MITSUBISHI

GENERAL-PURPOSE AC SERVO
MELSERVO-SC

— Instruction Manual —

MITSUBISHI ELECTRIC

BNC-C31005-019*

Thank you for your purchase of Mitsubishi MELSERVO-SC.
This instruction manual describes handling, installation, operation and maintenance of your AC servo system.
Although it is easy to use the AC servo amplifier and motor, inadequate use and operation might cause unforeseen trouble.
Before operating your system, read this manual carefully to use the system for a long time without problems.

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IMPORTANT

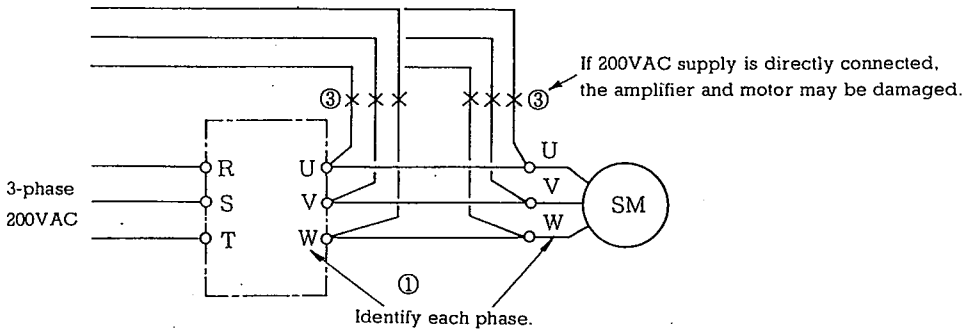
Before the use of your MELSERVO-SC, please read the instructions described here.
Note that inadvertent handling or operation may result in serious damage to your MELSERVO-SC.

(INSTALLATION)

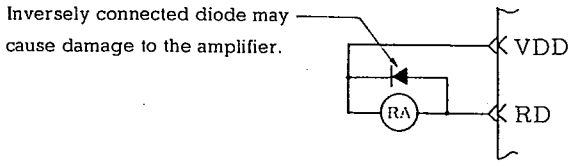
Install the amplifier in accordance with the instructions "INSTALLATION".
Particular attention should be paid to the ambient temperature, location of heat-generating devices (discharge resistor unit, etc.) and the handling of motor encoder.
Observe the designated combinations for the amplifier and motor or optional dynamic brake combination. If operated with combinations other than those specified, the motor may be damaged.

(WIRING)

1. Carefully identify each phase (U, V and W) on the amplifier output and the motor input and connect the cable correctly . . . . . See 4-8 (1).
2. Do not connect power supply other than that specified (3-phase 200V) to the amplifier power input terminals (R, S and T) (otherwise, the amplifier may be damaged) . . . . . See 4-8 (1).
3. Do not connect AC power supply to the amplifier output terminals (U, V and W) or the motor input terminals (U, V and W) (otherwise, the amplifier and motor may be damaged) . . . . . See 4-8 (1).



4. When a discharge resistor unit (option) is connected to the amplifier, remove the jumper bar (otherwise, the amplifier may be damaged) . . . . See 4-3 and 4-8 (1).
5. When a diode is used with relay for output signal (RD, PF, etc.), do not connect it inversely (otherwise, the amplifier may be damaged) . . . . See 4-2 and 4-8 (2).



6. When input signal using "b" contact is used, connect the signal line to "SG" terminal . . See 4-2 and 4-8 (2).
7. Ground the amplifier and the motor to a single point . . . . . See 4-1 and 4-8 (1).

(OPERATION AND OPERATION SEQUENCE)

1. Do not frequently turn on and off the power supply and the "SON" signal to be less than 10 or 20 times per day. (Otherwise, the amplifier might be damaged) . . . . . See 4-7 (1) and 4-7 (2).
2. Do not frequently turn off and on the power to restore the amplifier from alarm condition. (AL30,50,51) (Otherwise the amplifier might be damaged) . . . . . See 4-7 (3) and 7-1.
3. When a braked motor is used, the start signal should be given after the motor is released from the brake. . . . . See 4-8 (1)

(MAINTENANCE AND TROUBLESHOOTING)

1. Do not use a megger to check the amplifier (otherwise, the amplifier may be damaged) . . . . . See 8-1.
2. While the "CHARGE" lamp is on, do not touch any live part of the amplifier (otherwise, you may receive an electric shock) . . . . . See 8-1.
3. P.C. board dedicated to each model is used and not compatible with other model.

1. UNPACKING AND CHECKING

After unpacking the MELSERVO-SC, check the following points at first.

(1) Check the nameplates of amplifier and motor to make sure the models and output ratings meet your order.

(2) Check that the amplifier and servo motor have not been damaged during transportation.

If you have any question or find trouble with your MELSERVO-SC system, contact nearby-located our sales representative.

[Combination of the motor and amplifier]

The motor and amplifier can be used with the following combinations. These cannot be used with other combinations, so always confirm before wiring. The options are also exclusive, so inspect simultaneously.

Servo motor	Series	HA-SC series					HA-SA series		
	Model	HA-SC053	HA-SC13	HA-SC23	HA-SC43	HA-SC63	HA-SA22 HA-SA32U HA-SA33	HA-SA52 HA-SA52L HA-SA52U HA-SA53	HA-SA102 HA-SA102L HA-SA102U HA-SA103
Servo amplifier		MR-SC10	MR-SC10	MR-SC20	MR-SC40	MR-SC60	MR-SC40	MR-SC60	MR-SC100
Regenerative option unit		None			MR-RB082, MR-RB32				Mount one of these
Dynamic brake		MR-SDBU-1C						MR-SDBU-1A	

2. HANDLING

Carry and handle the servo amplifier and motor carefully to avoid damage to them.

(1) The cover of servo amplifier is made of steel sheet. When the servo amplifier is carried, do not hold it in such a manner that force is exerted on only the cover.
Do not place an object on the cover. Otherwise the cover might be deformed or damaged.

(2) Carefully handle the encoder of servo motor and use care not to give mechanical impact to it.
When carrying the motor, do not apply hand or slinger to the encoder to lift.

3. INSTALLATION

3-1 Servo amplifier

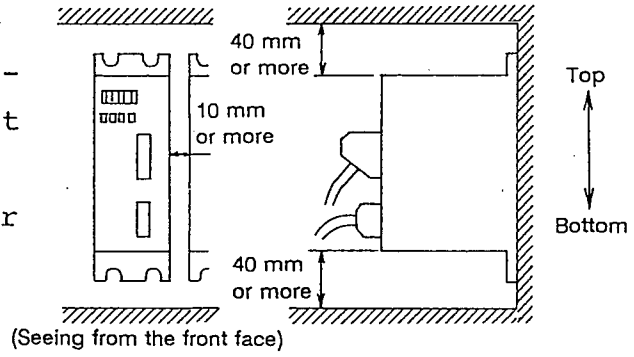
(1) Install the servo amplifier in a clean and well-ventilated location. Do not install the servo amplifier in direct sunlight, or areas with high temperature, high humidity, dust and corrosive gases.

Environmental conditions

Ambient temperature	0°C to 55°C (to be free from freezing)
Ambient humidity	90% RH or less (to be free from condensation)
Vibration	5.9m/s^2 or less

(2) The servo amplifier is a wall-mount type. Install it on a wall vertically and securely with bolts or screws so that the letters "MELSERVO-SC" face front. (see the figure below).

(3) Since the servo amplifier generates heat during operation, provide sufficient clearance (at least 40mm around the servo amplifier (see the right figure).



(Seeing from the front face)

(4) When the servo amplifier is housed in a cubicle, enclosure, etc., pay attention to prevent deposit of dust in the unit.

(5) The discharge resistor unit (option) generates heat. If it is used under heavy service duty, its temperature may reach about 100°C.

① Do not install it on a wall vulnerable to heat.

② It is recommended that the unit is installed outside the panel.... for prevention of heat rise in the panel.

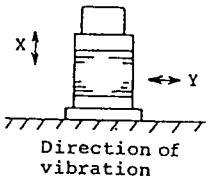
③ Make suitable provisions to prevent any cable or wire from coming into contact with the discharge resistor unit. Also note the nistruction and caution described in 4-3 for safe use of the unit.

3-2 Servo motor

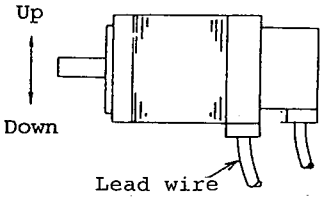
(1) Do not install the servo motor to direct sunlight, high temperature and high humidity.

Environment

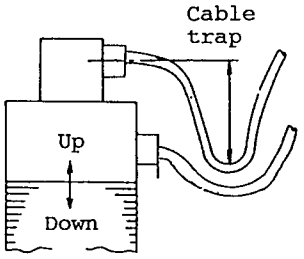
Ambient temperature		0 ~ 40°C (to be free from freezing)
Ambient humidity		80% RH or less (to be free from condensation)
Vibration	HA-SC	19.6m/S^2 or less
	HA-SA	X:9.8m/S^2 Y:24.5m/S^2 or less



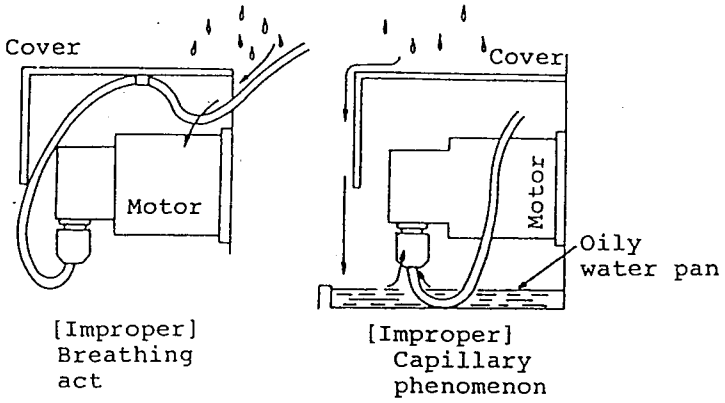
(2) If the servo motor may be exposed to water or oil, protect the motor with a cover or other suitable means and install the motor with the leads directed downward so that water or oil cannot run into the motor along the leads (see the figure).



When the motor is mounted vertically or slantly, provide a trap for cable.



The cable sometimes guides oily water to the motor or detector to take an adverse effect on it. Take care to prevent the cable from guiding oily water or dipping in the oily water pan.



(3) Sufficiently check the cable clamp method, and prevent the cable connection area from being exposed to the bending stress or the weight stress of the cable itself. In the application where the motor is moved, determine the curveture radius of the cable judging from the bending durability and cable type.
Take care to prevent the cable sheath from being cut by sharp cut chips, torn with the corner or the machine or stepped on by man or cart.

(4) The servo motor is horizontally mounted, and the spindle can be faced upward or downward as desired.

① When the spindle is faced upward, take some counter-measures to prevent oil from entering the motor from the gear box or similar. In this case, only the oil seal provided on the motor can not prevent entry of the oil.

② The motor provided with electromagnetic brake is also horizontally mounted, and the spindle can be faced upward or downward as desired.
When it is faced upward, vibration of the brake plate may result in sounding. But it is not an abnormality.

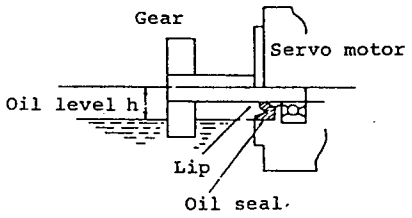
③ The motor provided with reducer can not be operated in any other position except shown in the outline drawing. Use the motor as specified in the outline drawing.

④ When the motor is horizontally mounted, always keep the oil level lower than the oil seal ripple of the servo motor shaft, and provide the air breather port on the gear box to prevent the inner pressure from rising.
If it is higher than the oil seal ripple, oil may enter the motor.

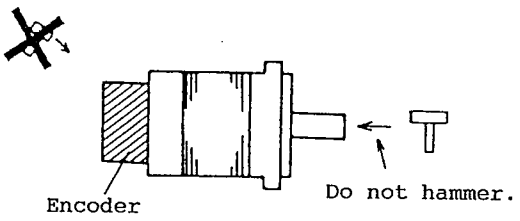
Series		HA-SA			HA-SC		
Model	Standard	HA-SA22 HA-SA33	–	HA-SA52,53 HA-SA102,103	HA-SC053 HA-SC13	HA-SC23	HA-SC43 HA-SC63
	Low inertia	–	–	HA-SA52L HA-SA102L			
	Flat	–	HA-SA32U HA-SA52U	HA-SA102U			
Height from motor shaft center h(m)		11	15	20	8 (11)	12 (13)	14 (18)

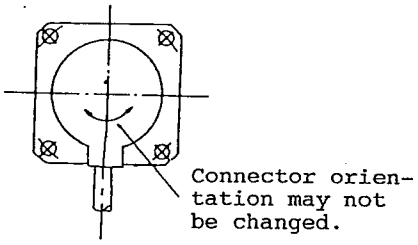
Note: Values in ( ) are for when the brake is used.
The HA-SA motor is the same as that with a brake.

Note: For geared motors, some restrictions are imposed on installation.
Install such a motor in accordance with the applicable drawing.



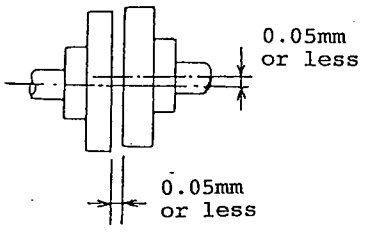
(5) During transportation and installation, use care not to give mechanical shock or impact to the encoder of motor.
Do not hold the encoder by hand, nor apply a wire rope or slinger to the encoder to life the motor.
In installation or assembly, do not hammer the motor end.
Do not change orientation of the encoder.





(6) For connection of the motor shaft to a machine shaft, it is recommended to use a "flexible coupling" which can automatically adjust misalignment of two shafts.
When the motor is secured in position, be sure to align its shaft with the shaft of the associated machine.
Upon periodic inspection, check shaft alignment and correct if necessary.

[Permissive shaft core alignment]
Measure 4 circumference locations for the shaft core alignment.
Mount the shaft so that the difference between the maximum and minimum values is less than that shown in the diagram.

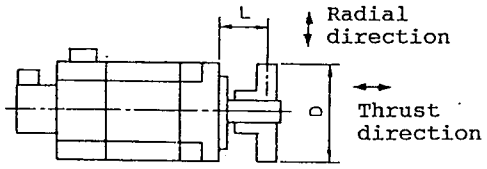


(7) Do not exert a load exceeding the limit shown below to the motor shaft.

Permissive shaft end load for the servo motor

Series		Motor	Permissive radial load	Permissive thrust load
HA-SC		HA-SC053	L=30 107N•m	98N•m
		HA-SC13	L=30 117N•m	98N•m
		HA-SC23	L=30 176N•m	147N•m
		HA-SC43,63	L=40 323N•m	284N•m
HA-SA	Standard	HA-SA22,33	L=25 196N•m	147N•m
		HA-SA52,53(T) ~ HA-SA102,103(T)	L=55 980N•m (L=58 392N•m)	490N•m
	Flat	HA-SA32U HA-SA52U	L=35 294N•m	196N•m
		HA-SA102U	L=55 637N•m	490N•m
	Low inertia	HA-SA52L HA-SA102L	L=55 980N•m	490N•m

Notes:
1. The permissive thrust load and permissive radial load are applicable when they work independently.
2. The permissive radial load parenthesized with ( ) is applicable for the taper-shafted motor.
3. The codes in the table are as follows:

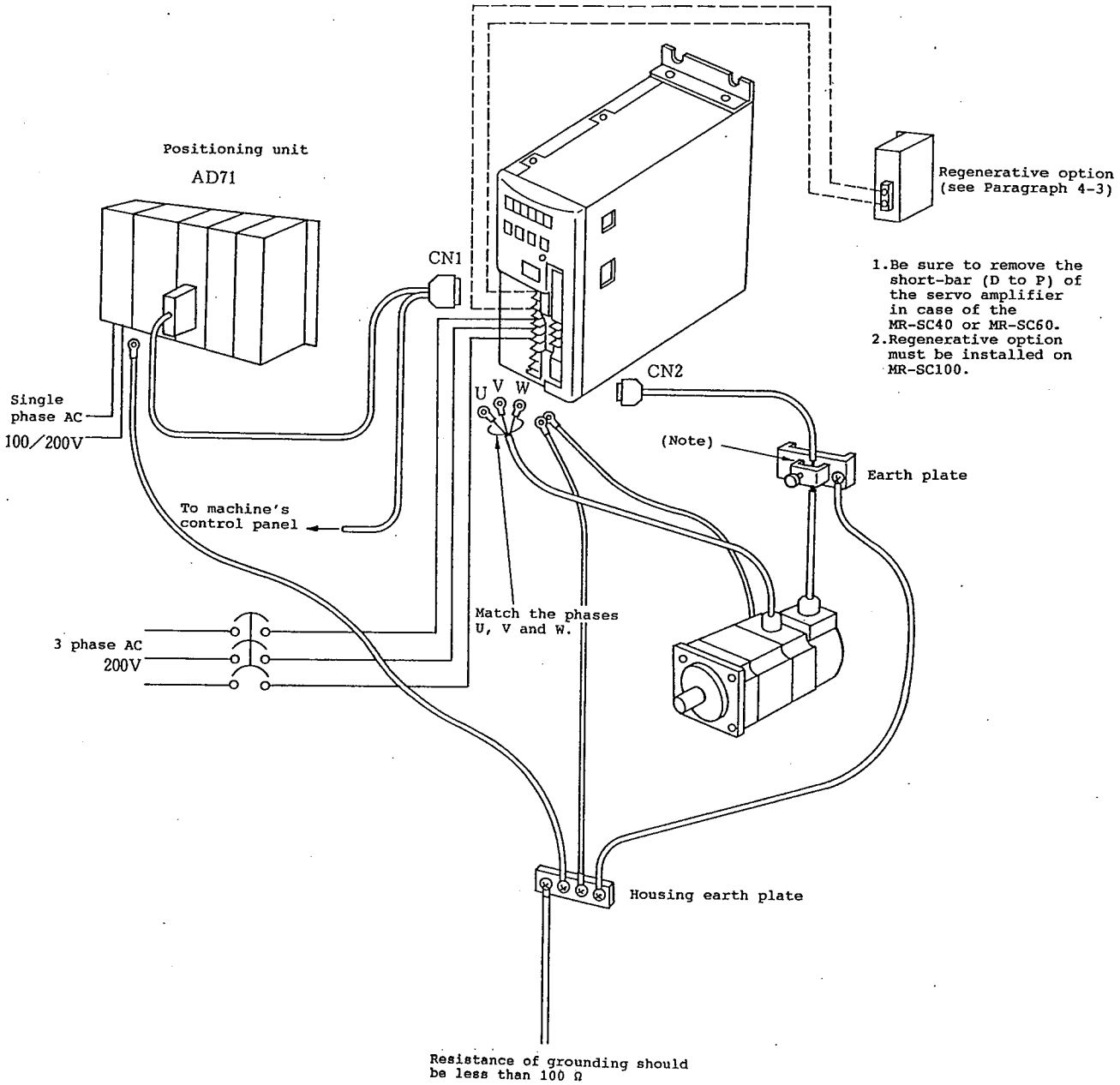


L: Distance (mm) from the flange mounting surface to the center of the load.

4. EXTERNAL WIRING AND CONSTRUCTION

4-1 Power supply connection

The power supply and ground wiring is shown below.
To prevent malfunction caused by external interference (noises) and to assure safe operation, the servo amplifier, positioning unit and servo motor should be grounded.
The servo motor and the servo amplifier should be grounded to a single point (common grounding line).



Notes: 1) Better noise withstanding effect can be expected if the shield of motor detector cable is grounded via the earth plate. See 4-9 (5).
2) Arrange the signal cables remotely from the power cables.

