnect cables from U, V, W, including detector cables.	5M Ω or more.	500V megger
	Detector	Check for unusual vibration and noise.	○		Auditory, sensory checks.	No fault	
	Cooling fan	(1) Check for unusual vibration and noise. (2) Check for mist, foreign matter, etc. stuck.	○		(1) Turn by hand with power off. (2) Visual check.	(1) Smooth rotation. (2) No fault.	
	Bearing	Check for unusual vibration and noise.	○		Auditory, sensory checks.	No fault	
Option	Battery unit	Check for warning, alarm.	○		Measure battery voltage.	3.2 \pm 0.2V or more.	Tester

6. TROUBLESHOOTING

6-1 Protective Functions

The servo amplifier has the following protective functions to protect the servo motor and servo amplifier completely. When the protective circuit is activated, the transistor base drive circuit is shut off to stop the output and protect the devices. At this time, the servo motor is dynamic braked to a stop and the motion controller and servo amplifier LED display the corresponding alarm code. Remove the cause of the alarm and switch the control power off once to reset.

The occurrence of warning (from 92 on) does not stop operation but may lead to an alarm if left as it is. Immediately check and remove the cause.

	Servo Amplifier LED Display	Function Name	Protection Provided
Alarm code	10	Undervoltage	Activated to indicate that the power supply voltage dropped to or below a given level or that an instantaneous power failure occurred for 15msec or longer.
	12	Memory alarm 1	Activated to indicate that a memory alarm was detected in the printed board.
	13	Clock alarm	Activated to indicate that a printed board alarm was detected.
	15	Memory alarm 2	Activated to indicate that a memory alarm was detected in the printed board.
	16	Encoder alarm 1	The encoder type is different. Activated to indicate that normal communication cannot be made with the encoder.
	17	Board alarm	Activated to indicate that the device fault of the servo amplifier board was detected.
	20	Encoder alarm 2	Activated to indicate that the encoder and encoder cable faults were detected.
	25	Absolute position erase	Indicates that the battery voltage fell and absolute position data was erased.
	30	Regenerative alarm	Activated to indicate that excessive loading on the regenerative brake resistor and a regenerative circuit alarm were detected due to the excessive frequency of use of regenerative braking.
	31	Overspeed	Activated to indicate that the servo motor speed reached or exceeded the permissible speed.
	32	Overcurrent	Activated to indicate that overcurrent was detected.
	33	Overvoltage	Activated to indicate that an excessive converter voltage was detected.
	34	CRC alarm	Activated to indicate that the communication fault of the bus cable (MR-HBUS) was detected.
	35	Command pulse frequency alarm	Indicates that the command pulse of excessive frequency was entered.
	36	Transfer alarm	Activated to indicate that the motion network cable or printed board alarm was detected.
	37	Parameter alarm	Activated to indicate that any parameter outside the setting range was detected during parameter check made at power on and reset.
	45	Main circuit device overheat	Activated to indicate that heat sink overheat was detected in the servo amplifier.
	46	Motor overheat	Activated to indicate that the actuation of the thermal protector (of the detector) was detected in the servo motor due to servo motor overheat.
50	Overload 1	Activated to indicate that the overload of the servo motor and servo amplifier was detected.	
51	Overload 2	Activated to indicate that the overload of the servo motor and servo amplifier was detected.	

6. TROUBLESHOOTING

	Servo Amplifier LED Display	Function Name	Protection Provided
Alarm code	52	Error excessive	Activated to indicate that a difference between the input pulse and feedback pulse is 80k pulses or more in the position control mode.
	88	Watchdog	Indicates that the CPU misoperated.
Warning code	92	Open battery cable warning	Indicates that the battery cable connected to the encoder is open. (ABS data not erased)
	96	Zero setting error	Activated to indicate that the home position was not set after the CR (clear) signal had been entered in the absolute position detection system.
	E7	PC emergency stop	Indicates that the emergency stop signal was entered into the motion controller.
	E4	Parameter warning	Indicates that data in excess of the parameter setting range was set during ordinary operation.

- Note:
1. For regenerative alarm (display code 30) and overload 1, 2 (display codes 50, 51), the state at the time of activation is held in the controller after the protective circuit has been activated. The data stored is cleared when the control power is switched off but remains held when the RES terminal is switched on.
 2. When the display code 30, 50 or 51 has occurred, remove the cause of the alarm without fail before restarting operation. If reset is repeated by switching the control power off, overheating will lead to device damage.
 3. The alarm code 46 (motor overheat) is not displayed for the HA-FH series servo motors which do not contain the thermal protector.

6. TROUBLESHOOTING

6-2 Alarm Troubleshooting

The alarm (servo amplifier protective function) is activated for the following factors. When the alarm has occurred, check the alarm code on the display, find the cause, and take an appropriate corrective action.

If the servo amplifier and/or servo motor has become faulty or the component has been damaged for any other factor than those given below or if you have any problem, please contact your sales representative.

Note: 1. For regenerative alarm protection (alarm code 30) and overload protection 1, 2 (alarm codes 50, 51), the state at the time of activation is held in the servo amplifier after the protective circuit has been activated. The data stored is cleared when the external power is switched off.

2. When the alarm code 31, 50 or 51 has occurred, remove the cause of the alarm without fail before restarting operation. If reset is repeated by switching the external power off, overheat will lead the devices to damage.

3. When the regenerative alarm (alarm code 30) has occurred, remove the cause of the alarm without fail before restarting operation. If reset is repeated by switching the external power off, the external resistor (such as the regenerative brake option) will overheat, leading to an accident.

- Inspection at the time of alarm occurrence

When any alarm has occurred, make check and inspection as follows.

Check the LED display on the servo amplifier front face and check according to the following table.

Servo Amplifier LED Display	Name and Definition	Occurrence Factor	Check Point	Remedy
10	Undervoltage The power supply voltage (R, S, T) fell to or below the given level (160V).	1. The power supply voltage is 160VAC or less.	Measure the input voltage (R, S, T) with a voltmeter.	Reconsider the power supply capacity.
		2. An instantaneous power failure occurred for 15msec or longer.	Check if an instantaneous power failure occurred. Observe the input voltage with an oscilloscope.	
		3. The shortage of the power supply capacity caused the power supply voltage to drop at start.	Measure the input voltage (R, S, T) with a voltmeter.	Reconsider the power supply capacity.
12	Memory alarm 1 ROM, RAM	J-C21 printed board fault	Change the unit.	Change the unit.
13	Clock alarm	J-C21 printed board fault	Change the unit.	Change the unit.
15	Memory alarm 2 EEPROM	J-C21 printed board fault	Change the unit.	Change the unit.

6. TROUBLESHOOTING

Servo Amplifier LED Display	Name and Definition	Occurrence Factor	Check Point	Remedy
16	Encoder alarm 1	1. The encoder connector is disconnected.	Make visual check (to see if the connector is disconnected or almost disconnected).	Connect properly.
		2. Failure in the servo motor encoder	Change the motor.	Change the servo motor.
		3. Encoder cable fault (open cable or short circuit)	Check the cable. (Change the cable.)	Correct or change the cable (do not apply external force to the cable).
17	Board alarm	J-P4[] printed board fault	Change the unit.	Change the unit.
20	Encoder alarm 2	1. Excessive noise generated.	Check if the MC, etc. are operated at alarm occurrence.	Provide measures against noise.
		2. Encoder cable fault (open cable or short circuit)	Check the cable. (Change the cable.)	Correct or change the cable (do not apply external force to the cable).
25	Absolute position erase	1. Voltage low in the super capacitor in the detector (set-up start)	Keep the power on for a few minutes in the alarm state and switch the power off, then on.	Keep the power on for a few minutes to charge the super capacitor, and switch the power off, then on. Perform initial setting of the zero.
		2. Battery voltage low.	After switching the power off, measure the voltage across the battery.	
		3. Battery cable or battery is faulty.	If the alarm still persists after the above remedy.	Change the battery.
30	Regenerative alarm	1. Parameter setting wrong.	Check parameter *PEG setting.	Set correctly.
		2. Regenerative resistor not connected.	Check the connection.	Connect correctly.
		3. Max. regenerative load exceeded. (1) High-duty operation caused the maximum load capacity of the regenerative brake resistor to be exceeded. (2) Continuous regenerative operation caused the maximum load capacity of the regenerative brake resistor to be exceeded.	1. Reconsider the regenerative brake torque and the frequency of use of regenerative braking. 2. Check the regenerative load factor in the monitoring mode.	1. Reduce the frequency of use of positioning. 2. Add the regenerative brake option. 3. Increase the servo motor capacity. 4. Reduce the load.

6. TROUBLESHOOTING

Servo Amplifier LED Display	Name and Definition	Occurrence Factor	Check Point	Remedy
30	Regenerative alarm	4. Regenerative power transistor damaged (short circuit).	Using a tester, check the resistance of the regenerative power transistor.	Change the unit.
		5. Regenerative brake resistor faulty.	Check the resistance of the regenerative brake resistor.	Change the regenerative brake resistor.
31	Overspeed Motor speed reached or exceeded the permissible speed.	1. The command speed exceeded the permissible speed.	1. Check the speed command (pulse train frequency). 2. Check if the motor speed determined by the set speed of the motion controller has exceeded the rated speed of the servo motor.	Set the speed correctly.
		2. The acceleration/deceleration time constant is so small that overshoot occurs.	1. Increase the acceleration/deceleration time constant. 2. Reduce the speed.	Reconsider the acceleration/deceleration time constant.
		3. The servo system is unstable to cause overshoot.	1. Adjust the servo gain. 2. Check the load inertia moment ratio. 3. Increase the acceleration/deceleration time constant. 4. Reduce the speed.	1. Re-set the servo gain to a proper value. 2. If setting cannot be made by the servo gain, 1) reduce the load inertia moment ratio or 2) reconsider the acceleration/deceleration time constant.
		4. Parameter setting wrong.	Check parameters MOTOR TYP and ROTATION SPEED(R).	Set correctly.
		5. Detector fault	1. Change the cable. 2. Change the servo motor.	Change the cable Change the motor.
32	Overcurrent Current not less than the permissible value flew in the servo amplifier bus.	1. Output phases U, V, W of the servo amplifier were connected with each other.	Check if the U, V, W cables have been connected using a tester.	Correct the wiring.
		2. Servo amplifier transistor damaged.	Measure the resistance across transistor module terminals using a tester.	Change the transistor module or unit.

