MITSUBISHI

GENERAL-PURPOSE AC SERVO

MELSERVO-SA

— Instruction Manual —

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GENERAL-PURPOSE AC SERVO

MELSERVO-SA

-- Instruction Manual --

Thank you for your purchase of Mitsubishi MELSERVO-SA.
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, ready this manual carefully to use the system for a long time without problems.

CONTENTS

INPORTANT

Before the use of your MELSERVO-SA, please read the instructions described here.

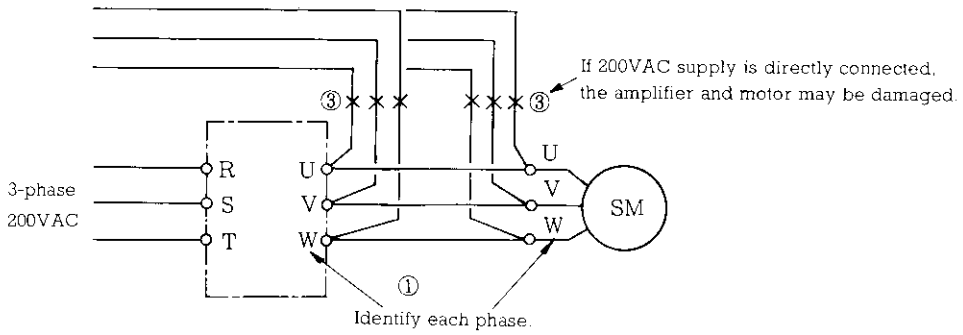
Note that inadvertent handling or operation may result in serious damage to your MELSERVO-SA.

(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.

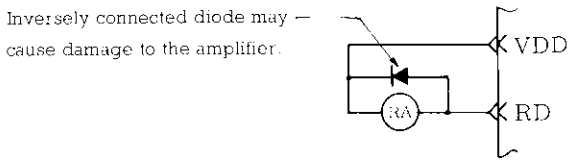
(WIRING)

1. Carefully identify each phase (U, V and W) on the amplifier output and the motor input and connect the cable correctly.... See 4-7 (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 4-7 (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 4-7 (1).



4. Do not insert a power factor correction reactor in the input circuit of amplifier (otherwise, the amplifier may be damaged.... See 4-7 (1).

5. 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 4-7 (1).
6. 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 4-7 (2).



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

(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 4-6 (1) and 4-6 (2).
2. Do not frequently turn off and on the power to restore the amplifier from alarm condition (AL30, 50, 50)(otherwise the amplifier might be damaged).... See 4-6 (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.

(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 toch 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-SA, 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-SA system, contact nearby-located our sales representative.

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) Servo motor having capacity larger than that of HA-SA202 comes with eye bolts.
To lift and transfer such a servo motor, install the eye bolts and apply wire ropes, hooks, etc. to them.

3. INSTALLATION

3.1 Servo amplifier

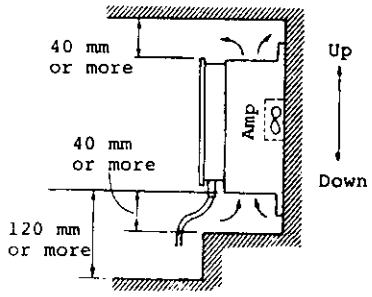
(1) Install the servo amplifier in a clean and well-ventilated location. Do not install the servo amplifier to direct sunlight, high temperature, high humidity, dust and corrosive gases.

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	4.9m/s^2 or less

(2) The servo amplifier is of wall-mount type. Install it on a wall vertically and securely with bolts or screws so that the letters "MELSERVO-SA" 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).



(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.

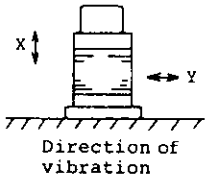
③ Make suitable provisions to prevent any cable or wire from coming into contact with the discharge resistor unit. Also note the nistructions and caution described in 4-5 for safe use of the unit.

3-2 Servo motor

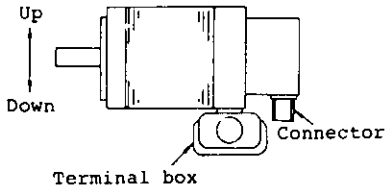
(1) Do not install the servo motor to direct sunlight, high temperature and high humidity.

Environment

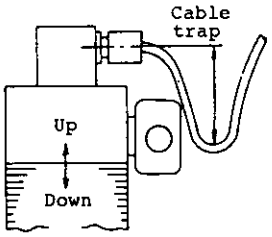
Ambient temperature		0 - 40°C (to be free from freezing)
Ambient humidity		80% RH or less (to be free from condensation)
Vibration	1.5kW or less	X: 9.8m/s^2 Y: 24.5m/s^2
	2, 3.5kW	X: 19.6m/s^2 Y: 49m/s^2
	5, 7kW	X: 11.7m/s^2 Y: 29.4m/s^2



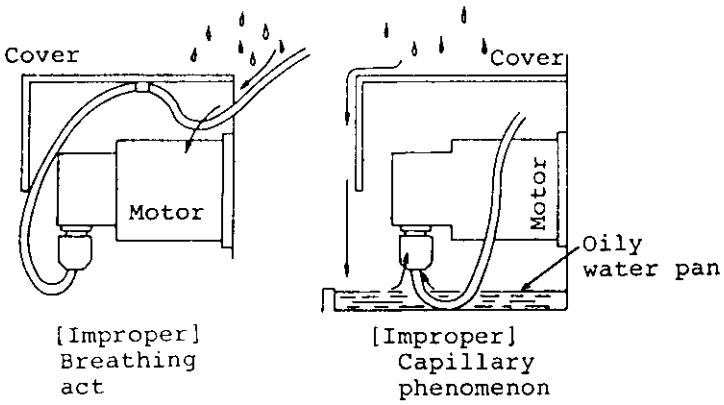
(2) If the servo motor may be exposed to water or oil, protect the motor with a cover or other suitable means and install the motor with the leads directed downward so that water or oil cannot run into the motor along the leads (see the figure).



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



(4) 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.



(5) 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.

(6) 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 chipps, torn with the corner or the machine or stepped on by man or cart.

(7) 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-measure 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.

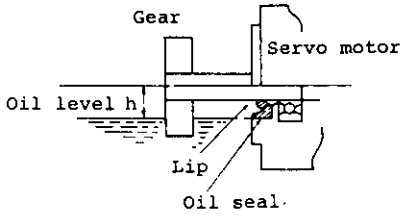
② The motor provided with electromagnetic brake is also horizontally mounted, and the spindle can be faced upward or downward as desired.
When it is faced upward, vibration of the brake plate may result in sounding. But it is not an abnormality.

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.

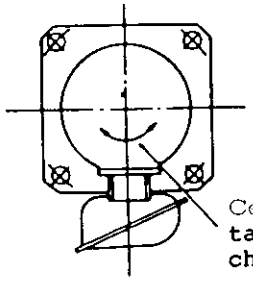
④ When the motor is horizontally mounted, always keep the oil level lower than the oil seal ripple of the servo motor shaft, and provide the air breather port on the gear box to prevent the inner pressure from rising.
If it is higher than the oil seal ripple, oil may enter the motor.

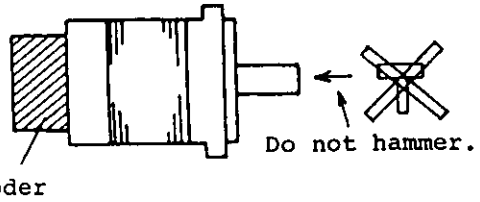
Model	Stand-ard	HA-SA22 HA-SA33	-	HA-SA52,53 to HA-SA 152, 153	HA-SA202 to HA-SA702	-
	Low inertia	-	-	HA-SA52L HA-SA152L	HA-SA202L HA-SA302L	HA-SA502L HA-702L
	Pancake	-	HA-SA32U HA-SA52U	HA-SA102U to HA-SA302U	-	HA-SA502U
Height from the motor shaft center h (mm)		11	15	20	25	30

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



(8) 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.



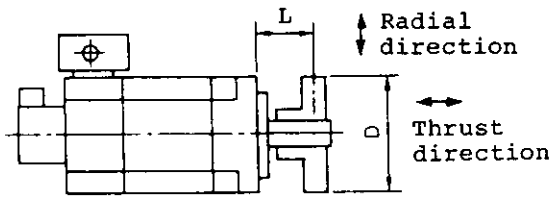


(9) For connection of the motor shaft to a machine shaft, it is recommended to use a "flexible coupling" which can automatically adjust misalignment of two shafts. When the motor is secured in position, be sure to align its shaft with the shaft of the associated machine. Upon periodic inspection, check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

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

Series	Motor	Permissive radial load	Permissive thrust load
Standard	HA-SA22, 33	L=25 196N	147N
	HA-SA52, 53(T) to HA-SA152, 153(T)	L=55 980N (L=58 390N	490N
	HA-SA202 to HA-SA702	L=79 2060N	980N
Pancake	HA-SA32U HA-SA52U	L=35 294N	196N
	HA-SA102U HA-SA202U	L=55 637N	490N
	HA-SA302U	L=65 980N	590N
	HA-SA502U	L=79 2060N	980N
Low inertia	HA-SA52L to HA-SA152L	L=55 980N	490N
	HA-SA202L HA-SA302L	L=79 2060N	980N
	HA-SA502L HA-SA702L	L=85 2450N	980N

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.

(11) The servo motor shaft is not provided with key groove. For connection of the motor shaft with a machine shaft, use a coupling requiring no key.

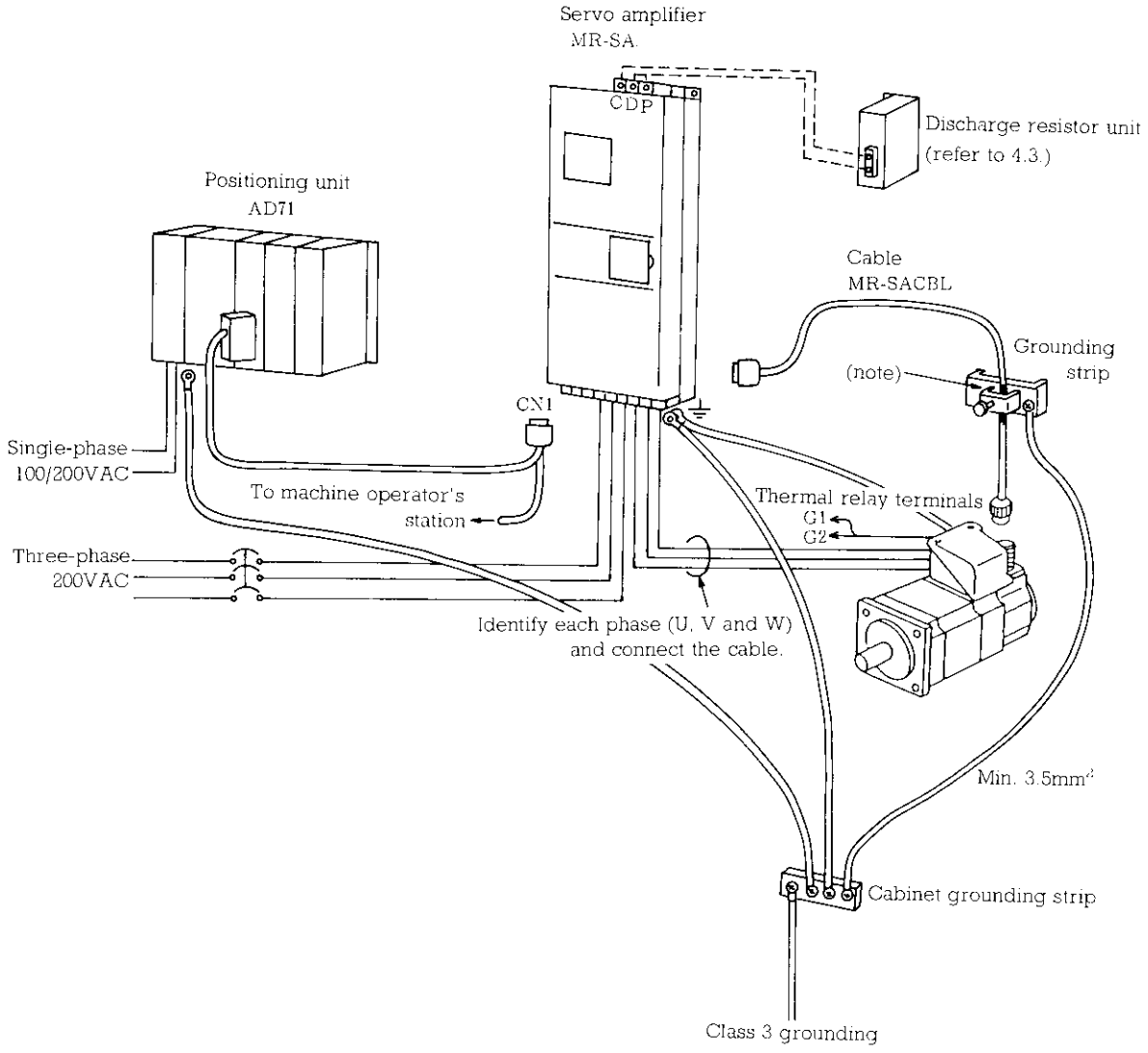
4. EXTERNAL WIRING

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. It is recommended for protection against interference that the shielding of motor position detector cable is grounded with a grounding plate (refer to 4-8(5)).