4-2 Standard wiring diagram

(1) Example of connection with the positioning control operation AD71

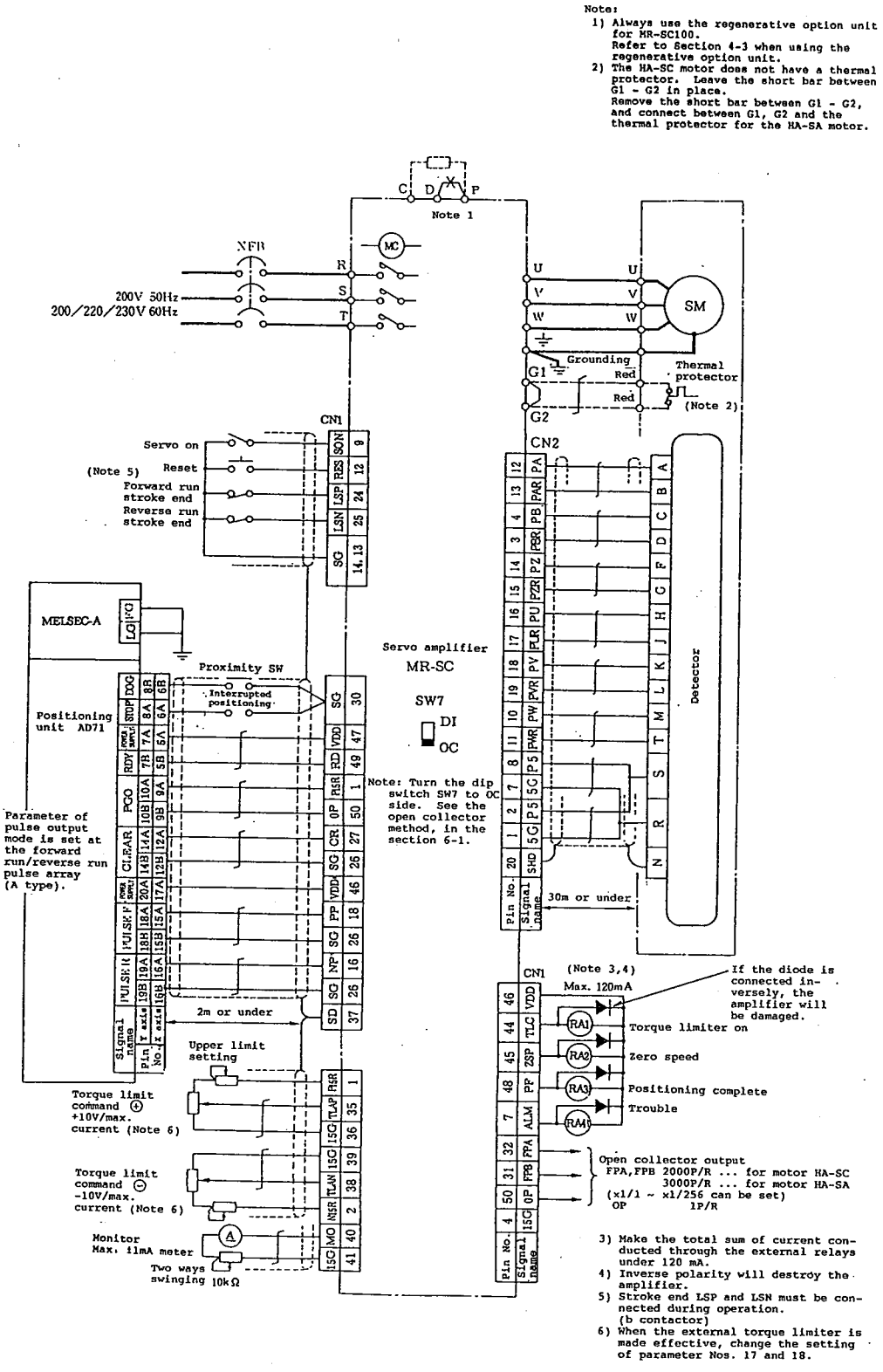


Fig. 4-1 Example of connection with positioning control operation AD71

(2) Example of connection with the positioning control operation MR-PO

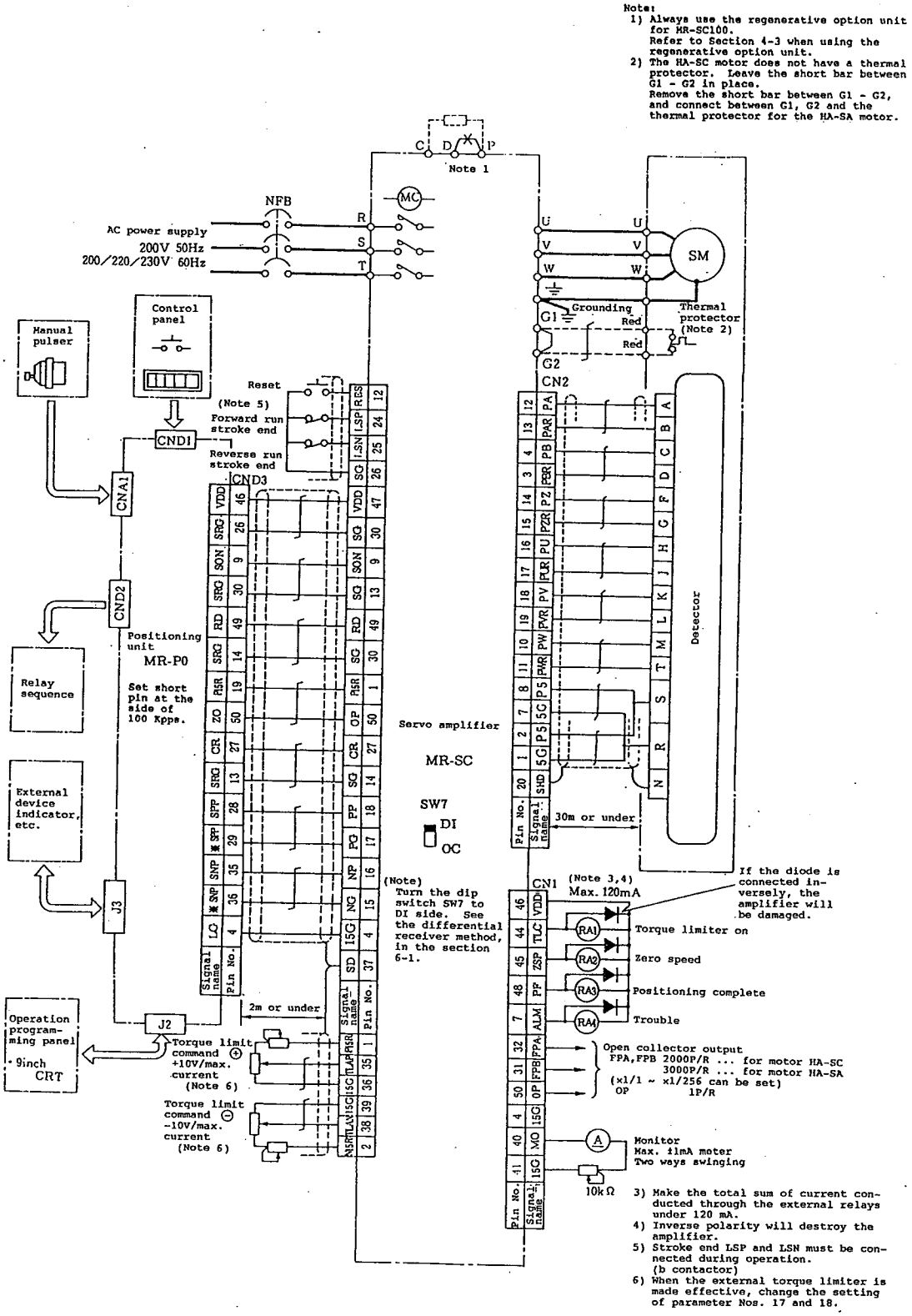
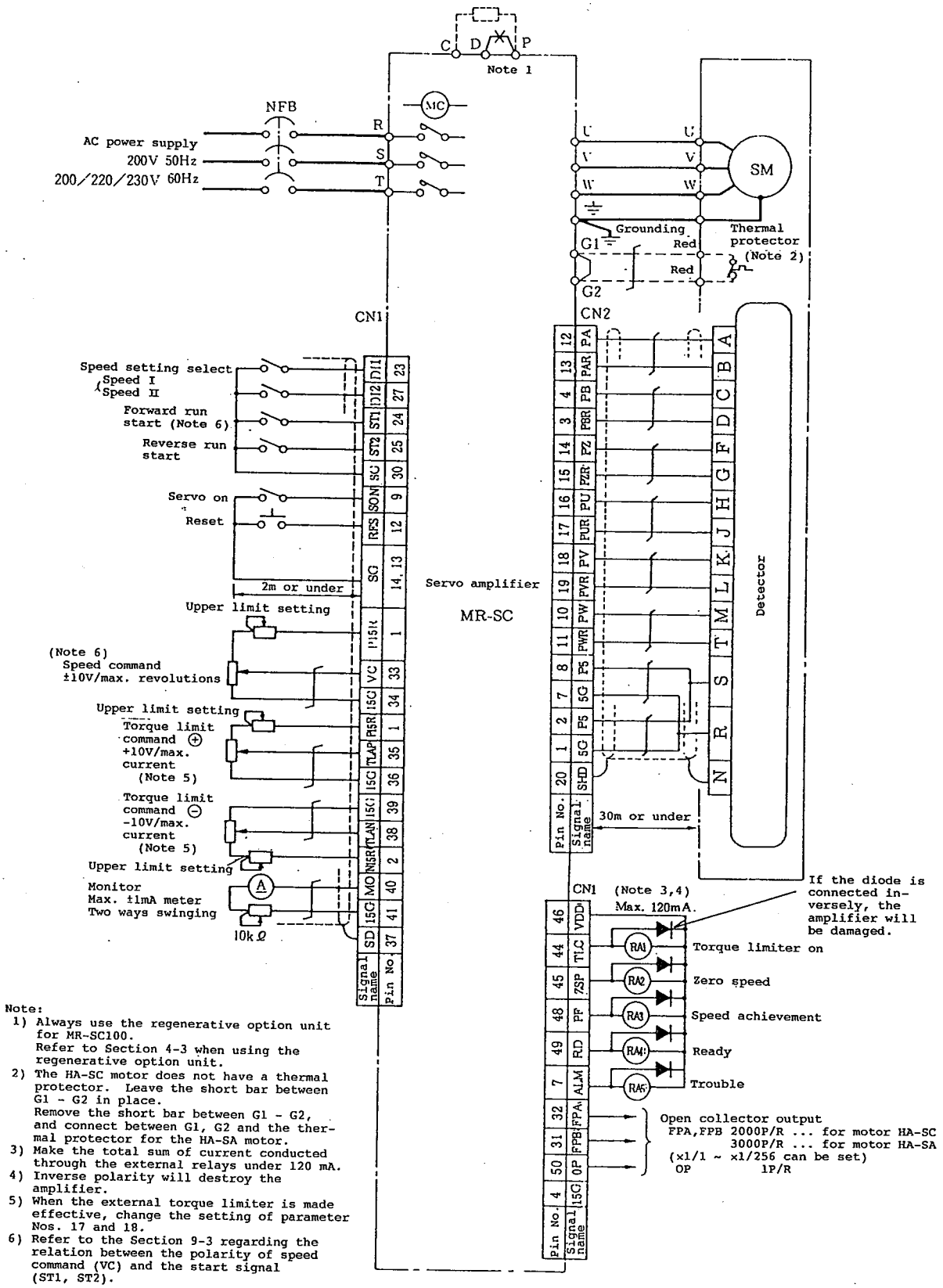


Fig. 4-2 Standard connecting diagram II of positioning control operation

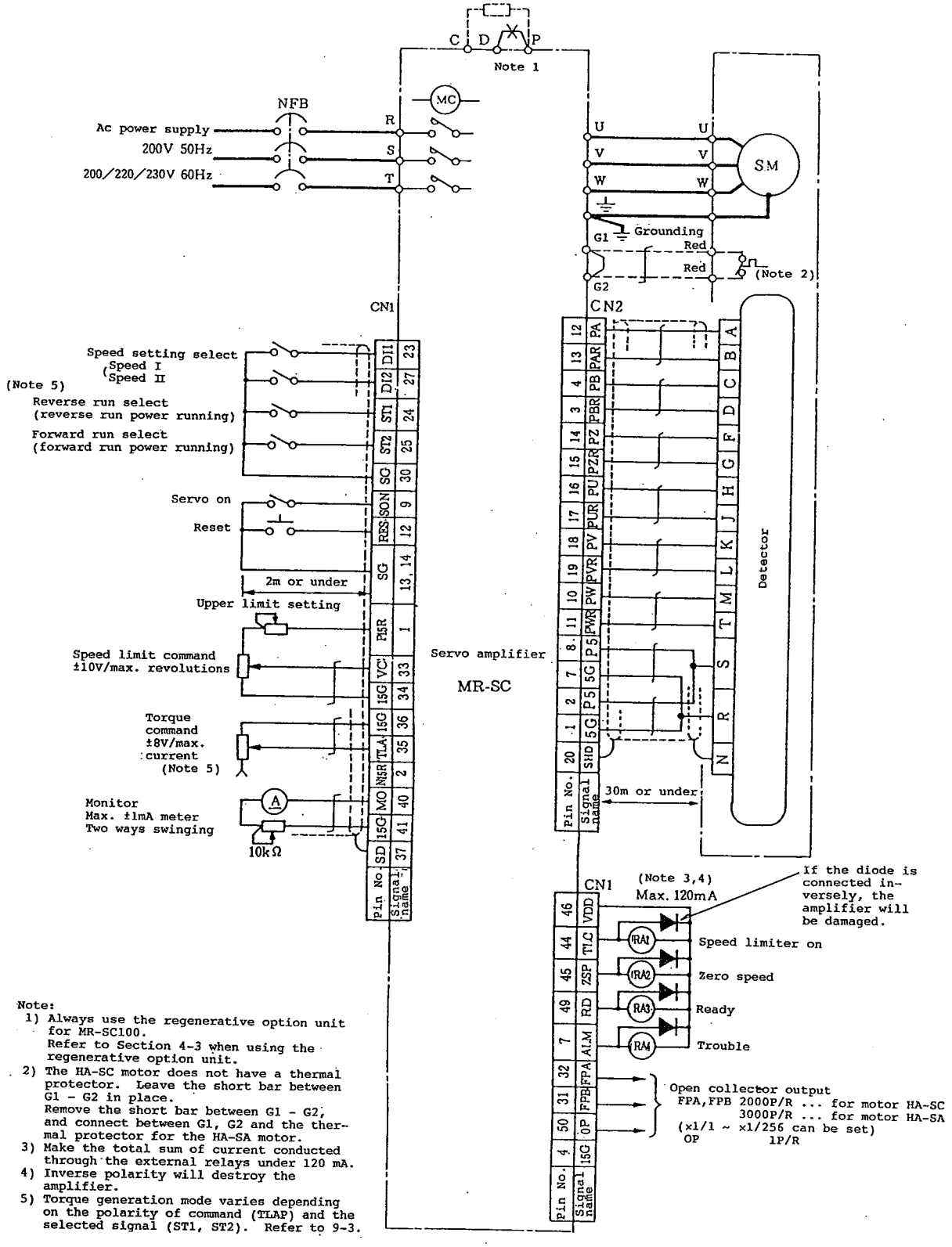
(3) Speed control operation



Note:
1) Always use the regenerative option unit for MR-SC100.
   Refer to Section 4-3 when using the regenerative option unit.
2) The HA-SC motor does not have a thermal protector. Leave the short bar between G1 - G2 in place.
   Remove the short bar between G1 - G2, and connect between G1, G2 and the thermal protector for the HA-SA motor.
3) Make the total sum of current conducted through the external relays under 120 mA.
4) Inverse polarity will destroy the amplifier.
5) When the external torque limiter is made effective, change the setting of parameter Nos. 17 and 18.
6) Refer to the Section 9-3 regarding the relation between the polarity of speed command (VC) and the start signal (ST1, ST2).

Fig. 4-3 Standard connecting diagram of speed control operation

(4) Torque control operation



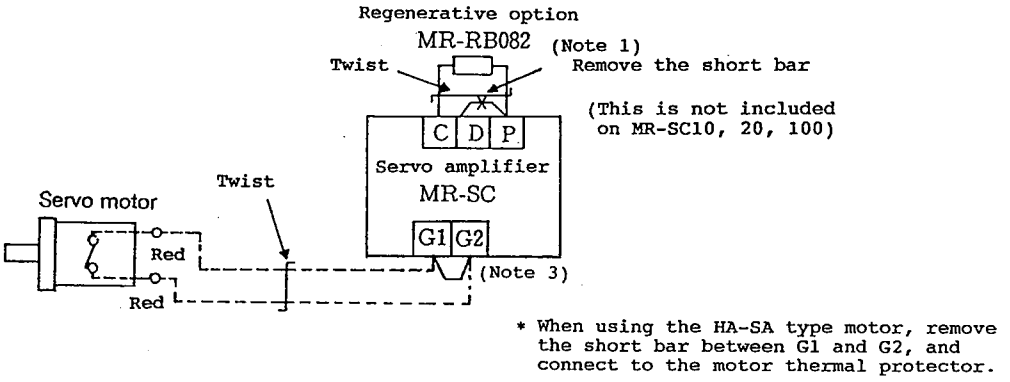
Note:
1) Always use the regenerative option unit for MR-SC100.
   Refer to Section 4-3 when using the regenerative option unit.
2) The HA-SC motor does not have a thermal protector. Leave the short bar between G1 - G2 in place.
   Remove the short bar between G1 - G2, and connect between G1, G2 and the thermal protector for the HA-SA motor.
3) Make the total sum of current conducted through the external relays under 120 mA.
4) Inverse polarity will destroy the amplifier.
5) Torque generation mode varies depending on the polarity of command (TLAP) and the selected signal (ST1, ST2). Refer to 9-3.

Fig. 4-4 Standard connecting diagram of torque control operation

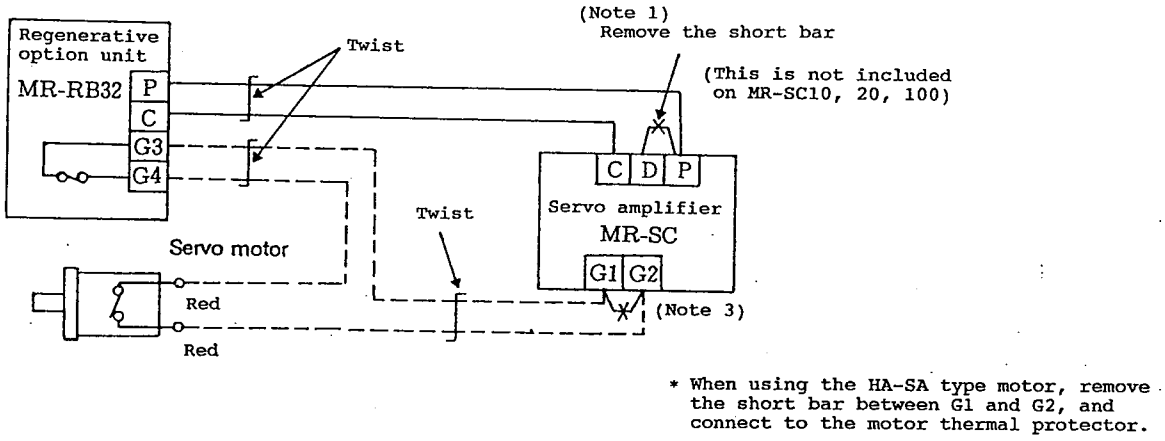
4-3 Connection of the regenerative unit

When the regeneration frequency is high and a regenerative option unit is used, connected as shown below. Always connect the regenerative option unit when using the MR-SC100.

Servo amplifier	Regenerative option unit used	Short bar at shipping
MR-SC10,20	None	None
MR-SC40,60	Connect MR-RB082 or MR-RB32 as necessary.	Always remove when using the regenerative option unit.
MR-SC100	Connect either MR-RB082 or MR-RB32.	None



(a) Connection of the regenerative option unit MR-RB082



(b) Connection of the regenerative option unit MR-RB32

Fig. 4-5 Connection of the regenerative unit

Cautions for operations

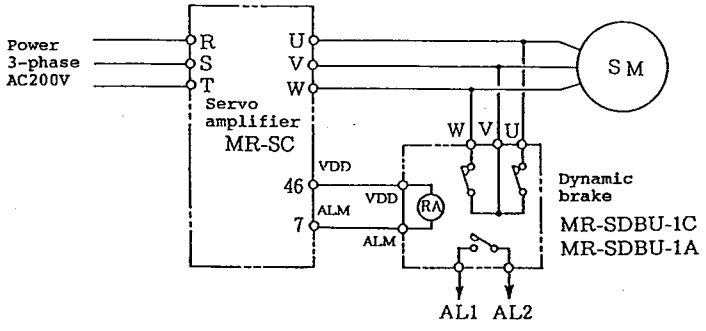
1. When the regenerative option is used, be sure to remove the short bar (D to P) in the servo amplifier (for MR-SC40 or MR-SC60. This is not included in MR-SC100 at shipment.) When operated with the short bar attached, the amplifier may be damaged.
2. When the regenerative option unit is wired, be sure to use twist cables. Make the cables as short as possible (5m or less).
3. Always use twist cables for the temperature detector when using the HA-SA motor to prevent malfunctions with inductive noise. Remove the short bar between G1 and G2 at this time.
4. The regenerative option unit main body generates a heat of up to 100 deg. so do not mount it directly onto a wall surface that is not heat resistant. Use nonflammable wires or those that have been protected with nonflammable means (silicone tubing, etc.), and make sure that they do not touch the regenerative option unit.
5. When the regenerative option unit is used, set a value that corresponds with parameter No.1.

4-4 Connection of the dynamic brake option

Rapid stop is applied with the dynamic brake option when it is necessary to stop the motor due to an emergency stop or an alarm.

Select according to the motor being used. If mistaken, the motor may burn out.

Dinamic brake option	Applicable motor
MR-SDBU-1C	HA-SC series
MR-SDBU-1A	(Note) HA-SA series



(Note) Use MR-SDBU-1C when 0.3kW or less (HA-SA22, HA-SA32U, HA-SA33).

1. The dynamic brake connector is b contact point. During normal operations the internal relay is on, and turns off when the power is turned off or an error occurs.
2. There may be a delay of approximately 10ms until the dynamic brake operates when the internal relay turns off.
3. The contact point between AL1 and AL2 will open when the power is turned off or an error occurs.
4. If the motor revolves at a high speed with the dynamic brake is on, the motor may burn out. When the motor revolves, turn the servo power on, and the dynamic brake contact point off.
5. The dynamic brake has a short time rating. Do not use it at a high repetition.

Fig. 4-6 Connection of the dynamic brake

4-5 Assembly of the detector cables

Assemble the connection cables with the motor PLG and servo amplifier as shown below. When placing an order (core wire of 0.2mm^2), specify the type of the cable set corresponding to the necessary wire length.

(1) Relay cable for HA-SC type motor detector

A cable connector (1m) is built into the encoder so it can be connected to the servo amp connector (CN2). However, if a wire length exceeding 1m is necessary, assemble as shown below.

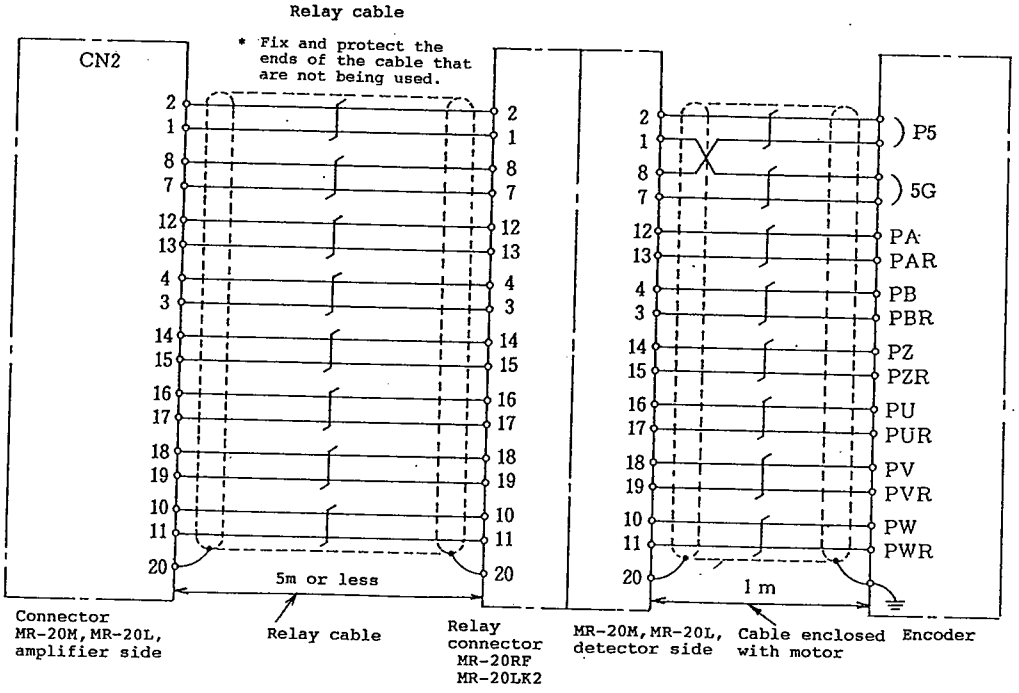


Fig. 4-7 Connecting diagram 1 for encoder cable (relay cable length 5m or less)

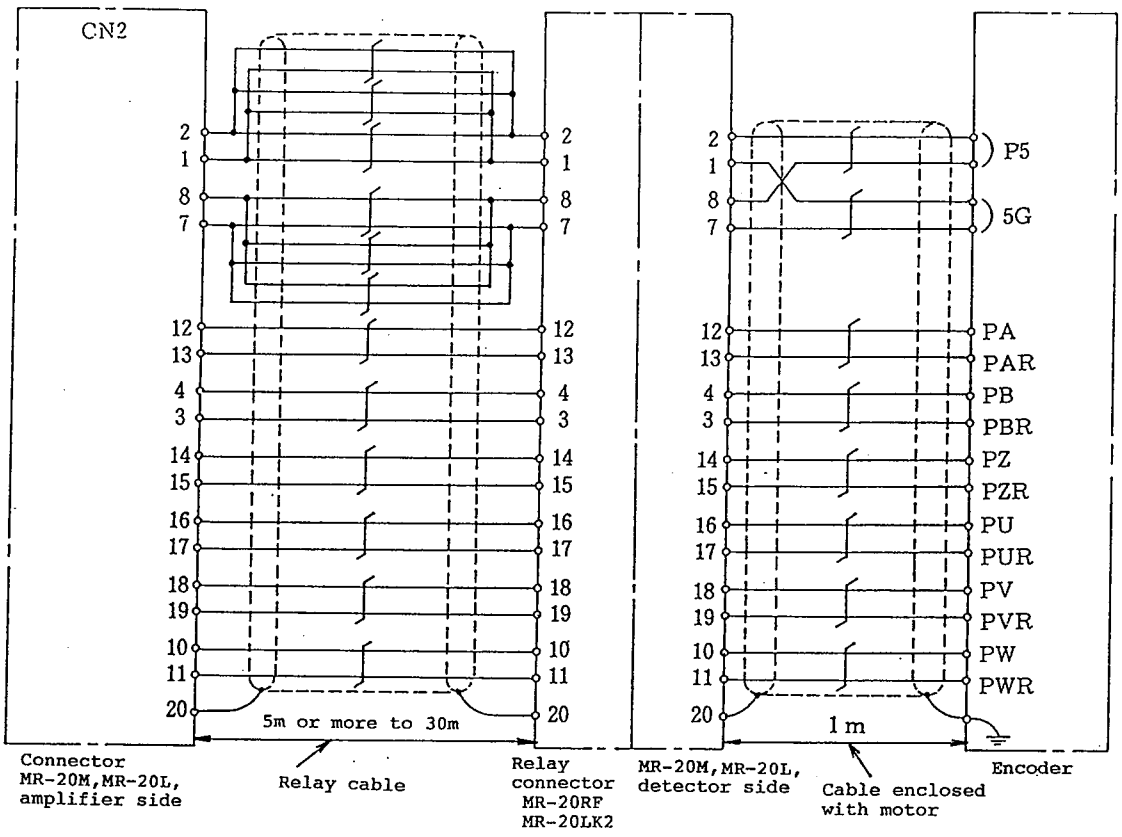


Fig. 4-8 Connecting diagram II for encoder cable (relay cable length 5m to 30m)

(2) Cable for HA-SA type motor detector

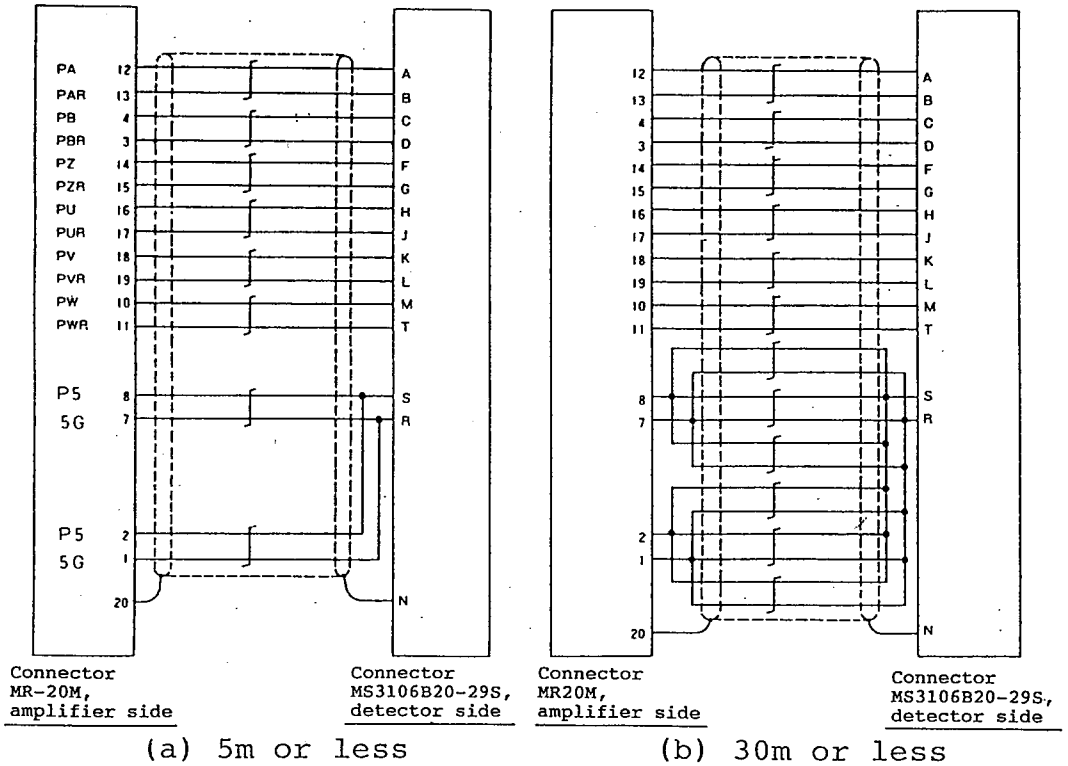


Fig. 4-9 Connecting diagram for PLG cable

4-6 Common line

The common line in the servo amplifier is shown below. The digital input and output signals are insulated from the internal circuit with the photocoupler. The analog output signal is connected to the pulse series input and output signal with the internal common line.