6. TROUBLESHOOTING

Servo Amplifier LED Display	Name and Definition	Occurrence Factor	Check Point	Remedy
32	Overcurrent Current not less than the permissible value flew in the servo amplifier bus.	3. Ground fault occurred in the servo amplifier output phases U, V, W.	1. Check across terminal block U; V, W phases and case using a tester. 2. Check across servo motor U, V, W phases and core using a tester and megger.	Correct the ground fault.
		4. Noise entered the overcurrent detection circuit.	Check if the relay or valve has operated in the periphery.	Provide measures against noise.
33	Overvoltage Converter bus voltage reached or exceeded 400V.	1. Regenerative brake resistor connection fault.	Check the connection across terminal block C-P.	Connect correctly.
		2. Regenerative power transistor damaged.	Check the resistance of the regenerative power transistor using a tester.	Change the unit.
		3. Regenerative brake resistor in the servo amplifier switched off.	Measure across terminal block C-P using a tester (measure 3 minutes after the change lamp goes off).	Change the unit.
		4. Power supply voltage high.	Measure the input voltage (R, S, T) with a voltmeter.	Reconsider the power supply capacity.
34	CRC alarm Command cable fault	The bus cable (MR-HBUS) is disconnected.	Check for disconnection of the cable connector.	Connect the connector.
		Bus cable (MR-HBUS) fault	Check for an open cable, etc.	Change the cable.
		Noise entered the motion network cable (MR-HBUS).	The relay or valve has operated in the periphery.	Provide measures against noise.
		The terminal connector is disconnected.	Check for disconnection of the terminal connector.	Connect the terminal connector.
35	Command pulse frequency alarm	1. Command pulse frequency too high.	Check if the input pulse is faulty.	Change the command unit.
		2. Noise entered the command pulse.	Check if the relay or valve has operated in the periphery.	Provide measures against noise.
36	Transfer alarm Command cable fault	The bus cable (MR-HBUS) is disconnected.	Check for disconnection of the cable connector.	Connect the connector.
		Bus cable (MR-HBUS) fault	Check for an open cable, etc.	Change the cable.
		Printed board fault	Change the unit.	Change the unit.
		The terminal connector is disconnected.	Check for disconnection of the terminal connector.	Connect the terminal connector.

6. TROUBLESHOOTING

Servo Amplifier LED Display	Name and Definition	Occurrence Factor	Check Point	Remedy
37	Parameter alarm	1. Parameter data corrupted.	1. Check if dirt, etc. stuck on the card.	1. Remove the dirt on the card and re-set.
		2. Parameter data mis-setting	2. Re-set the parameters.	2. Change the card and re-set.
45	Main circuit device overheat	1. Servo amplifier faulty (rated output exceeded).	—	Change the unit.
		2. Power on/off repeated in overload state.	Check if the servo motor is operated by switching the power on/off.	Reconsider the operating method.
		3. Cooling fault.	<ol style="list-style-type: none"> 1. Check if the servo amplifier fan is at a stop. 2. Check if ventilation is inhibited. 3. Check if temperature in panel is too high (0 to +55°C). 4. Check the effective load factor in the monitoring mode. 	Improve cooling.
46	Servo motor overheat	1. Servo motor overloaded.	<ol style="list-style-type: none"> 1. Check the effective load factor in the monitoring mode. 2. Measure the servo motor input current. (Refer to Section 5-1.) 3. Measure servo motor temperature rise. 4. Reduce the load. 	<ol style="list-style-type: none"> 1. Reduce the load. 2. Increase the capacity.
		2. Servo motor ambient temperature exceeded the operating value of 40°C	<ul style="list-style-type: none"> • Check the ambient temperature of the servo motor (0 to +40°C). • Check if the servo motor is overheated by a nearby furnace or the like. 	Operate at the ambient temperature of 0 to +40°C.
		3. Thermal protector built in the detector faulty.	Change the servo motor.	Change the servo motor.
50	Overload 1 About 200% of overload current flew continuously.	1. Current exceeded the continuous output current of the servo amplifier.	Refer to the alarm code 46-1.	
		2. Servo system is unstable to cause hunting.	Refer to the alarm code 31-3.	
		3. Machine struck something.	<ol style="list-style-type: none"> 1. Check if the machine struck something. 2. Check if the stroke end limit switch is actuated properly. 	<ol style="list-style-type: none"> 1. Reconsider the operation pattern. 2. Change the limit switch.

6. TROUBLESHOOTING

Servo Amplifier LED Display	Name and Definition	Occurrence Factor	Check Point	Remedy
50	Overload 1 About 200% of overload current flew continuously.	4. Servo motor miswiring. Servo amplifier terminals U, V, W do not match servo motor terminals U, V, W.	Check the connection of U, V, W.	Connect correctly.
		5. Encoder faulty.	1. Change the cable. 2. Change the servo motor.	1. Change the cable. 2. Change the servo motor.
51	Overload 2 Max. current flew for several seconds.	1. Machine struck something.	Refer to the alarm code 50-2.	
		2. Servo motor miswiring. Servo amplifier terminals U, V, W do not match servo motor terminals U, V, W.	Refer to the alarm code 50-4.	
		3. Servo system is unstable to cause hunting.	Refer to the alarm code 31-3.	
		4. Bus voltage in the servo amplifier low.	Check if the charge lamp is on.	Change the unit.
		5. Encoder faulty.	Refer to the alarm code 50-5.	
52	Error excessive Droop pulse value of the deviation counter reached or exceeded 80K pulses.	1. Acceleration/deceleration time constant too small.	Increase the acceleration/deceleration time constant.	Increase the acceleration/deceleration time constant.
		2. Start disabled due to torque shortage.		
		3. Servo gain (PG1) setting too low.	Increase the setting of parameter PG1.	Set a proper value.
		4. Bus voltage in the unit low.	Refer to the alarm code 51-3.	
		5. Servo motor rotated one turn by external force.	1. Check the droop pulse value and regenerative load factor value in the monitoring mode. Check if the values have changed at the time of motor stop. 2. Check the torque limit value. Check if the servo torque setting is smaller than external force.	1. Change the torque limit value. 2. Reduce the load. 3. Increase the capacity.
		6. Machine struck something.	Check if the machine struck something.	Reconsider the operation pattern.
		7. Encoder faulty.	Refer to the alarm code 50-5.	
88	Watchdog	J-C21 printed board fault	Change the unit.	Change the unit.

6. TROUBLESHOOTING

6-3 Warning Troubleshooting

The warning occurs for the following factors. The servo is not switched off. Check the warning code, find the cause, and take an appropriate corrective action.

- Inspection at the time of warning occurrence
When any warning has occurred, make check and inspection as follows.
Check the LED display on the servo amplifier front face and check according to the following table.

Servo Amplifier LED Display	Name and Definition	Occurrence Factor	Check Point	Remedy
92	Open battery cable warning	1. Encoder cable open. 2. Battery voltage low.	Check the cable for continuity.	Repair or change the cable.
E7	PC emergency stop	Emergency stop signal was entered into the motion controller.	Check the motion controller emergency stop signal.	Switch off the emergency stop signal.
E4	Parameter warning	The parameter set during operation exceeds the parameter setting range. The set parameter is ignored.	Input the correct set value.	Re-set.

7. CHARACTERISTICS

7-1 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 below.

Overload 1 alarm (50) is displayed to indicate that overload operation has been performed above the electronic thermal relay protection curve shown below. Overload 2 alarm (51) is displayed to indicate that the maximum current flow continuously for several seconds because the machine struck something, for example.

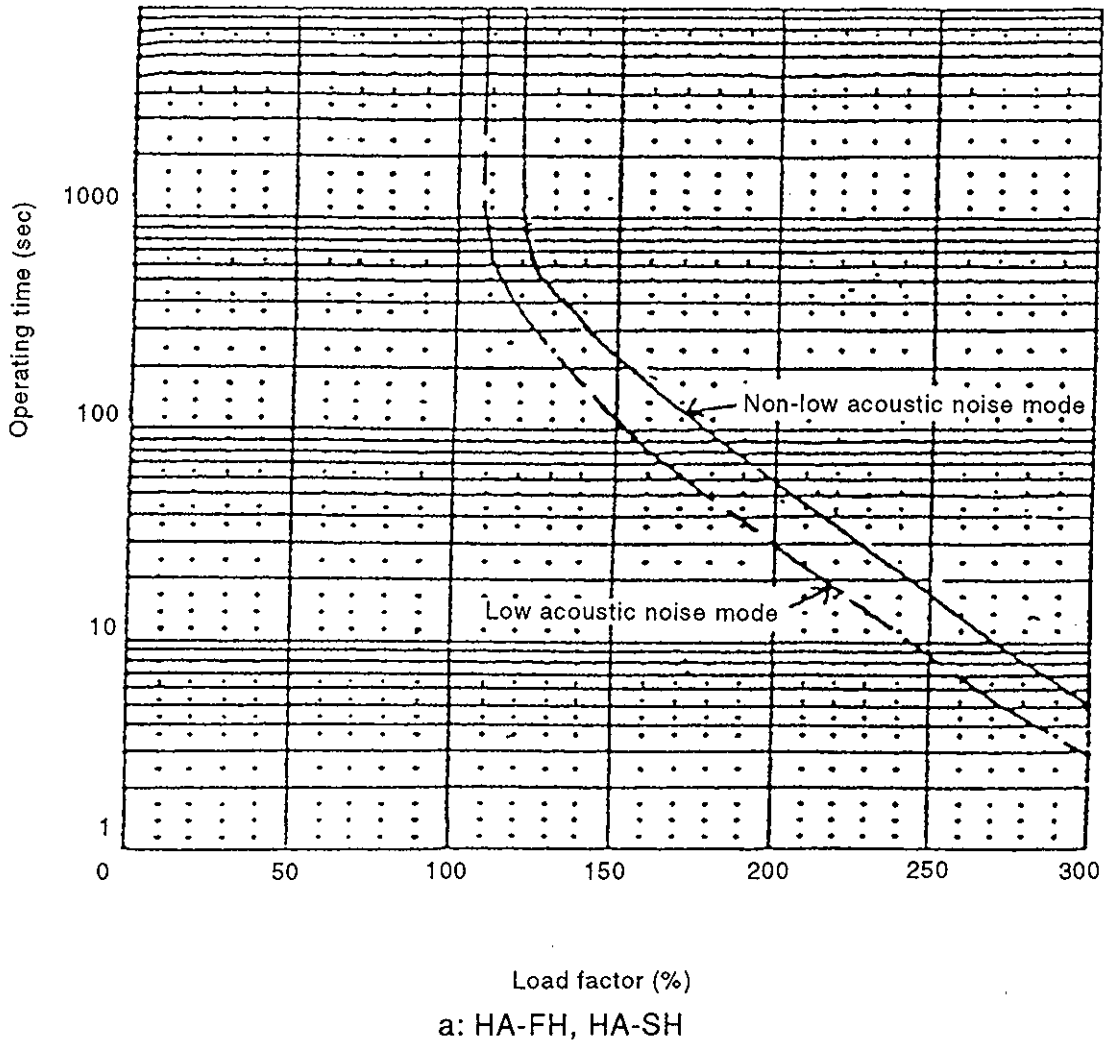


Fig. 7-1 Electronic Thermal Relay Protection Characteristics

Note: If load is applied at a stop (during servo lock), 70% (60% in the low acoustic noise mode) of the rated torque must not be exceeded.