2. The signal cables should be run away from the power (high-voltage) cables.

4-2 Standard wiring diagram

(1) Example of connection to positioning control unit AD71

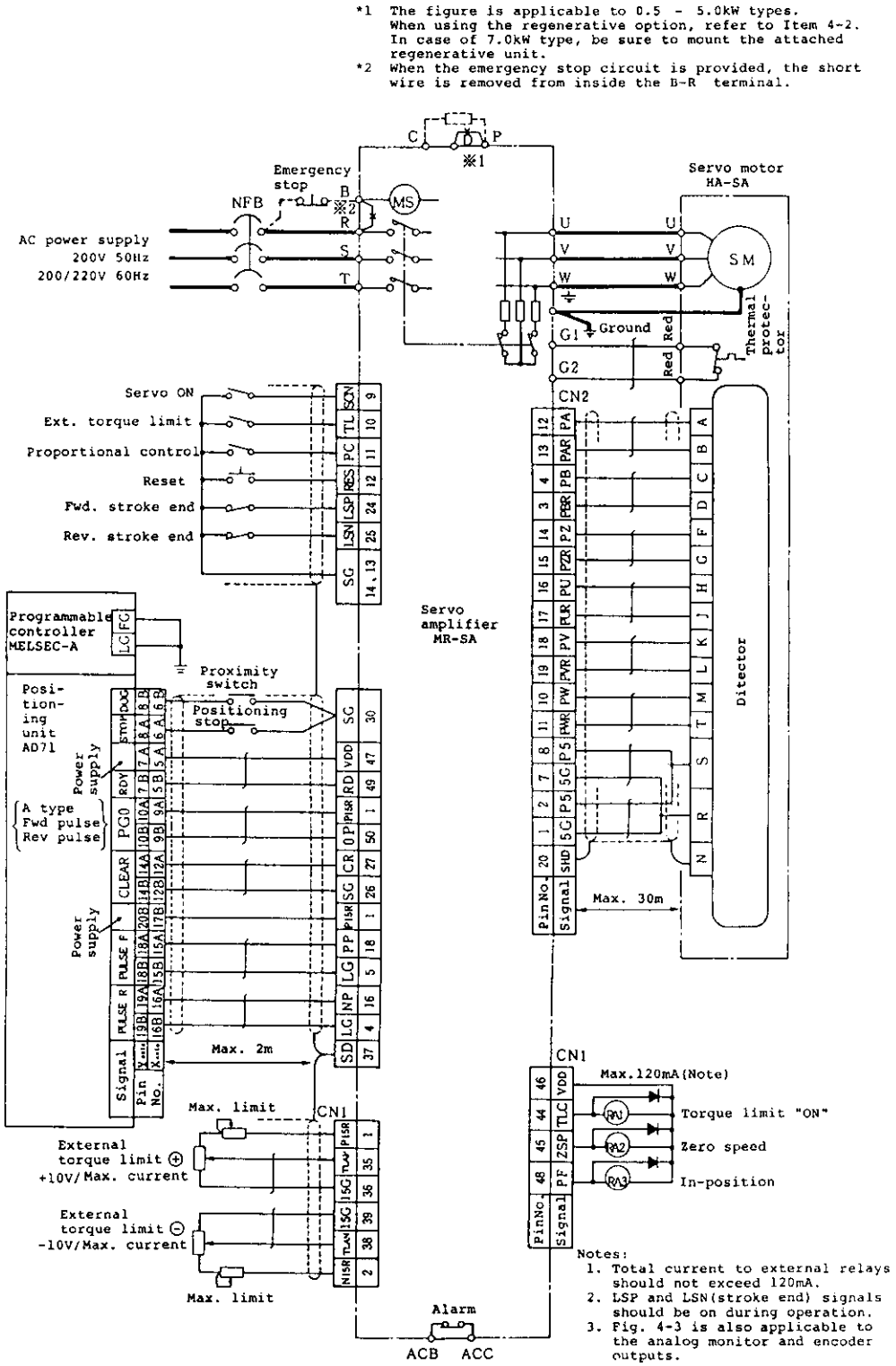


Fig. 4-1 Example of connection to positioning control unit AD71

(2) Example of connection to positioning control unit MR-P0

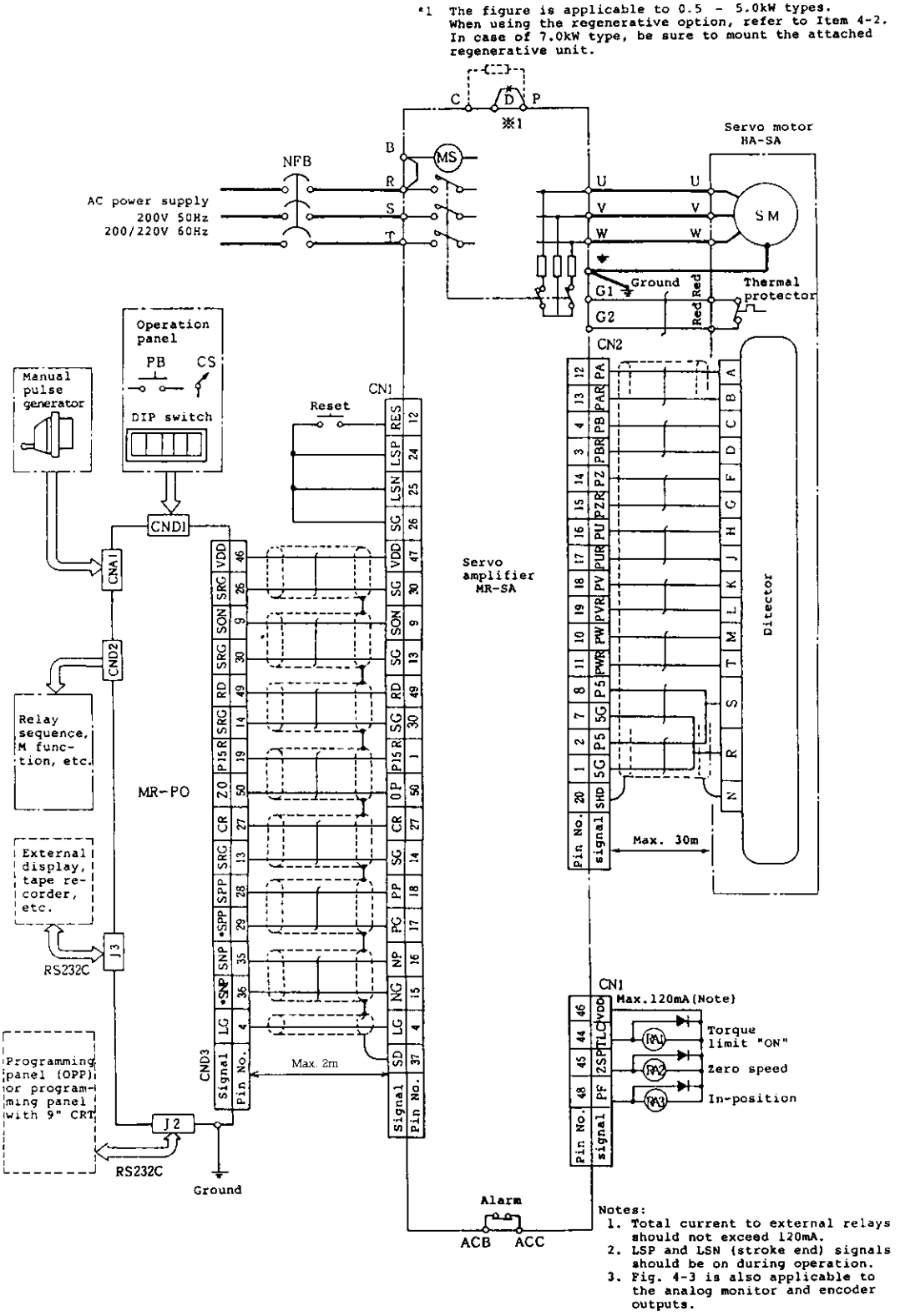


Fig. 4-2 Example of connection to positioning control unit MR-P0

(3) Connection for speed control

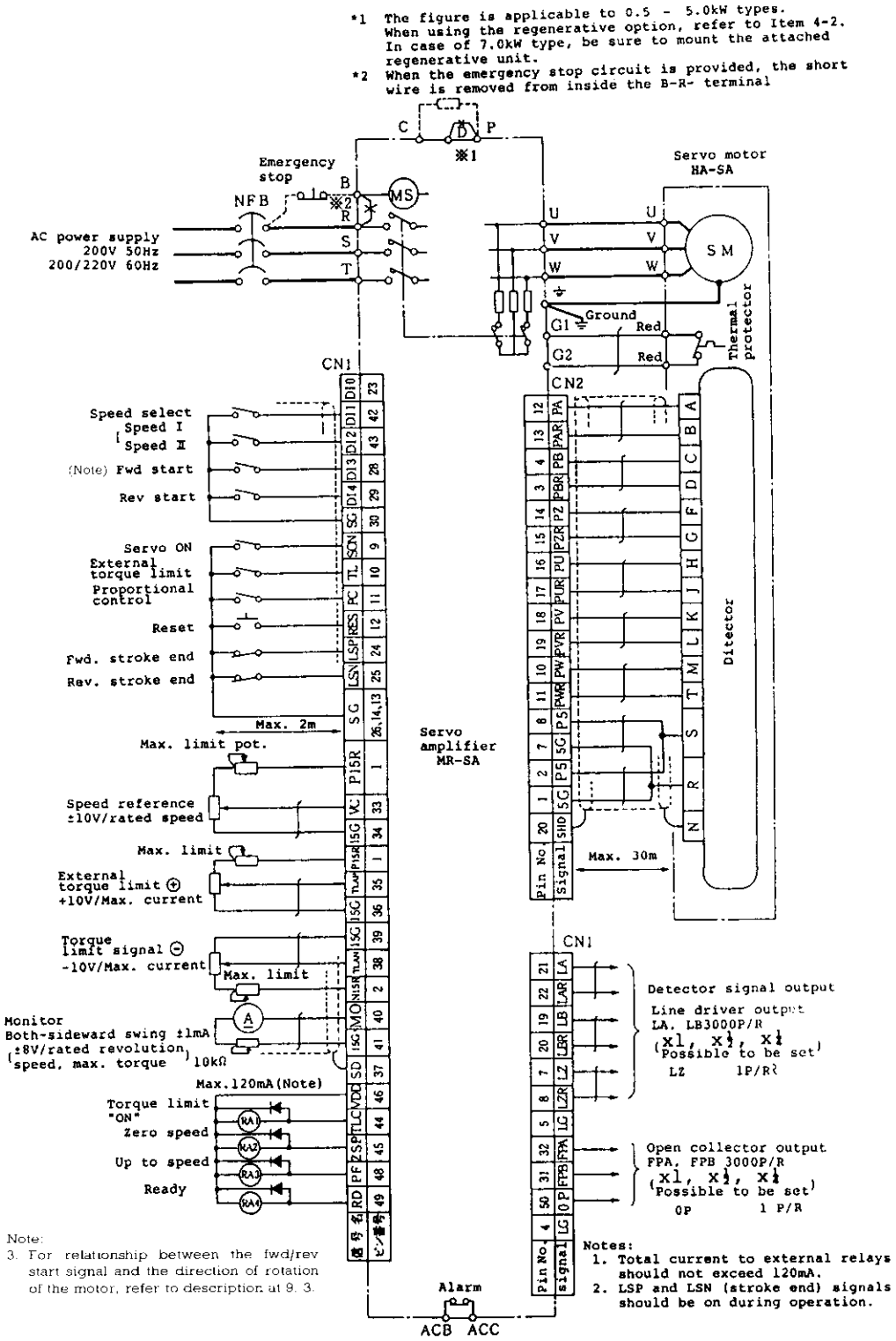


Fig. 4-3 Example of connection for speed control

(4) Connection for torque control

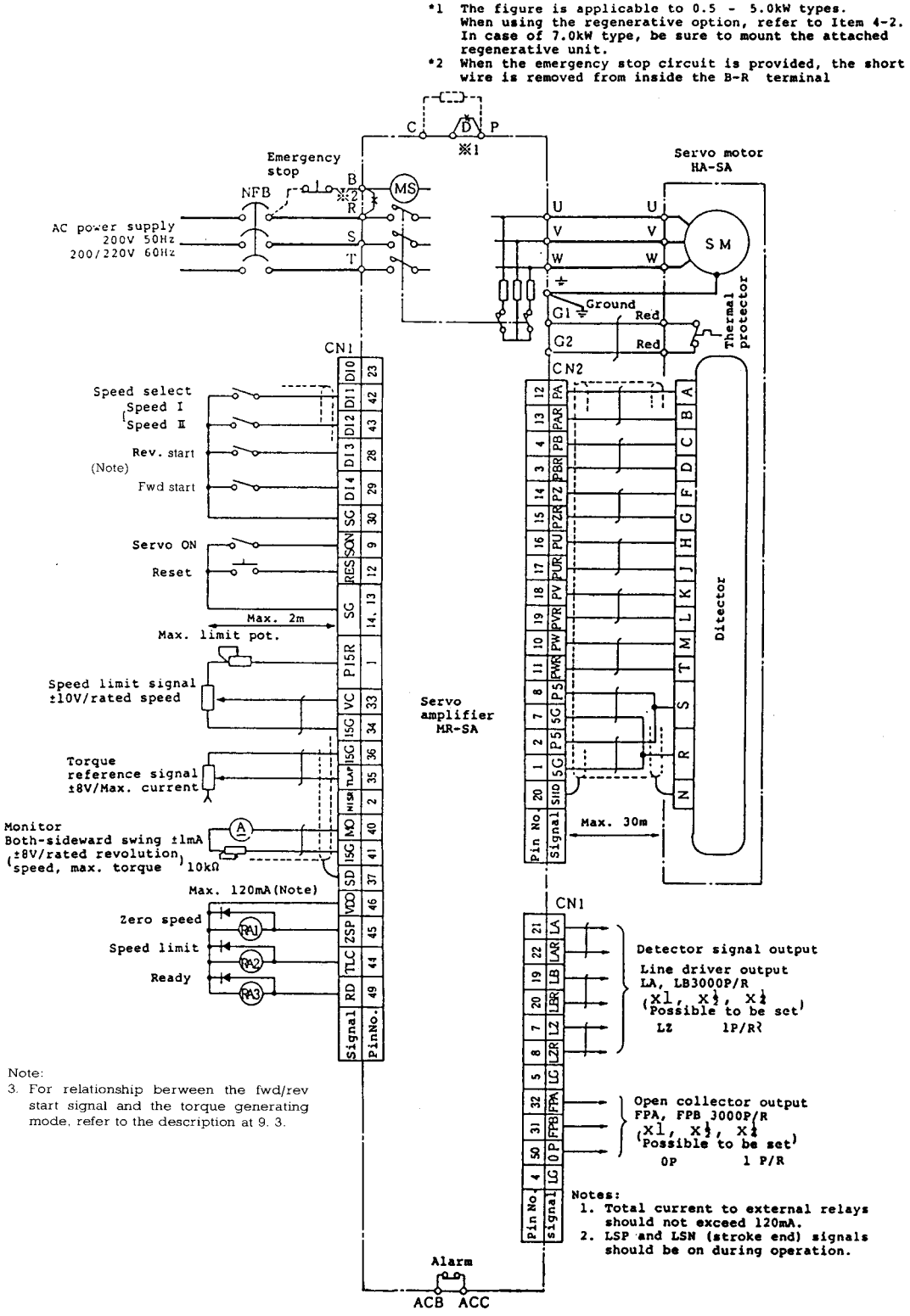
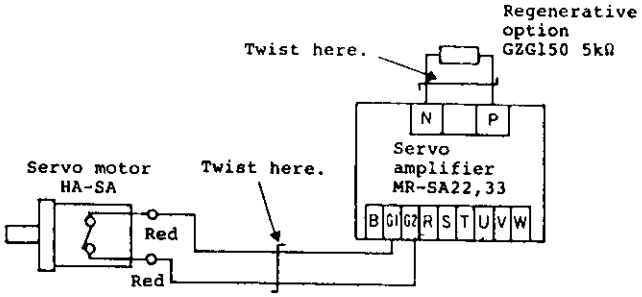


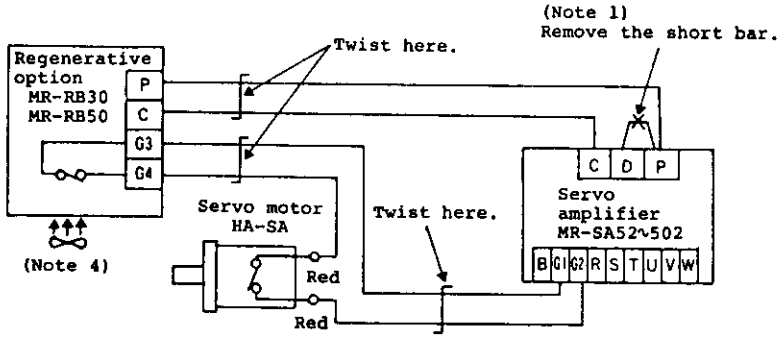
Fig. 4-4 Example of connection for torque control

4-3 Connection of regenerative unit

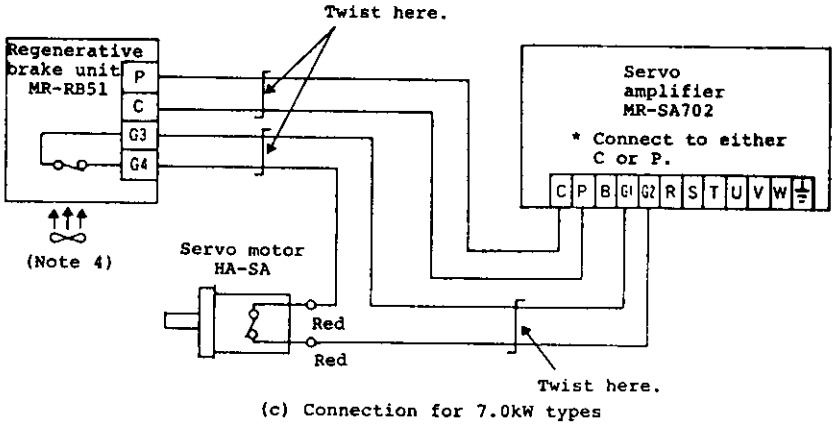
When the regeneration frequency is high and the regenerative unit is used, it is wired as shown below. Since the external mount type regenerative unit is standard in case of 7.0kW type, be sure to connect the unit.



(a) Connection for 0.2 and 0.3kW types



(b) Connection for 0.5 to 5.0kW types



(c) Connection for 7.0kW types

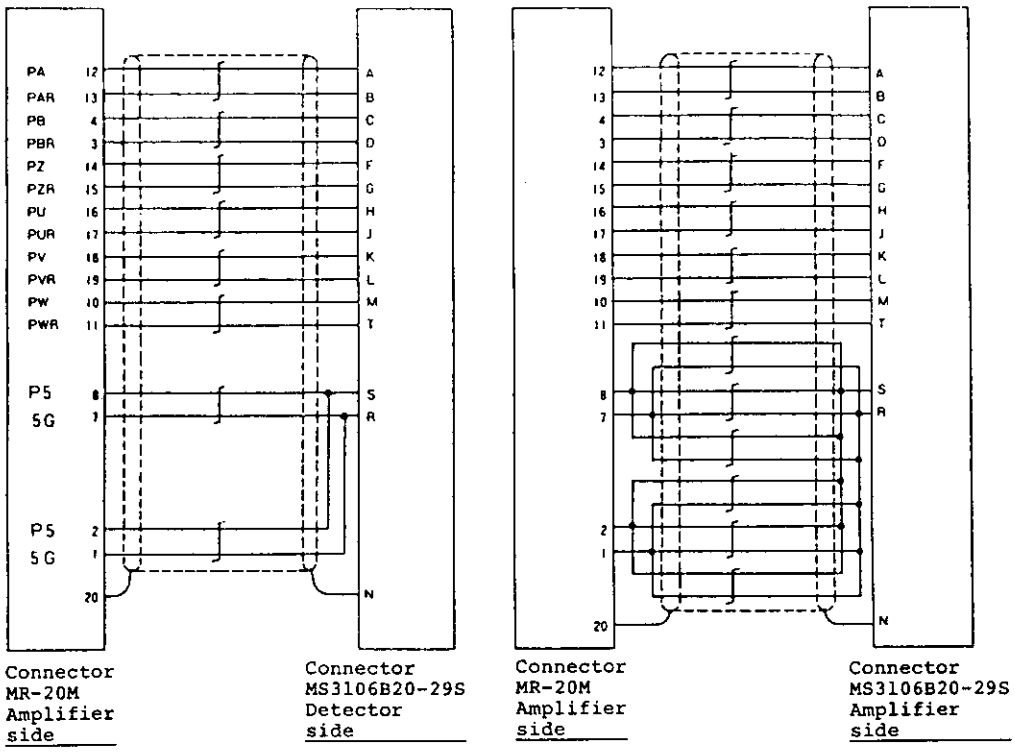
Fig. 4-5 Connection for regenerative unit

Cautions for operations

1. When the regenerative option is used, be sure to remove the short-bar (D to P) of the servo amplifier (in case of 0.3 to 5.0kW types).
   When operated with the short bar attached, the amplifier may be broken.
2. After the regenerative option is wired, be sure to twist the cables. Make the cables the shortest possible (5m or less).
3. Be sure to use the twisted cables for wiring the temperature detector. Prevent malfunction caused by inductive noise.
4. When MR-RB50 or MR-RB51 is used, it must be forcibly cooled down with the cooling fan (3.5m/sec 92mm square size).