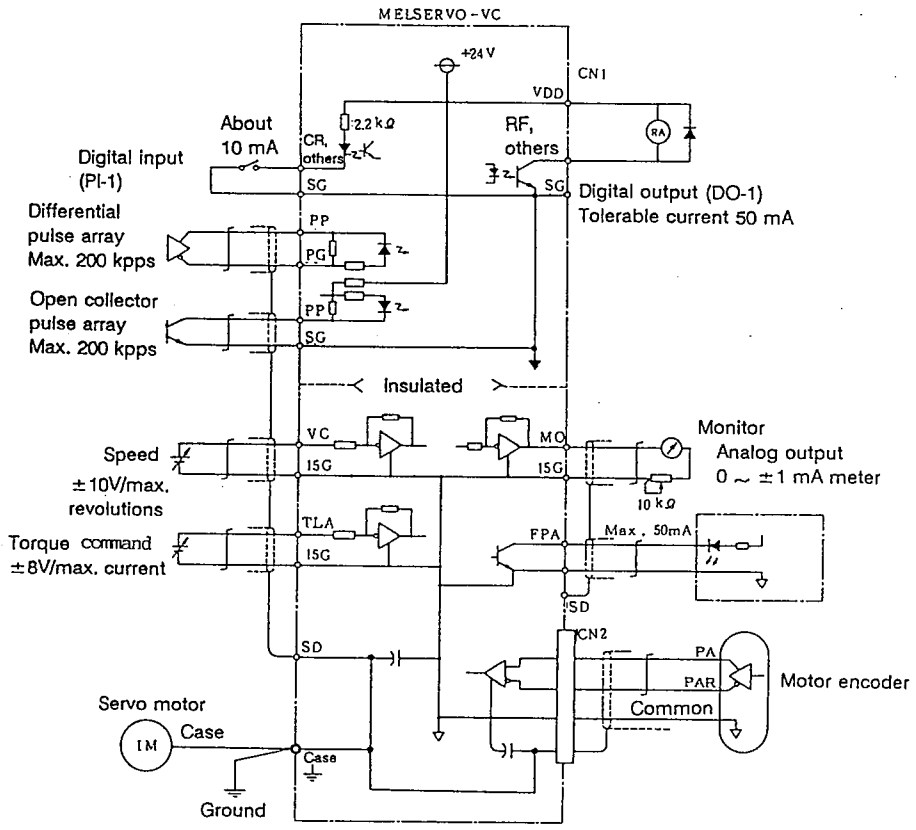


Fig. 4-10 Common line in the servo amplifier

4-7 Signal circuitry

(1) Power-on sequence

① Apply a 3-phase AC power supply to terminals R, S, and T to start the power in the control circuit.
It will take a maximum of one second (normally 0.3 sec.) to initialize the servo amplifier.

② The alarm signal will turn on in 0.1 second after the power is turned on. This will turn off when an alarm occurs or the power is turned off.

③ If the servo on (SON) signal turns on after initializing, and the internal contactor (MC) is turned on, the main circuit will be fed with power and operation will be possible.

④ If the reset signal (RES) turns on, the base current of the transistor is shut off, the motor will coast.

⑤ If the servo on signal turns off, the contactor will be open.

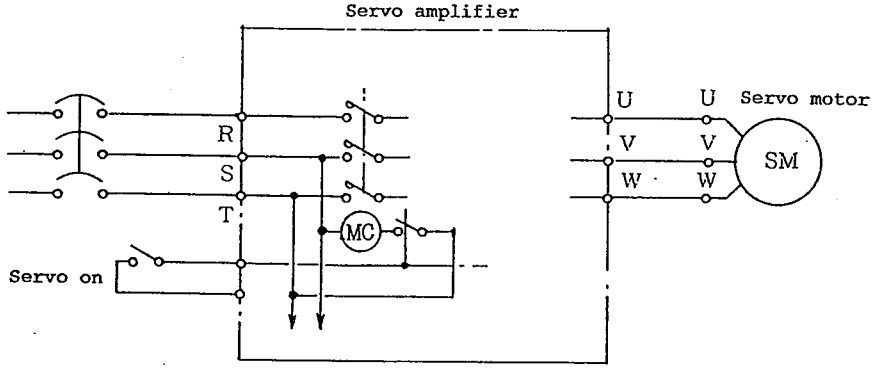


Fig. 4-11 Main circuit external connection diagram

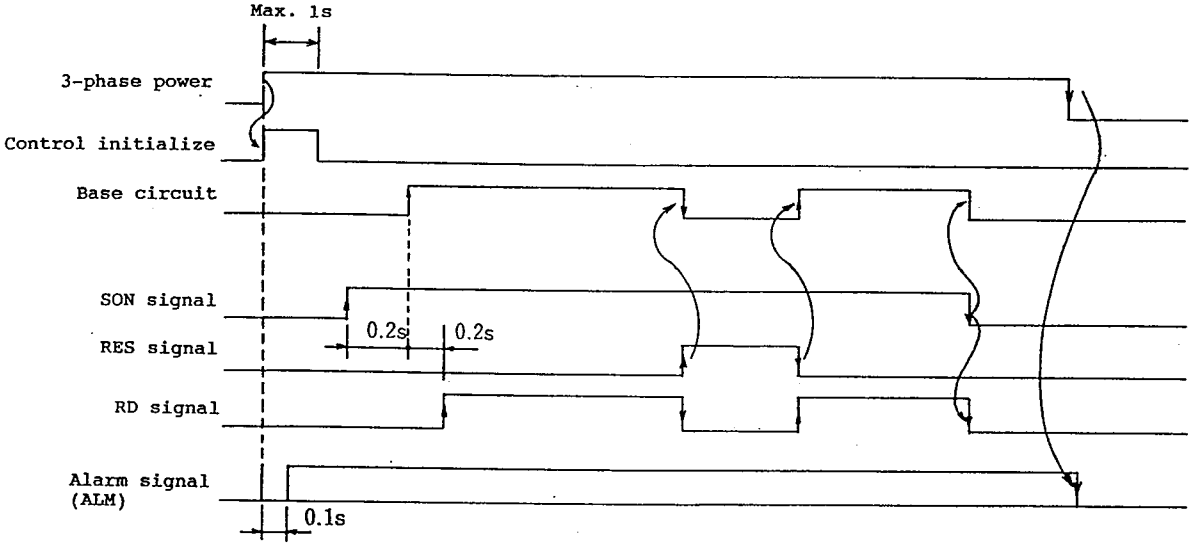


Fig. 4-12 Timing chart for when the power is turned on

[Important] Do not turn the SON signal ON and OFF frequently, as it will lead to trouble.
(The total open/close times: 100000 times.
Guideline: 20 times/day or less)
Always start and stop with the special external input signal.

(2) Emergency stop circuit

Use the dynamic brake (optional) when the motor must be stopped suddenly due to an alarm or emergency.
For details on the external connections refer to section 4-4, and for the timing chart, refer to section (3) below.

(3) Timing chart in case of alarm

If an alarm occurs in the servo amplifier, the power transistor base current will be shut off and the motor will stop.
To remove the alarm condition, use the "RES" signal or turn the power off and on. ("The overload" alarm cannot be reset with the "RES" signal ... refer to Section 7.1).

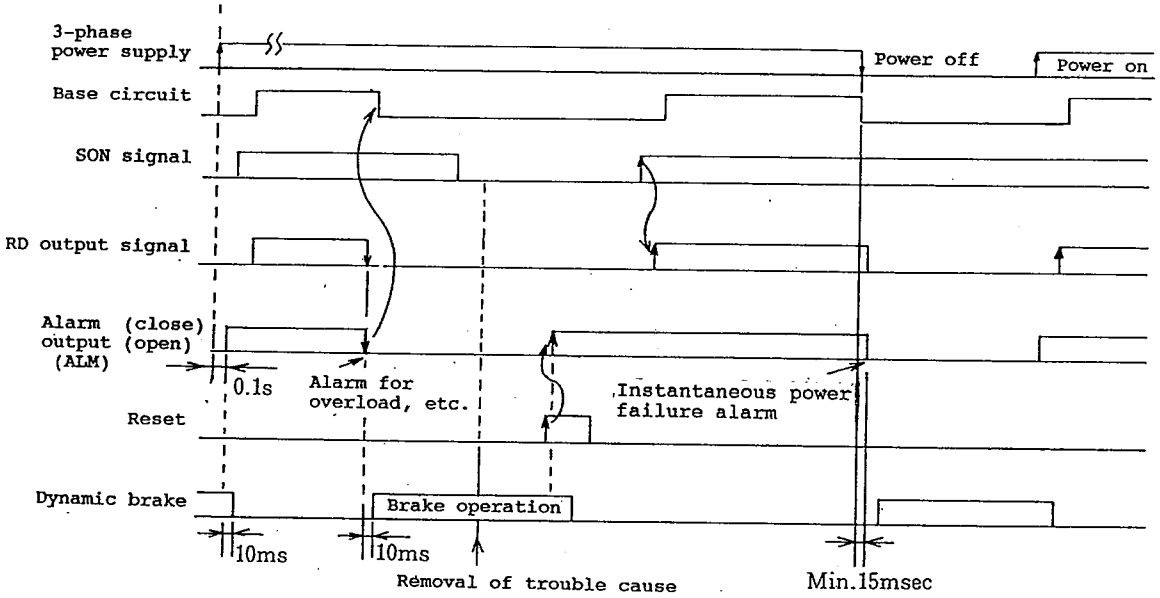


Fig. 4-13 Timing chart in case of alarm

[Important]

1. If the power is turned on and off repeatedly to reset without removing the cause of the alarm (overcurrent or overload), the heat rise may result in damage to the power transistor in the servo amplifier.
   Operation should be resumed after allowing the power transistor to cool off for at least 30 minutes after the cause of the alarm is removed.
2. If the power is turned off and then on repeatedly to reset the regenerative overvoltage alarm (AL30), the discharge resistor may overheat and cause trouble.
3. If instantaneous power failure lasting 15 msec or longer occurs, the protective function will activate. If the power failure continues for another 10 msec (20 to 30 msec.), the power will stop, the protective function will be reset. The servo amplifier will be initialized when the power is restored. To prevent accidents, the "SON" signal should be turned of when instantaneous power failure occurs.

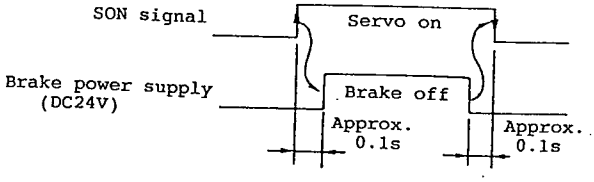
(4) Use of motor equipped with magnetic brake

If a magnetic brake is used as additional safety means (for prevention of upper/lower shaft falling, or support of dynamic brake during emergency), pay attention to the following points.

① The brake should be for safety type, and is activated when the DC24V power is turned off.

② When the brake is activated, the "SON" signal should be turned off.

③ When the brake is used to prevent upper/lower shaft from falling, an appropriate time delay should be considered for the sequence.



* If a time delay cannot be provided at servo off ("SON" signal OFF), the DC power supply should be turned off when the "SON" signal turns off so that the dropping distance is minimized as much as possible.

  Braking delay time AC off: Approx. 0.1 sec.
  DC off: Approx. 0.03 sec.

4-8 Cautions for wiring

(1) Main circuit

Table 4-1 Cautions for wiring (main circuit)

<table>
<tr><th></th><th>Description</th></tr>
<tr><td>AC power supply</td><td>1. For AC power supply, 200V supply is used. If available power supply is 400V, use an insulating transformer to provide 200V supply.
Single-phase operation is impossible.

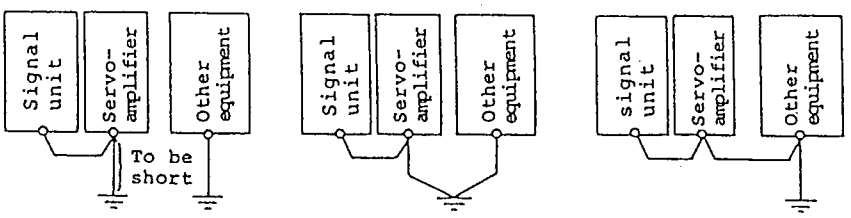
2. Capacitor is used in the primary supply circuit. Immediately after the power is turned on, large current flows for charge of the capacitor and may cause voltage drop.
Consequently, it is recommended that programmable controller, if used together with the servo amplifier, is fed with independent power.

3. Do not connect a wire 10m or less to a power source that exceeds 1000kVA.</td></tr>
<tr><td>Magnetic brake power supply</td><td>For the motor magnetic brake, DC24V is used. Note that servo amplifier driver power supply "VDD" (DC24V) may not be used to drive the magnetic brake.</td></tr>
<tr><td>Cable size and no-fuse breaker</td><td>Recommended cable/wire size and no-fuse breaker are listed below.
<table>
<tr><th colspan="2" rowspan="2">Model</th><th rowspan="2">No-fuse breaker</th><th colspan="5">Wire (mm²)</th></tr>
<tr><th>Motor capacity</th><th>R,S,T,⏚</th><th>U,V,W</th><th>P,C</th><th>G1,G2</th><th>Magnetic brake</th></tr>
<tr><td rowspan="5">HA-SC</td><td>0.05kW</td><td>NF30 type 5A</td><td>2</td><td>2</td><td>2</td><td rowspan="5">-</td><td rowspan="5">1.25</td></tr>
<tr><td>0.1</td><td>NF30 type 5A</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>0.2</td><td>NF30 type 5A</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>0.4</td><td>NF30 type 10A</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>0.6</td><td>NF30 type 15A</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td rowspan="3">HA-SA</td><td>0.2,0.3</td><td>NF30 type 10A</td><td>2</td><td>2</td><td>2</td><td rowspan="3">1.25</td><td rowspan="3">1.25</td></tr>
<tr><td>0.5</td><td>NF30 type 10A</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>1.0</td><td>NF30 type 15A</td><td>2</td><td>2</td><td>2</td></tr>
</table></td></tr>
</table>

Continued on the next page.

	Description
Wiring	1. Note that each phase of servo amplifier output (U,V,W) Must meet that of motor input. If phase sequence does not meet, the motor may run out of control or generate intense vibration. Note that correct phase sequence cannot be achieved only by changing connection between two phases. For power source terminals (R,S,T) of servo amplifier, it is not necessary to consider phase sequence. 2. Do not connect power source to the output terminals (U,V,W). 3. The servo amplifier cannot be covered accidents due to leakage. Pay attention so that the cable does not touch the chassis, etc. If the overcurrent protector is repeatedly operated, it will lead to deterioration of the parts, and the transistor will be sometimes broken. If the protector is activated, securely correct the cause. 4. Be sure to use twisted wires for connection of motor thermal protector (G1, G2). ..... When HA-SA motor is used. When thermal protector is not used, short-circuit terminals G1 and G2. ..... When HA-SC motor is used. 5. Optional discharge resistor for regenerative brake. The regenerative option is differently connected depending on a model. Refer to Item 4-3. Any other except the exclusive unit can not be connected to the connection terminals of the regenerative option of the servo amplifier. If it is improperly wired, the amplifier will be broken. Moreover, refer to Item 4-3 for other cautionary points.

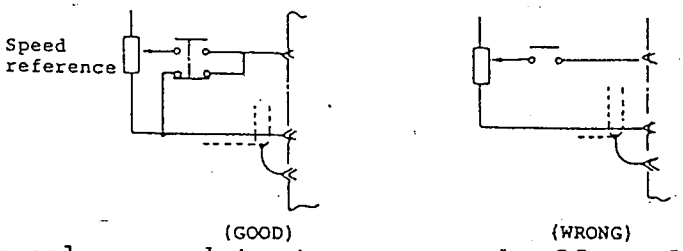
Continued on the next page.

<table>
<tr><th></th><th>Description</th></tr>
<tr><td>Dynamic brake</td><td>Connect the dynamic brake option that corresponds to the motor being used
..... Refer to Section 4-4.
The motor may burn out if mistaken.
<table><tr><th>Dynamic brake option</th><th>Applicable motor</th></tr><tr><td>MR-SDBU-1C</td><td>HA-SC series</td></tr><tr><td>MR-SDBU-1A</td><td>(Note) HA-SA series</td></tr></table>(Note) Use MR-SDBU-1C when 0.3kW or less (HA-SA22, HA-SA32U, HA-SA33).</td></tr>
<tr><td>Operation sequence</td><td>1. When a motor equipped with electromagnetic brake is used, motor is not released immediately after brake is energized. Therefore, operation sequence should be that motor start signal is input after brake release is completed.
2. Don't use the electromagnetic brake for deceleration except in case of emergency stop.
It is allowable to use the electromagnetic brake in combination with the dynamic brake in case of emergency stop.
3. Do not use the dynamic brake excessively as the parts will deteriorate.</td></tr>
<tr><td>Grounding</td><td>Ground the system referring to the standard connection diagram in Item 4-1. Be sure to ground the servomotor together with the servo amplifier at one point.
It is recommended to use an independent ground line. If a common ground line must be used, the connection should be as shown below.
 

(1) Exclusive grounding line ... BEST
(2) Common grounding line ... GOOD
(3) Common grounding line ... NOT ACCEPTABLE</td></tr>
</table>

(2) Control circuit

Table 4-2 Cautions for wiring (control circuit)

	Description
Protection against noises	Control signal lines should be protected from noises properly.
Operation sequence	Do not start or stop the motor by turning the power ON and OFF. This is a condenser input type, so frequent turning on and off of the power using the SON signal will shorten the life of the parts. Start or stop the motor with the forward/reverse run commands (ST1, ST2) during speed control.
Signal circuits	1. Design external analog signal circuit (circuit for speed reference signal, torque reference signal, etc.) so that it remains close at all times to protect against inductive noises.  2. For relay used to turn on and off analog and digital reference signal, select relay for faint current application (with two parallel contacts, for example). Open collector transistor may be used in lieu of relay. 3. When wire is connected to connector, strip the wire carefully. Use care to avoid short-circuiting caused by loosened wire filament or solder whisker. 4. When the servo motor itself is movable or portable, provide the motor cable with a suitable strain release to protect the cable and connector from detrimental tension. 5. Be sure to connect LSP (forward stroke end) and LSN (reverse stroke end) terminals to SG terminal. Otherwise, the motor does not start. 6. The permissive maximum current of interface driver power supply (VDD) is 200mA. Note that the total current for external control unit, relay, etc. should not exceed 200mA. 7. Check polarity of flywheel diode used for output signal relay. If polarity is inverse, the servo amplifier may be damaged.

4-9 Countermeasure against noise

If noise enters the servo amplifier, operation panel or detector from the external, it will result in malfunction which prevents generation of the required performance. It is important to prevent generation of noise. Even if noise generates, it must not be induced into the servo amplifier. When designing the operation panel and manufacturing and routing the signal cables, observe the following to take secure countermeasure against noise.

(1) Signal cable selection

If the signal cable becomes long, it works as an antenna which is liable to receive external noise. Therefore, take care to prevent the cable from being longer than specified. Moreover, use the twist pair shield cable as the signal cable. The signal cables are specified as follows:

① Use the twist pair shield cables as the connection cables (CN2) to the detector. The cables must be 30m or shorter.

② Use the twist pair shield cables as the control signal cables (CN1) to the detector. The cables must be 2m or shorter. If the length exceeds inevitably 2m, provide a low-level relay to make the relay to servo amplifier cable 2m or shorter. In case of the multi-core cable, the separate pair cable is more noise-resistant than the general shield cable.

(2) Grounding

Referring to Items 4-1 and 4-8, securely ground the system.

(3) Wiring

① Securely separate the signal cables from the AC100V or higher power cables when routing them (provide 20cm or wider clearance.), and don't route them in the same duct.

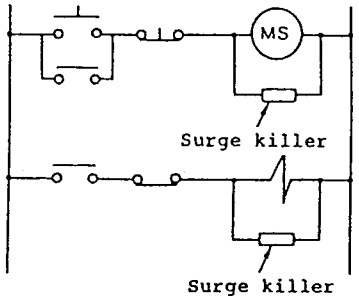
② If it is difficult to separate the signal cables from the power cables, route them with care to prevent them from running parallel.

(4) Surge killer

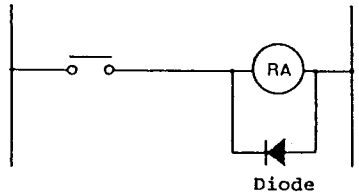
① Surge killer mounting

Around the amplifier, provide the surge killers on the AC relays, AC valves, AC electromagnetic brake, etc. and the diodes (Voltage resistance: 4 times or more than the drive voltage of the relay, etc. Current: Two times or more of the drive current of the relay, etc.) on the DC relays, DC valves, etc. parallel to the relays.

Figs. 4-14 and 4-15 show the mounting examples of the surge killers.

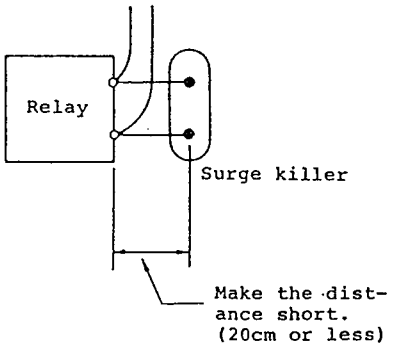


(a) Mounting on the AC relay, AC valve, etc.

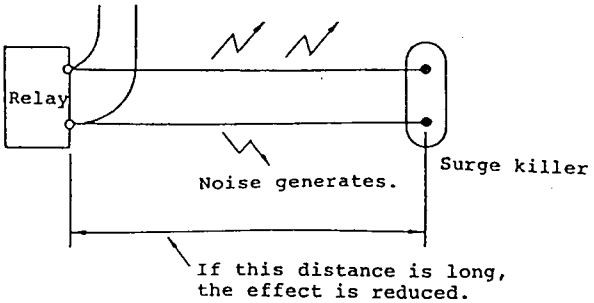


(b) Mounting on the DC relay, etc.