7. CHARACTERISTICS

7-2 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 7-1 Power Capacity and Generated Heat Amount Per Servo Amplifier

Servo Amplifier	Servo Motor	Power Supply Capacity (kVA)	Servo Amplifier-Generated Heat		Area Required for Heat Dissipation (m ²)	Approx. Enclosed Box Size (mm)
			At Rated Output (W)	At Zero Torque (W)		
MR-J10B	HA-FH053, 13	0.3	25	15	0.5	280W × 300D × 300H
MR-J20B	HA-FH23	0.5	25	15	0.5	280W × 300D × 300H
MR-J40B	HA-FH33	0.7	35	15	0.7	350W × 400D × 300H
	HA-FH43	0.9	35	15	0.7	350W × 400D × 300H
MR-J60B	HA-FH63	1.1	40	15	0.8	400W × 400D × 300H
MR-J100B	HA-SH52, 53	1.0	50	20	1.0	400W × 400D × 300H
	HA-SH102, 103	1.7	50	20	1.0	400W × 400D × 300H
	HA-SH81	1.5	50	20	1.0	400W × 400D × 300H
MR-J200B	HA-SH121	2.1	50	20	1.0	400W × 400D × 300H
	HA-SH152, 153	2.5	90	20	1.8	400W × 400D × 300H
	HA-SH202, 203	3.5	90	20	1.8	400W × 400D × 300H
	HA-SH201	3.5	90	20	1.8	400W × 400D × 300H

- 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 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.

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

- Here: J_L : Load inertia converted into motor shaft [kgf·cm²]
 J_M : Servo motor inertia [kgf·cm²]
 N : Servo motor speed [r/min]
 f_s : No. of decelerations [times/min]

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(2) Heat dissipation area for enclosed servo amplifier

An enclosure for the servo amplifier should be designed 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.

$$A = \frac{P}{K \times \Delta T} \dots\dots\dots(7-1)$$

- Here, A : Heat dissipation area [m²]
- 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 (7-1) 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 enclosure's 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 dissipation will not be possible. Therefore, arrangement of the equipment in the enclosure and the use of a fan should be considered .

Table 7-1 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.

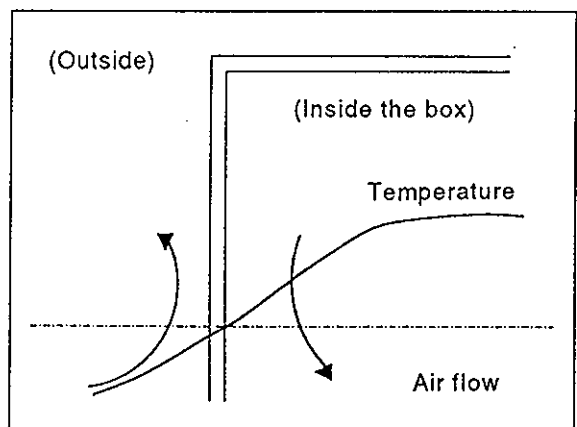


Fig. 7-2 Distribution of Temperature in Enclosure

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.

7. CHARACTERISTICS

7-3 Magnetic 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. The electromagnetic brake must not be used at any other time than at a stop or in case of emergency. Otherwise, the brake life will be extremely short.

(1) Characteristics

Table 7-2 Magnetic Brake Characteristics

Item	HA-FH Series			HA-SH Series		
	HA-FH053B HA-FH13B	HA-FH23B HA-FH33B	HA-FH43B HA-FH63B	HA-SH52B to 152B HA-SH53B to 153B HA-SH81B	HA-SH202B HA-SH203B HA-SH121B, 201B	
(Note 2) Type	Spring-loaded safety brake					
Rated voltage	24VDC					
Rated current (A)	Cold (20°C)	0.22	0.31	0.46	0.63	1.04
	Hot (95°C)	0.17	0.24	0.36	0.49	0.80
Excitation coil resistance (Ω)	Cold (20°C)	111	78	52	38	23
	Hot (95°C)	144	101	67	49	30
Capacity (W)	7	7.4	11	15	25	
ON current (A)	0.15	0.2	0.3	0.25	0.4	
OFF current (A)	0.06	0.06	0.1	0.14	0.2	
Static friction torque	(N·m)	0.39	1.18	2.3	7.84	29.4
	(kgf·cm)	4	12	23.5	80	300
Inertia moment (Note 3)	J(kg·cm ²)	0.02	0.13	0.34	0.68	4.25
	GD ² (kgf·cm ²)	0.07	0.53	1.4	2.7	17
(Note 4) Release delay time (S)	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	0.12	0.12
	DC off (Fig.s b, c)	0.01	0.03	0.03	0.03	0.03
Permissible braking work (N·m {kgf·m})	Per braking	3.9 {0.4}	18 {1.8}	46 {4.7}	390 {40}	4400{450}
	Per hour	39 {4.0}	180 {18}	460 {47}	3900 {400}	44000{4500}
Brake looseness at motor shaft (degrees)	0.3 to 3.5	0.2 to 2.0	0.2 to 1.3	0.2 to 0.6		
(Note 3) Weight (kg)	0.3	0.6	0.8	2	6	
Brake life (Note 1)	30,000 times at the braking value of 4 (N·m) per braking	30,000 times at the braking value of 18 (N·m) per braking	30,000 times at the braking value of 47 (N·m) per braking	20,000 times at the braking value of 200 (N·m) per braking	20,000 times at the braking value of 2000 (N·m) per braking	

7. CHARACTERISTICS

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 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) Electromagnetic brake power supply

- 1) Examples of connection of the brake power supply are shown in Fig. 7-3(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 4-2-2.)
- 4) Connect the lead (blue) of the magnetic brake to the power supply regardless of the polarity.

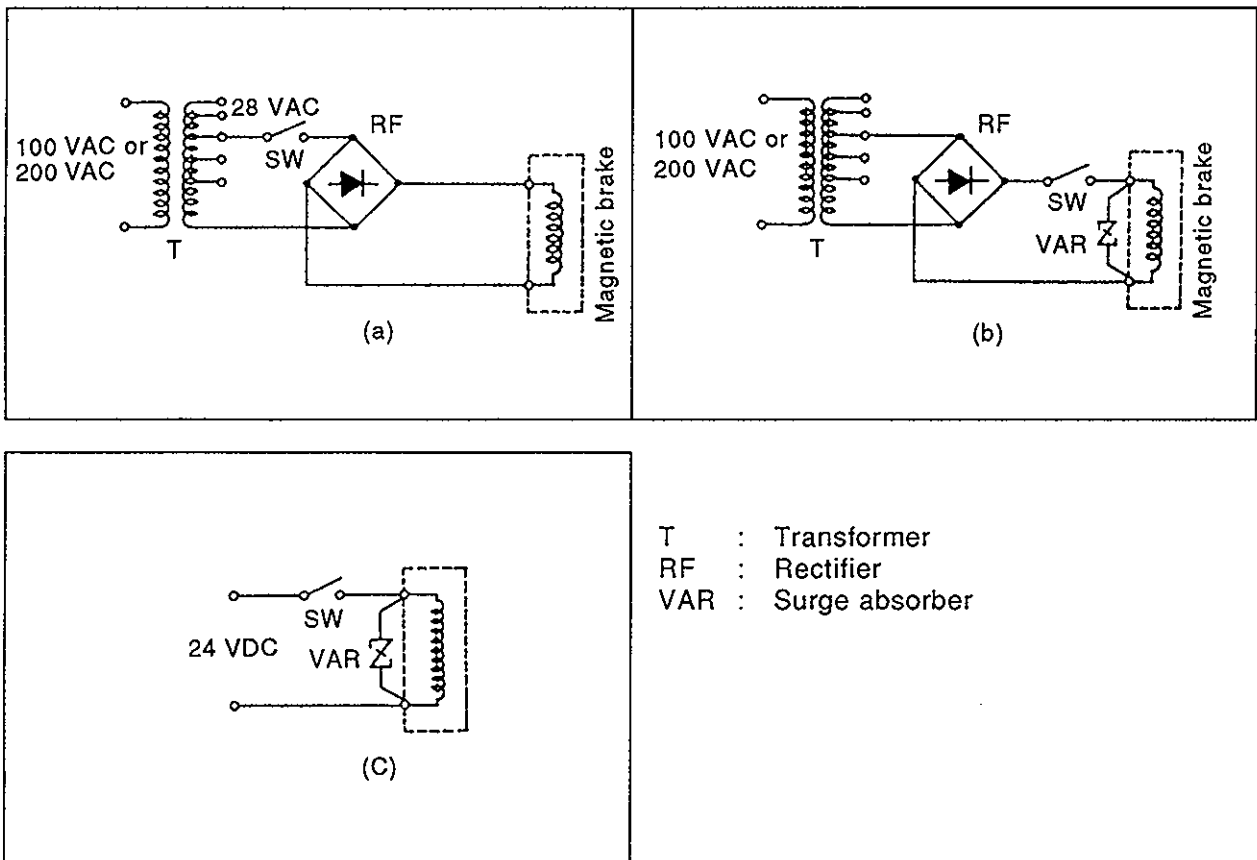


Fig. 7-3 Connection Examples

7. CHARACTERISTICS

(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), L_{max} , 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 servo motor will stop faster than the value obtained in the equation.

$$L_{max} = \frac{V_0}{60} \times \left(t_1 + t_2 + \frac{t_3}{2} \right) \dots \dots \dots (7-2)$$

Here,

- L_{max} : Maximum coasting distance [mm]
- V_0 : 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]

$$t_3 = \frac{(J_L + J_M) \times N_0}{9.55 \times 10^4 (T_L + 0.8T_B)}$$

- J_L : Load inertia converted into equivalent value on servo motor shaft [kg.cm²]
- J_M : Servo motor inertia [kg.cm²]
- N_0 : 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 7-2 Characteristics.
 J_M is the sum of the electromagnetic brake's inertia (Table 9-2) and the motor's inertia.

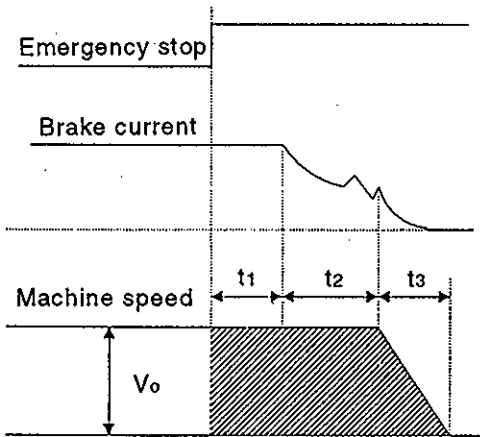


Fig. 7-4 Coasting Distance During Emergency Stop

7. CHARACTERISTICS

7-4 Dynamic Brake Characteristics

The MR-J□B servo amplifier contains a dynamic brake circuit. When an alarm occurs in the servo amplifier, when the emergency stop signal is received, or when the power is switched off, sudden stop control is exercised or the dynamic brake is operated to bring the servo motor to a sudden stop.

CAUTION

If eight times larger than the load inertia moment of the MR-J100B or 200B is exceeded, the built-in dynamic brake is not applicable. Please contact Mitsubishi.

(1) Dynamic brake operation mode

1) Sudden stop control mode

When an emergency stop, a power failure or a controllable alarm occurs, the motor is decelerated to a stop at the maximum torque.

2) Dynamic brake mode

When a controllable alarm occurs, the dynamic brake circuit is actuated to decelerate the servo motor to a stop

(2) Maximum coasting

Maximum coasting up to a servo motor stop (L_{max}) is the larger one of the values calculated by Expressions (7-3) and (7-4).