5. Since the main body itself of the regenerative option generates heat, don't mount it directly on the wall surface which is weak against heat.
6. The cables or wires should be those having nonflammable insulator or those protected with nonflammable means (such as silicone tube).
   The cables or wires should run away from the discharge resistor unit (option).
7. When a discharge resistor unit "MR-RB100" (for 0.5-5kW) or "MR-RB101" (for 7kW)(5 resistors) is used all 5 resistors should be connected in series.
   If they are connected in parallel or one or more resistors are not used, the amplifier may be damaged or the resistors may be burnt

4-4 PLG cable assembly

The cable connection between the motor PLG and the servo amplifier is shown below.
When ordering cable, please let us know the designation of cable assembly.



(a) MR-SACBL5M(5m)

(b) MR-SACBL10M～MR-SACBL30M(10m～30m)

Fig. 4-6 PLG cable wiring diagram

4-5 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.
If it is influenced by external noise, ground the LG terminal.

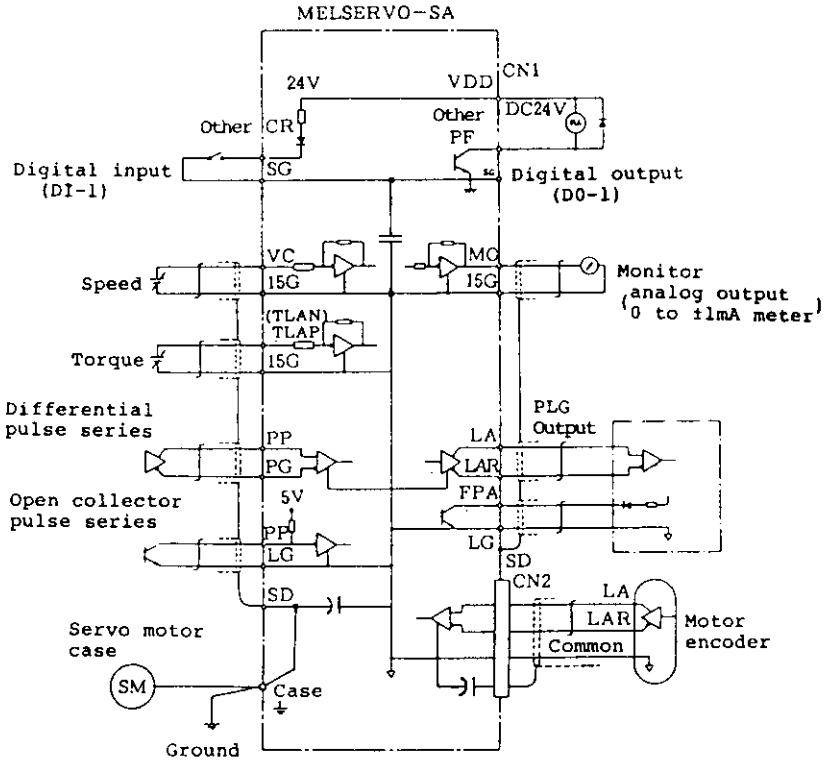


Fig. 4-7 Common line in the servo amplifier

4-6 Signal circuitry

(1) Power-up sequence

① Apply 3-phase AC power supply to the terminals R, S andTto make live the control circuitry.

It will take maximum 1sec. (usually 0.3 sec.) to initializethe servo amplifier.

② When "servo ON" (SON) signal turns on after the initialization, the internal contact (MC) closes, the dynamic brakecircuit opens and at the same time the main circuit is fed with thepower supply.

③ Whin "reset" (RES) signal turns on, the power transistorbase current is shut off and the motor coasts(the dynamicbrake remains turned off).

④ When "servo on" signal is turned off, the contact (MC) opens and the dynamic brake is activated.