Fig. 4-14 Surge killer mounting diagram



(a) Proper example



(b) Improper example

Fig. 4-15 Surge killer layout

② Attach the surge killers to be adjacent to the device (relay, etc.) which actually produces noise. As the wiring becomes longer, not only the effect becomes smaller but also the noise absorbed by the surge killer is more liable to be induced in the other signal cable. Keep in mind that the reverse effect will thus result. Refer to Fig. 4-15.

(5) Shield cable processing

As aforementioned in Item (1), the shield cables are securely used as the signal cables. However, not only the effect is reduced but also the adverse effect may result unless the shield is properly processed. Securely process the shield as follows:

① Connect the outer sheath of the shield cable to the terminal SD of the servo amplifier connector, and be sure to open the other end. Refer to Fig. 4-16 and 4-17.

[Example 1]
Normal shield

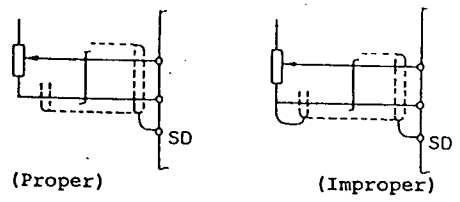


Fig. 4-16 Connection I of shield sheath

[Example 2]
Junction of shield cable

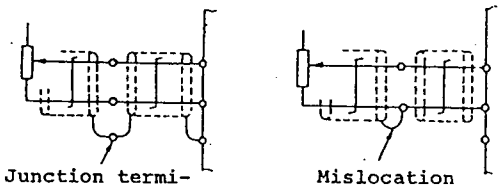
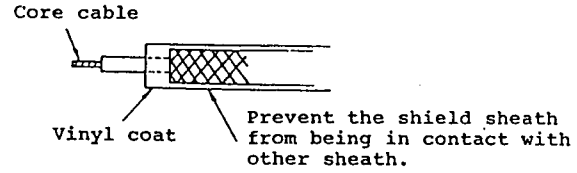
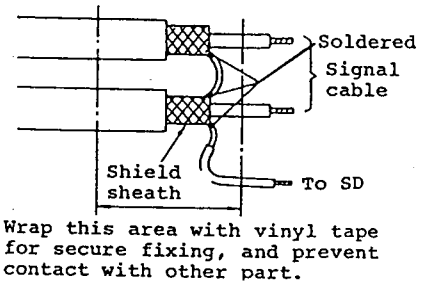


Fig. 4-17 Connection II of shield sheath

② Shield sheath processing



(a) Processing on the release side



(b) Process on the terminal SD side

Fig. 4-18 Shield sheath processing

③ Grounding the shield sheath

Though it is sufficient to connect the shield sheath to the SD terminal of the connector, the effect can be improved by directly connect the shield sheath to the ground plate of the control panel as shown below. If the noise environment is specially poor, the ground plate connection is recommended for the cable of the motor detector.

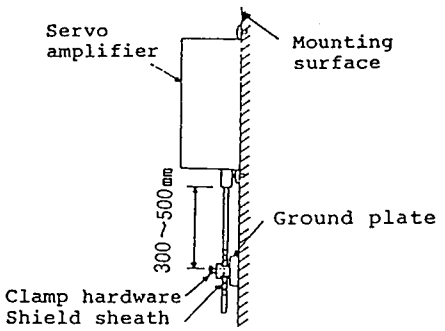
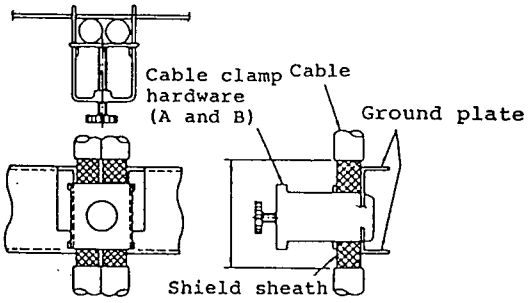


Fig. 4-19 Shield sheath connection

Partially peel off the cable coat to expose the sheath, and press the peeled area against the ground plate with the cable clamp hardware. If the cables are fine, clamp several cables with the clamp.



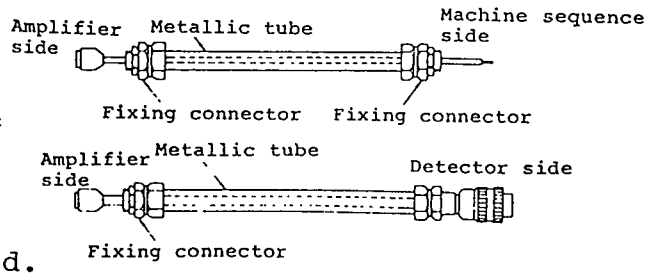
Clamped area outline

(6) LG terminal

Though the ordinary LG terminal is separated from the earth ground, it is sometimes effective to ground the LG terminal if it is influenced by external noise. However, keep in mind that it will take adverse effect if it is insufficiently connected to the earth ground.

(7) Enforced noise resistance

To sufficiently gain the performance specified for the servo system, take the noise resistant counter-measure referring to Items (1) thru (6) aforementioned.



If the noise influence can not be avoided, or if the signal cable can not be separated from the power cable, the signal cable must be routed through the metallic tube to shut out the noise.

4-10 Configuration of the input/output terminals

(1) Servo motor

① Always match the phases (U, V, and W) on the motor power lead and the phases (U, V, and W) of the amplifier output terminals.

② If commercial power is applied to the motor terminal (U, V, and W), the motor may be demagnetized or burn out. Do not connect these other than to the servo amplifier output terminal (U, V, and W).

③ Always ground the unit with the grounding terminal E. To ground, connect with the servo amplifier grounding terminal and ground through the ground plate in the control panel. Refer to sections 4-2 and 4-8.

④ Prepare a DC24V power supply (10W or more for HA-SC motor, 15W or more for the HA-SA motor) for the brake lead of the motor with magnetic brake.
The servo amplifier alarm power source VDD (DC24V) cannot be used.

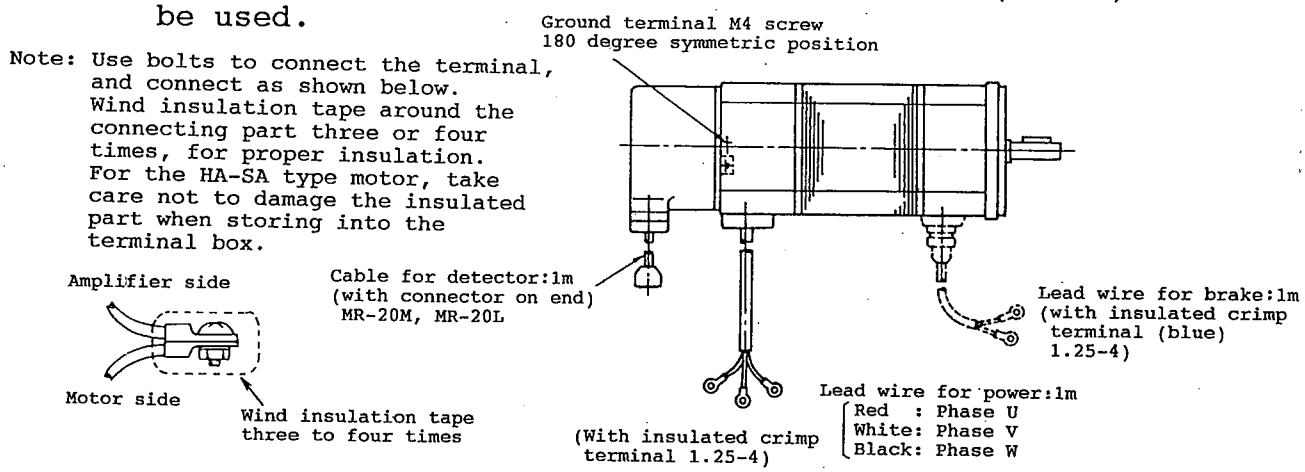
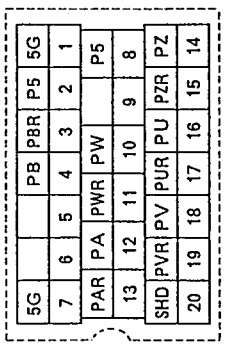


Fig. 4-20 Details of HA-SC terminals (Refer to 6 and 7 on the following page for the HA-SA motor)

⑤ The motor encoder signal wires are color coded as shown in Table 4-3. When changing the connector connections, refer to this table and Fig. 4-21 "Pin arrangement diagram".



Signal name	Pin No.

Arrangement diagram looked from wiring side
Honda Tsushin connector MR-20M

Fig. 4-21 Connector for encoder signals
Connector pin arrangement diagram

Table 4-3 Encoder signal wire color coding table

Signal name	Color code Increment detector
PA/PAR	Green/white
PB/PBR	Gray/white
PZ/PZR	Yellow/white
PU/PUR	Brown/white
PV/PVR	Blue/white
PW/PWR	Orange/white
P5/P5	Red/white
5G/5G	Black/white

Note: Check a color corresponding to the white line, so take care not to be mistaken.

⑥ Details of HA-SA motor terminal box

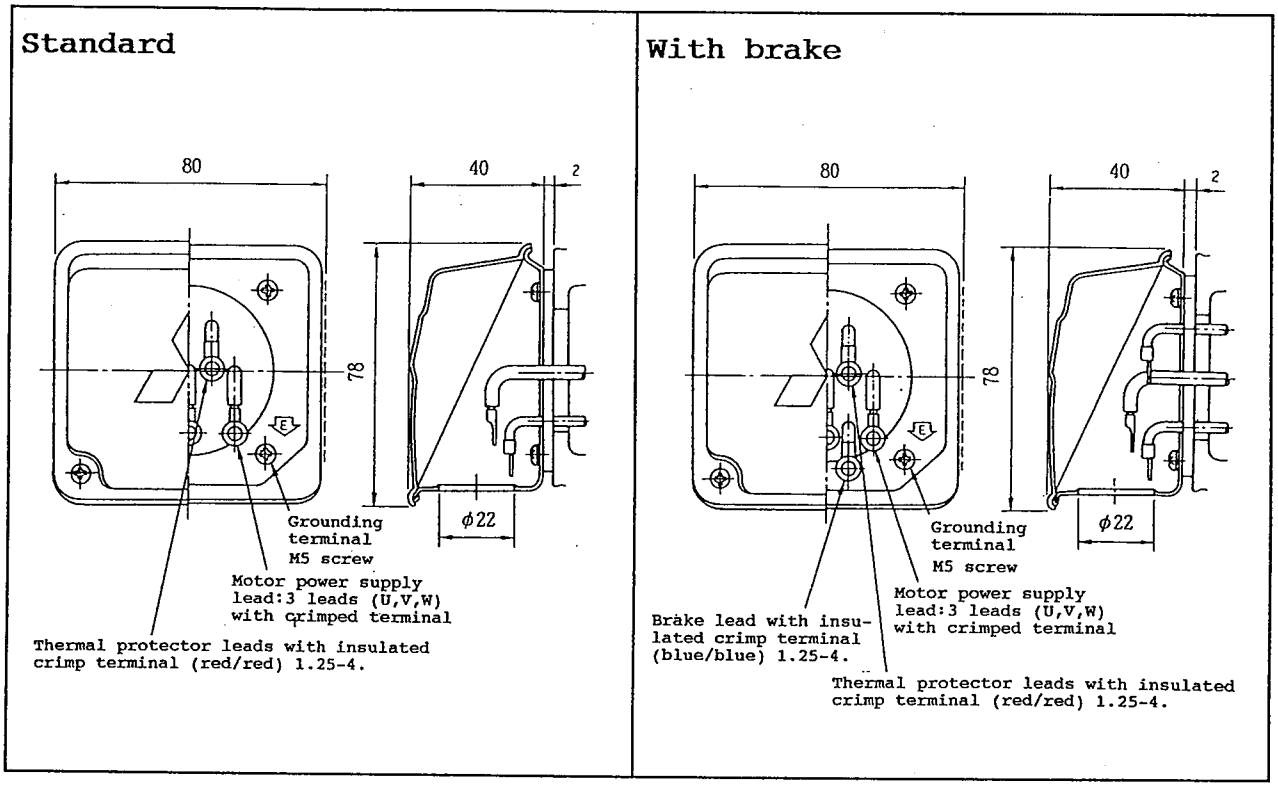


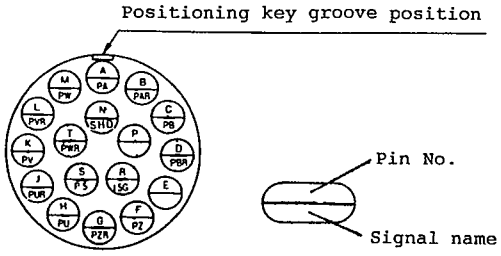
Fig. 4-22 Details of HA-SA52 ~ HA-SA102 terminal box

(Note) HA-SA22, 32, 33 are the same as HA-SC but have a thermal protector lead.

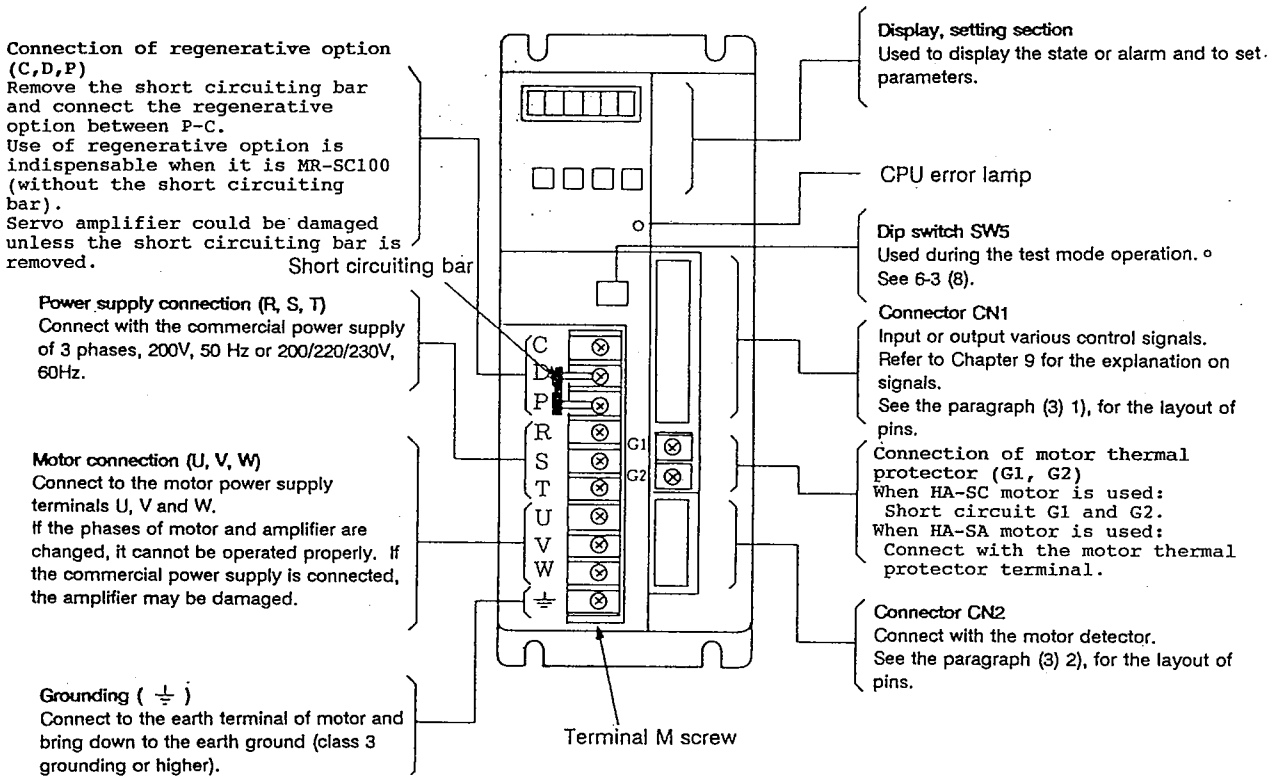
⑦ HA-SA type motor detector connector pin arrangement diagram

Cables are not lead to the HA-SA type motor detector, so always provide the cables. Refer to Section 4-5.

Model name MS3106B20-29S (MS3108B20-29S)



(2) Servo amplifier



Detailed view of area B

Fig. 4-23 Main circuit terminals of servo amplifier

(3) Connector pin arrangement

The connector pin arrangement, as viewed from the cable connection side, is schematically shown below. In the schema, pin No. and signal symbols are indicated in the upper line and lower line respectively.

① CN1 (Connector for general control signals)

Model: MR-50M, HONDA

50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
OP	RD	PF	VDD	VDD	ZSP	TLC			15G	MO	15G	TLAN	SD	15G	TLAP	15G	VC
		32	31	30	29	28	27	26	25	24	23	22	21	20	19		
		FPA	FPB	SG			CR	SG	LSN	LSP	DI1						
18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
PP	PG	NP	NG	SG	SG	RES			SON		ALM	SD	15G	15G		N15R	P15R

Pin No.
Signal name

(Note) Signal names quoted here represent those for the position control mode.

(a)

* Prepare MR-50F (female) for the cable side.

② CN2 (Connector for PLG signals)
Model: MR-20F products of HONDA
* The cable side will be MR-20M (male).

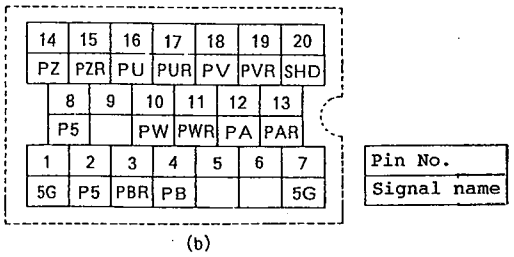


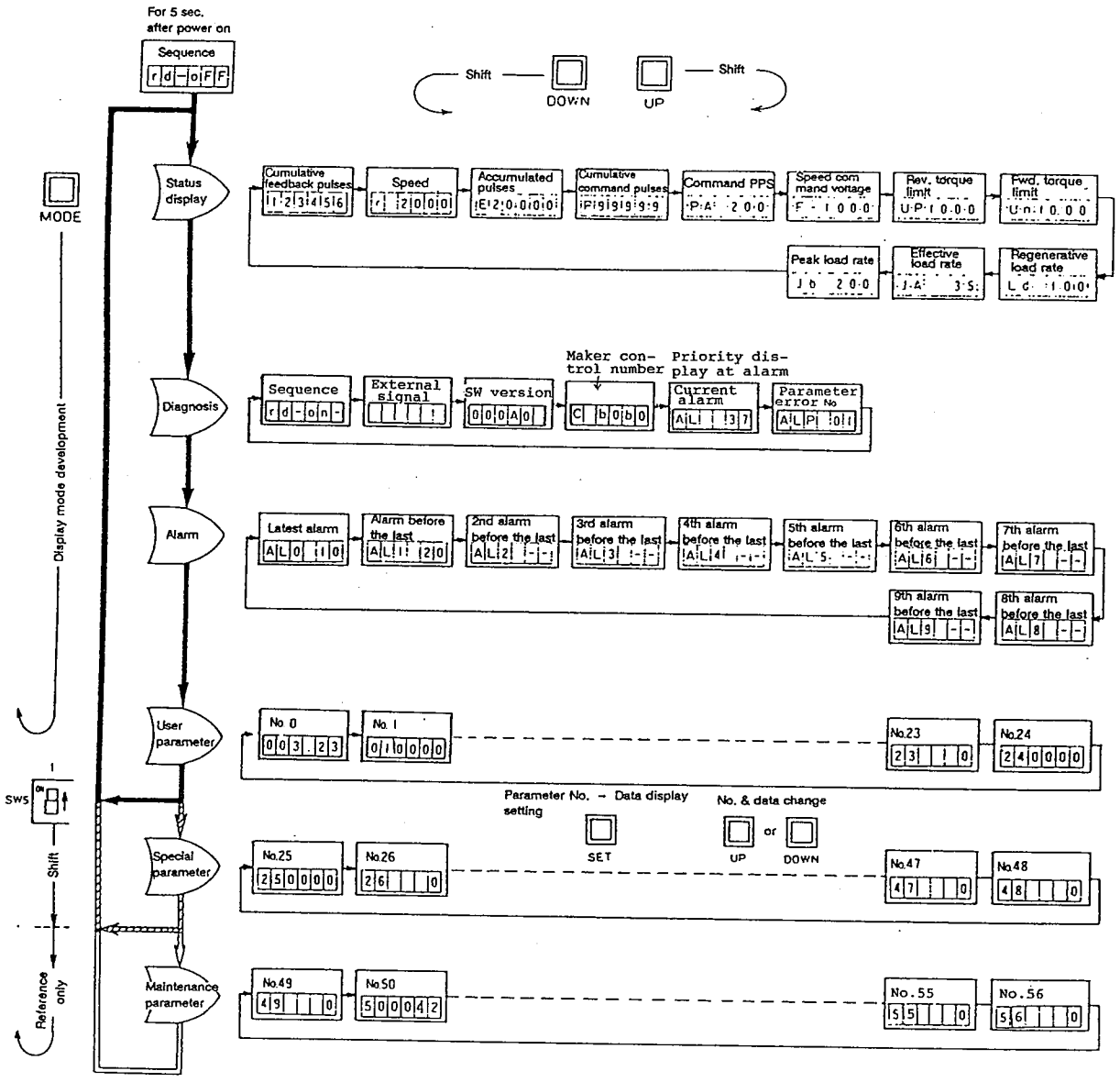
Fig. 4-24 Connector pin arrangement

5. PUSHBUTTON SWITCH OPERATION

5-1 Display description

Operation of the servo amplifier can be monitored and parameter (control variable) can be set by using the 6-digit readout in the front panel of servo amplifier. The available readout functions include "parameter setting", "diagnosis", "external control sequence check" and "operation status monitor".

Fig. 5-1 shows the display mode development. For details, refer to 10-1 and thereafter.



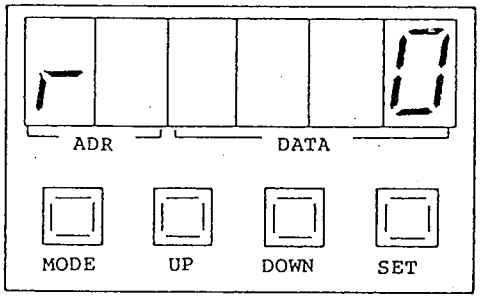
Note: When verifying the special parameter, turn on SW5-1, turn off the power supply once and resupply the power.

Fig. 5-1 Display mode development

In 5 sec. after the power is turned on and [rd-OFF] is displayed by the readout, "status monitor" mode is selected automatically.

By pressing "UP" button, display mode can be changed in the order from the left to right, shown in Fig. 6-1.

When this button is pressed first, motor speed is displayed as shown to the right. In this example, motor speed is "0".



When "DOWN" button is pressed, display mode changes in the order from the right to the left in Fig. 5-1.

Display mode can be changed step by step from the top to the bottom by pressing "MODE" button.

When this button is pressed first after the power is turned on, "diagnosis" mode is selected. Successive two touches of the button causes selection of "user parameter" mode.

To check a user parameter, press "UP" or "DOWN" button to call up the corresponding parameter No. after "user parameter" mode is selected.

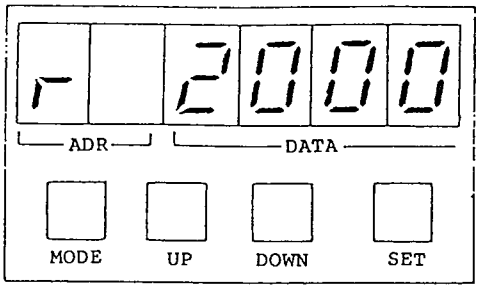
When parameter No.8 must be called up, for example, press "UP" button 8 times.

5-2 How to read display and how to set parameter

To read desired data and set desired parameter, button under the readout is pressed.

(1) Turning power

Turn on the power with "SON" signal turned off. [r d - O F F] will be displayed and "operation status" display mode is automatically selected in 5 sec. after the power is turned on.



After power turned on [r d - o F F]

↓ (In 5 sec)

Status display [ ][ ][ ][ ][ ][0] (Cumulated feedback pulses are displayed.)

(2) Operation status

"Cumulative feed back pulses" is displayed first. To change display, press "UP" key (See Fig. 5-1).

For the first display, desired variable can be specified by using parameter No.24 (refer to 10-4, Table 10-4).