1) L_{max} in sudden stop control mode

$$L_{max} = \frac{V_o}{60} \left\{ t_e + \frac{1}{2} \frac{(J_L + J_M) \times N_o}{9.55 \times 10^4 \times T_M} \right\} \quad \dots\dots\dots(7-3)$$

Symbols in Expressions (7-3) and (7-4)

L_{max}	: maximum coasting	[mm]
V_o	: rapid feedrate of the machine	[mm/min]
N_o	: servo motor speed at rapid feed	[r/min]
t_e	: control section delay time (about 10ms)	
T_M	: maximum torque	[Nm]
J_M	: servo motor inertia moment	[kg·cm ²]
J_L	: load inertia moment converted into the equivalent value at the servo motor shaft	[kg·cm ²]
τ	: brake time constant (Tables 7-3, 7-4)	[sec]

2) L_{max} in dynamic brake mode

$$L_{max} = \frac{V_o}{60} \left\{ t_e + \tau \left(1 + \frac{J_L}{J_M} \right) \right\} \quad \dots\dots\dots(7-4)$$

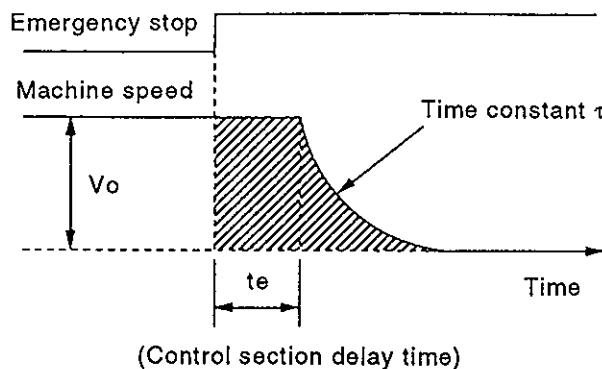


Fig. 7-5 Coasting at Emergency Stop



7. CHARACTERISTICS

Table 7-3 Dynamic Brake Time Constant (HA-FH)

Model	Brake Time Constant τ (sec)
HA-FH053, 13	0.02
HA-FH23	0.05
HA-FH33	0.07
HA-FH43	0.09
HA-FH63	0.12

Table 7-4 Dynamic Brake Time Constant (HA-SH)

Model	Brake Time Constant τ (sec)
HA-SH52, 102, 152	0.06
HA-SH202	0.14
HA-SH53, 103, 153	0.1
HA-SH203	0.2

7-5 Vibration Rank

The servo motor vibration rank is V-10 at the rated speed. Fig. 7-6 shows the servo motor installation position and measuring position at the time of measurement.

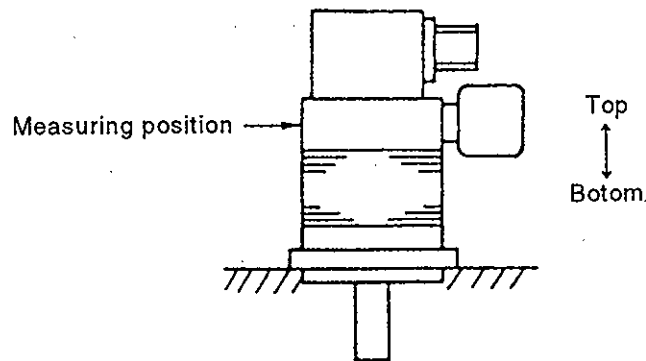


Fig. 7-6 Servo Motor Vibration Measuring Condition

7. CHARACTERISTICS

7-6 Permissible Shaft End Load

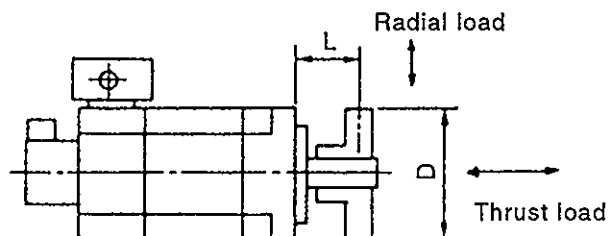
The permissible shaft end load of the servo motor is indicated in Table 7-5. When the load is not connected directly to the servo motor, e.g. is driven via gears, timing belt or the like, the load applied to the shaft end should be not more than the value in Table 7-5 because of the distance between the flange installation surface and the load center. For the load connected directly to the servo motor, note that excessive load must not be applied to the servo motor shaft due to off-center, etc.

Table 7-5 Permissible Servo Motor Shaft End Load

Servo Motor	Permissible Radial Load (N)			Permissible Thrust Load (N)	
HA-FH053	108	{11 kgf}	L = 30	98	{10 kgf}
HA-FH13	118	{12 kgf}	L = 30	98	{10 kgf}
HA-FH23, 33	176	{18 kgf}	L = 30	147	{15 kgf}
HA-FH43, 63	323	{33 kgf}	L = 40	284	{29 kgf}
HA-SH52 to 152	980	{100 kgf}	L = 55	490	{50 kgf}
HA-SH53 to 153					
HA-SH81					
HA-SH202	2058	{210 kgf}	L = 79	980	{100 kgf}
HA-SH203					
HA-SH121 to 201					

Note: 1. The permissible thrust load and permissible radial load are values working independently of each other.

2. See below for the symbols in the table:



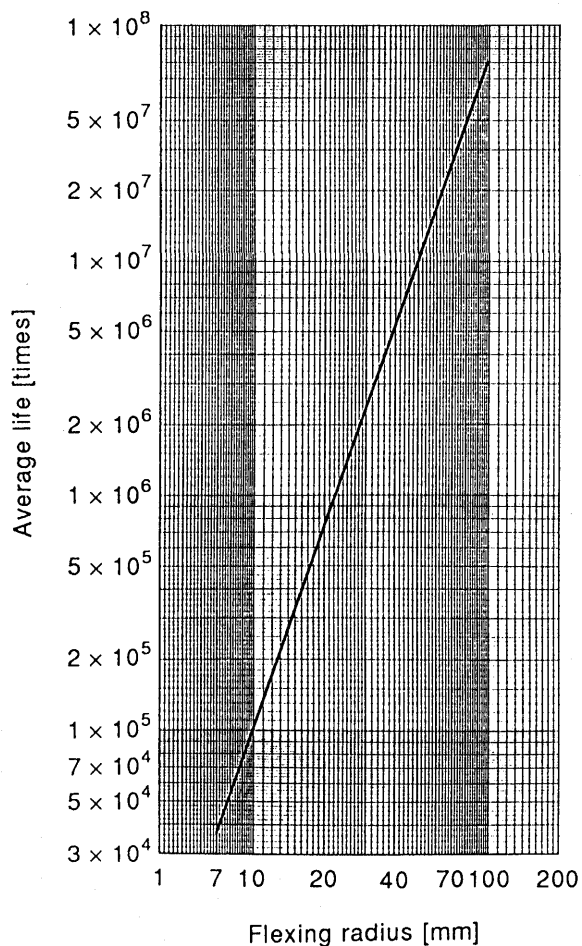
L: Distance between flange installation surface and load center [mm]

D: Gear diameter or pulley diameter [mm]

7. CHARACTERISTICS

7-7 Flexing Life of the Cables

The flexing life of the encoder cables (MR-HCBL[]M, MR-HSCBL[]M) and bus cable (MR-HBUS[]M) is shown below. Note that the following values are calculated values. In actuality, provide a little allowance for these values. For installation on a machine where the servo motor will move, the flexing radius should be as large as possible.

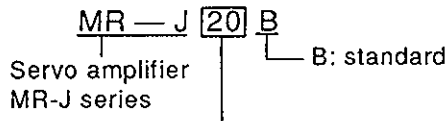


This graph gives calculated values and not guaranteed values.

8. SPECIFICATIONS

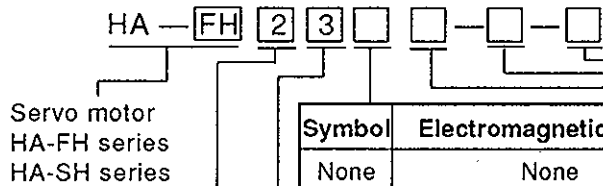
8-1 Model Designation

• Servo amplifier



Symbol	Capacity (W)	Applicable Servo Motor
10	50, 100	HA-FH053/13
20	200	HA-FH23
40	300, 400	HA-FH33/43
60	600	HA-FH63
100	500, 850, 1000	HA-SH81/52/102/53/103
200	1200, 1500, 2000	HA-FH121/201/152/202/153/203

• Servo motor



Symbol	Electromagnetic Brake
None	None
B	With electromagnetic brake

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

Symbol	Shaft End
None	Standard (Note 1)
T	Tapered
K	Straight shaft with key groove
D	D cut shaft

Note: 1. HA-FH23 to HA-FH63 are provided with the keyway (K) as standard.
 2. T (tapered) applies only to the 1.5kW and down of the HA-SH.
 3. For the servo motor with speed reducer, the output shaft shape depends on the type. See the corresponding outline drawing.

Symbol	Encoder
None	Incremental
Y	Absolute

Symbol	Rated Output (W)	Symbol	Rated Output (W)
05	50	6	600
1	100	8	850
2	200	10	1000
3	300	12	1200
4	400	15	1500
5	500	20	2000

Symbol	Reduction Gear
None	None
G	With reduction gear

Note: The HA-SH1000 and 3000 r/min series are not provided with the reduction gear.

8. SPECIFICATIONS

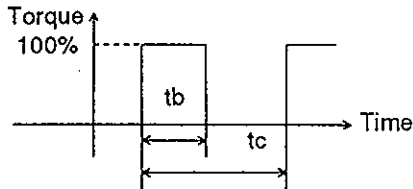
8-2 Standard Specifications

Table 8-1 Servo Motor Standard Specifications

Specifications	Model	Motor Series	HA- FH Series (Small power)					
		Servo motor model HA-□	FH053	FH13	FH23	FH33	FH43	FH63
		Servo amplifier model MR-□	J10B		J20B	J40B		J60B
Servo motor (Note 1)	Continuous duty 80%ED in low noise mode (Note 2)	Rated output (kw)	0.05	0.1	0.2	0.3	0.4	0.6
		Rated torque (N-m {kgf-cm})	0.16 {1.62}	0.32 {3.25}	0.64 {6.5}	0.95 {9.7}	1.3 {13.0}	1.9 {19.5}
	Rated speed (r/min)	3000						
	Max. speed (r/min)	4000						
	Permissible speed (r/min)	4600						
	Max. torque (N-m {kgf-cm})	0.48 {4.86}	0.95 {9.74}	1.9 {19.5}	2.9 {29.2}	3.8 {39.0}	5.7 {58.5}	
	Power rate at continuous rated torque (kW/s)	4.0	10.2	11.7	18.1	17.2	30.1	
	Inertia moment	J (kg-cm ²)	0.063	0.10	0.35	0.50	0.98	1.2
		GD ² {kgf-cm ² }	0.25	0.38	1.4	2.0	3.9	4.8
	Speed/position encoder	Encoder 2048P/rev (resolution 8192P/rev)						
	Accessories	Encoder, V ring						
	Structure	Totally-enclosed, self-cooled						
	Ambient temperature	0 to 40°C						
Weight (kg)	1.3	1.5	2.3	2.6	4.2	4.8		

Note: 1. When the servo is used in places where it is subjected to oil and/or water, such as on machine field sites, optional features apply to the servo. Please contact.

2. 80%ED indicates that operation is performed at the rated torque during 80% of the operation time and is performed under no load during the remaining 20% of the operation time in a single operation cycle.