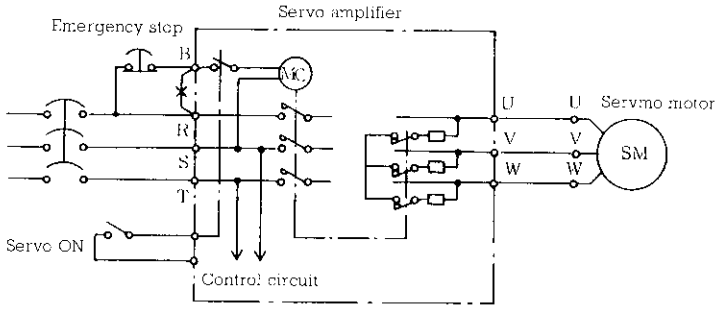


Fig. 4-8 Main circuit connection diagram

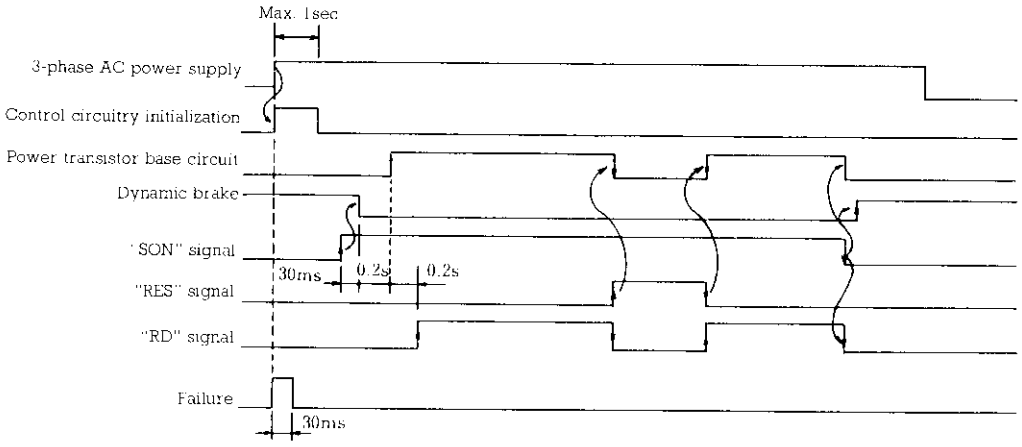


Fig. 4-9 Power-up timing chart

Note: "SON" signal should not be turned on and off frequently .... Allowable maximum on/off switching cycles are 50,000 (10-20 cycles/day or less).

To start and stop, use the dedicated external input signal.

(2) Emergency stop circuit

An external emergency stop button may be connected to the unit.To-connect, remone the internationa jumper bar from the terminals Band R (servo amplifier terminal block). (Refer to Fig. 4.8.)

When the external emergency stop button is pressed, the internal contact (MC) opens and the dynamic brake is activated stopping the motor.

In this cace, alarm "AL55" aries and "RD" output signal turns off.

Notes: 1. The emegency stop button should not be frequently operated.

2. The dynamic brake is in action only while the motor is running (the stopped motor is not held braked). If the dynamic brake is used to stop vertical motion, a magnetic brake shoukd be also used for prevention of descent in case of power failure.

(3) Timing chart in case of alarm

If the servo amplifier falls into alarm condition, the power transistor base current is shut off and the motor is stopped by the dynamic brake.

To remove the alarm condition, use "RES" signal ot turn the power off and then on ("overload" alarm cannot be reset with "RES" signal .... see 7.1).

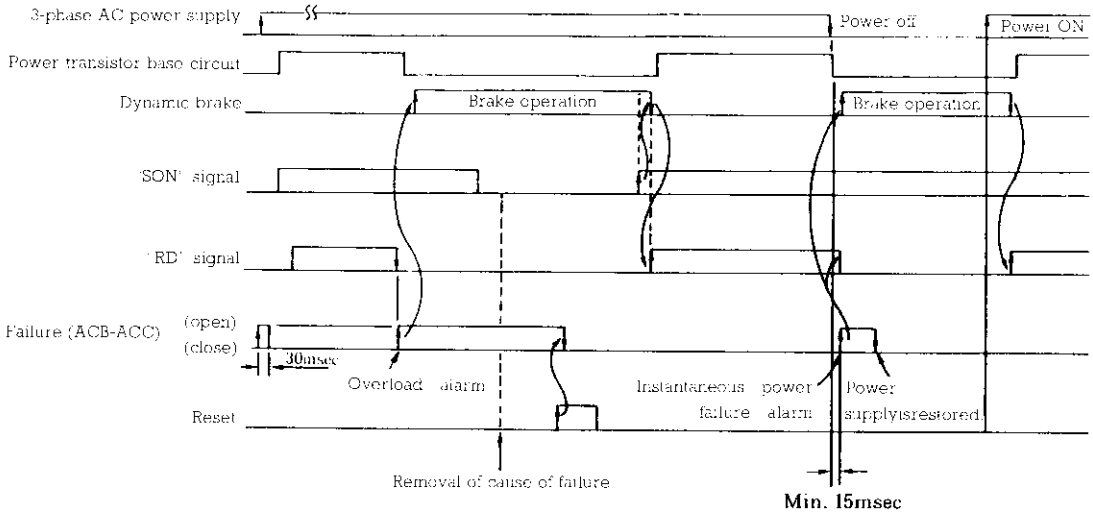


Fig. 4-10 Timing chart in case of alarm

IMPORTANT: 1. If the power is turned off and then on repeatedly to reset without removing the cause of alarm (overcurrent or overload), the heat rise may result in danage to semiconductor. Operation should be resumed in at least 30 min. after the cause of alarm is removed.

2. If the power is turned off and then on repeatedly to reset-regenerative overvoltage alarm (AL30), the discharge resistor may overheat and cause trouble.

3. If instantaneous power failure lasting for 15msec or longer occurs, the protective function becomes active. If the power failure further continues for 10msec (20 - 30msec.), the protective function is not held active (reset). If the power supply is restored, the servo amplifier is initialized. To prevent accident, "SON" signal should be turned off in case of instantaneous power failure.

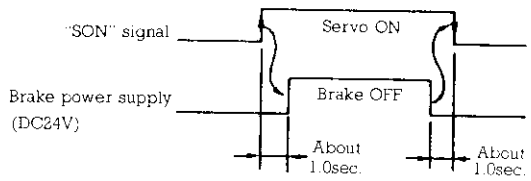
(4) Use of motor equipped with magnetic brake

If a magnetic brake is used as additional safety means (for prevention descent motion, or support of dynamic brake),pay attention to the following points:

① The brake is for safety and activated when the DC24V power supply turns off.

② The brake should be activated with "SON" signal turned off.

③ When the brake is used to prevent descent motion, a suitable time delay should be taken into consideration.



※Whin time delay cannot be provided at servo off ("SON" signal OFF), the brake power supply should be turned off at the same time as"SON"signal is turned off so that distance of descent motion is as minimum as possible.
Braking delay time .... AC off: Approx. 0.1sec.
DC off: Approx. 0.03sec

4-7 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. The reactor which improves the power factor can not be used. Because it may brake the amplifier.</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 rowspan="2">Model</th><th rowspan="2">No-fuse breaker</th><th colspan="5">Wire size mm²</th></tr>
<tr><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>MR-SA 22,32,33</td><td>NF30 type 10A</td><td>2</td><td>2</td><td>2</td><td></td><td></td></tr>
<tr><td>MR-SA 52, 53</td><td>NF30 type 10A</td><td>2</td><td>2</td><td>2</td><td rowspan="8">1.25</td><td rowspan="8">1.25</td></tr>
<tr><td>MR-SA 102, 103</td><td>NF30 type 15a</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>MR-SA 152, 153</td><td>NF30 type 15A</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>MR-SA 202, 203</td><td>NF30 type 20A</td><td>3.5</td><td>3.5</td><td>2</td></tr>
<tr><td>MR-SA 302, 352</td><td>NF30 type 30A</td><td>5.5</td><td>5.5</td><td>2</td></tr>
<tr><td>MR-SA 502</td><td>NF50 type 50A</td><td>5.5</td><td>5.5</td><td>3.5</td></tr>
<tr><td>MR-SA 702</td><td>NF100 type 75A</td><td>8</td><td>8</td><td>3.5</td></tr>
</table>
</td></tr>
</table>

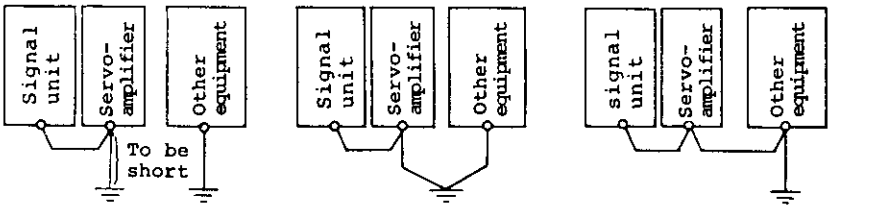
Continued on the next page.

	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 thermal protector is not used, short-circuit terminals G1 and G2. 5. Optional discharge resistor for regenerative brake. The regenerative option is differently connected depending on a model. Refer to Item 4-2. 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 4-2 for other cautionary points. ① 0.2 or 0.3kW ... Connect the exclusive option GZG150 5kOHM between P and N.

Continued on the next page.

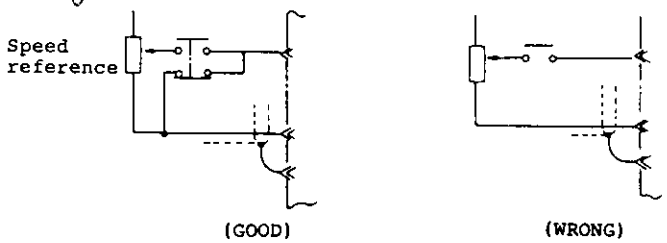
	Description
Wiring (cont'd)	② 0.5 to 5.0 kW ... Connect the exclusive option MR-RB30 or MR-RB50 between P and C. Be sure to remove the short bar from between D and P. ③ 7.0kW ..... Since it is standard, connect the attached MR-RB51 between P and C.
Dynamic brake	The dynamic brake circuit is integrated in the servo amplifier, but is sometimes impossible to use if the load inertia is large. (Special servo amplifier is necessary.) If the load inertia rate is 30 times or more for 2.0kW or less, 15 times or more for 3.0 and 3.5kW or 10 times or more for 5.0 and 7.0kW, contact your dealer or our representative.
Operation sequence	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, and that the brake operation does not last for over 1 sec. 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. Don't use the dynamic brake very frequently, or the parts will be deteriorated.

Continued on the next page.

	Description
Grounding	Round 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

(2) Control circuit

Table 4-2 Cautions for wiring (control circuit)

	Description
Protection against noises	Control signal lines should be protected from noises properly.
Signal circuits	1. Design external analog signal circuit (circuit for speed reference signal, torque reference signal, etc.) so that it remain close at all times to protect against inductive noises. 

Continued on the next page.

	Description
Signal circuits (cont'd)	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.

4-8 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 4-6, 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.

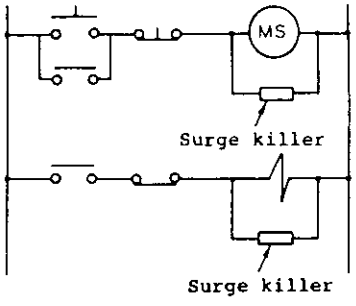
② If it is difficult to separate the signal cables from the power cables, route them with care to prevent them from running parallel.

(4) Surge killer

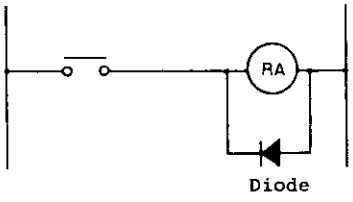
① Surge killer mounting

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. 4-11 and 4-12 show the mounting examples of the surge killers.

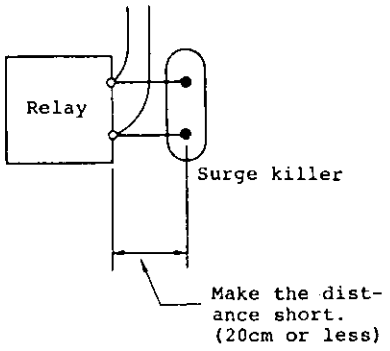


(a) Mounting on the AC relay, AC valve, etc.

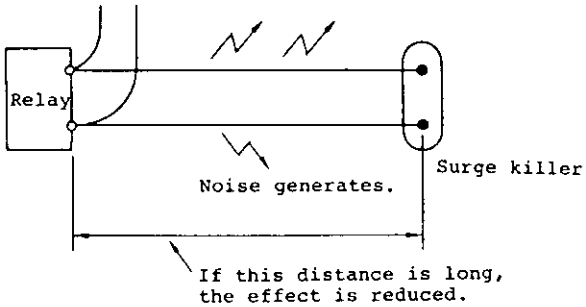


(b) Mounting on the DC relay, etc.

Fig. 4-11 Surge killer mounting diagram



(a) Proper example



(b) Improper example

Fig. 4-12 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. 4-12.