(3) Parameter

When "MODE" button is pressed three times successively, [0 0 3 □ 2 3] (parameter No.0, data 3□23; for MR-SC20) will appear.

By pressing "UP" button, "ADR" (parameter No.) of readout can be changed from 00 to 24 step by step, as shown in Table 10-4.

When parameter No. is selected, the corresponding setting is displayed by "DATA" section of readout.

(4) Setting of parameter

Call desired parameter No. by pressing "UP" or "DOWN" button.

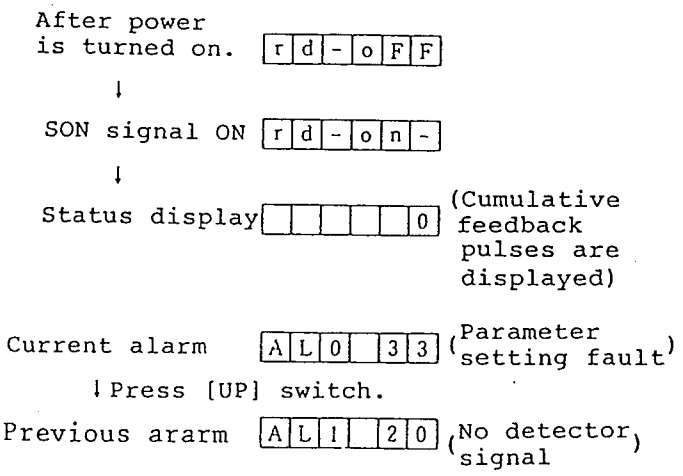
Press "SET" button and display in "ADR" section flickers.

Set value for "DATA" by pressing "UP" or "DOWN" button.
Setting can be completed by pressing "SET" button.
When setting is completed, the next parameter No. appears in "ADR" section.
By repeating these steps, data can be set for other parameter.

Note: Setting of parameter No.0 (motor type), No.1 (servo loop type), No.17, and No.18 cannot be completed unless the power is turned off and then on.
To set or verify the special parameters, turn on SW5-1, turn off the power supply once and resupply the power.
Parameter setting should be made with SON signal turned off (if SON signal is on, setting is impossible).

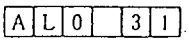
(5) Turning on SON signal

When SON signal is turned on, the contactor closes and the system becomes ready for operation.
When SON signal is turned on, display changes as shown to the right.



(6) Alarm

Alarm or alarm history can be read by pressing "MODE" button.
When "UP" button is pressed, the previous alarm code is displayed.



If alarm occurs during operation, it is immediately displayed.
Alarm history is held even after the power is turned off.

(7) Display of status during operation

Press "MODE" button to call "operation status" mode and then pressure "UP" or "DOWN" button to select desired variable.

Setting example 1:

To set speed control mode for servo loop type (parameter No.1) ....

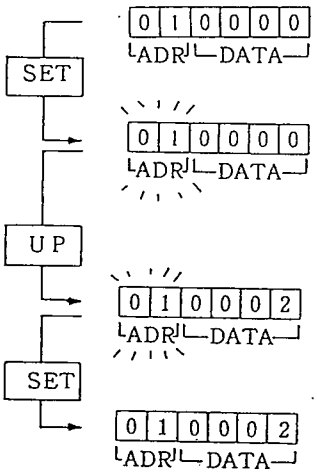
1) Press "UP" or "DOWN" button to set [01] for parameter No. and press "SET" button.

   ◦ When parameter No. is set to [01], initial setting "0" appears.
   ◦ Press "SET" button and [01] flickers.

2) Press "UP" button to set [02] for "DATA" and press "SET" button.

   ◦ Press "UP" or "DOWN" button to set [02] for "DATA".
   ◦ Press "SET" button

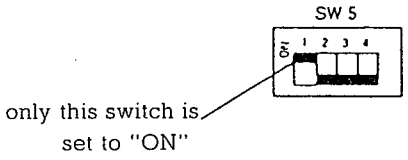
3) Turn off the power and then on.



Setting example 2: Setting of special parameter

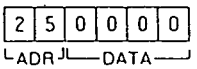
Encoder output division ratio (parameter No.39) is set to "2".

(1) Set the left end switch of DTP switch SW5 on the amplifier front panel to "ON" position, where by "special parameter" mode is selected.



(2) Press "MODE" switch to change the display mode to "special parameter" mode.

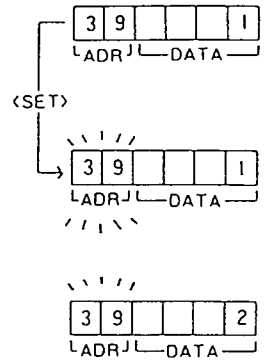
"Special parameter" mode is selected.



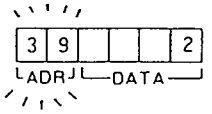
(3) Press "UP" switch to set [39] for parameter No.
Press "SET" switch and [39] will flicker.

[39] is set for parameter No.
Initial value "1" will appear.

[39] flickers when "SET" switch is pressed.

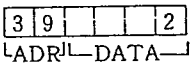


(4) Press "UP" switch to set [2] for "DATA".
If the display exceeds "2", press "DOWN" switch to set [2].



(5) Press "SET" switch and the flickering will stop.

The setting ends when "SET" switch is pressed.

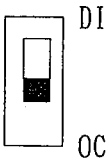
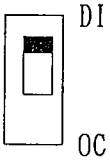


Note: In this example, it is assumed that the parameter setting is the initial setting. If the parameter setting is other than the initial setting, the changed value is displayed for "DATA" (same as for "Example 1").

6. OPERATION PROCEDURE

6-1 Setting of switch 7

Before starting operation, check setting of switch 7 in accordance with the pulse train input interface.

Pulse train input interface	Setting position of switch 7	Reference
Open collector	Lower side (OC)  	Refer to 8-5
Differential driver	Upper side (DI)  	

6-2 Initialization

Each parameter has been set with initial value.
For successful use of the servo amplifier, initial setting must be changed properly for individual application.
Before starting operation, check the following parameter setting and change setting if necessary (refer to 10-4).

(1) Motor combination (Parameter No.0)

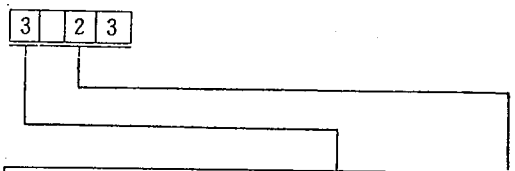
Set the parameter according to the motor to be used. The motors that can be driven with each amplifier are shown in Table 6-1.
However, a parameter error will occur when set to other settings. If the motor is run with a motor and amplifier combination other than that shown in the table, the motor may be damaged.

Table 6-1 Parameter setting value list

Servo amplifier name	MR-SC10	MR-SC20	MR-SC40		MR-SC60		MR-SC100
Names of servo motors that can be combined	HA-SC053 HA-SC13	HA-SC23	HA-SC43	HA-SA22 HA-SA32U HA-SA33	HA-SC63	HA-SA52 HA-SA52L HA-SA52U HA-SA53	HA-SA102 HA-SA102L HA-SA102U HA-SA103
Settable parameters	3 5 3 3 1 3	3 2 3	3 4 3	0 2 2 2 3 2 0 3 3	3 6 3	0 5 2 1 5 2 2 5 2 0 5 3	0 1 0 2 1 1 0 2 2 1 0 2 0 1 0 3

Note: The shaded values are the servo amplifiers initial values.

[Parameter setting procedure]



		Motor series	Motor rating					
Amplifier name	MR-SC	-	10		20	40	60	100
Motor name	HA-SC	3	053	13	23	43	63	
	HA-SA	0	-			22	52	102
			-			33	53	103
	HA-SA□L(Low inertia)	1	-			-	52	102
	HA-SA□U (Flat)	2	-			32	52	102

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

Parameter No.1 is initially set to "positioning control", no regenerative option unit (when MR-SC100, MR-RB082 has been set in Pr.1). Therefore, to operate with other controls, the initial setting must be changed.

(3) Command pulse multiplication (Parameter No.2, 3)

When the servo amplifier is used for positioning control or positioning/speed control, the initial setting must be set according to the machine system or command unit specifications.

① Set the command pulse multiplication (parameter No.2 (CMX), No.3 (CDV)) according to the machine system, so that a fraction does not occur in the amount of machine movement per reference pulse.

[Setting example]

The following relation exists between the movement amount per one motor rotation ΔS [mm], movement amount per one command pulse $\Delta \ell$ [mm], motor feed back pulse number Pf [pulse], and parameters CMX, CDV.

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

The Pf value is as follow according to the motor series used:

HA-SC series: 8000 [pulses]
HA-SA series: 12000 [pulses]

With the above formula, if a HA-SC motor is used, and ΔS=10 [mm], and $\Delta \ell$=0.001 [mm] the following will be obtained.

$$\left(\frac{CMX}{CDV}\right) = 0.001 \times \frac{8000}{10} = \frac{4}{5}$$

Therefore, CMX=4 and CDV=5 will be set in the parameters. Refer to Table 10-4 for the parameter setting ranges.

② Set the relation of the input pulse frequency from the control unit and the motor speed with the command pulse multiplication.

[Setting example)

To run the motor at 3000 r/min. with an input pulse frequency of 200 kpps with the positioning unit AD71. With the following formula:

$$fo \times \left(\frac{CMX}{CDV}\right) = \frac{Pf \times No}{60}$$

Using the HA-SC motor, the pulse frequency is $fo=200\times10^3$ [PPS], motor speed No=3000 [r/min.], the following will be obtained.

$$\left(\frac{CMX}{CDV}\right) = \frac{8000 \times 3000}{60} \times \frac{1}{200 \times 10^3} = 2$$

Therefore CMX=2, and CDV=1 will be set for the parameters.

(4) Positioning loop gain (Parameter No.5)

When the servo amplifier is operated in positioning mode or positioning/speed control mode, parameter No. 5 should be set for load inertia.

For method of setting, refer to Table 10-4 and para. 6-4.

(5) Speed loop gain and speed integral compensation (parameter No.6, 7)

For parameters No.6 and 7, settings should be made in accordance with load inertia.

For method of settings, refer to Table 10-4 and para. 6-4.

(6) Speed reference 1, 2 or 3 (Parameter No.8, 9 or 10)

When speed reference or speed limit is internally set, set parameter No.8, 9 or 10 in accordance with desired speed of motor.

6-3 Test operation

Perform test operation in accordance with the following procedure:

(1) Turning on the power

Make sure SON signal is off, then turn on the power (3-phase 200V).

[r][d][-][o][F][F] appears in the readout initially.

In 5 sec. after the power is turned on, "operation status" display mode is established.

(2) Parameter setting

The parameters are set initially as shown in Table 10-6. Change setting(s) if necessary (refer to 10-4, 10-5 and 10-6, 6-2).

(3) Turing on SON switch

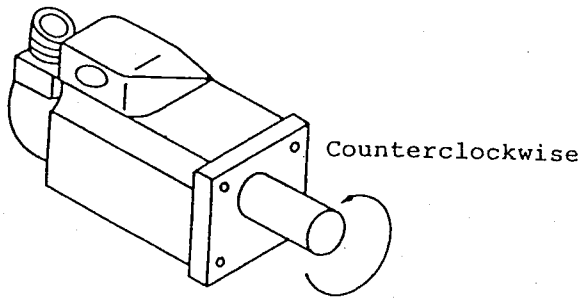
After parameter setting is completed, turn on SON switch, then the contactor in the servo amplifier will close.

(4) When the motor is operated for positioning mode, make sure terminals LSP (forward stroke end) and LSN (reverse stroke end) are connected to SG (common).

If they are not connected, the motor does not start.

(5) Operation

Start the motor at low speed to check direction of rotation, sound and vibration of the motor.



If motor operation is not in good condition, or alarm occurs, refer to para. 7-1 to remedy.

In the case of operation in torque control mode, the motor may run out of control if it is operated without load.

For safety, therefore, start the motor from low speed.

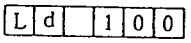
(6) Coupling of motor to machine

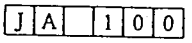
After test operation of the motor alone, couple the motor to a machine and try test operation. During test operation, check emergency stop function and interlock functions.

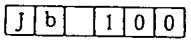
If alarm occurs during operation, refer to 7-1 to remedy.

(7) Regular operation under loaded condition

Perform regular operation with the motor under loaded condition and check the monitor operation status.

1) Regenerative brake load ... Display: 

2) Effective load ..... Display: 

3) Peak torque ..... Display: 

In practice, it is recommended that these variables are below about 80%.

If any variable exceeds 100%, (I) lighten the load, (II) prolong accel./decel. time, or (III) decrease start stop frequency.

For details of readout display, refer to 5-1 and Sec. 10.

(8) TEST mode operation

Perform motor test operation without using control signal (CN).

This test operation should not be operated under the motor coupled with a machine.

Otherwise, driven component of machine might hit the stroke end.

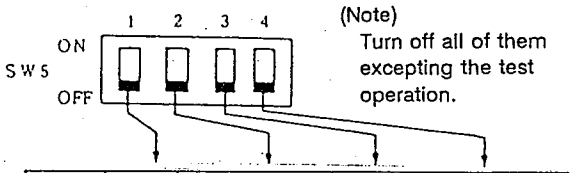
① Parameter setting

- Set parameter No.1 in the position control mode.
- Set 1 for parameter No.42. (Test mode operation is possible.)

Turn off the power and then on after setting complete.

② Operating pattern

By setting DIP switch "SW5", desired pattern can be selected from the patterns listed below.

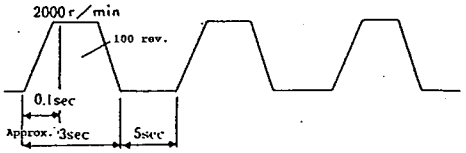


(Note)
Turn off all of them excepting the test operation.

SW ON	Servo on	Operation	2000 r/min.	Forward run
SW OFF	Servo off	Stop (servo lock)	200 r/min.	Reverse run

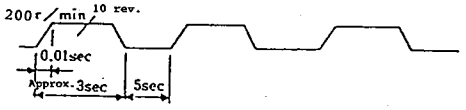
- 2000 r/min. operation

  When the operation signal (SW5-2 above) is turned on, the motor will operate with a repetition of the following pattern.



- 200 r/min. operation

  When the operation signal (SW5-2 above) is turned on, the motor will operate with a repetition of the following pattern.



③ After the end of test mode operation, set 0 for parameter No.42. Set all the switches SW5 to "off" and turn the power off and then on (if the switches SW5 are not set to "OFF", alarm occurs and operation cannot be resumed).

6-4 Optimizing the operating conditions

The servo amplifier is provided with various parameter functions.

Usually operation goes successfully with the initial parameter settings. But if moment of inertia of load is excessively large or intense vibrations or noise occurs during operation, parameter setting(s) must be changed to optimize servo amplifier operation.

(1) If intense vibrations or noise occurs .....

If intense vibrations or noise occurs, the servo gain setting does not meet the moment of inertia of load perhaps.

① Parameters

The parameters that may affect vibrations and noise of the motor are listed below.

The initial setting of J_L/J_M is approximately 1 and must be changed if intense vibrations or noise occurs due to large moment of inertia of load.

Table 6-2 Position control loop gain (Parameter No.5 PGN)

Moment of inertia of load J_L/J_M		0	1	3	5
Setting	Standard	35	25	25	15
	Maximum	100	80	40	25

Table 6-3 Speed control loop gain (Parameter No.6 VGN)

Moment of inertia of load J_L/J_M	0	1	3	5
Setting	100	100	200	300

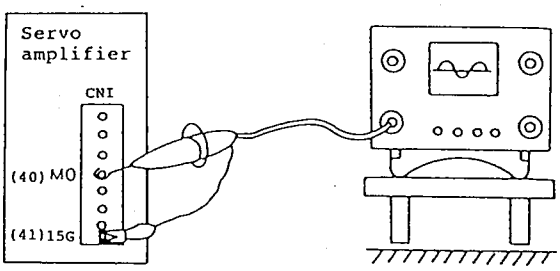
Table 6-4 Speed integral compensation (Parameter No.7 VIC)

Moment of inertia of load J_L/J_M	0	1	3	5
Setting	20	20	30	40

② Parameter setting procedure

a. Observation of signal

A synchroscope is used to observe the speed control feedback signal with speed monitor terminal MO (pin No.40) for connector CN1. The synchroscope should be isolated from the ground or floor and care should be taken to prevent contact of the probes with the servo amplifier casing or other objects.

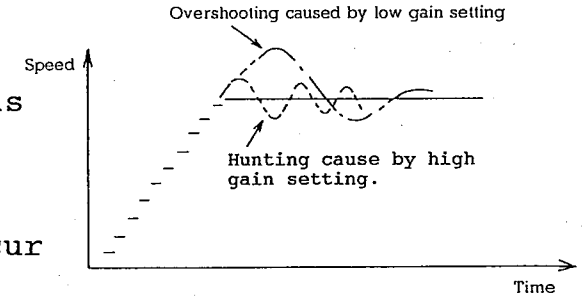


b. Setting of servo gain

1) Set the PGN to a value lower than the standard value. Increase the VGN setting up to the value just before occurrence of hunting.

2) Set the VIC to the optimum value and the VGN as high as possible.

3) When the optimum speed control loop gain (VGN) is achieved in steps 1) and 2), set the PGN so that overshooting does not occur at stop.

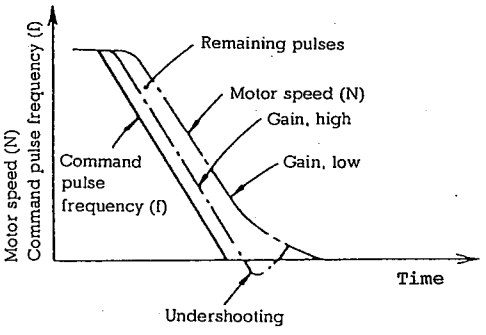


Note: When the speed control feedback signal (speed monitor) is observed with a synchroscope, the waveform will appear as discontinuous signal as shown to the above Fig. (in case of short acceleration time).

(2) If shorter stop time constant is desirous .....

The stop time constant may be decreased by increasing the position control loop gain (PGN).

But if the setting of PGN is excessively high, undershooting or intense vibrations may occur.



(Ref.) Position control loop gain and remaining pulse with the following formula ..... (6.1)

$$\varepsilon = \frac{f}{Kp}$$

where, ε : Remaining pulses
f : Command pulse frequency (pps)
Kp: Position control loop gain (rad/s)

If Kp is excessively high, the motor may generate vibration. If Kp is excessively low, too much remaining pulses may cause alarm (large error) during high-speed operation.
Should Kp setting is 6 in operation at 400 Kpps for example.

$$\varepsilon = \frac{400 \times 10^3}{6} \fallingdotseq 67 \times 10^3 \text{ (pulses)}$$

Alarm (alarm 52) will occur if the remaining pulses are more than 65 Kpulses.
In this case, Kp should be set so that the following condition is met:

$$\varepsilon < 65 \times 10^3 \text{ (pulses)}$$

(3) If the motor runs in spite of the speed command is "0" during speed servo operation .....
This problem occurs due to the offset of the input of an external speed reference signal (does not occur when the internal speed reference command is used).
To stop the motor.

① set "VC offset (parameter No.13) so that the motor does not run when speed reference voltage is 0V.

② turn off start signal (DI3, DI4) at stop of the motor ..... control loop changes to position control loop and servo lock occurs.

③ if start signal cannot be turned off, "proportional control" mode should be selected (external signal PC-SG "ON") and setting of parameter No.31 (speed proportional control) be decreased (about 800 to 980).

7. TROUBLESHOOTING

7-1 Investigation procedure and countermeasure for alarm occurrence

The alarm (servo protective function) activates because of the following causes. If an alarm occurs, check the alarm code on the display, grasp the cause and take the suitable countermeasure.

Note:

1. In case of the regeneration abnormality protection (alarm code AL30) and overload protections 1 and 2 (alarm codes AL50 and 51), the operation state is held in the servo amplifier even if the protective circuit is activated. The memorized content can be cleared by turning off the external power supply, but can not be cleared with the RES signal. This will not be cleared even when the servo on (SON) signal is turned off.
2. If resetting is repeated by turning off the external power supply when the alarm code AL30, 50 or 51 occurs, overheating may lead to breakage of the element. After the cause is securely removed, restart the operation.
3. In case of alarm (AL30) if the input power supply is frequently turned off and then on to reset the system, overheat of the discharge resistor unit may cause trouble to the servo amplifier.
   Reset the system after the cause of alarm is removed.

Table 7-1 Investigation procedure and coutnermeasure for alarm occurrence

Alarm code	Error/Alarm	Cause	Check	Remedy
LED (CPU) lighting	CPU error	1. CPU malfunction of servo amplifier	1. Turn the power supply from off to on. 2. Replace the servo amplifier.	If it is not recovered by resetting, replace the unit.
AL10	Insufficient voltage (UV) The power supply voltage (R, S, and T) is lower than the specified level (160V).	1. Since the power supply capacity is insufficient, the power supply voltage drops at the starting time.	Measure the input voltage (R, S and T) with the voltmeter.	Recheck the power supply capacity.
		2. An instantaneous power failure of 15 msec. or more occurs.	Check whether an momentary stop occurs or not. Observe the input voltage with the synchroscope.	
AL12	Card failure (ME1)	Card RG504 is defective.	Replace the card RG504 with a sound one to check.	Replace the defective card.
AL13	Card failure (CE)	Card RG504 is defective.	Replace the card RG504 with a sound one to check.	Replace the defective card.
AL14	Watchdog (WD)	1. EPROM is defective.	Check the EPROM for installation (location and bending of pin)	Install the EPROM correctly.
		2. Card RG504 is defective.	Replace the card RG504 with a sound one to check.	Replace the defective card.
AL15	Card failure (ME2)	1. Card RG504 is defective.	Replace the card RG504 with a sound one to check.	Replace the defective card.
		2. External interference (noises)	Check if a relay or valve located near the amplifier is in operation.	Remove the cause of interference.
AL16	Magnetic polarity detection error (RD) The magnetic polarity of the motor could not be detected normally when the power was turned on. U, V, and W phase detection failure.	1. The detector connector is disconnected.	Check visually. (See if the connector is disconnected or not.)	Connect properly.
		2. Detector cable is defective. (breakage, short circuit)	1. Inspect the cable. (Try replacing the cable.) 2. Check the detector feedback signal, turn the motor by hand, observe U, V, and W on the printed circuit board check pin J4 with a synchroscope, and see if they are all "H" or "L". (Is the cable loose?)	Repair or replace the cable. Take care so that external force is not applied onto the cable.
		3. Motor detector is defective.	Detector feedback signal check (same as above)	Replace the motor.
AL17	Card failure (A/D)	1. Printed circuit board RG504 defective	Replace the card RG504.	Replace the defective card.
		2. Power P15R, N15R overload.		

Continued to the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL20	Non-signal from the detector (NS1) [The both differential signals of a pair of detectors are "H" or "L".]	1. The detector connector is disconnected.	1. The connector lock screw is insufficiently tightened. 2. Visually check the connection for disconnection and loose connection.	Properly connect.
		2. Detector cable is improper. (Cable breakage and short circuit.)	1. Check the cable. (Trially replace the cable.) 2. The curveture radius of the cable is small. (Alarm results on the specially functional position on the half broken cable.)	Repair or replace the cable. (Take care not to apply an external force to the cable.)
		3. Motor detector is improper.	Trially replace the motor.	Replace the motor.
AL24	Main circuit abnormality (PC)	1. Ground fault	1. Motor and cable grounding 2. TR failure	1. Correct the cable grounding 2. Replace the motor 3. Replace the amplifier
		2. Error in the converter d.c. line voltage	1. Motor, cable, TR error 2. Insufficient power capacity 3. Regenerative TR error	
AL30	Regeneration abnormality (OR)	1. Parameter is improperly set.	Check the setting value of the parameter. Parameter No.1 (STY) 00[0][0]: Regenerative option is not provided. 01[0][0]: Regenerative option MR-RB082. 02[0][0]: Regenerative option MR-RB32.	Properly set the parameter.
		2. Positioning (regeneration) is frequent.	1. Recheck the regenerative brake torque and regeneration frequency. (Check whether it is allowable or not.) 2. Check the valve of Ld. 3. Check the inertia.	1. Reduce the positioning frequency. 2. Attach the regenerative option. 3. Increase the motor capacity. 4. Reduce the load.
		3. The power transistor for regeneration is broken. (Short circuit)	Using the tester, check the resistance of the regenerative power transistor.	Replace the unit.
AL31	Overspeed (OS) [The motor revolution speed rises up to 115% or more of the rated revolution speed.]	1. Overshoot occurs due to excessively small acceleration/deceleration time constant.	1. Increase the acceleration/deceleration time constant. 2. Trially reduce the speed.	Recheck the acceleration/deceleration time constant.