$t_b < 60$ seconds (continuous operation time)

$$\%ED = \frac{t_b}{t_c} \times 100$$

8. SPECIFICATIONS

HA-SH1000r/min Series			HA-SH2000r/min Series				HA-SH3000r/min Series			
SH81	SH121	SH201	SH52	SH102	SH152	SH202	SH53	SH103	SH153	SH203
J100B	J200B		J100B		J200B		J100B		J200B	
0.85	1.2	2.0	0.5	1.0	1.5	2.0	0.5	1.0	1.5	2.0
8.12 {82.8}	11.5 {117}	19.1 {195}	2.39 {24.4}	4.78 {48.7}	7.16 {73.1}	9.55 {97.4}	1.59 {16.2}	3.18 {32.5}	4.78 {48.7}	6.37 {65.0}
1000			2000				3000			
1200			2500			2300	3000			
1380			2875			2645	3450			
24.4 {248}	34.4 {351}	57.3 {585}	7.16 {73.1}	14.4 {146}	21.6 {219}	28.5 {292}	4.77 {48.7}	9.55 {97.4}	14.3 {146}	19.1 {195}
22.3	19.3	27.8	5.8	11.8	17.6	13.2	2.6	5.2	7.7	5.9
29.5	68.5	131	9.80	19.6	29.5	68.5	9.80	19.6	29.5	68.5
118	274	525	39.2	78.4	118	274	39.2	78.4	118	274
Encoder 4096P/rev (resolution 16384P/rev)										
Encoder, oil seal										
Totally-enclosed, self-cooled										
0 to 40°C										
16	21	32	8	12	16	21	8	12	16	21

8. SPECIFICATIONS

Table 8-2 Servo Amplifier Standard Specifications

Model	Motor Series		HA- FH Series (Small power)					
	Servo motor model HA-□		FH053	FH13	FH23	FH33	FH43	FH63
Specifications	Servo amplifier model MR-□		J10B		J20B	J40B		J60B
	Power supply (Note 2)	Voltage/frequency		3-phase 200 to 230VAC/50, 60Hz				
Permissible voltage variation		170 to 253V/50, 60Hz						
Permissible frequency variation		Within ± 5%						
Power supply capacity (kVA)		0.3	0.3	0.5	0.7	0.9	1.1	
Control system			Sine-wave PWM control, current control system					
Rated output current (A)			0.6	1.1	1.3	1.9	2.5	3.6
Max. output current (A)			1.8	3.3	3.9	5.7	7.5	10.8
Regenerative brake duty (times/minute) (Note 3) D: If the effective torque is not more than the rated torque, there are no restrictions on the frequency of use of regenerative braking. ø: This combination cannot be used.	MR-RB013		Δ	Δ	Δ	315	145	120
	MR-RB033		Δ	Δ	Δ	945	440	360
	MR-RB064 (2 pcs.)		Δ	Δ	Δ	1818	1250	1200
	MR-RB32		×	×	×	Δ	Δ	Δ
	MR-RB064		×	×	×	×	×	×
	MR-RB34		×	×	×	×	×	×
	MR-RB54		×	×	×	×	×	×
Dynamic brake			Built-in					
Recommended load inertia ratio			Not more than 10 times of servo motor inertia					
Protective functions			Overcurrent shut-off, regenerative overvoltage shut-off, overload shut-off (electronic thermal relay), servo motor overheat protection, main circuit device overheat protection, encoder alarm protection, regenerative alarm protection, undervoltage/instantaneous power failure protection, overspeed protection, excessive error protection					
Feedback pulse of encoder			8192P/rev per servo motor revolution					
Structure			Open					
Environment	Ambient temperature		0 to + 55°C (non-freezing), storage -20 to 65°C					
	Ambient humidity		90%RH or less (non-condensing)					
	Ambience		No corrosive gas, dust, dirt					
	Altitude		1000m or less					
Vibration			5.9m/S ² {0.6G} or less					
Weight (kg)			0.8			1.0		

Note: 1. The values in the table are specified for the power supply voltage of 200V. At the time of a power supply voltage drop, the output and rated speed cannot be guaranteed. The current values are the rated and maximum output currents of the servo amplifier.

2. The power supply capacity depends on the power supply impedance.

3. The regenerative brake duty indicated is the permissible duty when the servo motor running alone at the rated speed is decelerated to a stop. When the load is connected, the value in the table is multiplied by $1/(m + 1)$, where m = load inertia servo motor inertia. At the speed higher than the rated speed, the permissible number of times is in inverse proportion to the square of (running speed/rated speed). When the running speed varies frequently or when the regenerative mode continues as in vertical feed, regenerative heat generated during operation must be calculated so as not to exceed the permissible value.

8. SPECIFICATIONS

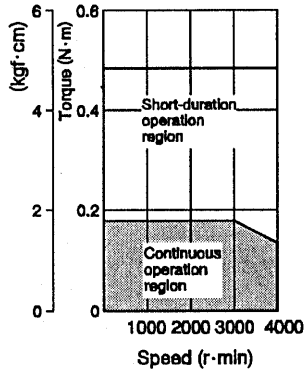
HA-SH1000r/min Series			HA-SH2000r/min Series				HA-SH3000r/min Series			
SH81	SH121	SH201	SH52	SH102	SH152	SH202	SH53	SH103	SH153	SH203
J100B	J200B		J100B		J200B		J100B		J200B	
3-phase 200 to 230VAC/50, 60Hz										
170 to 253V/50, 60Hz										
Within $\pm 5\%$										
1.5	2.1	3.5	1.0	1.7	2.5	3.5	1.0	1.7	2.5	3.5
Sine-wave PWM control, current control system										
4.5	6	9.5	3	5.5	8	10	3	5	8	9
13.5	18	28.5	9	16.5	24	30	9	15	24	27
43	18	x	33	16	x	x	14	7	x	x
130	55	x	100	48	x	x	44	22	x	x
438	188	x	330	160	x	x	147	73	x	x
Δ	x	x	Δ	Δ	x	x	Δ	180	x	x
x	x	55	x	x	67	29	x	x	27	11
x	564	417	x	x	348	199	x	x	154	88
x	940	695	x	x	580	331	x	x	256	146
Built-in										
Not more than 10 times of servo motor inertia										
Overcurrent shut-off, regenerative overvoltage shut-off, overload shut-off (electronic thermal relay), servo motor overheat protection, main circuit device overheat protection, encoder alarm protection, regenerative alarm protection, undervoltage/instantaneous power failure protection, overspeed protection, excessive error protection										
16384P/rev per servo motor revolution										
Open										
0 to + 55°C (non-freezing), storage -20 to 65°C										
90%RH or less (non-condensing)										
No corrosive gas, dust, dirt										
1000m or less										
5.9m/S ² (0.6G) or less										
2.3										

8. SPECIFICATIONS

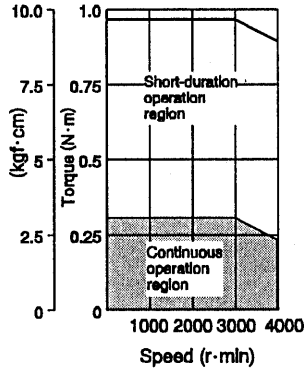
8-3 Torque Characteristics

(1) HA-FH series

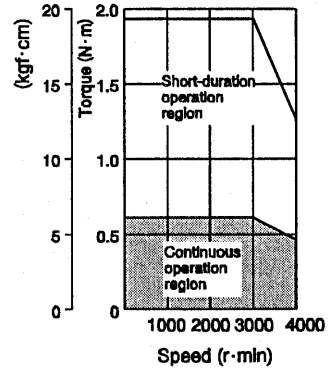
[HA-FH053]



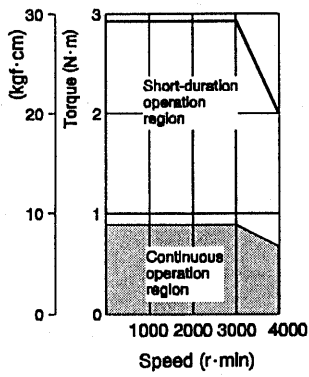
[HA-FH113]



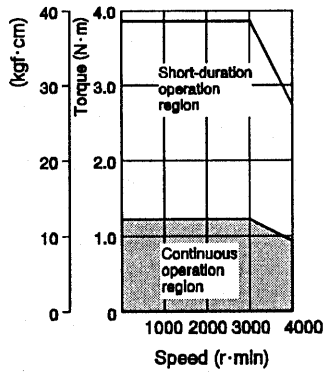
[HA-FH23]



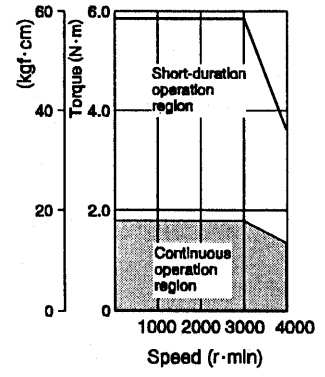
[HA-FH33]



[HA-FH43]

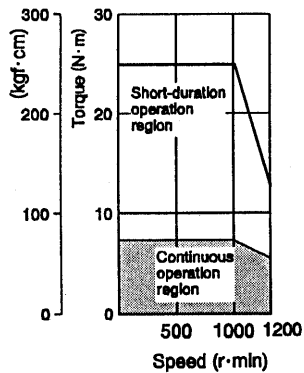


[HA-FH63]

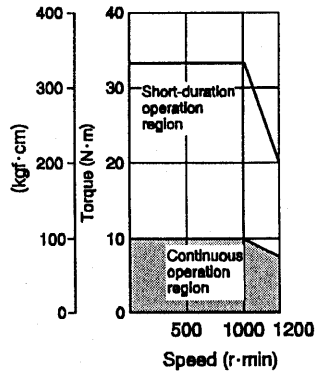


(2) HA-SH 1000r/min series

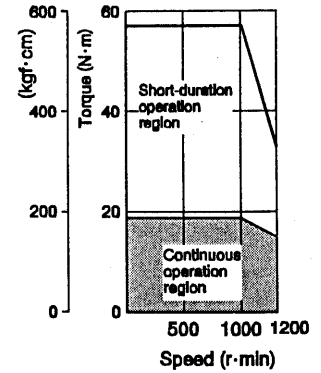
[HA-SH81]



[HA-SH121]



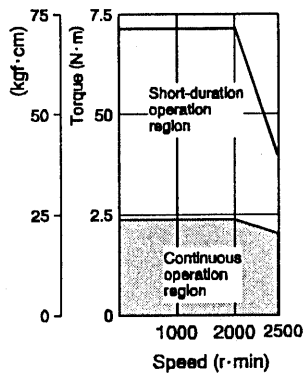
[HA-SH201]



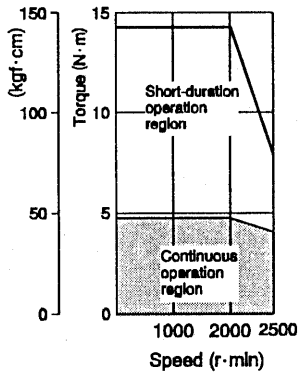
8. SPECIFICATIONS

(3) HA-SH 2000r/min series

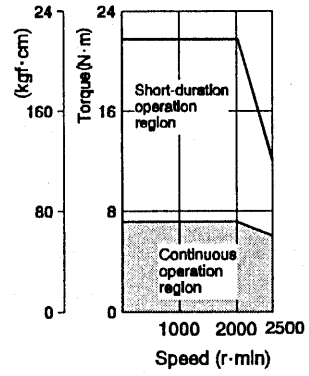
[HA-SH52]