(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. 4-13 and 4-14.

[Example 1]
Normal shield

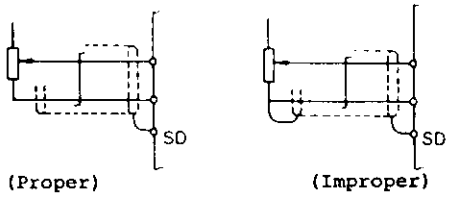


Fig. 4-13 Connection I of shield sheath

[Example 2]
Junction of shield cable

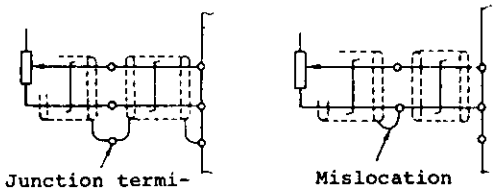
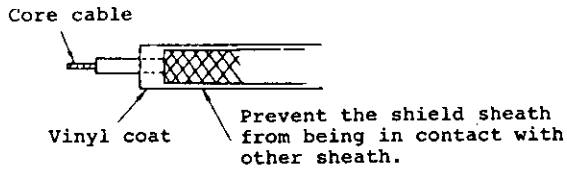
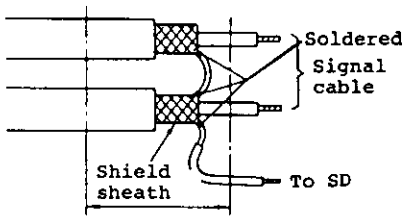


Fig. 4-14 Connection II of shield sheath

② Shield sheath processing



(a) Processing on the release side



(b) Process on the terminal SD side

Fig. 4-15 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.
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.

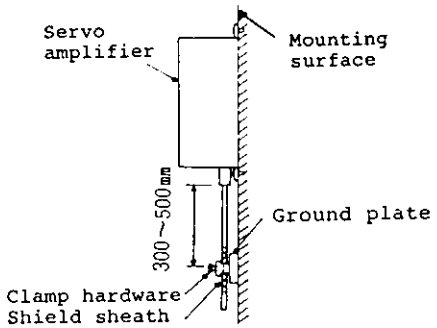
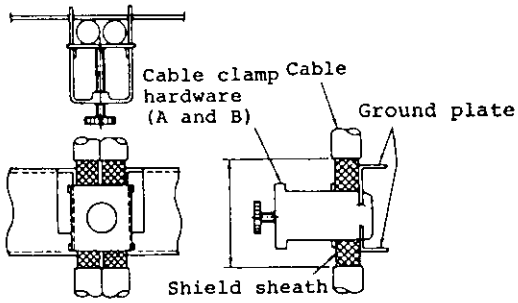


Fig. 4-16 Shield sheath connection



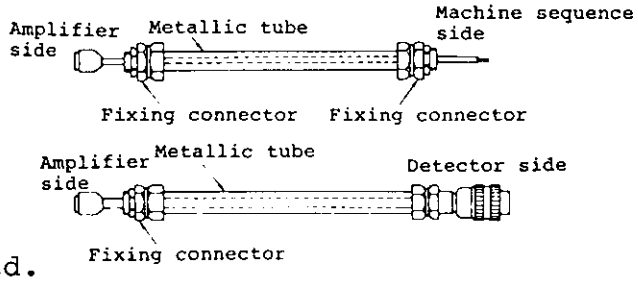
Clamped area outline

(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 countermeasure 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.

4-9 Configuration of input/output terminals

(1) Servo motor

The configuration of servo motor terminal box is shown below.
Referring to the figure, connect the cable to the motor terminals correctly.
Before connection, be sure to identify each motor lead and servo amplifier output terminal for phase (U, V and W) and assure correct phase sequence.

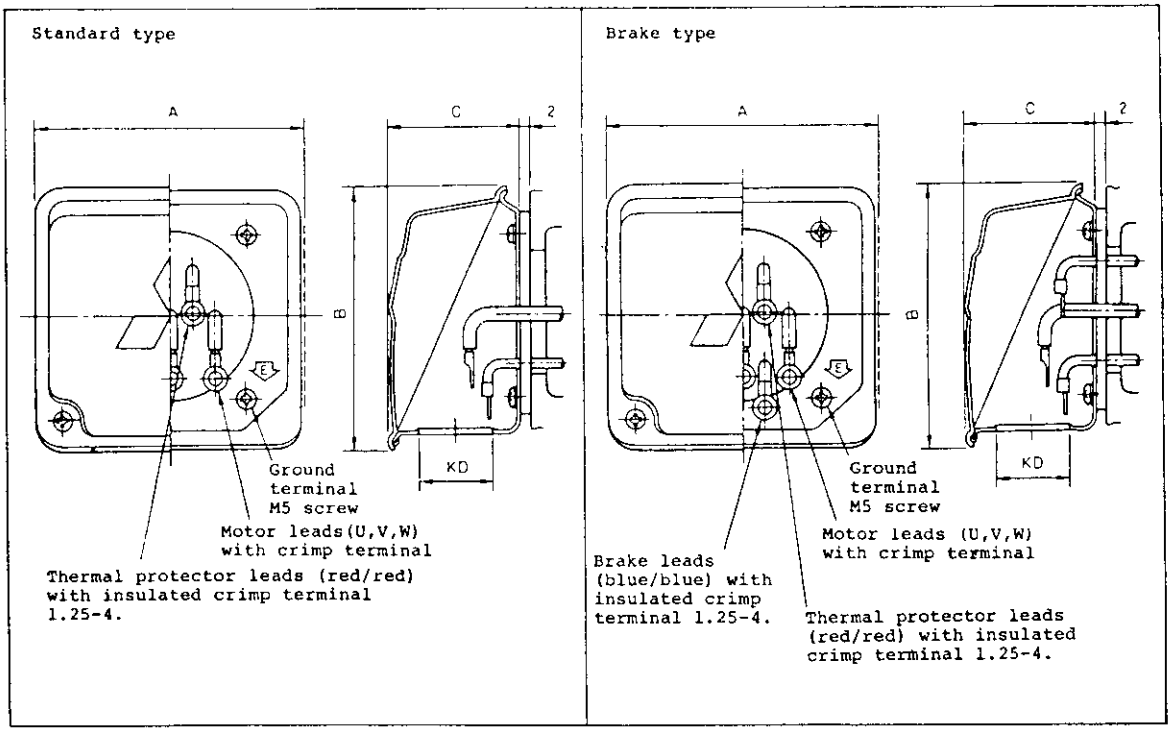


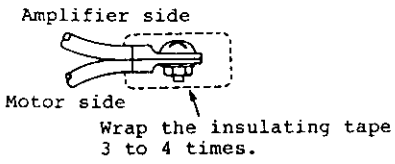
Fig. 4-17 Detail of motor terminal box

Table 4-3 Dimensions of motor terminal box

Model	A	B	C	KD	Power lead terminal size
HA-SA52(B), 53 to HA-SA352(B)	80	78	40	22	M4
HA-SA502(B)	93	104	48	27	M6
HA-SA702(B)	131	144	78	35	M6

Note:

1. For terminal connection, use the bolts shown above and connect the terminal as shown below.
   Wrap insulating tape on the connected area 3 to 4 times for sufficient insulation. When storing the terminal in the terminal box, take care to prevent injuring the insulated area.



2. Be sure to connect the cable to the ground terminal in the control box. Connect to the ground terminal of the servo for grounding through the ground plate in the control box.
   Refer to Items 4-1 and 4-7.
3. No terminal box is provided for HA-SA22(B) and 33. The power cable lead cables are of a direct connection type.
4. The DC24V power supply (15W or more for 1.5kW or less motor and 25W or more for 2.0kW or more) shall be procured for the brake lead cables of the electromagnetic braked motor by the user.
   The driver power supply VDD (DC24V) of the servo amplifier can not be used commonly.

(2) Servo amplifier

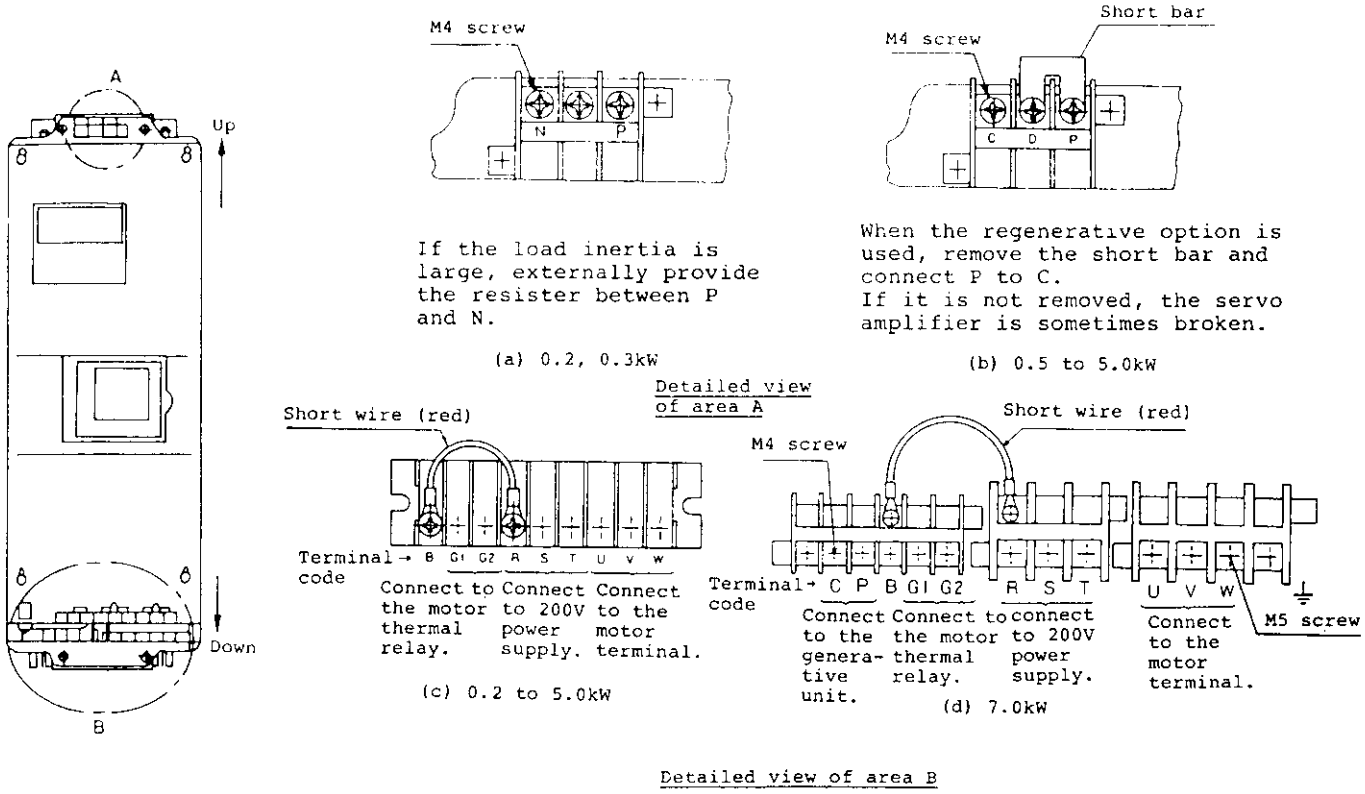


Fig. 4-18 Main circuit terminals of servo amplifier

(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-50F, MR-50L, 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	DI2	DI1	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	DI4	DI3	CR	SG	LSN	LSP	DI0	LAR	LA	LBR	LB		
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	PC	TL	SON	LZR	LZ	SD	LG	LG		N15R	P15R

Pin No.
Signal name

② CN2 (Connector for PLG signals)

Model: MR-20M, MR-20L
HONDA

14	15	16	17	18	19	20
PZ	PZR	PU	PUR	PV	PVR	SHD

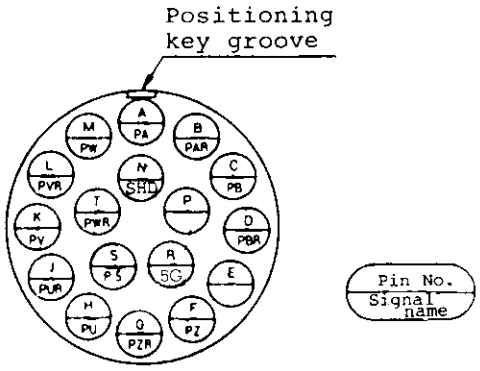
8	9	10	11	12	13
P5		PW	PWR	PA	PAR

1	2	3	4	5	6	7
5G	P5	PBR	PB			5G

Pin No.
Signal name

③ PLG connector: Motor side

Model: MS3106B20-29S
MS3108B20-29S



(c)