Continued to the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL31	Overspeed (OS) 〔The motor revolution speed rises up to 115% or more of the rated revolution speed.〕	2. Overshoot results from the unstable servo system.	1. Trially adjust the servo gain. Increase (decrease) VGN. Increase VIC. Decrease PGN. 2. Check the load inertia rate. 3. Increase the acceleration/deceleration time constant. 4. Decrease the speed.	1. Set again the servo gain to the suitable value. 2. If it is not recovered by the servo gain, ① Decrease the load inertia rate. ② Recheck the acceleration/deceleration time constant.
		3. Detector signal abnormality	1. Trially replace the cable. 2. Trially replace the motor.	Replace the cable. Replace the motor.
		4. Parameter setting error	Check whether the set speed command is beyond the tolerable speed level since the parameter No.30 (VCM) is set at higher side.	Set the parameter properly.
AL32	Overcurrent (OC) 〔More current than allowable flows in the d.c. line of the servo amplifier.〕	1. U,V,W phases of servo amplifier output have been shorted each other.	Check U, V, W wires for short circuit with a tester.	Correct the wiring.
		2. Mistaken connection of the motor wiring. The servo amplifier terminals U, V, and W do not match with the motor terminals U, V and W.	Check the connection of U, V and W cables.	Correct the wiring.
		3. U, V or W phase cables of servo amplifier output is ground.	1. Using the tester, check the short circuit of the case to the U, V or W phase cable on the terminal base. 2. Using the tester and megger tester, check the insulation of the case of the U, V or W phase cable on the motor.	Correct if grounded. Replace the unit or motor.
		4. Breakage of servo amplifier transistor	Using the tester, measure the resistance between the transistor module terminals.	Replace the transistor module or unit.
		5. External noise	1. Investigate the peripheral devices. (Check whether the 100V class relay or valve is activated or not.) 2. Check whether dirt sticks to the circuit printed board or not.	Recheck the noise countermeasure. (Refer to item 4-9.) Clean the circuit printed board off dirt.
AL33	Overvoltage (OV) 〔A d.c. line voltage of the converter is 400V or more.〕	1. Short circuiting bar is improperly connected on the terminal block.	Short circuiting bar should be connected when regenerative option is not provided. Short circuiting bar is not connected when regenerative option is provided.	Connect or disconnect properly.

Continued to the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL33	Overvoltage (OV) [A d.c. line voltage of the converter is 400V or more.	2. Acceleration/deceleration time constant is small.	1. Trially increase the acceleration/deceleration time constant. 2. Trially reduce the speed.	1. Recheck acceleration/deceleration time constant.
		3. Regenerative resistor in the servo amplifier is broken.	Using the tester, measure the C-to-P resistance on the terminal block (wait for approx. 3 minutes after the charge lamp goes out). Resistance between P + and C - is approx. 50Ω.	Replace the unit.
		4. The regenerative power transistor is broken.	Refer to the alarm code AL30-3.	Replace the unit.
AL35	Data trouble (DE)	Acceleration rate is excessively high.	1. Check if electronic gear ratio is excessively high. 2. Check if acceleration time is too short. 3. Check if a relay or valve located near the amplifier is in operation.	1. Reduce the electronic gear ratio. 2. Prolong the acceleration time. 3. Remove the cause of interference (noises).
AL37	Parameter error (PE)	The parameter data is broken.	1. Check whether dirt, etc. sticks to the card or not. 2. Check the parameter.	1. Clean the card off dirt, and set again the parameter. 2. Replace the card and set again the parameter.
AL46	Motor overheat (OHM) [The thermal protector integrated in the motor or regenerative option is activated. * Only during use of the HA-SA motor.	1. The motor is overloaded.	1. Check the effective torque (JA state indicating value). 2. Measure the motor input current (Refer to Item 8-2). 3. Measure the temperature rise of the motor.	1. Reduce the load. 2. Increase the capacity.
		2. Cable are improperly connected on the terminal block (TE2).	Are the G1 and G2 on the thermal block (TE2) connected to the thermal protector terminals of the motor?	Connect properly.
		3. The motor or regenerative option is insufficiently cooled.	Check the ambient temperatures of the motor and regenerative option. (0 to +40°C) Check whether the oven or similar is placed around to overheat the motor or not.	Run at an ambient temperature of 0 to +40°C.
		4. Hunting results from the unstable servo system.	Refer to the alarm code AL31-2.	
		5. The thermal protector integrated in the motor or regenerative option is defective.	Using the tester, check the continuity between the thermal protector terminals in the motor and regenerative option.	Replace the motor. Replace the regenerative option.

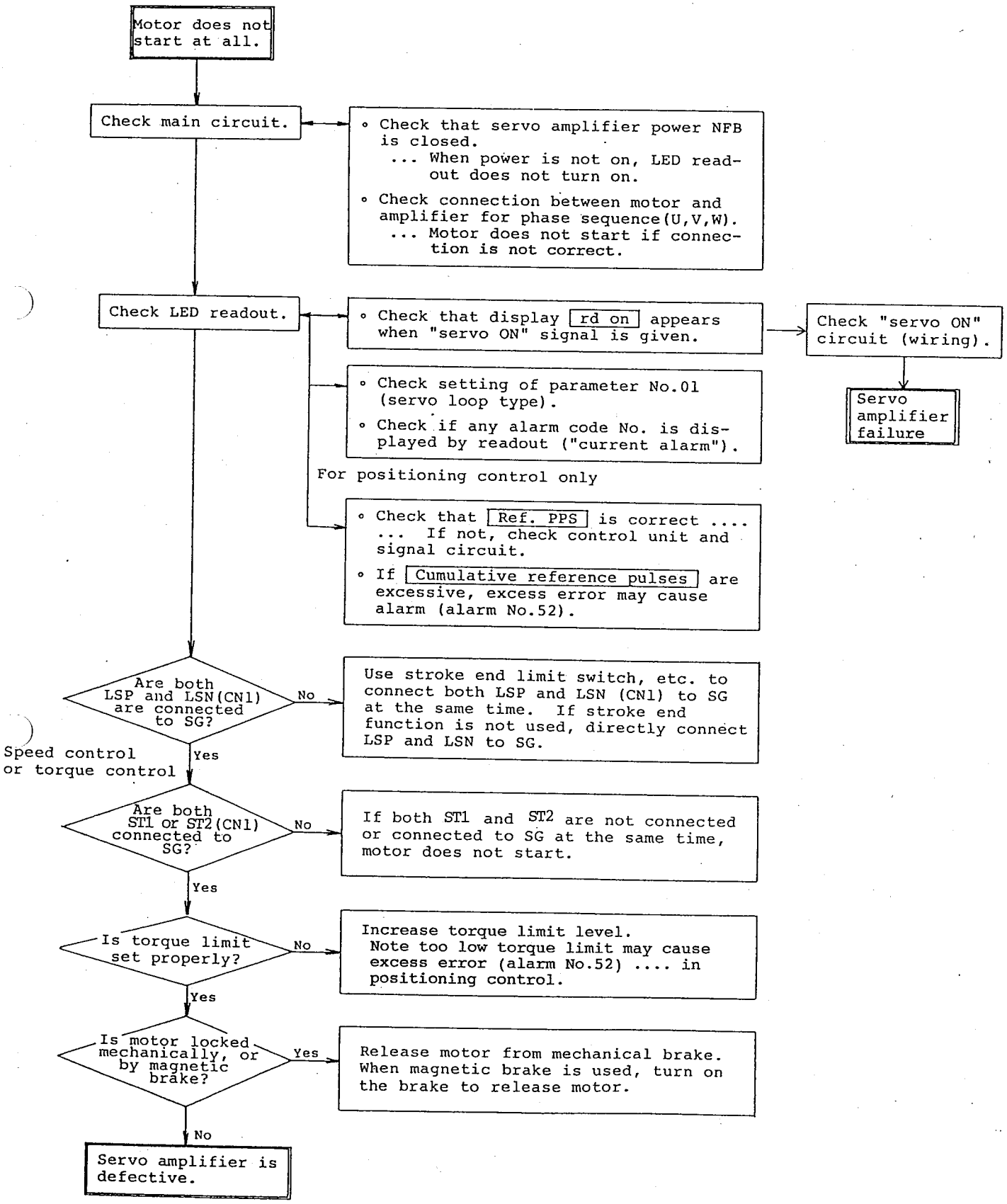
Continued to the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL50	Overload 1 (OL1)	1. Continuous output current of the servo amplifier is excessive during operation.	Refer to the alarm code AL46-1.	
		2. It collides with the machine.	1. Check whether the machine collides or not. 2. Check whether the stroke end limit switch operates properly or not.	1. Recheck the operation pattern. 2. Replace the limit switch.
		3. Hunting results from the unstable servo system.	Refer to the alarm code AL31-2.	
		4. Wiring in the motor is improper. The terminals U, V and W of the servo amplifier do not match the terminals U, V and W of the motor.	Check the connection of U, V and W cables.	Connect properly.
AL51	Overload 2 (OL2)	1. It collides with the machine.	Refer to the alarm code AL50-2.	
		2. Hunting results from the unstable servo system.	Refer to the alarm code AL31-2.	
		3. Wiring in the motor is improper. The terminals U, V and W of the servo amplifier do not match the terminals U, V and W of the motor.	Refer to the alarm code AL50-4.	
		4. A d.c. line voltage drops.		Replace the unit.
AL52	Excessive error (EEX) {The number of residual pulses in the deviation counter exceeds 65K.	1. Acceleration/deceleration time constant is excessively short.	Check the acceleration/deceleration time constant. The acceleration /deceleration time which can follow up the motor can be calculated through the formula (6-1). Calculate the time for check.	Elongate the acceleration/deceleration time constant.
		2. It collides with the machine.	Check whether it collides with the machine.	Recheck the operation pattern.
		3. The servo gain PGN is set to be excessively low.	Trially increase the value of PGN.	Set the suitable value.
		4. Detector signal defective	Refer to alarm code AL20	
		5. Drop in a d.c. line voltage in the unit.		Replace the unit.

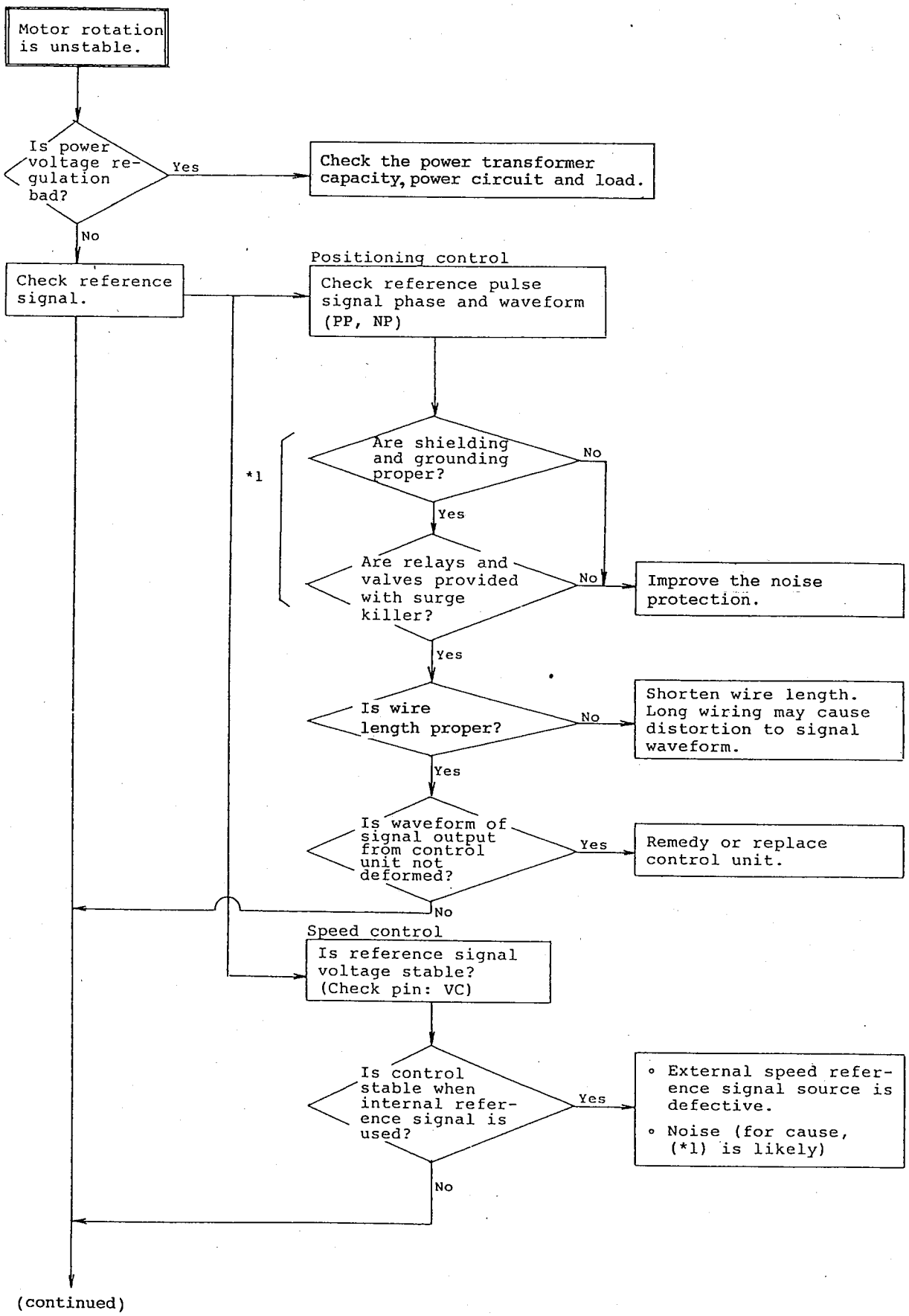
7-2 Troubleshooting

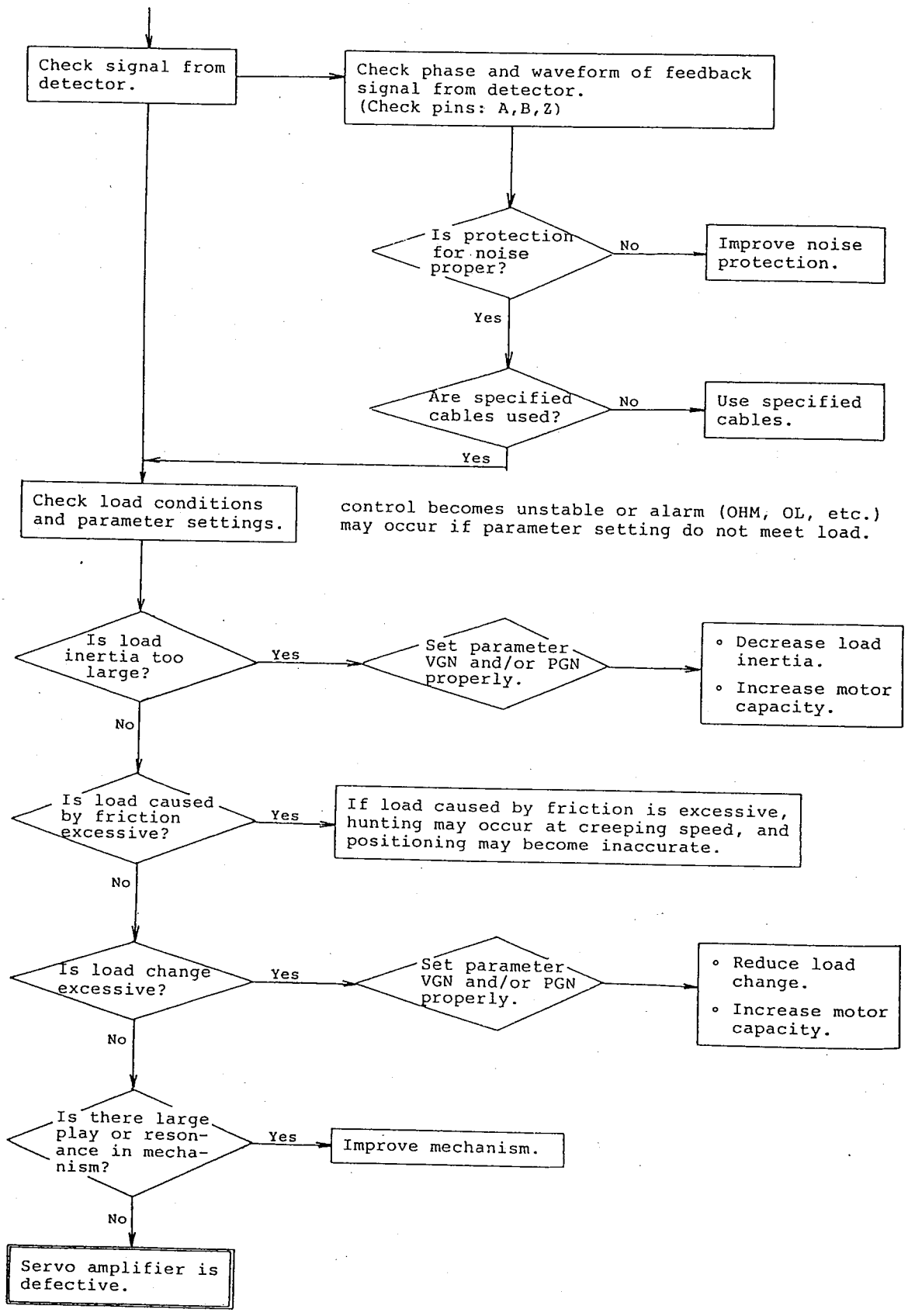
If trouble occurs with the servo motor or amplifier, find the cause and remedy in accordance with the following chart:

(1) Motor does not start.

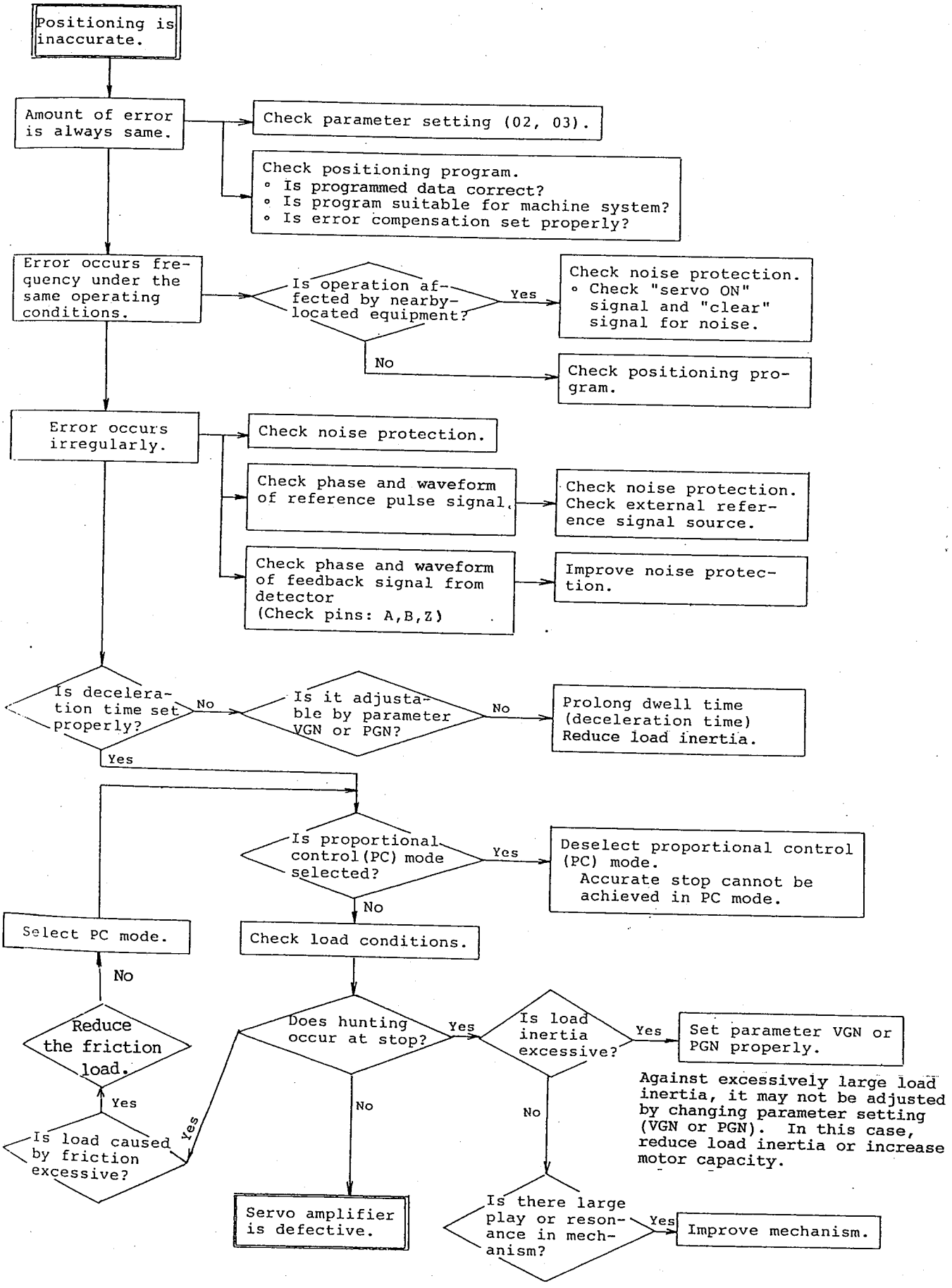


(2) Motor rotation is unstable.

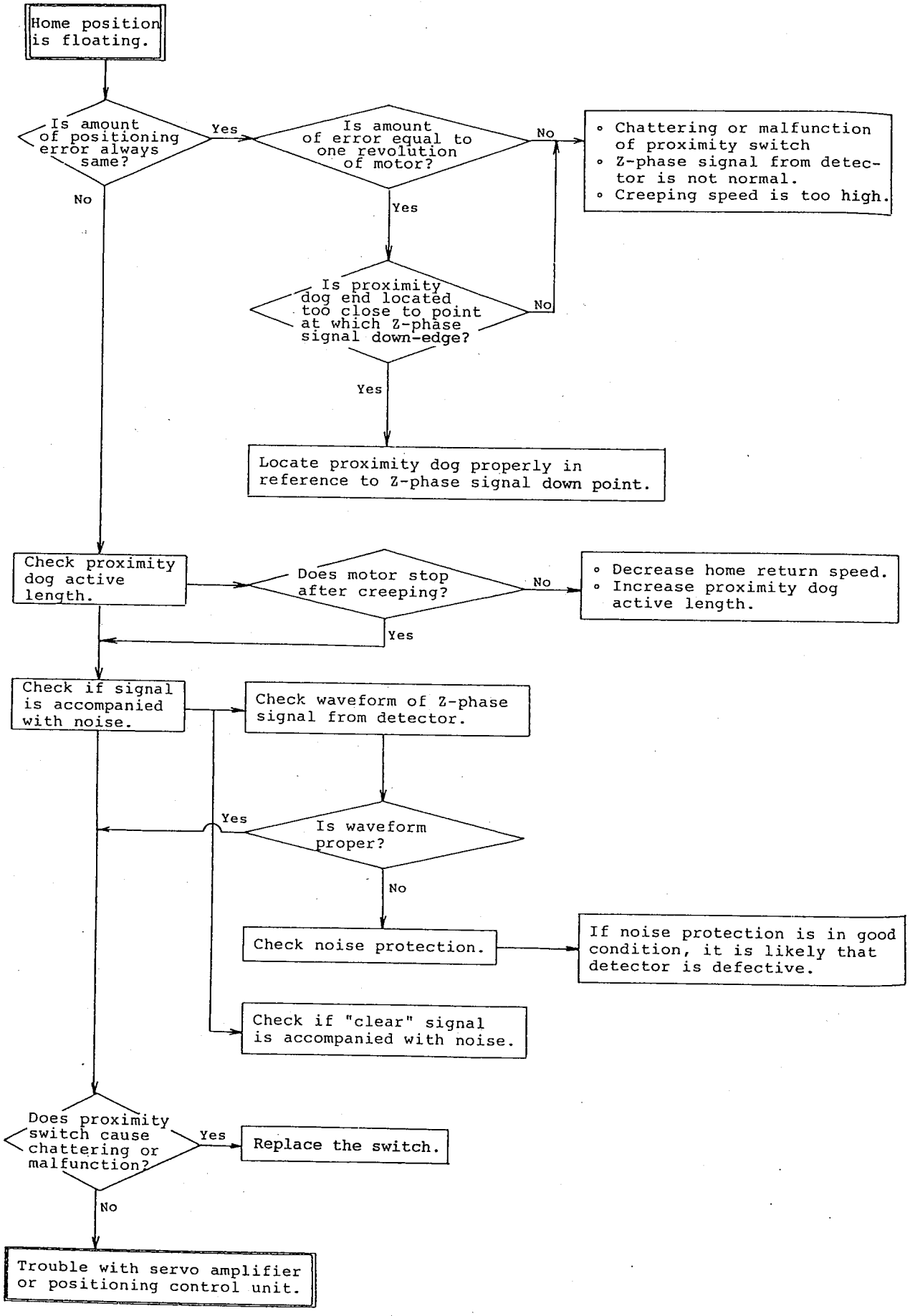



Check signal from detector.
Check phase and waveform of feedback signal from detector. (Check pins: A,B,Z)
Is protection for noise proper?
No
Improve noise protection.
Yes
Are specified cables used?
No
Use specified cables.
Yes
Check load conditions and parameter settings.
control becomes unstable or alarm (OHM, OL, etc.) may occur if parameter setting do not meet load.
Is load inertia too large?
Yes
Set parameter VGN and/or PGN properly.
∘ Decrease load inertia.
∘ Increase motor capacity.
No
Is load caused by friction excessive?
Yes
If load caused by friction is excessive, hunting may occur at creeping speed, and positioning may become inaccurate.
No
Is load change excessive?
Yes
Set parameter VGN and/or PGN properly.
∘ Reduce load change.
∘ Increase motor capacity.
No
Is there large play or resonance in mechanism?
Yes
Improve mechanism.
No
Servo amplifier is defective.