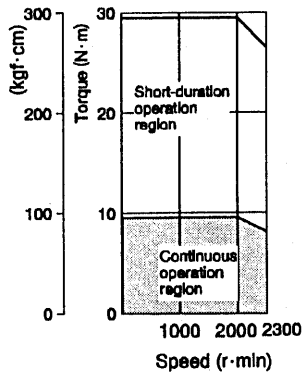
[HA-SH102]



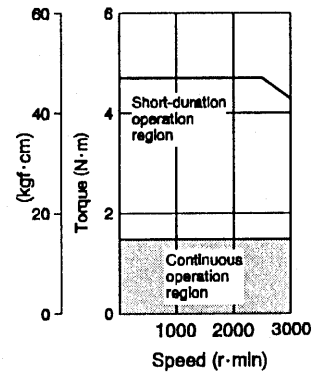
[HA-SH152]



[HA-SH202]

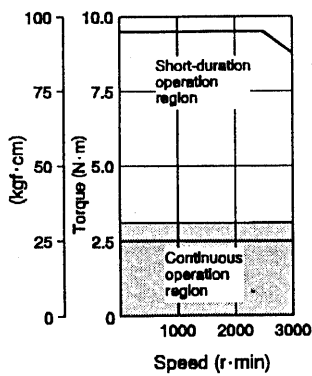


[HA-SH53]

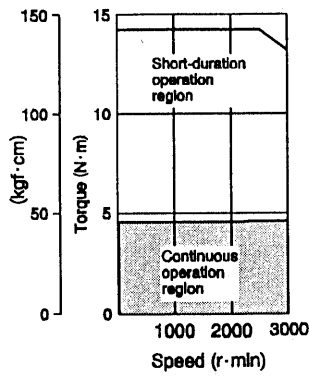


(4) HA-SH 3000r/min series

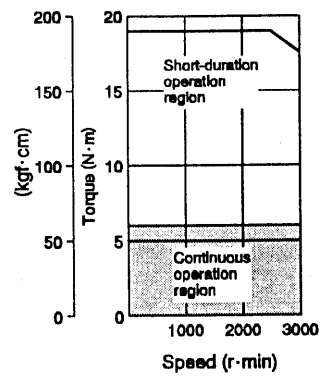
[HA-SH103]



[HA-SH153]



[HA-SH203]

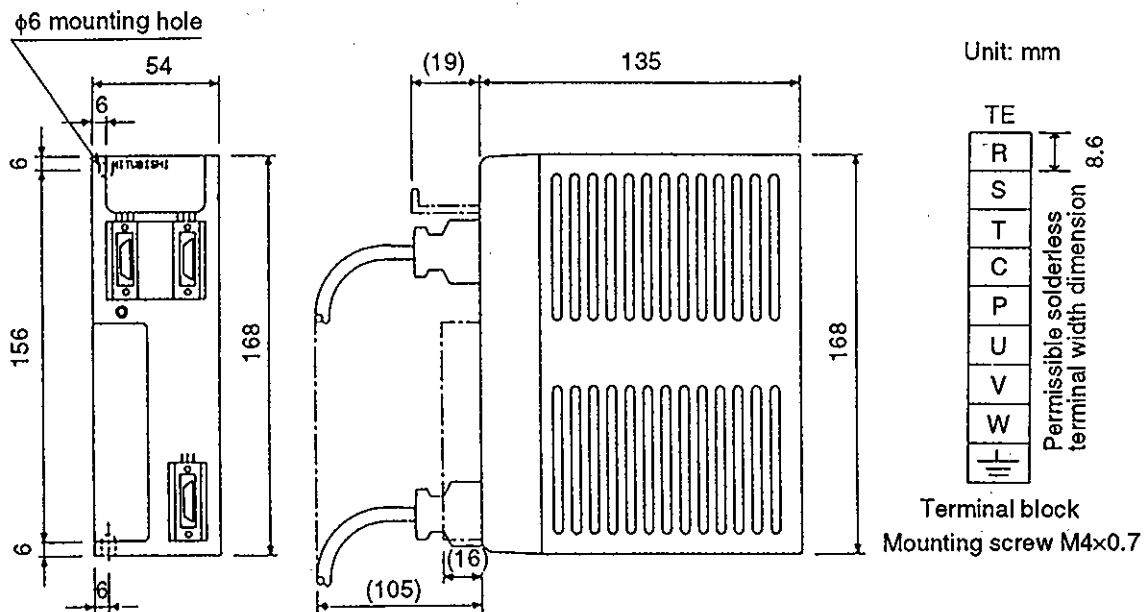


8. SPECIFICATIONS

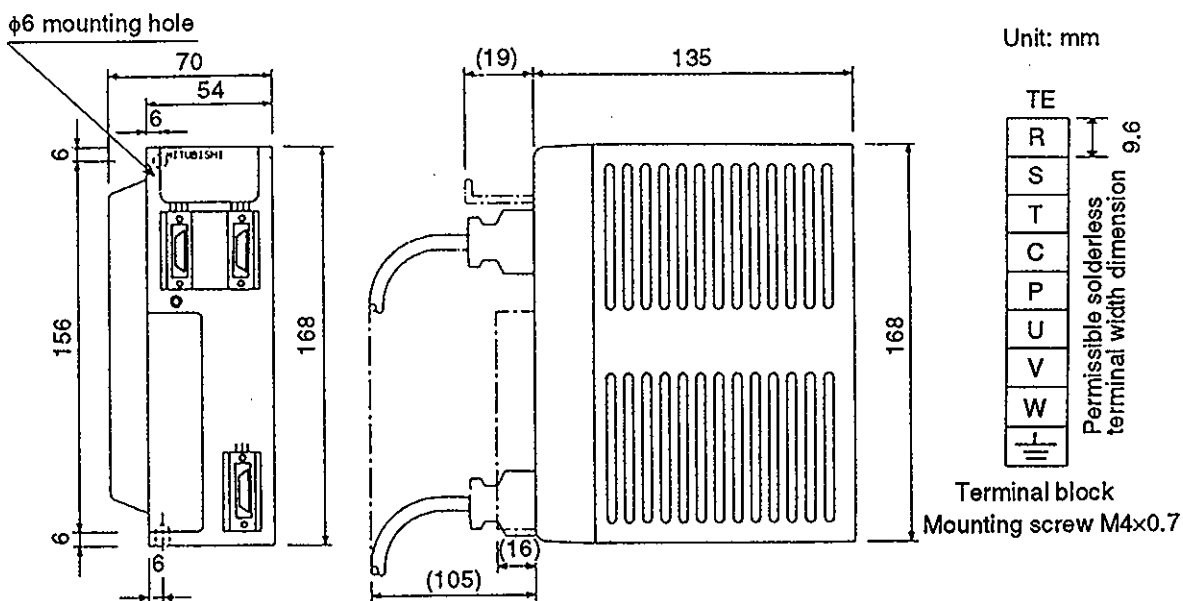
8-4 Outline Drawings

8-4-1 Servo amplifiers

MR - J10B to MR - J20B

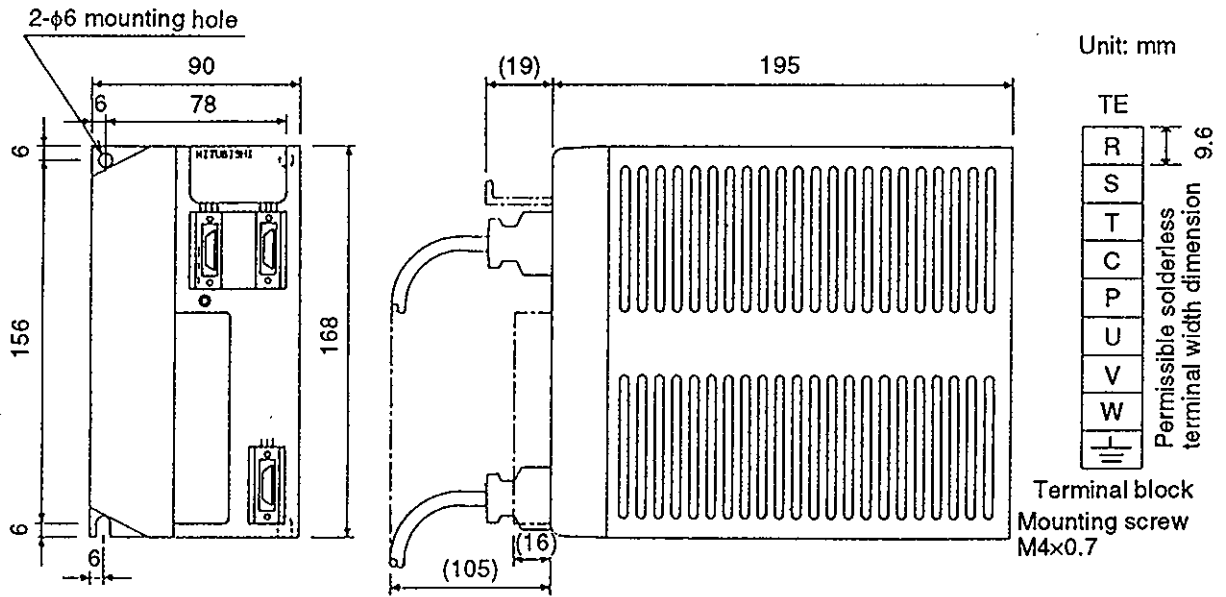


MR - J40B, MR - J60B



8. SPECIFICATIONS

MR - J100B, MR - J200B



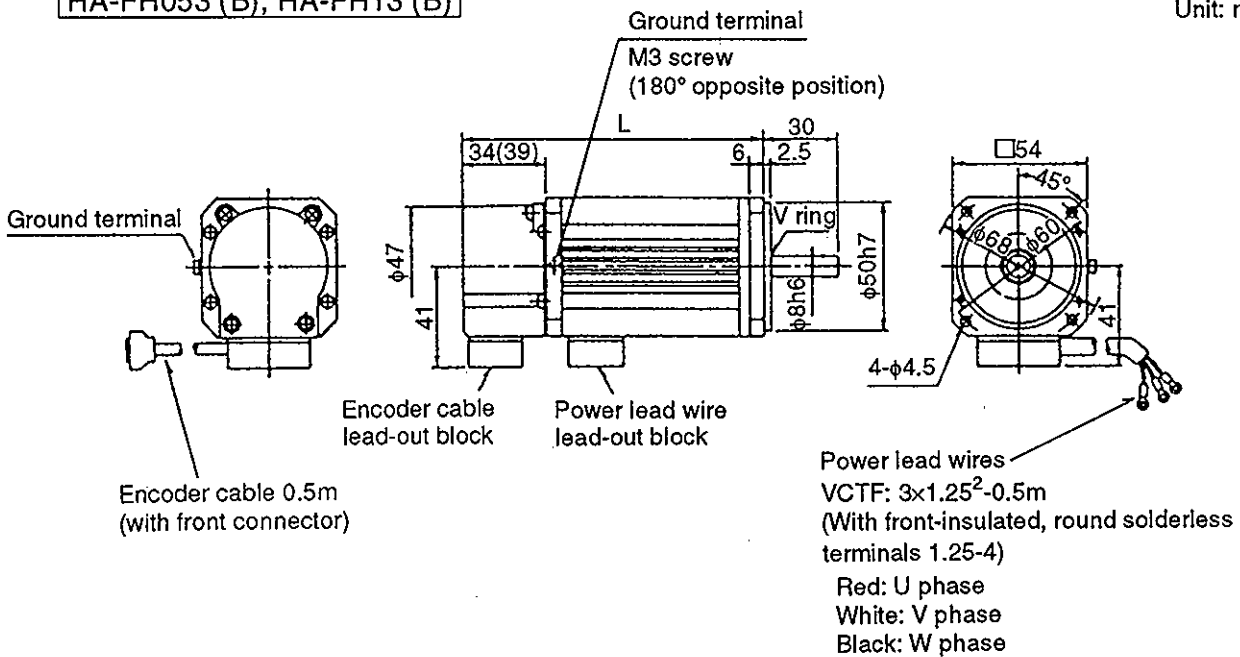
8. SPECIFICATIONS

8-4-2 Servo motors

(1) HA-FH series

HA-FH053 (B), HA-FH13 (B)