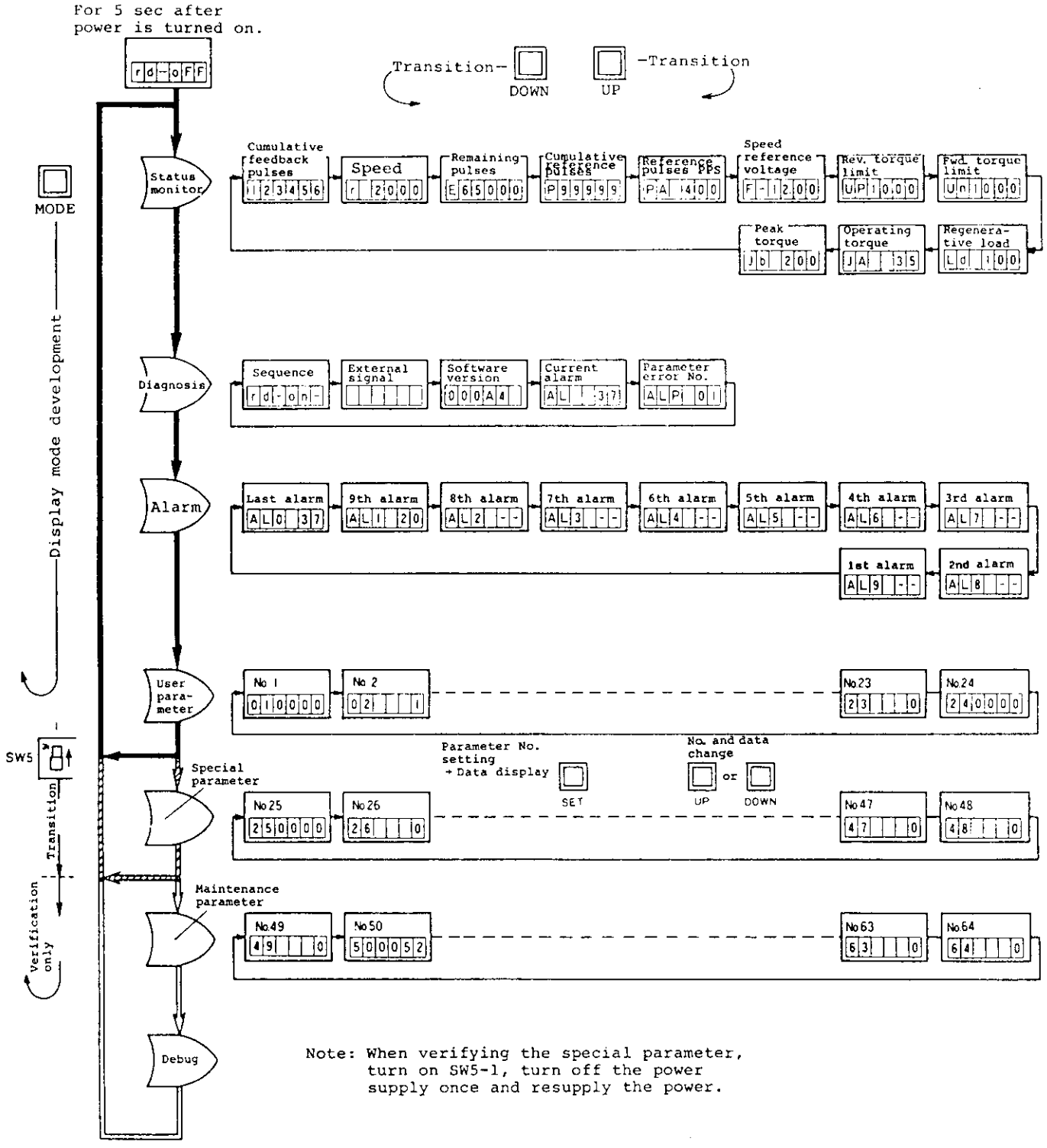
Fig. 4-19 Connector pin arrangement

5. PUSHBUTTON SWITCH OPERATION

5-1 Display descripion

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".

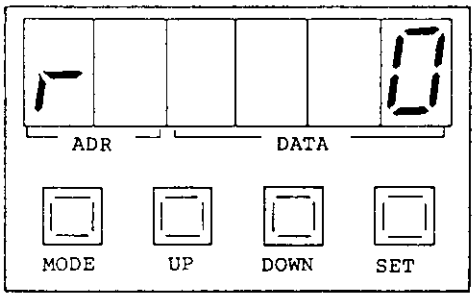
Fig. 5-1 shows the display mode development. For details, refer to 10-1 and thereafter.



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".



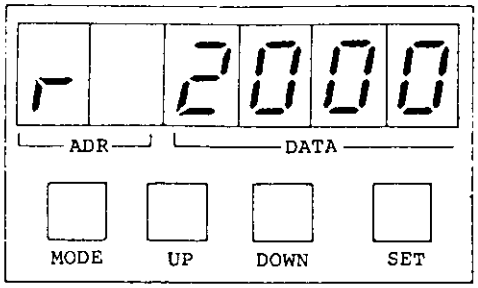
When "DOWN" button is pressed, display mode changes in the order from the right to the left in Fig. 5-1.
Display mode can be changed step by step from the top to the bottom by pressing "MODE" button.
When this button is pressed first after the power is turned on, "diagnosis" mode is selected. Successive 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 7 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][1][0][0][0][0] (parameter No.1, data 0000... initial setting) will appear.

By pressing "UP" button, "ADR" (parameter No.) of readout can be changed from 01 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.

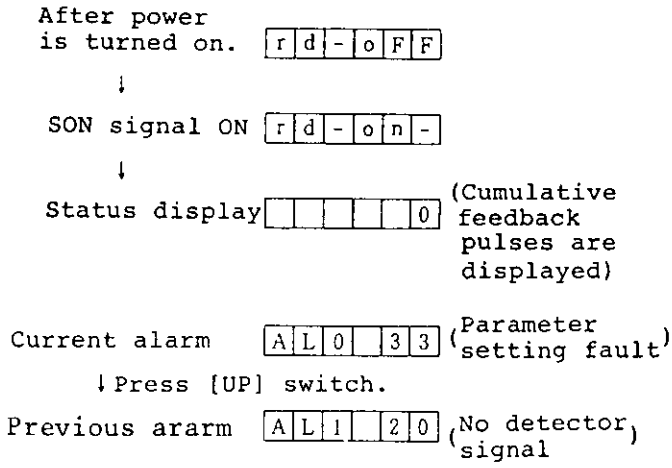
Press "SET" button and display in "ADR" section flickers.

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.1" (servo loop type) 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

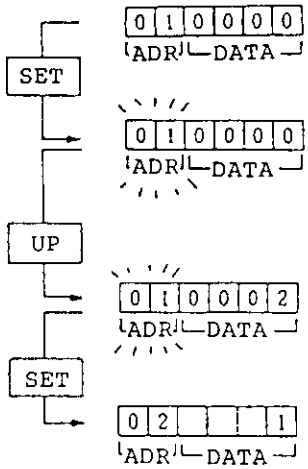
Press "MODE" button to call "operation status" mode and then pressure "UP" or "DOWN" button to select desired variable.

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.

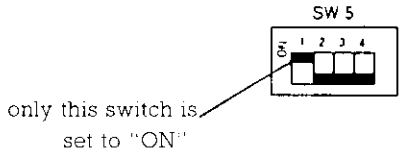
   ◦ Press "UP" or "DOWN" button to set [02] for "DATA".
   ◦ Press "SET" button and parameter No. [02] and its initial setting [1] are displayed.

3) Turn off the power and then on.

Setting example 2: Setting of special parameter

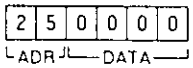
Encoder output division ratio (parameter No.39) is set to "2".

(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.

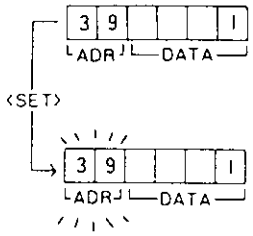
"Special parameter" mode is selected.



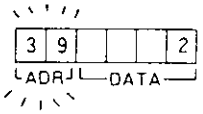
(3) Press "UP" switch to set [39] for parameter No.
Press "SET" switch and [39] will flicker.

[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.

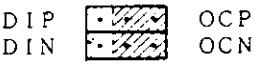
Note: In this example, it is assumed that the parameter setting is the initial setting. If the parameter setting is other than the initial setting, the changed value is displayed for "DATA" (same as for "Example 1").

5.3 Setting of jumper pins

Table 5.1 lists the jumper pins used in the servo amplifier.

Before starting operation, check setting of each jumper pin.

Table 5-1 Jumper pin list

P.C. board	Pin	Initial setting	Function
RF81	DIP DIN	Not set	Set positioning pulse train input interface to differential type. 
	OCP OCN	Set Set	Set positioning pulse train input interface to open collector type. 
	SP	Set	Spare
RF08 (RF18)	ASY AD NSE EXR DO D1 CB TCE EMG	Set Set Set Set Not set Not set Not set Set Set	For setting by manufacturer

6. OPERATION PROCEDURE

6-1 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) Servo loop type (parameter No.1)

Parameter No.1 is initially set to "positioning control".
If the servo amplifier is used in other control mode, the initial setting must be changed.

(2) Reference pulse multiplication (parameter No.2, 3)

When the servo amplifier is used for positioning control or positioning/speed control, reference pulse multiplication should be set in accordance with associated machine specification or control unit specification.

① Set it so that fraction is not produced in amount of machine movement per reference pulse.

Setting example:

Reference pulse multiplication $(\frac{CMX}{CDV})$ can be determined from the following formula:

$$(\frac{CMX}{CDV}) = \Delta\ell \times \frac{12000}{\Delta S}$$

When ΔS is 10mm and $\Delta\ell$ must be set to 0.001mm,

$$(\frac{CMX}{CDV}) = 0.001 \times \frac{12000}{10} = \frac{6}{5}$$

Consequently, set CMX to 6, and CDV to 5.
For range of parameter setting, refer to Table 6.6.

② Set multiplication to determine relationship between pulse frequency from control unit, and motor speed.

Setting example:

To run motor at 2000 rpm by using a position control unit AD71 and input pulse frequency of 100kpps,

$$f_0 \times \left(\frac{CMX}{CDV}\right) = \frac{12000 \times N_0}{60}$$

Since pulse frequency (f_0) and motor speed (N_0) are 100×10^3 (pps) and 2000 (r/min) respectively,

$$\left(\frac{CMX}{CDV}\right) = \frac{12000 \times 2000}{60} \times \frac{1}{100 \times 10^3} = \frac{4}{1}$$

Consequently set 4 for CMX, and 1 for CDV.

(3) 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. 4-5.

(4) 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. 4-5.

(5) 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.

6-2 Test operation

Perform test operation in accordance with the following procedure:

(1) Turning on the power

After making sure SON signal is off, 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 10.4. Change setting(s) if necessary (refer to 10-4, 10-5 and 10-6, 6-1).

(3) Turning on SON signal

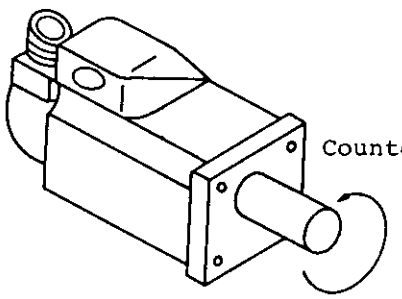
After parameter setting is completed, turn on SON signal.
When SON signal is turned on, the contactor in the servo amplifier closes and the motor is released from the dynamic brake.

(4) 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.



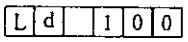
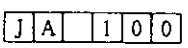
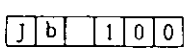
In the case of operation in torque control mode, the motor may run out of control if it is operated without load.
For safety, therefore, start the motor from low speed.

(6) Coupling of motor to machine

After test operation of the motor alone has been completed, 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 load condition

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

① Regenerative brake load ... Display: 
② Operating torque ..... Display: 
③ Peak torque ..... Display: 

In practice, it is recommended that these variables are at about 80%.
If any variable exceeds 100%, (I) lighten the load, (II) prolong acceleration time, or (III) decrease strat/stop frequency.
For details of readout display, refer to Sec. 10.

(8) TEST mode operation

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

THIS TEST OPERATION SHOULD NOT BE CONDUCTED WITH THE MOTOR COUPLED WITH A MACHINE.
OTHERWISE, DRIVEN COMPONENT OF MACHINE MIGHT HIT AGAINST OBJECT.

① Parameter setting

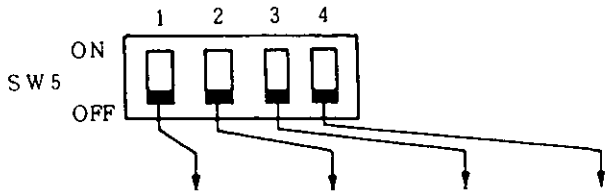
Set the parameter No.1 in the position control mode.

② Selection of TEST mode

Set a jumper pin to terminal "DO" of P.C. board (jumper pin set in terminal "SP" (spare) can be used for this purpose).

③ Operating pattern

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



SW ON	Servo ON	Run	2000 r/min	Rev run
SW OFF	Servo OFF	(Stop servo lock)	200 r/min	Fwd run

Note: After test operation is accomplished, be sure to set each switch to "OFF".