(3) Positioning is inaccurate.



(4) Home position is floating.



8. MAINTENANCE AND INSPECTION

8-1 Cautions and inspection

If any trouble occurs with your servo system, perform inspection in accordance with the following instruction:

CAUTIONS

MELSERVO-SC servo amplifier uses large capacitor. After the power is turned off, the capacitor remains charged for a while.
Before making inspection, check that the CHARGE lamp (red lamp on P.C. board) is off.
Parts at upper portion of P.C. board RG60 to RG69 are at high voltage. during inspection, take care not to touch these parts.
Do not use a megger to check insulation resistance, withstand voltage, etc. Otherwise the servo amplifier might be damaged seriously.

General inspection

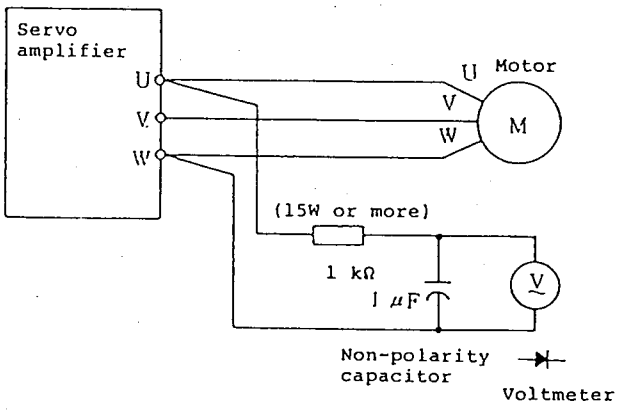
(1) Is alarm code displayed?
(2) Is the same trouble reproducible (check alarm history)?
(3) Are temperature of motor and servo amplifier, and ambient temperature normal?
(4) When does the trouble occur? (during acceleration, deceleration or constant-speed operation)?
(5) Is direction of rotation of the motor correct?
(6) Did instantaneous power failure occur?
(7) Does the trouble occur when specific operation is done or specific reference signal is given?
(8) Does the same trouble occur frequently (what is the frequency)?
(9) Did the trouble occur when load was applied to the motor?
(10) Did the servo motor or servo amplifier be remedied in the past?
(11) How long have the servo motor and servo amplifier been used?

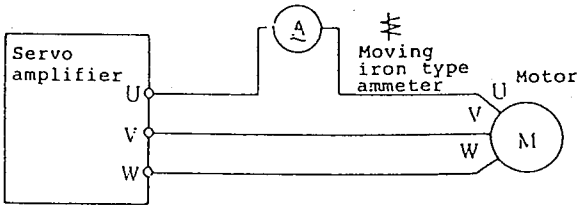
(12) Is the supply voltage proper?
Does voltage regulation change remarkably during operation?

8-2 Voltage and current measurement

(1) Motor voltage measurement

Voltage output from the servo amplifier is under PWM control and therefore has pulse waveform. To measure this type of voltage accurately, use a filter circuit shown to the right and a rectifier type voltmeter.





(2) Motor current measurement

Since pulse waveform of current is transformed to sine waveform by reactance of the motor, a moving core type current meter can be used.

(3) To measure power, use an electrodynamometer type instrument.

(4) Other instruments

When a synchroscope or digital voltmeter is used, do not ground it. Use an instrument requiring input current less than 1mA.

8-3 Periodic inspection

The servo amplifier is a static equipment, and requires no daily maintenance and inspection.
However, perform inspection at least yearly.
The servo motor is of brush-less type, and requires no periodic maintenance.
But, it is recommended to check for sound level and vibration from time to time.

(1) Cautions

When inspection is made under live condition, pay attention to the cautions described in para. 8.1 and 8.2.

(2) Inspection points

a. Check if dust deposit is found in the servo amplifier and clean, if necessary.
b. Check terminal screws for looseness and retighten.
c. Check if any component is defective or damaged (discoloration due to overheat, open circuit, etc.).
d. For continuity test of control circuit, use a multimeter (high-resistance range). Do not use a megger or buzzer.
e. Check cooling fan for operation.
f. Check that motor bearings, brake, etc. do not generate abnormal sound.
g. Check cables (particularly, detector cable) for condition.

(3) Replacement of components

the following components wear or deteriorate with time and wear or deterioration may adversely affect the performance of the amplifier or cause trouble with the amplifier and therefore should be periodically checked and replaced.

① Smoothing capacitor .... It deteriorates due to ripple current. Though the life of the smoothing capacitor depends on ambient temperature and service conditions, is should be replaced in 10 years (when used continuously in an air-conditioned room).

Since the capacitor may deteriorate suddenly, it should be checked at least yearly (every 6 months if it has been long used).

Make visual check for

a. Casing ... Swell of side wall or bottom

b. Sealing plate ... Remarkable warpage or crack

c. Relief valve ... Remarkable extended or opened valve

Also check the capacitor for visible defect, discoloration, electrolyte leakage, etc.

The life terminates when the capacitance decreases to 85% or less of the initial capacitance.

Capacitance can be measured with a capacitometer (various capacitometers are available in the market).

② Relays .... Worn out contacts may cause contact failure.

The life of relay will be usually 100,000 cycles of operation (though it largely depends on voltage and current applied).

③ Motor bearings .... The life of motor bearings is 20,000-30,000 hr of operation when the motor is operated at the rated speed and under the rated load. If the motor generates foreign sound or intense vibrations, it should be replaced.

Component	Standard life	Replacement, etc.
Smoothing capacitor	10 years	Replace (the card.)
Relays	-	Check and determine. (Replace the card.)
Motor bearings	2 ~ 3 years	Check and determine.

8-4 Storage

(1) Motor

When the motor is kept stored for any length of time, pay attention to the following:

a. Store it in a clean and dry location.

Storage temperature	Storage humidity
-15°C to +70°C	90% RH or less

Note: To be free from freezing and condensation.

b. If the motor is stored outdoor or in humid environment, cover it properly to prevent entrance of rain water and dust.

c. When once used motor is stored long, apply anti-corrosive compound to shaft and other unprotected surfaces.

(2) Servo amplifier

It is not recommended to store the servo amplifier long. If long storage is necessary, store it with the following caution.

a. Store it in a clean and dry location.

Storage temperature	Storage humidity
−15°C to +65°C	90% RH or less

Notes:

1. To be free from freezing and condensation.
2. Storage temperature shown above is for short-term storage.

b. Because it is of open construction, take care not to allow entrance of dust and foreign matter.

8-5 Layout on the printed circuit board

Check pins and switches are laid out as shown in Fig. 8-1. Though the ordinary inspection and state check are carried out by the key setter and indicator, check the following states and signals as necessary. The switches which are designated "maker setting purpose" shall not be operated by the user.

① LED

Table 8-1 LED

CPU error indication lamp (red)	Located on the printed circuit board RG580. It is lit when the CPU error occurs in the servo amplifier.

② Switches

The following switches are provided. Set the switches according to the operation purpose.

Table 8-2 Setting switch list

Printed board	Switch name	Set at delivery	Function
RG580	MODE	Push-button switch	Used for display of state and alarm and setting of parameter. (Refer to the Chapter 5)
	UP		
	DOWN		
	SET		
	SW-5 1	OFF	It is turned on to set the special parameter and check the maintenance parameter.
	SW-5 2 to 4	OFF	Maker setting purpose or test mode operation.
RG504	SW-6	OFF	Maker setting purpose
	SW-7	DI / OC	In accordance with the pulse train input interface, • Open collector type ... Lower side (OC) • Differential driver type ... Upper side (DI)

③ Check pins

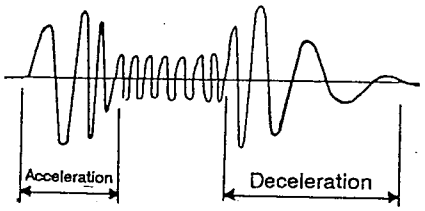
The functions and voltage waveforms of the check pins on the printed circuit board are shown below. The check pin terminals are located on the printed circuit board RG504. For pin locations, refer to Fig. 8-1.

Table 8-3 Check pin list

Terminal name	Signal name	Ground terminal	Signal, content and waveform
J2	W	J2(G)	Motor W-phase current
	V		Motor V-phase current
	G		Control ground

Waveform example
IW/IV

The waveform is different depending on the load, etc.

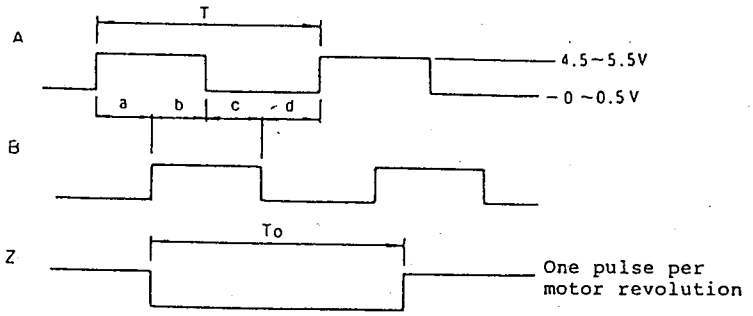
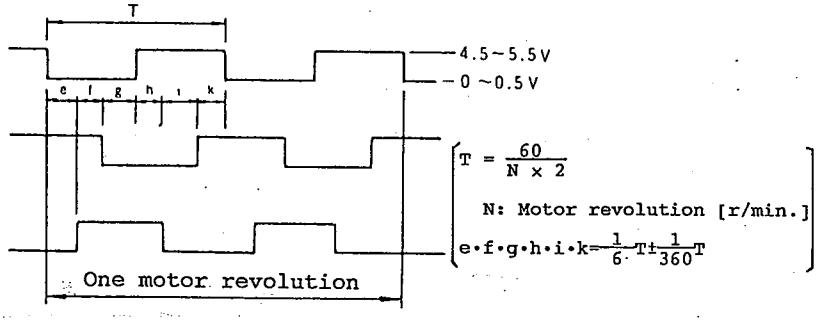


Motor	Converted value
HA-SC053	1.25 (A/V)
HA-SC13	1.25
HA-SC23	2.5
HA-SC43	3.75
HA-SC63	5.0
HA-SA22,32,33	3.0 (A/V)
HA-SA52,53	6.2
HA-SA102,103	10.4

Motor	Rated current (A)		
	Standard 2000, 3000 r/min.	Low inertia	Flat
HA-SC053	1.7 (0.6)		
13	3.1 (1.1)		
23	4.2 (1.5)		
43	7.6 (2.7)		
63	10.2 (3.6)		
HA-SA 22	5.7 (2)	-	-
32	-	-	7.9 (2.8)
33	5.7 (2)	-	-
52	8.5 (3)	9.9 (3.5)	9.9 (3.5)
53	8.5 (3)	-	-
102	15.6 (5.5)	19.8 (7)	19.8 (7)
103	14.1 (5)	-	-

Note: 1. Rated current is indicated in P-P value, ( ) indicates r.m.s. value.
2. Converted value is equivalent to p-p value.

Continued to the next page.

Terminal name	Signal name	Ground terminal	Signal, content and waveform
J4	A B Z	J2 (G)	Encoder Phase A Encoder Phase B Encoder Phase Z Waveform example CCW revolution viewed from the load shaft of the motor.  $T = \frac{60}{N \times A}$ (sec) N: Motor revolution [r/min.] A: Encoder divisions HA-SC motor 2000 P/R HA-SA motor 3000 P/R $a, b, c, d = \frac{1}{4}T \pm \frac{1}{8}T$ $To = T - 3T$
J4	U V W	J2 (G)	Encoder Phase U Encoder Phase V Encoder Phase W Waveform example CCW revolution viewed from the load shaft of the motor  $T = \frac{60}{N \times 2}$ N: Motor revolution [r/min.] $e \cdot f \cdot g \cdot h \cdot i \cdot k = \frac{1}{6}T \pm \frac{1}{360}T$
J7	LG P5 N15 P15	J7 (LG)	Control ground +5V (4.75 to 5.25V) −15V (−14.25 to −15.75V) +15V (14.25 to 15.75V)
J7	P24	J7 (SG)	Interface signal ground +24V

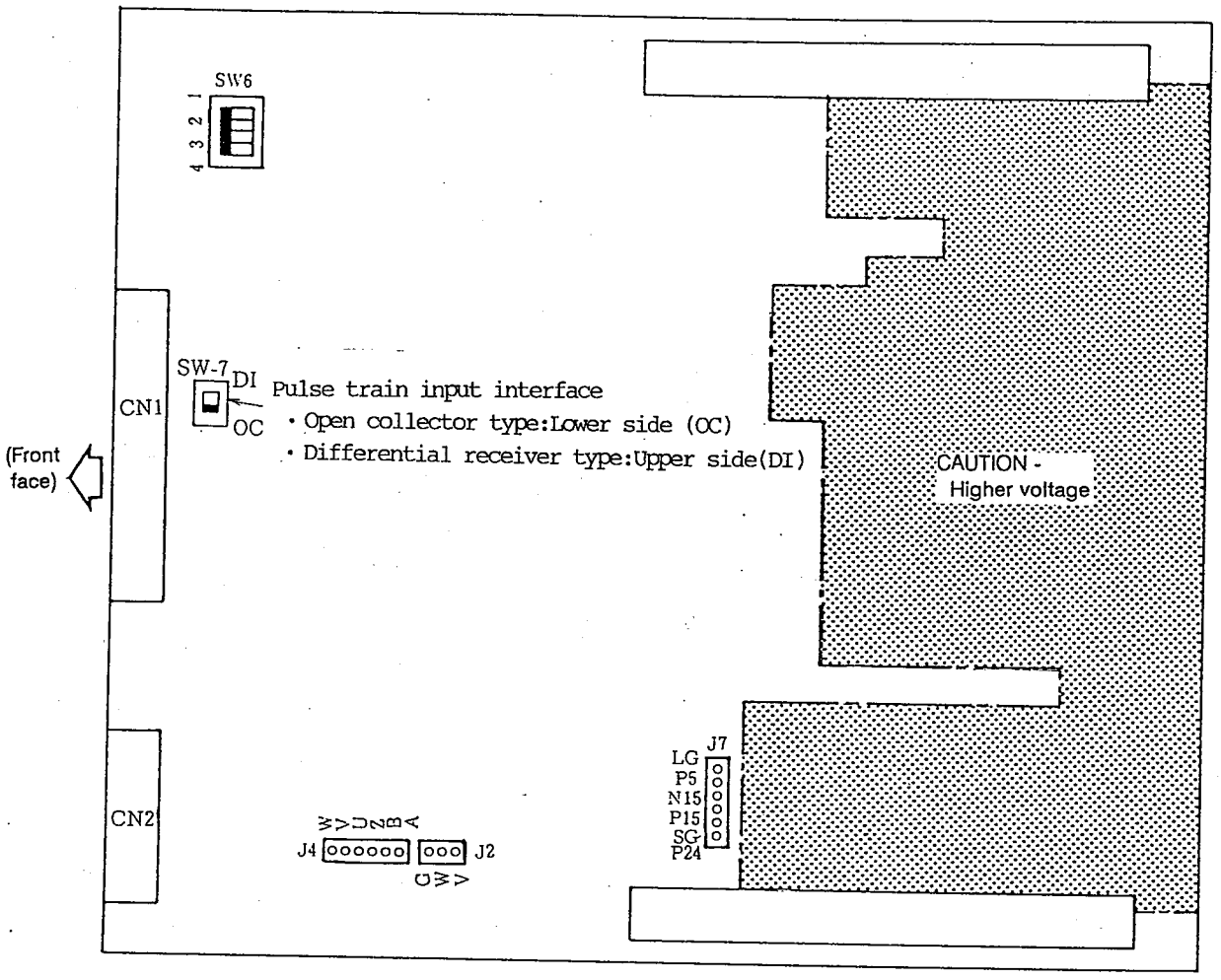


Fig. 8-1 Layout drawing of printed circuit board

(Note) J2, J4, J7 show check pins.

9. INPUT/OUTPUT TERMINALS

9-1 Description of terminals

Table 9-1 Terminal list

Terminal	Symbol	Terminal No.	Description
AC power supply	R,S,T	TE1	Connect to the commercial power supply (200V/50Hz or 200/220/230V/60Hz).
Servo amplifier output	U,V,W		Connect to the motor terminals (U,V,W ... phase sequence may not be changed).
Discharge resistor for regera-tive brake (option)	P,D,C		When using the regenerative option unit, connect it between P-C. In units that have a short-bar mounted between P-D at shipment (MR-SC40, MR-SC60), remove the short-bar when connecting the regenerative option unit.
Motor protec-tion	G1,G2	TE2	Connect to motor thermal protector terminal (red).
Ground	⏚	TE1	Connected to ground (internally connected to the neutral point of power filter, and chassis). • Surely grounded together with motor ground at one point.

Table 9-2 CN1

Signal name	Symbol	Connector pin No.	Description of function, application	I/O classification	Control mode (Note 1)
Servo on	SON	9	Operation becomes ready as the servo on signal terminal and SG terminal are short-circuited.	DI-1	
Reset	RES	12	As the reset terminal and SG terminal is shortcircuited for more than 50 msec, the alarm, etc. is reset as the case with power on.		
Forward run stroke end Reverse run stroke end	LSP LSN	24 25	Forward/reverse run stroke end LS terminals under position control mode. As SG is opened, the torque is not generated.Opposite side run can be operated. Use the stroke end LS (or directly if there is no LS) and shortcircuit with SG.		P
or Forward run start Reverse run start	ST1 ST2	24 25	It becomes the motor start signal under the speed control or torque control mode. If it is connected between ST1-SG under the speed control mode, motor is operated in forward direction (CCW) or in reverse run direction (CW) by connecting ST2-SG. If both ST1 and ST2 are opened, it stops and the servo lock is activated. Under the torque control mode, the torque occurrence mode (forward/reverse run, power running/regeneration) is determined. If both of them are opened,the torque is not generated.		S, C
Clear	CR	27	Clear terminal under the position control mode. If the connection with SG is shortcircuited, the position control counter is cleared at the touch down edge.		P
Speed I select Speed II select	DI1 DI2	23 27	Speed select signal terminal under the speed control or torque control mode. If DI1-SG is shortcircuited, it is operated with the speed set by the internal parameter sc1. If DI2-SG is shortcircuited, it is operated with the speed set by sc2. If both connections are shortcircuited, it is operated with the speed set by SC3. To operated with external speed, open both of them.		S, C
Control mode select	DI0	23	If DI0-SG is shortcircuited under the position/speed, speed/torque or torque/position select mode, the speed, torque and position control modes are selected respectively.		
Ready	RD	49	Ready output terminal. With the state of servo on and ready, the connection with SG is established.	DO-1	
Positioning complete or speed achieved	PF	48	Positioning complete output terminal. When it is within the positioning complete range under the position control mode, it is conducted if it is under the speed control mode and the motor speed is within +/-15% of setting speed.		P, S
Torque limit on or speed limit on	TLC	44	Torque limit on output terminal. If it enters into the motor torque limit range, the connection with SG is established. It is conducted if it enters into the speed limit range under the torque control mode.		
0 speed detection	ZSP	45	Connection with SG is established when the motor speed is 50 rpm or under.		
Alarm	ALM	7	When the protection circuit and base shut down are activated, the connection with SG is opened.		

Continued to the next page.

Signal name	Symbol	Connector pin No.	Description of function, application	I/O classification	Control mode (Note 1)
Driver power supply	VDD	46, 47	Driver power supply for interface. About 24VDC is output. Tolerable current Max. 200 mA (Make it less than 200 mA the sum of command unit and I/O relay drive.)		
Common	SG	13, 14, 26, 30	Contactor input signal common terminal. Not connected to the common of control circuit.		
Forward run pulse array	PP	18	Forward run pulse array input terminal. Gives the pulse array from the pulse array generating unit such as MR-PO, AD71, etc.	DI-2	P
	PG	17	Same as above. Differential input terminal.		
Reverse run pulse array	NP	16	Reverse run pulse array input terminal.		
	NG	15	Same as above. Differential input terminal.		
Speed command	VC	33	Speed command input terminal. Applies 0 - ±10VDC. When +10V is applied, the motor runs at the rated speed to the CCW direction. When -10V is applied, it runs at the rated speed to the CW direction. Input resistance 10 ~ 12 kΩ. Set the speed limit value under the torque limit mode.	Analog input	S, C
Torque limit command (+) or torque control command	TLAP	35	(+) torque limit command input terminal. Forward run regeneration, reverse run power running. Apply 0 - +10VDC. When +10VDC is applied, if the external torque limit signal (TL) is turned on, it is limited to the max. current. Input resistance is 10 ~ 12 kΩ. Input the torque command (±8V/max. torque) under the torque control mode.	Analog input	
Torque limit command (-)	TLAN	38	(-) torque limit command input terminal. Valid with the reverse run regeneration, forward run power running. Apply 0 - -10VDC. When -10VDC is applied, if the external torque limit signal (TL) is turned on, it is limited to the max. current. Input resistance 10 - 12 kΩ. It is invalid under the torque control mode.		
Monitor	MO	40	Motor speed or torque is output with the internal selection. Max.±10V, ±1 mA (about ±8V/max. revolutions, max. torque)	Analog output	
DC power supply	P15R	1	+15VDC power supply terminal. Used for the speed command power supply, etc. Tolerable current Max. 30 mA		
	N15R	2	-15VDC power supply terminal. Used for the speed command power supply, etc. Tolerance current max. 30 mA		
Control common	15G	4, 5, 34 36,39,41	Common terminals for control signals, not connected with SG.		
Shield	SD	6, 37	Connects the one side of shield wire.		
Encorder output (open collector method)	FPA	32	[For HA-SC motor] With FPA, FPB, 2000 pulses (x1/1~x1/256) are output for each turn of the motor. With OP, 1 pulse is output per turn of the motor. When the motor is revolving in the CCW direction, the pulse of FPA is ahead of FPB by π/2. [For HA-SA motor] With FPA, FPB, 3000 pulses (x1/1~1/256) are output for each turn of the motor. With OP, 1 pulse is output per turn of the motor. When the motor is revolving in the CCW direction, the pulse of FPA is ahead of FPB BY π/2.	DO-2	
	FPB	31			
	OP	50			

Notes:
1. It means the special pins for control mode P (position), S (speed) and C (torque). Pins not marked are common with P, S and C.
2. Refer to Section 9-3 on details of the relation of the command voltage polarity and orientation.
3. The torque limit function is invalid at shipment. To validate, give the external torque limit signal (TL) with parameters No.17 and 18. Refer to P.83.
TLAP is always valid during the torque control mode operation.