Unit: mm



With incremental encoder

With absolute position encoder

With incremental encoder		With absolute position encoder	
Type	Variable dimensions L	Type	Variable dimensions L
HA-FH053 (B)	101 (136)	HA-FH053 (B)-Y	106 (141)
HA-FH13 (B)	118 (153)	HA-FH13 (B)-Y	123 (158)

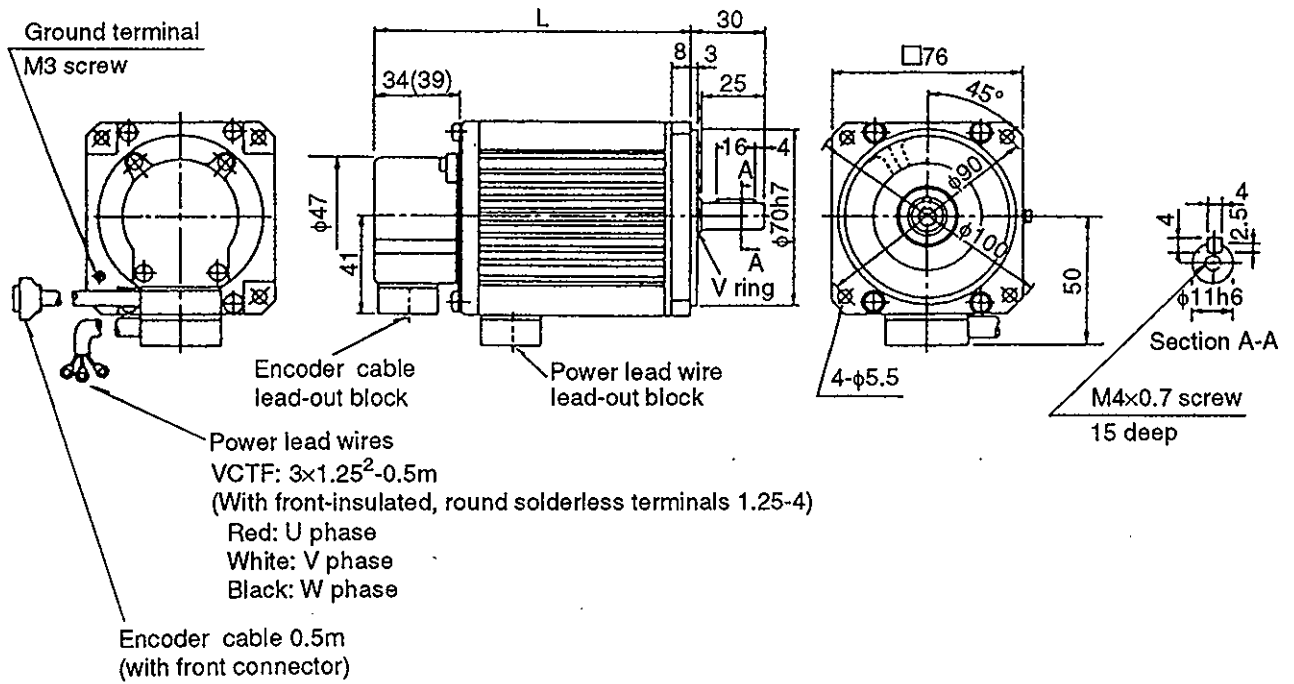
L in the parentheses indicates the value of the servo motor with electromagnetic brake.

- Note: 1. For the servo motor with electromagnetic brake, the inertia J of 0.02kg·cm² (GD² of 0.07kgf·cm²) and the weight of 0.3kg are added to those of the servo motor without electromagnetic brake.
2. The encoder values in the parentheses indicate those of the absolute position encoder.
3. Use a compression coupling for connection.

8. SPECIFICATIONS

HA-FH23 (B), HA-FH33 (B)

Unit: mm



With incremental encoder

With absolute position encoder

Type	Variable dimensions	L	Type	Variable dimensions	L
HA-FH23 (B)		126 (163)	HA-FH23 (B)-Y		131 (168)
HA-FH33 (B)		143 (181)	HA-FH33 (B)-Y		148 (186)

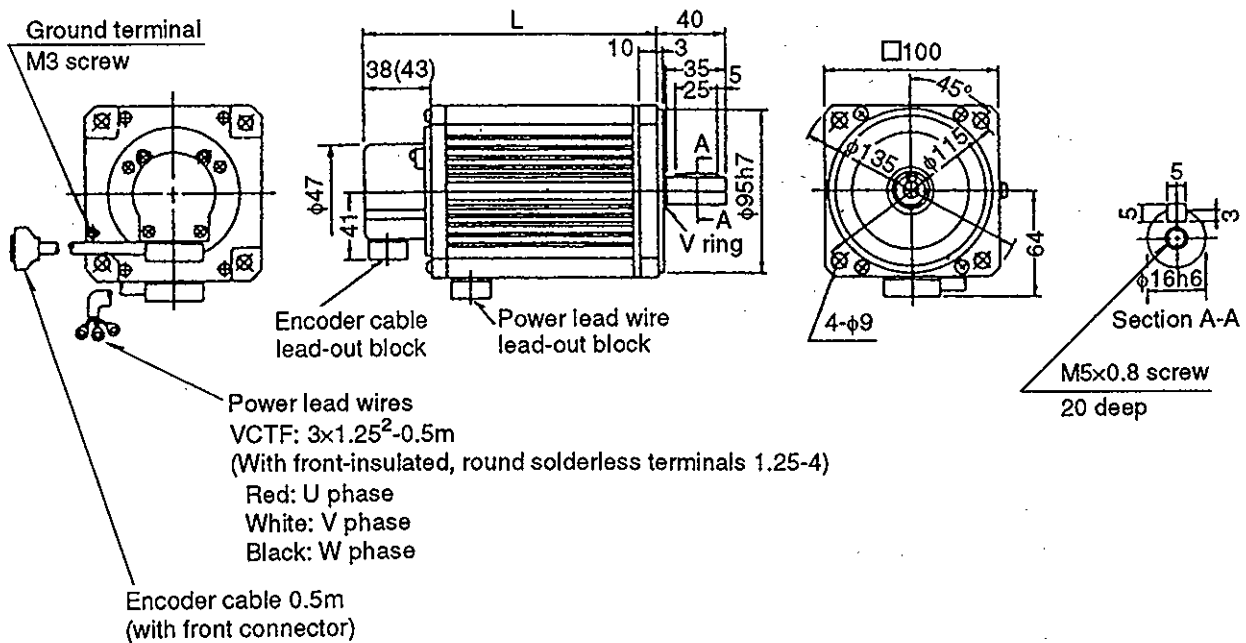
L in the parentheses indicates the value of the servo motor with electromagnetic brake.

- Note: 1. For the servo motor with electromagnetic brake, the inertia J of 0.13kg·cm² (GD² of 0.53kgf·cm²) and the weight of 0.6kg are added to those of the servo motor without electromagnetic brake.
2. The encoder values in the parentheses indicate those of the absolute position encoder.
3. Use a compression coupling for connection with the load.

8. SPECIFICATIONS

HA-FH43 (B), HA-FH63 (B)

Unit: mm



With incremental encoder

With absolute position encoder

Variable dimensions	L	Variable dimensions	L
Type		Type	
HA-FH43 (B)	150(187)	HA-FH43 (B)-Y	155 (192)
HA-FH63 (B)	165 (202)	HA-FH63 (B)-Y	170 (207)

L in the parentheses indicates the value of the servo motor with electromagnetic brake.

Note: 1. For the servo motor with electromagnetic brake, the inertia J of 0.34kg·cm² (GD² of 1.4kgf·cm²) and the weight of 0.8kg are added to those of the servo motor without electromagnetic brake.

2. The encoder values in the parentheses indicate those of the absolute position encoder.

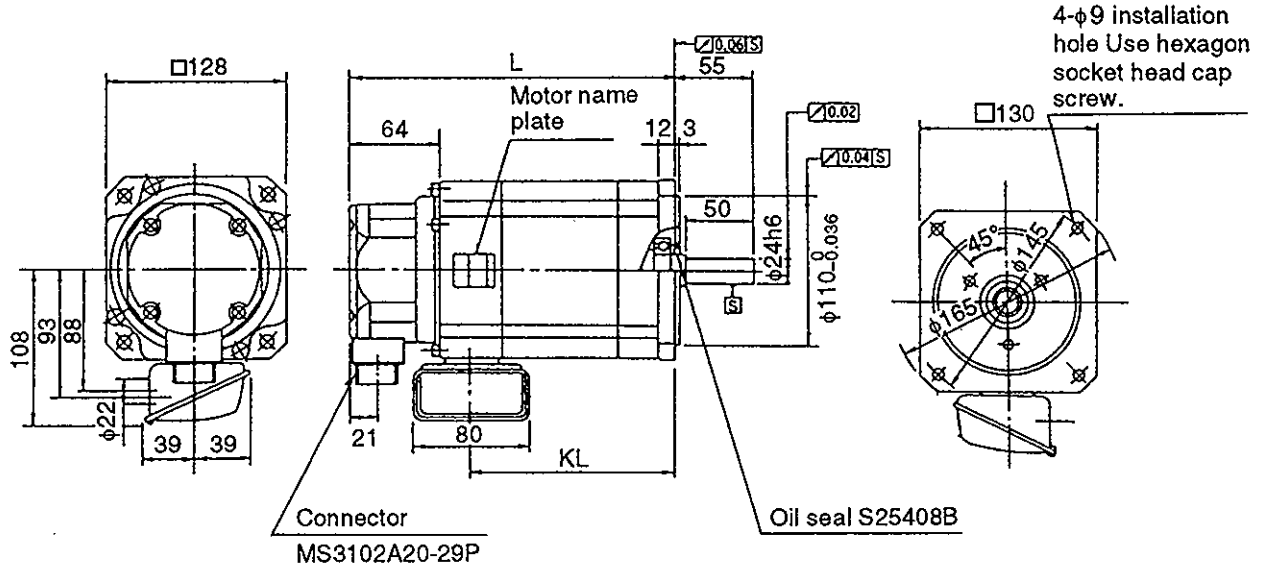
3. Use a compression coupling for connection with the load.