④ After the end of test mode operation, remove the jumper pin from DO, 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).

6-3 Optimizing the operating conditions

The servo amplifier is provided with various parameter settings.

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

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

Intense vibrations or noise occur if the servo again setting does not meet the moment of inertia of load.

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 1 Position control loop gain (param. 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 2 Speed control loop gain (param. No.6 VGN)

Moment of inertia of load J_L/J_M			0	1	3	5
Setting	Standard	0.2, 0.3kW	70	70	150	200
		0.5~7.0kW	100	100	200	300
	Low inertia	0.3~3.0kW	30	30	60	100
		5.0, 7.0Kw	50	50	100	150

table 3 Speed integral compensation (param. No.7 VIC)

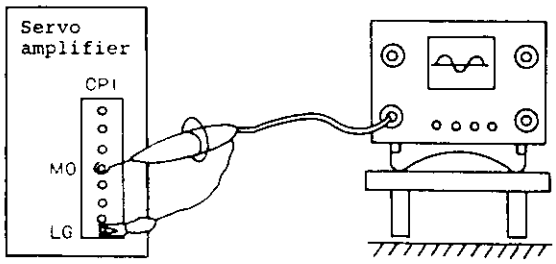
Moment of inertia of load J_L/J_M	0	1	3	5
Setting	20	20	30	40

② Parameter setting procedure

a. Observation of signal

A synchroscope is used to observe the speed control feedback signal on the check pins (see Table 8.3 and Fig. 8.1).

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.

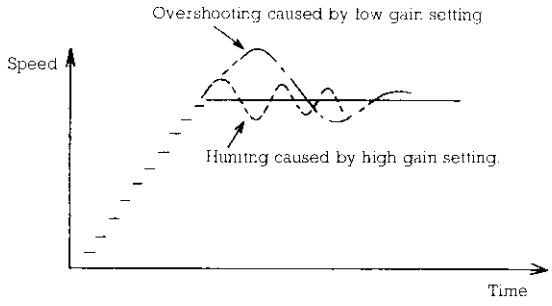


b. Setting of servo gain

① Set the PGN to a value lower than the standard value. Increase the VGN setting up to the poent 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.

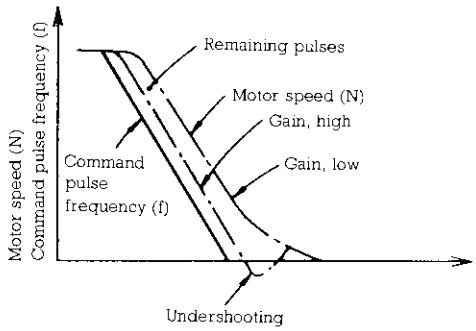


Note: When the speed control feedback signal (speed monitor) is observed with a synchroscope, the waveform will appear as discontinuous signal as shown to the right (short acceleration time).

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

The stop time constant may be decreased by increasing position control loop gain.

If the setting of the position control loop gain (PGN) is excessively high, overshooting or intense vibrations may occur.



(Ref.) Position control loop gain and remaining pulsessed 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 400Kpps, for example,

$$\varepsilon = \frac{400 \times 10^2}{6} \fallingdotseq 67 \times 13 \text{(pulses)}$$

Alarm (alarm 52) will occur if the remaining pulses are more than 65Kpulses.

In this case, Kp should be set so that the following condition is met:

$$\varepsilon = \frac{65 \times 10^3}{6} \fallingdotseq 67 \times 10^3 \text{(pulses)}$$

(3) If the motor runs while speed command is "0" during speed servo operation .....

This problem occurs when an external speed reference signal is used (does not occur when the internal speed reference command is used).

To stop the motor,

① set "VC offset (param, 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 - 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.
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. If the input power supply is frequently turned off and then on to reset the system in case of alarm (AL30), 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 countermeasure 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 (U, V and W) is lower than specified (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 momentary stop of 15msec or more occurs.	Check whether an momentary stop occurs or not. Observe the input voltage with the synchroscope.	
AL12	Card failure (ME1)	Card RF08 or RF18 is defective.	Replace the card RF08 or RF18 with a sound one to check.	Replace the defective card.
AL13	Card failure (CE)	Card RF08 or RF18 is defective.	Replace the card RF08 or RF18 with a sound one to check.	Repalce 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 RF08 or RF18 is defective.	Replace the card RF08 or RF18 with a sound one to check.	Replace the defective card.
AL15	Card failure (ME2)	1. Card RF08 or RF18 is defective.	Replace the card RF08 or RF18 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) (When power is supplied, the magnetic polarity of the motor is not detected properly. Improper detection of U, V and W.	1. The detector connector is disconnected.	Visually check 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. Check the detector feed-back signal. Turn the motor by hand, and observe the U, V and W of the check pin J4 on the circuit printed board with the synchro scope to check all are "H" or "L". (shake the cable for check.)	Correct or replace the cable. (Take care not to apply an external force to the cable)
		3. Motor detector is improper.	Check the detector feedback signal. (Same as above)	Replace the motor.
AL17	Card abnormality (A/D)	FOB is improper on the circuit printed board.	Replace the circuit printed board RF08.	Replace the circuit printed board.

Continued on 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. Check the detector connector for disconnection	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.
AL30	Regeneration abnormality (OR)	1. Parameter is improperly set.	Check the value set in the parameter. Parameter No.1 (STY) 00 □ □: Regenerative option is not provided. 01 □ □: Regenerative option MR-RB30 02 □ □: Regenerative option MR-RB50 MR-RB51	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 value on the state display Ld.	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.

Continued on the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL31	Overspeed (OS) (The motor revolution speed becomes 115% or more of the rated revolution speed.)	1. Overshoot results from excessively small acceleration/deceleration time constant.	1. Increase the acceleration/deceleration time constant. 2. Trially reduce the speed.	Recheck the acceleration/deceleration time constant.
		2. Oversoot results from the unstable servo system.	1. Trially adjust the servo gain. Trially increase (decrease) VGN. Trially increase VIC. Trially decrease PGN. 2. Check the load inertia rate. 3. Increase the acceleration/deceleration time constant. 4. Decrease the speed.	1. Reset the servo gain to the suitable value. 2. If the servo gain can not be set, 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 is improperly set.	Check whether the maintenance parameter No.50 (MTY) is as follows or not according to the motor rating. □□□ 2: 2000rpm series □□□ 3: 3000rpm series	Use the proper unit.
AL32	Overcurrent(OC) (More current than allowable flows in the base cable of the servo amplifier.)	1. U, V and W phase cables of servo amplifier output are short-circuited.	Using the tester, check U, V and W connection cables for short circuit.	Correct the wiring.
		2. 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.
		3. Breakage of servo amplifier transistor	Using the tester, measure the resistance between the transistor module terminals.	Replace the transistor module or unit.
		4. External noise	1. Investigate the peripheral device. (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 resistance countermeasure. (Refer to item 4-7.) Clean the circuit printed board off dirt.

Continued on the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL33	Overvoltage (OV) (The voltage on the base cable of the converter is 400V or more.)	1. Cable is improperly connected on the terminal block (TE2).	Connection when regenerative option is not provided. Connection when regenerative option is provided.	Connect cables properly.
		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 (TE2) (approx. 3 minute after the charge lamp goes out). Resistance between P ⊕ and C ⊖ is approx. 13Ω.	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. Trially reset the parameter.	1. Clean the card off dirt, and reset the parameter. 2. Replace the card and reset the parameter.

Continued on the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL45	Heat sink overheat (OHF) {The thermal protector on the cooling fin in the servo amplifier is activated.}	1. Continuous output current of the servo amplifier is excessive during operation.	1. Check the effective torque (JA state indicating value). 2. Measure the motor input current (Refer to Item 7-2). 3. Measure the temperature rise of the motor. 4. Trially reduce the load.	1. Reduce the load. 2. Increase the capacity.
		2. Positioning (regeneration) frequency is high.	1. Trially reduce the acceleration/deceleration frequency. 2. Reduce the speed.	Recheck the positioning (regeneration) frequency.
		3. Cooling is improper.	1. Check whether the cooling fan in the servo amplifier runs or not. 2. Check whether ventilation is blocked or not. 3. Check the internal temperature of the enclosed box. (0°C to +55°C)	Improve cooling.
		4. Hunting results becuase of unstable servo system.	Refer to the alarm code AL31-3.	
		5. Electromagnetic brake is activated during operation.	Check operation of the electromagnetic brake.	Improve the sequence.
		6. Thermal protector is improper.	Check whether it activates in the non-loaded state or not.	Replace the unit.
AL46	Motor overheat (OHM) {The thermal protector integrated in the motor or generative option is activated.}	1. The motor is overloaded.	Refer to the alarm code 45-1.	
		2. Cables are improperly connected on the terminal block (TE1).	Are the G1 and G2 on the thermal block (TE1) connected to the thermal protector terminals of the motor?	Connect the cables 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 over 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 AL45-4.	
		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 on the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL50	Overload 1 (OL 1) (Approx. 200% overload current flows continuously.)	1. Continuous output current of the servo amplifier is excessive during operation.	Refer to the alarm code AL45-1.	
		2. It collides with the machine.	1. Check whehter 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 AL45-4.	
		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 the cables properly.
		5. Detector signal is improper.	1. Trially replace the cable. 2. Trially replace the motor.	1. Replace the cable. 2. Replace the motor.
AL51	Overload 2 (OL 2) (Maximum current flows for several minutes.)	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 AL45-4.	
		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. Detector signal is improper.	Refer to the alarm code AL50-5.	
		5. The base cable voltage in the unit drops.	Is the charge lamp lit?	Replace the unit.

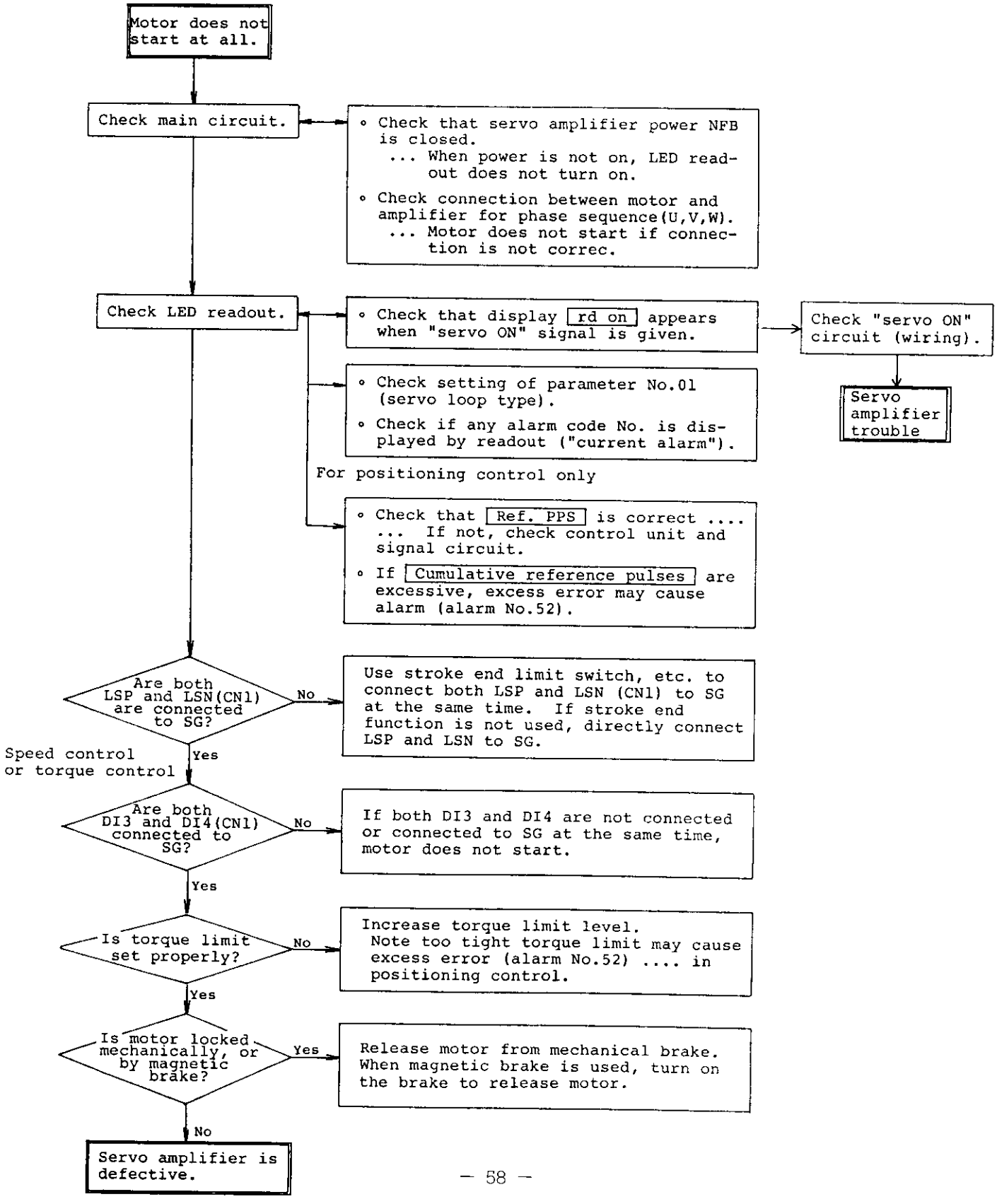
Continued on the next page.