9-3 Control signals and operation modes

① Torque limit signal (TLAP, TLAN)

The relationship between torque limit reference signal and operation mode in position control and speed control operation is shown below. To use torque limit, turn on TL (external torque limit) signal.
Pay attention to polarity of TLAP and TLAN.

Torque limit signal		Operation mode	
Signal	Signal voltage		
TLAP	+0.05 to +10V	Fwd reg. brake	Rev run
TLAN	-0.05 to -10V	Fwd run	Rev reg. brake

② Monitor

Relationship between speed or torque monitor output and operation mode is as listed below.

Monitor	Operation mode		±8V output
	⊕ Output	⊖ Output	
Speed	Forward	Reverse	Rated speed
Torque	Rev run	Fwd run	Max. torque

③ Selection of direction of rotation

Relationship between combination of external speed reference signal (VC) and forward/reverse start signal (ST1, ST2), and direction of rotation of motor in speed control operation is listed below.

Ext. speed reference (VC) polarity	Fwd start ST1 ON	Rev. start ST2 ON
⊕ plus	Fwd run	Rev run
⊖ minus	Rev run	Fwd run

④ Speed selection

Relationship between speed select signal (DI1, DI2) and external speed reference signal in speed control or torque control operation is listed below.

Speed reference		DI1	DI2
Speed set by parameter	1st speed (SC1)	ON	OFF
	2nd speed (SC2)	OFF	ON
	3rd speed (SC3)	ON	ON
External speed reference (VC)		OFF	OFF

⑤ Torque type selection

Relationship between combination of forward/reverse start signal (ST1 , ST2) and torque control signal (TLAP), and torque type in torque control operation is listed below.

Torque reference TLAP polarity	Operation mode	
	ST1 ON	ST2 ON
⊕ plus	Rev run	Fwd run
⊖ minus	Fwd run	Rev run

10. DISPLAY AND PARAMETER LIST

10-1 Operation status monitor

During operation, variables listed below can be displayed for monitor.
Desired variable can be selected even during operation by pressing [UP] or [DOWN] button.
Usually, variable can be read in the order listed below. It is, however, possible to place a desired variable to the head by the parameter No.24 (refer to 10-4).

Table 10-1 Status monitor display list

Name	Sym-bol	Range/unit	Description (display example)
Cumulative feedback pulses		-999999 pulses to 999999 pulses	Amount of motor rotation is displayed in terms of pulses. HA-SC motor 8000 pulses/rev, HA-SA motor 12000 pulses/rev. If cumulative pulses exceed 999999, count returns to "0". When "SET" button is pressed, the readout is reset to "0". For reverse rotation, all displayed numerals are accompanied with decimal point. [9][9][9][9][9][9] ([Reverse rotation]) [ ][ ][ ][ ][ ][0] [9][9][9][9][9][9] ([Forward rotation])
Motor speed	r	−3000 r/min to 3000 r/min	Motor speed is displayed. For reverse rotation, symbol (-) is placed at head of numerals. [r][-][2][0][0][0] ([Reverse rotation]) [r][ ][ ][ ][0] [r][ ][2][0][0][0] ([Forward rotation])

Continued to the next page.

Name	Symbol	Range/unit	Description (display example)
Remaining pulses	E	−20000 pulses to 20000 pulses	Remaining pulses are displayed. For reverse rotation, all displayed numerals are accompanied with decimal point. E20000 (A negative number) E 0 E20000 (A positive number)
Cumulative reference pulses	P	-99999 pulses to 99999 pulses	Input positioning reference pulses are displayed. Value not subjected to pulse multiplication (CMX/CDV) is displayed. Pulse count may not meet cumulative feedback pulses. When count exceeds 99999, it returns to "0". The readout can be reset to "0" by pressing "SET" button. For reverse rotation, all displayed numerals are accompanied with decimal point. P99999 (Reverse rotation) P 0 P99999 (Forward rotation)
Reference pulse train frequency	PA	-200kpps to 200 kpps	Input positioning reference pulse train frequency is displayed. Unit is KPPS when decimal point is used, and PPS when decimal point is not used. Value not subjected to pulse multiplication is displayed. For reverse rotation, symbol (-) is placed at head of numerals. PA-200. (Reverse rotation 200kpps) PA.100 (Forward rotation 100pps) PA 200. (Forward rotation 200kpps)

Continued to the next page.

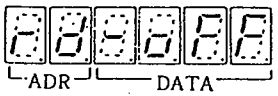
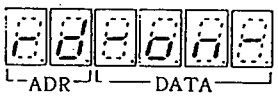
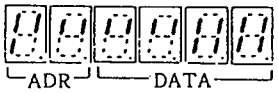
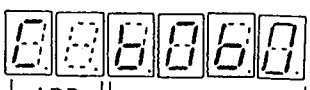
Name	Sym-bol	Range/unit	Description (display example)
Speed reference signal voltage	F	0 to ±10V	Speed reference signal (speed limit) voltage is displayed. It is 10V at full range. F -10.00 (Reverse rotation) F 0.00 F 10.00 (Forward rotation)
Reverse torque limit signal voltage	UP	0 to 10V	Reverse torque limit signal voltage is displayed. UP 10.00
Forward torque limit signal voltage	Un	0 to -10V	Forward torque limit signal voltage is displayed. Un -10.00
Regener-ative load ratio	Ld	0 to 100%	Regenerative brake load is displayed in terms of percentage to permissive regenerative brake duty. It depends on whether optional discharge resistor is used or not (parameter 1 should be set properly). Ld 100
Load ratio	JA	5 to about 250%	Continuous and effective load torque is displayed. JA 100
Peak load ratio	Jb	0 to about 300%	Peak torque during acceleration or deceleration is displayed in %. The maximum motor torque is assumed 100%. Jb 100

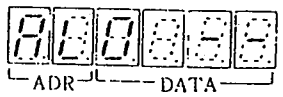
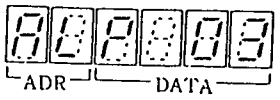
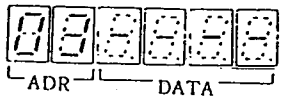
Continued to the next page.

10-2 Diagnosis indication

This display mode is selected to check external control sequence.

Table 10-2 Diagnosis display list

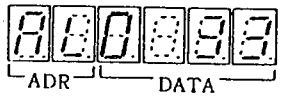
<table>
<tr><th>Name</th><th>Display</th><th>Description</th></tr>
<tr><td rowspan="3">Control sequence</td><td> 
</td><td>The system is not ready for operation.
This display appears during initialization after or before servo ON, or during alarming.</td></tr>
<tr><td> 
</td><td>The system is ready for operation.
This display appears when initialization is completed after the power is turned on, indicating that operation can be started.</td></tr>
<tr><td rowspan="2">External I/O signals</td><td> 
</td><td>Status (ON or OFF) of external input or output signal is displayed.
Upper vertical line of each LED segment corresponds to input signal, and lower vertical line to output signal.
In the example shown to the left, all input and output signals are on.
Relationship between segment vertical line and input/output signal is as shown below.</td></tr>
<tr><td colspan="2">
<table>
<tr><td>Input signal (CN1 pin No.)</td><td>SON (9)</td><td>TL</td><td>PC</td><td>RES (12)</td><td>LSP (24)</td><td>LSN (25)</td><td>CR (27)</td><td>DI0</td><td>DI1 (23)</td><td>DI2 (27)</td><td>ST1 (24)</td><td>ST2 (25)</td></tr>
<tr><td>Output signal (CN1 pin No.)</td><td>OP (50)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>TLC (44)</td><td>ZSP (45)</td><td>PF (48)</td><td>RD (49)</td></tr>
</table>
Note 1. Input signal pin No. is adapted to state at shipment.
(can be changed with the parameter No. 17,18)
2. LSP and LSN are glowing continuously under the speed or torque control mode. (setting at shipment)
</td></tr>
<tr><td>Software version</td><td>
</td><td>For manufacturer's control</td></tr>
<tr><td>Maker control number</td><td> 
</td><td>For maker control</td></tr>
</table>

Name	Display	Description
Current alarm		Current alarm is displayed by code No. If alarm occurs, priority is given to alarm display.
Parameter error	 	When parameter data was destroyed and protective function is worked (alarm code No.37), its parameter is displayed. In the example shown to the left, parameter No.3 is out of order. If the parameter is referred to when any error occurs, the display will be as at bottom on left.

10-3 Alarm indication

Alarm history or parameter error is displayed.

During alarm, the decimal point at the top digit flickers no matter what display mode is used.

Name	Display	Description
Alarm history		Current alarm and maximum 9 past alarms can be displayed in alarm code No. In the example shown on left, the latest alarm is "33" (over-voltage). During alarm, the decimal point at the top digit (A) flickers (flickering occurs only in alarm condition).

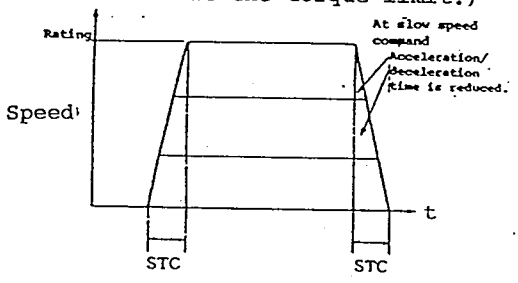
10-4 User parameter setting data

Table 10-4 User parameter setting

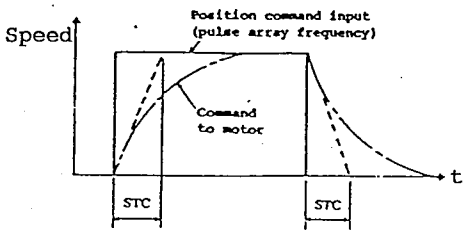
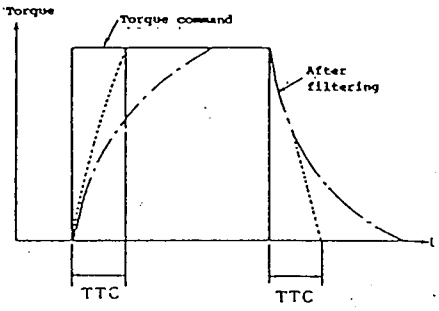
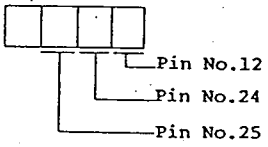
<table>
<tr><th>No.</th><th>Abbr.</th><th>Description</th><th>Control mode</th><th>Initial setting</th><th>Unit</th><th>Range</th></tr>
<tr><td>*00</td><td>MTY</td><td>Motor type
Set the motor name. The following settings are available according to the combination of the amplifier and motor being used.
3 | | 2 | 3
<table><tr><th colspan="2"></th><th>Motor series</th><th colspan="6">Motor rating</th></tr><tr><td>Amplifier</td><td>MR-SC</td><td>-</td><td colspan="2">10</td><td>20</td><td>40</td><td>60</td><td>100</td></tr><tr><td rowspan="5">Motor</td><td>HA-SC</td><td>3</td><td>053</td><td>13</td><td>23</td><td>43</td><td>63</td><td>-</td></tr><tr><td rowspan="2">HA-SA</td><td rowspan="2">0</td><td colspan="3">-</td><td>22</td><td>52</td><td>102</td></tr><tr><td colspan="3">-</td><td>33</td><td>53</td><td>103</td></tr><tr><td>HA-SA-L</td><td>1</td><td colspan="3">-</td><td>-</td><td>52</td><td>102</td></tr><tr><td>HA-SA-U</td><td>2</td><td colspan="3">-</td><td>32</td><td>52</td><td>102</td></tr></table></td><td>Set this before operation.
This parameter is activated by turning off the power supply and then turning it on again.</td><td></td><td></td><td></td></tr>
<tr><td>*01</td><td>STY</td><td>Servo loop (control mode) selection:
Servo loop (control mode) can be selected and optional discharge resistor unit can be used.
0 0 0 0
00: Positioning (pulse train)
01: Positioning (pulse train)/speed (analog, 3 speeds)
02: Speed (analog, 3 speeds)
03: Speed (analog, 3 speeds)/torque (analog)
04: Torque (analog)
05:Torque control(analog)and position (pulse array)select.
00: Without optional discharge resistor unit for regenerative brake
01: Regenerative option (MR-RB082) is used.
02: Regenerative option (MR-RB32) is used.</td><td></td><td>0000</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>0</td><td>CMX</td><td>Reference pulse multiplication (numerator):
Input reference pulses are multiplied.</td><td>P</td><td>1</td><td></td><td>1 to 9999</td></tr>
<tr><td>03</td><td>CDV</td><td>Reference pulse multiplication (denominator):
Input reference pulses are divided.
Ex.: Reference pulses
Input f_1 → CMX/CDV → Positioning reference $f_2 = f_1 \times \frac{CMX}{CDV}$
Note: $\frac{CMX}{CDV}$ should be larger than $\frac{1}{50}$, but smaller than 20</td><td>P</td><td>1</td><td></td><td>1 to 9999</td></tr>
<tr><td>04</td><td>INP</td><td>In-position zone:
Zone or range in which in-position signal is output is set.</td><td>P</td><td>100</td><td>Pulse</td><td>0 to 9999</td></tr>
</table>

Before operation, first set this.
This parameter is put into action by turning off the power supply once and resupplying the power.
Note: Always use the regenerative option unit for MR-SC100, and the initial value is 0100. If set 0000, parameter error occurs.

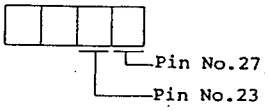
Note: When the parameter with * mark was set, turn off once the power supply.
If the display faded away after the power off, back on again the power so that the setting is completed.

No.	Abbr.	Description	Control mode	Initial setting	Unit	Range
05	PGN	Positioning control gain: This setting depends on application. The standard settings are shown below. If setting is less than 6, error may become excessive at speed of 2000r/min. J_L/J_M: 0 / 1 / 3 / 5 Setting — Standard: 35 / 25 / 25 / 15 Setting — Maximum: 100 / 80 / 40 / 25	P	25	rad/sec	5 to 150
06	VGN	Speed control gain: Speed control gain is set. The larger the gain, the faster is the response. Note, however, that excess gain causes large vibration or hum to motor. For setting, refer to the table below. J_L/J_M: 0 / 1 / 3 / 5 Setting value: 100 / 100 / 200 / 300	P,S	100	Set for $J_L/J_M \fallingdotseq 1$	20 to 2000
07	VIC	Speed integral compensation: Time constant for speed integral compensation is set. J_L/J_M: 0 / 1 / 3 / 5 Setting value: 20 / 20 / 30 / 40	P,S	20	msec	1 to 1000
08	SC1	Speed reference (1) 1st speed range (speed reference or speed limit) of internal 3-speed setting is selected.	S,C	100	r/min	0 to the rated speed
09	SC2	Speed reference (2) 2nd speed range (speed reference or speed limit) of internal 3-speed setting is selected.	S,C	1000	r/min	0 to the rated speed
10	SC3	Speed reference (3) 3rd speed range (speed reference of speed limit) of internal 3-speed setting is selected.	S,C	2000	r/min	0 to the rated speed
11	STC	Speed acceleration/deceleration time constant: Set the slope time to reach the max. speed against the speed command (internal 3 speed and external.) (This acceleration/deceleration time constant is valid also for the speed limit command at the torque limit.)  	S	0	10 msec	0 to 5000

Continued to the next page.

No.	Abbr.	Description	Control mode	Initial setting	Unit	Range
11	STC	Position acceleration/deceleration time constant: Sets the time constant when the filter is inserted shortly after the position command. It is valid when the parameter No.40 is set to 0100. 	S	0	10 msec	0 to 5000
12	TTC	Torque filter time constant: Sets the time constant to insert the filter shortly after the torque command or torque limit command. 	S, C	0	10 msec	0 to 2000
13	VCO	VC offset: Offset is specified for speed reference analog signal. Set so that servo motor does not rotate with speed reference set at zero.	S	0	mv	-999 to 999
14	TPO	TLAP offset: Offset is specified for reverse torque limit analog signal.	C	0	mv	-999 to 999
15	TNO	TLAN offset: Offset is specified for forward torque limit analog signal.	C	0	mv	-999 to 999
16	MOO	MO offset: Offset is specified for monitor output.	S,C	0	mv	-999 to 999
*17	IP1	Input signal select (1): Selects the functions of pin Nos.12, 24, 25 of connector CN1. * Refer to following explanation. 	P,S,C	0000		HEX setting

Note: When the parameter with * mark was set, turn off once the power supply.
If the display faded away after the power off, back on again the power so that the setting is completed.

No.	Abbr.	Description	Control mode	Initial setting	Unit	Range
*18	IP2	Input signal select (2): Selects the functions of pin Nos.27, 23 of connector CN1. * Refer to following explanation.  	P,S,C	0000		HEX setting

Explanation of parameter Nos.17, 18:

Selects the functions of input signal (connector CN1 Nos.12, 24, 25, 27, 23). Since the initial values are set at the shipment from factory, it is usually unnecessary to adjust. Initial values are as shown below.

1. Setting No. corresponding to each function

0: TL (external torque limit command valid)
1: PC (proportional control select valid)
2: RES (reset)
3: LSP (forward run stroke end)
4: LSN (reverse run stroke end)
5: CR (cumulative pulse clear)
6: DI0 (mode select)
7: DI1 (internal speed I select)
8: DI2 (internal speed II select)
9: ST1 (forward run start)
A: ST2 (reverse run start)
B: EMG (emergency stop)

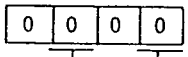
Initial value list

Parameter No. \ Pin No.	12	24	25	27	23
0 (position)	RES	LSP	LSN	CR	—
1 (position/speed)	↑	LSP/ST1	LSN/ST2	CR/—	DI0
2 (speed)	↑	ST1	ST2	DI2	DI1
3 (speed/torque)	↑	ST1	ST2	—	DI0
4 (torque)	↑	ST1	ST2	DI2	DI1
5 (torque/position)	↑	ST1/LSP	ST2/LSN	—/CR	DI0

2. If all are set to 0, the initial values are set.

3. Do not select the same functions.
It will be rejected as a parameter error. ('0' is excluded from all.)

4. Unless LSP, LSN are selected, if it turned on internally. (All of position, speed, torque)

No.	Abbr.	Description	Control mode	Initial setting	Unit	Range
24	DMD	Display mode:  (Status display immediately after power is turned on.) 0: Positioning control ... Cumulative reference pulses Speed control ..... Rev./min. Torque control .... Operating torque 1: Cumulative feedback pulses 2: Speed rpm 3: Remaining pulses 4: Cumulative reference pulses 5: Reference pulse frequency 6: Speed reference signal voltage(analog) 7: Reverse torque limit signal voltage 8: Forward torque limit signal voltage 9: Regenerative brake load A: Operating torque B: Peak torque (Monitor mode selection) 0: Speed monitor (± output) 1: Torque monitor (± output) *1 2: Speed monitor (+ output) 3: Torque monitor (+ output) *1 4: Current output (± output) *1, *2 *1: Torque control mode (8V output for maximum torque). In the torque control mode, the maximum output (8V) is linked with the value set in the parameter. This is applicable for the function-enhanced type produced from August, 1988. *2: Used as the output of the standard shaft of the multi-operation.		0000		Hex. decimal setting

Note: When the parameter with * mark is set, turn off once the power supply.
If the display faded away after the power off, back on again the power so that the setting is completed.

10-5 Special parameter data

Table 10-5

Classification	No.	Abbr.	Name and function	Loop	Initial value	Unit	Setting range
Special	25		For manufacturer's setting		0000		
	26		For manufacturer's setting		0		
	27		For manufacturer's setting		0000		
	28		For manufacturer's setting		65		
	29		For manufacturer's setting		1		
	30	VCM	Revolutions at 10V command: Sets the revolutions at 10V.	S	(Note 1) 0	r/min	0 to 5000
	31	VDC	Speed proportional control gain: Sets the proportional gain around the stop position with speed loop. It is an ordinary proportional integral with 1,000 and if it is smaller the range of proportional control is enlarged.	P,S	980		0 to 1000
	32		For manufacturer's setting		50		
	33	TLL	Torque limit value: It is set with the max. torque stated on catalogue = 100%. When the external torque limit is valid, the torque is restricted by either value of lower level. When the peak torque of speed reducer is restricted, set the torque limit value at a lower value.	P,S	100	%	0 to 100
			Torque control command full scale value: Under the torque control mode, the torque level is set. which is output with TALP input level ±8V. For example, if the parameter is set to 50%, the output torque with TLAP of 8V is (max. torque)/2.	C			
	34		For manufacturer's setting		210		
	35		For manufacturer's setting		600		
	36		For manufacturer's setting		0		
	37		For manufacturer's setting		0		
	*38		For manufacturer's setting		0		
	39	ENR	Encoder output dividing ratio: Denominator of diving ratio is set. Number of pulse per each 1 turn of motor for the encoder output (open collector method). It is 2000 pulses/rev (HA-SC motor) or 3000 pulses/rev (HA-SA motor) with the dividing ratio of 1/1.	P,S,C	1		1 to 256
	40	OP2	Position acceleration/deceleration time constant: When the filter is inserted after the position command, it is set to 0100. Refer to parameter No.11.		0000		
	*41		For manufacturer's setting		0		
	*42	TST	Test mode operation: It is set to 0001 for the test mode operation. See Section 6-3, (8).		0000		
	43 to 48		Spare		0		

Notes :

1. In case of the initial value (0), motor revolution speed at 10V is the rated speed of the motor to be used.
   When Pr. 30 is set at other than 0, the speed at 10V is the setting value.
2. For parameters marked with an asterisk, setting is completed, the set value will be valid by turning the power supply off and on.

10-6 Parameter setting value entry table

Set parameter according to the purpose of operation or specifications before starting operation. Parameters, as shown below, are composed of user parameters, special parameters and maintenance parameters but the setting by user is limited to the user parameters.

Table 10-6 Parameter setting recording table

Classification	No.	Abbr.	Name	Loop	Initial value	Unit	Recording column	
User Parameter	*00	MTY	Servo motor type	-	####			
	*01	STY	Servo loop type	-	0000(Note 4)			
	02	CMX	Command pulse multiplying factor numerator (Electronic gear)	P	1			
	03	CDV	Command pulse multiplying factor denominator (Electronic gear)	P	1			
	04	INP	In-position range	P	100	pulse		
	05	PGN	Position loop gain	P	25	sec^{-1}		
	06	VGN	Speed loop gain	P,S	100			
	07	VIC	Speed integral compensation	P,S	20	msec		
	08	SC1	Speed command (1)	S,C	100	r/min		
	09	SC2	Speed command (2)	S,C	1000	r/min		
	10	SC3	Speed command (3)	S,C	2000	r/min		
	11	STC	Speed acceleration/deceleration time constant	S	0	10msec		
	12	TTC	Torque filter time constant	S,C	0	10msec		
	13	VCO	VC offset	S	0	mV		
	14	TPO	TLAP offset	C	0	mV		
	15	TNO	TLAN offset	C	0	mV		
	16	MOO	MO offset	S,C	0	mV		
	*17	IP1	Input signal select (1)	P,S,C	0000			
	*18	IP2	Input signal select (2)	P,S,C	0000			
	24	DMD	Display mode (initial state display setting)	-	0000			
Special parameter	25		For manufacturer's setting		0000			
	26				0			
	27				0000			
	28				65			
	29		For manufacturer's setting		1			
	30	VCM	10V command revolution speed	S	0	r/min	—	—
	31	VDC	Speed proportional control	P,S	980			
	32		For manufacturer's setting	P,S,C	50		—	—
	33	TLS	Torque limit value (internal) [max. torque 100%] Torque command full scale value	P,S	100	%		
	34		For manufacturer's setting		210		—	—
	35				600		—	—
	36		For manufacturer's setting		0			
	37				0			
	*38				0			
	39	ENR	Encoder output dividing ratio	P,S,C	1			
	40	OP2	Position acceleration/deceleration time constant	P	0000		—	—
	*41		For manufacturer's setting		0			
	*42	TST	Test mode operation		0000			
	43 to 48		(Spare)		0			
Maintenance parameter	49		For manufacturer's setting		0			
	50				0			
	*51				0			
	52				4444			
	*53				0000			
	54				0			
	55				0			
	56				-			

Notes: 1. When the parameter with * mark was set, turn off once the power supply. If the display faded away after the power off, back on again the power so that the setting is completed.
2. P, S and C of setting mode indicate that they are effective parameter respectively at the position control (P), speed control (S) and torque control (C).
3. #### is set to the motor type as four digits number.
4. In case of the type MR-SC100, parameter No.01 is set to 0100.

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