8. SPECIFICATIONS

(2) HA-SH series

HA-SH81 (B)
HA-SH52 (B) to HA-SH152 (B)
HA-SH53 (B) to HA-SH153 (B)

Unit: mm



Type	Variable dimensions		L	KL
	1000r/min series	2000r/min series		
-	-	HA-SH52 (B)	214 (264)	124
-	-	HA-SH102 (B)	254 (304)	164
HA-SH81 (B)	HA-SH152 (B)	HA-SH153 (B)	294 (344)	204

L in the parentheses indicates the value of the servo motor with electromagnetic brake.

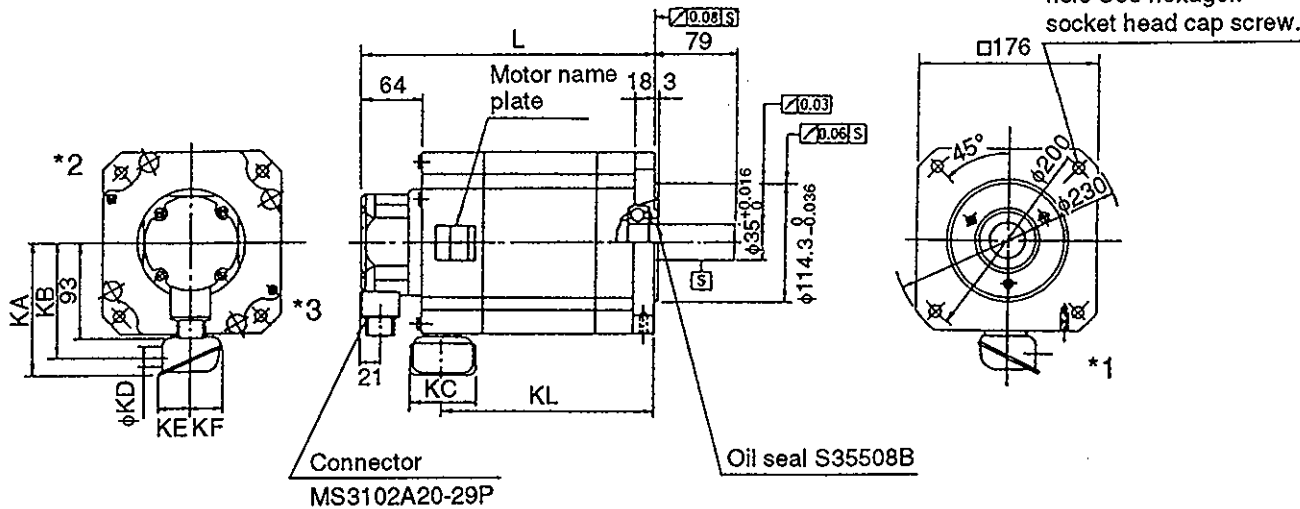
- Note: 1. Use a compression coupling for connection with the load.
 2. For the servo motor with electromagnetic brake, the inertia J of 0.68kg·cm² (GD² of 2.7kgf·cm²) and the weight of 2kg are added to those of the servo motor without electromagnetic brake.
 3. Fit the connector downward to produce a splash resistance effect.

8. SPECIFICATIONS

HA-SH121 (B) to HA-SH301 (B)
 HA-SH202 (B)
 HA-SH203 (B)

Unit: mm

4- ϕ 13.5 installation
 hole Use hexagon
 socket head cap screw.



Variable dimensions			L	KA	KB	KC	KD	KE	KF	KL
Type										
1000r/min series	2000r/min series	3000r/min series								
HA-SH121(B)	HA-SH202 (B)	HA-SH203 (B)	262 (329)	135	115	80	22	39	39	168
HA-SH201 (B)	-	-	330 (397)							236

L in the parentheses indicates the value of the servo motor with electromagnetic brake.

- Note: 1. Use a compression coupling for connection with the load.
 2. *1 to *3 indicate screw holes (M8) for sling bolts. For horizontal slinging, use *1 and *3.
 3. For the servo motor with electromagnetic brake, the inertia J of 4.25kg·cm² (GD² of 17kgf·cm²) and the weight of 6kg are added to those of the servo motor without electromagnetic brake.
 4. Fit the connector downward to produce a splash resistance effect.

8. SPECIFICATIONS

8-5 Servo Motor with Reduction Gear

The servo motors with reduction gears available are compatible with 1) high precision reduction gear and 2) general industrial reduction gear. The manufacturing ranges of the above two lines are given below. Since the installation position and lubrication method are different between the models, specify them in the outline drawing after determining the machine specifications.

- Manufacturing range of the servo motor with reduction gear

Reduction Gear		1) For High Precision					2) 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	1/5	1/10	1/30
Servo motor	HA-FH053(B)G to 63(B)G	—	—	—	—	—	—	—	—	—	—	—	—	○	○	○
	HA-SH52(B)G to 202(B)G	○	○	○	○	○	○	○	○	○	○	○	○	These reduction ratios are nominal values. For the actual reduction ratios, refer to Section 8-5-1.		

8-5-1 HA-FH series

Reduction Gear	For General Industrial Machines
Backlash	40 minutes to 1.5°
Method of mounting	Flange mounting
Output shaft rotating direction	The motor shaft and reduction gear output shaft rotate in the same direction. However, the HA-FH053(B)G 1/30 and HA-FH13(B)G 1/30 motor shafts rotate in the direction opposite to the reduction gear output shaft.
Permissible speed (at the reduction gear input shaft)	3000 r/min
Permissible 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 directions

The actual reduction ratios of the HA-FH series are as listed below:

Servo Motor Nominal Reduction Ratio	HA-FH053G	HA-FH13G	HA-FH23G	HA-FH33G	HA-FH43G	HA-FH63G
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

8. SPECIFICATIONS

8-5-2 HA-SH series

Reduction Gear	For High Precision	For General Industrial Machines
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 motor shaft and reduction gear output shaft rotate in the same direction.	The motor shaft and reduction gear output shaft rotate in the opposite directions.
Permissible speed (at the reduction gear input shaft)	2000 r/min	
Permissible load inertia moment ratio	5 times or less	3 times or less
Lubrication method	Grease (Recommended grease: LDR101BJ of America Oil Center Research)	As in (1) and (3) of this section
Mounting direction	In any directions	As in (1) of this section

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

Mounting Direction Reduction Gear Type (Note 1) Reduction Gear Frame No.	Shaft Vertical				Shaft Downward			Shaft Upward		
	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		

8. SPECIFICATIONS

Note: 1. The speed reducer frame numbers are as follows:

Motor type	Reduction ratio						
	1/6	1/11	1/17	1/29	1/35	1/43	1/59
HA-SH 52(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			

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

(2) Mounting of motors with speed reducers designed for general industrial machines

Speed reducer type	HM	HMS	VMH	WMH	HMV	VM	WMV	HMF	VMF	WMF
Mounting	Leg 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 (Unit: l)

		213	216
Lubrication amount	Horizontal type	0.7	1.4
	Vertical type	1.1	1.0

8. SPECIFICATIONS

8-6 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. 8-1 can be manufactured as special order for the 0.5 to 1.5kW 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.

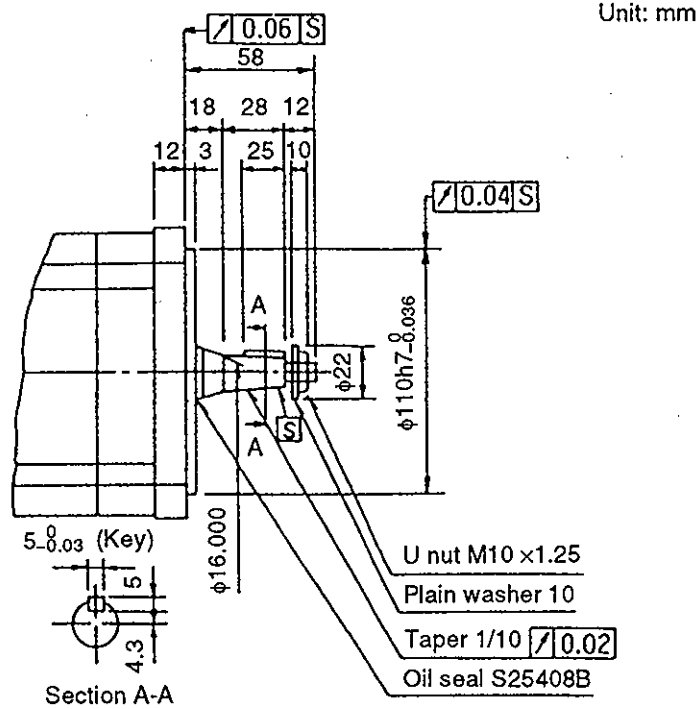


Fig. 8-1 Tapered Shaft Dimension Diagram

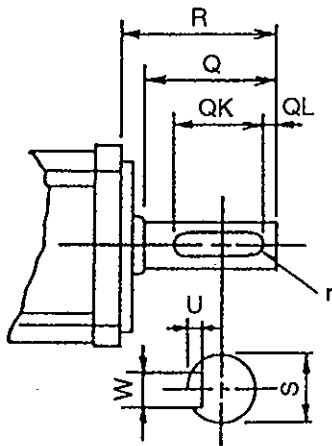
8. SPECIFICATIONS

8-7 Servo Motor with Special Shaft

The standard servo motor output shaft has a straight shaft without keyway. When the servo motor is coupled with the load by a key, the following keyway or D cut (HA-FH053, 13 only) is recommended for the servo motor shaft.

Note that the servo motor cannot be used in any application where frequent starts and stops are made. We are not liable for any accident such as shaft fracture attributable to a loose key. Use a friction coupling (e.g. locking element).

- Keyway



Variable Dimensions List

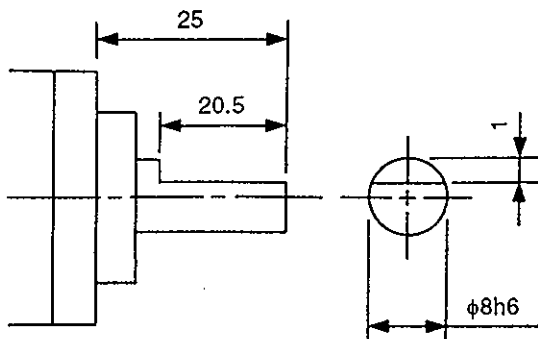
Unit: mm

Motor Series Capacity (kW)		Variable Dimensions							
		S	R	Q	W	QK	QL	U	r
HA-SH	0.5 to 1.5	24h6	55	50	$8_{-0.036}^0$	36	5	$4_{+0.2}^0$	4
	2.0	$35_{+0.01}^0$	79	—	$10_{-0.036}^0$	55	5	$5_{+0.2}^0$	5

Note: The key is not provided and should be prepared by the user.

- D cut

Applicable servo motors: HA-FH053, 13



REVISIONS

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

Print Date	*Manual Number	Revision
Mar., 1995	IB (NA) 67218-A	First edition