Alarm code	Error/Alarm	Cause	Check	Remedy
AL52	Excessive error (EEX) (The number of residual pulses in the deviation counter exceeds 65K.)	1. Acceleration/ deceleration time constant is excessively short.	Trially increases the acceleration/deceleration time constant. (The acceleration/ deceleration time which can follow up the motor can be calculated through the formulas (4-10) and (4-11). 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 set at PGN.	Set the suitable value.
		4. Detector signal is improper.	Refer to the alarm code AL50-5.	
		5. The base cable voltage in the unit drops.	Refer to the alarm code AL51-5.	
AL55	Emergency stop (EMG) (Connection is opened between B and R terminals on the terminal block because of emergency stop or similar.)	1. The emergency stop circuit is activated.	Is connection opened between B and R terminals on the terminal block.	Restore the emergency stop circuit into the initial state, and reset the system.
		2. Contactor (MC) in the unit is contacted improperly.	1. Check continuity between the contactor contacts. 2. Is excessive impact applied to the servo amplifier?	Replace the unit.

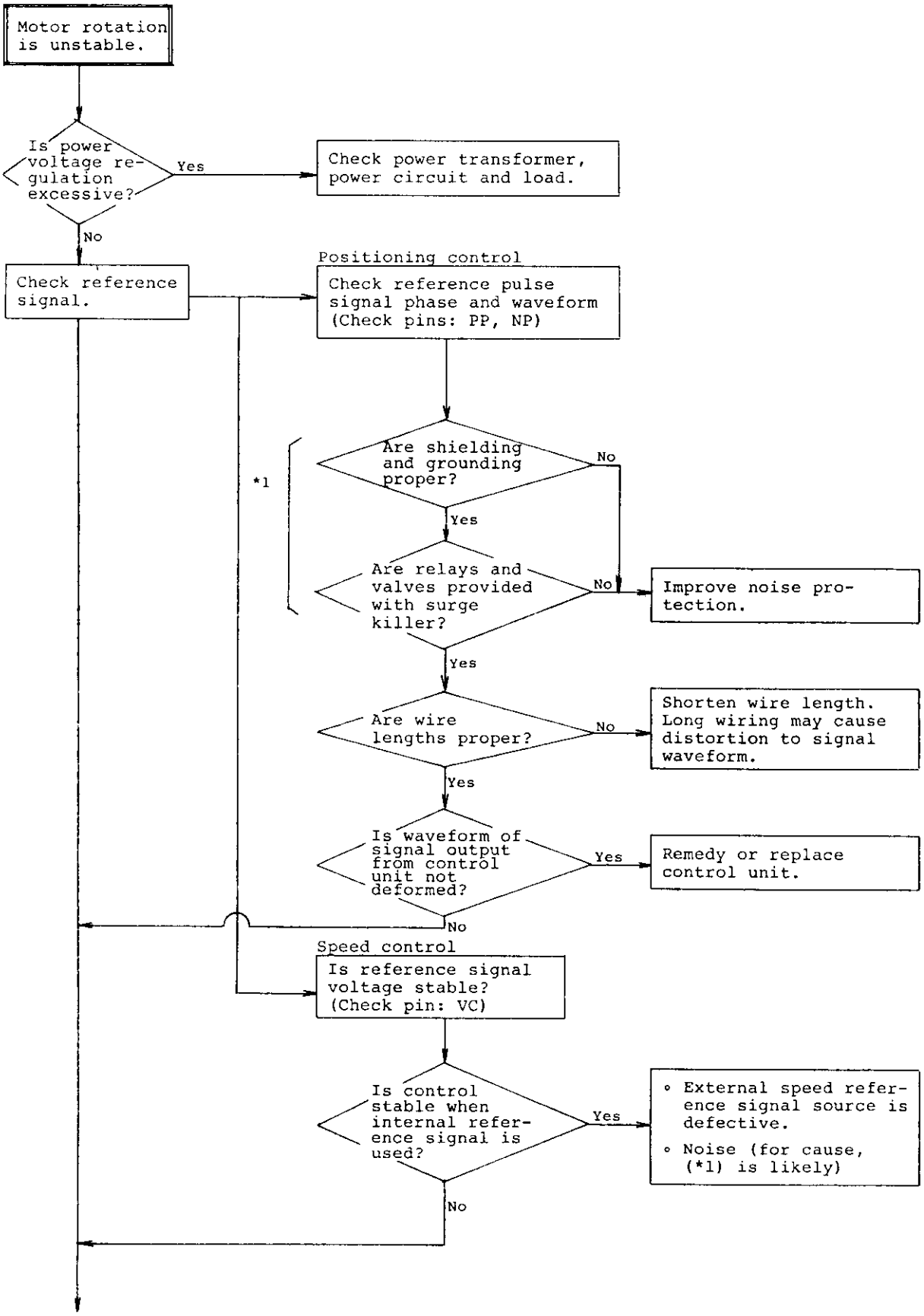
7-2 Troubleshooting

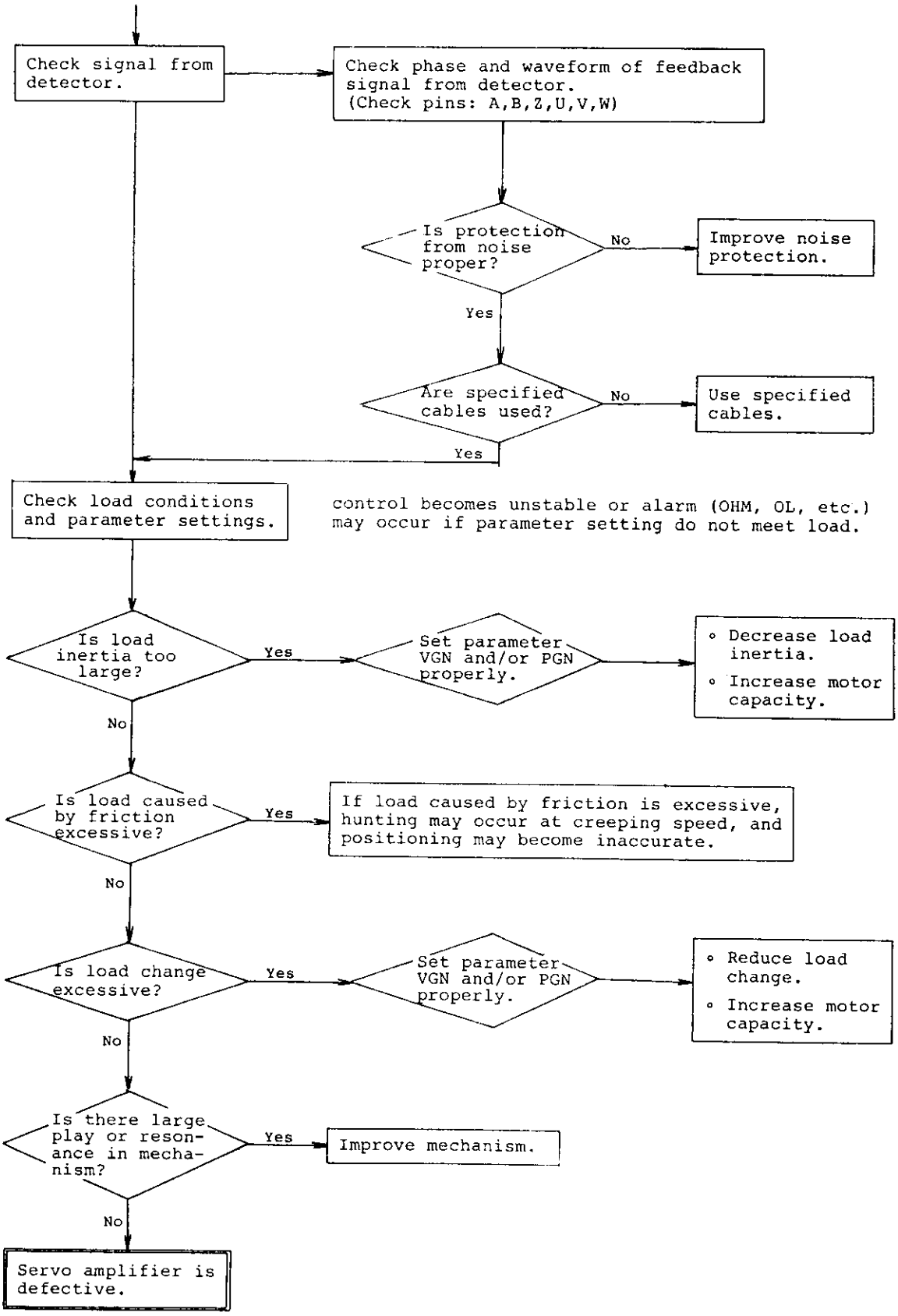
If trouble occurs with the servo motor or amplifier, find the cause and remedy in accordance with the following chart:

(1) Motor does not start.

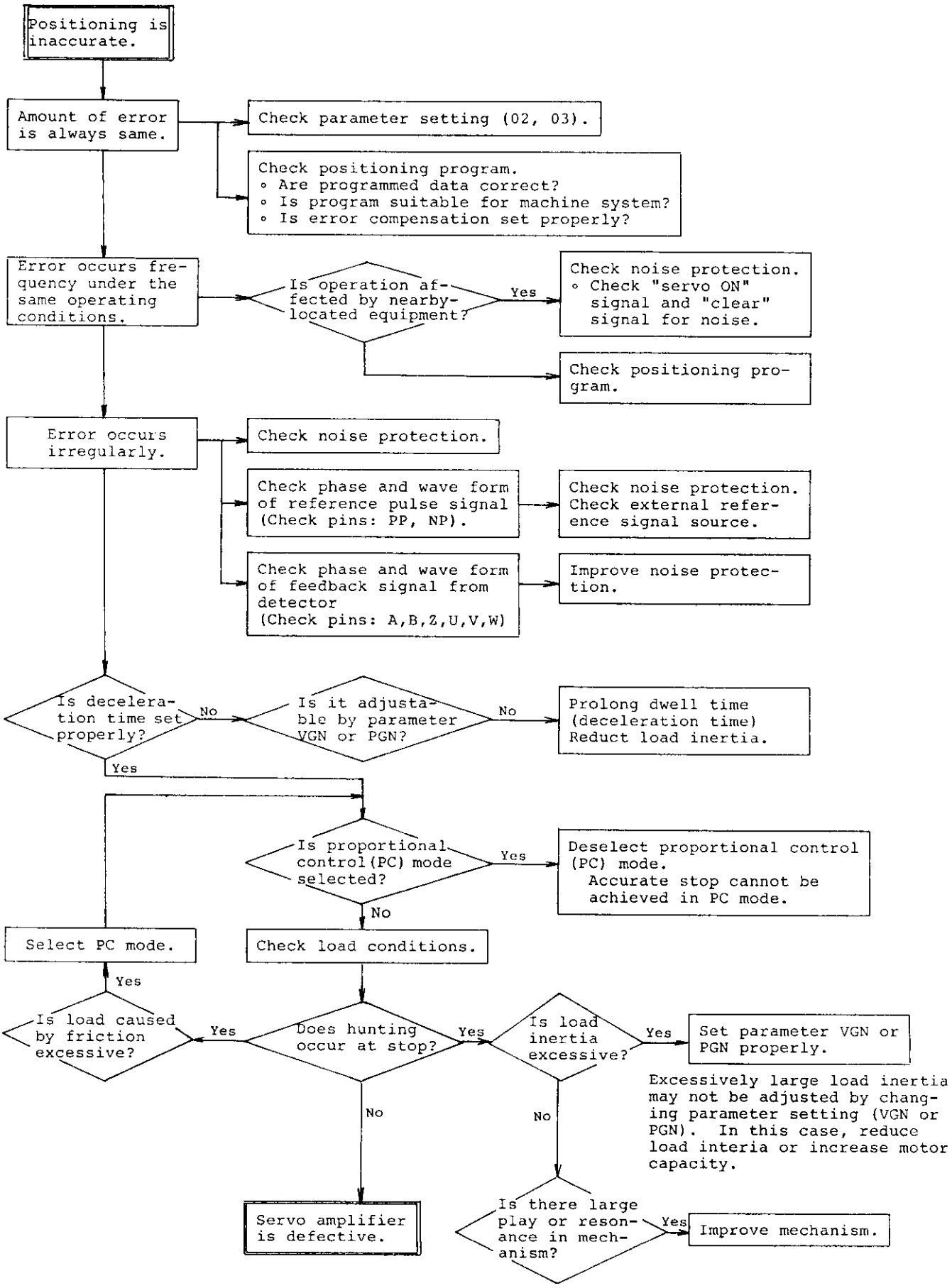


(2) Motor rotation is unstable.

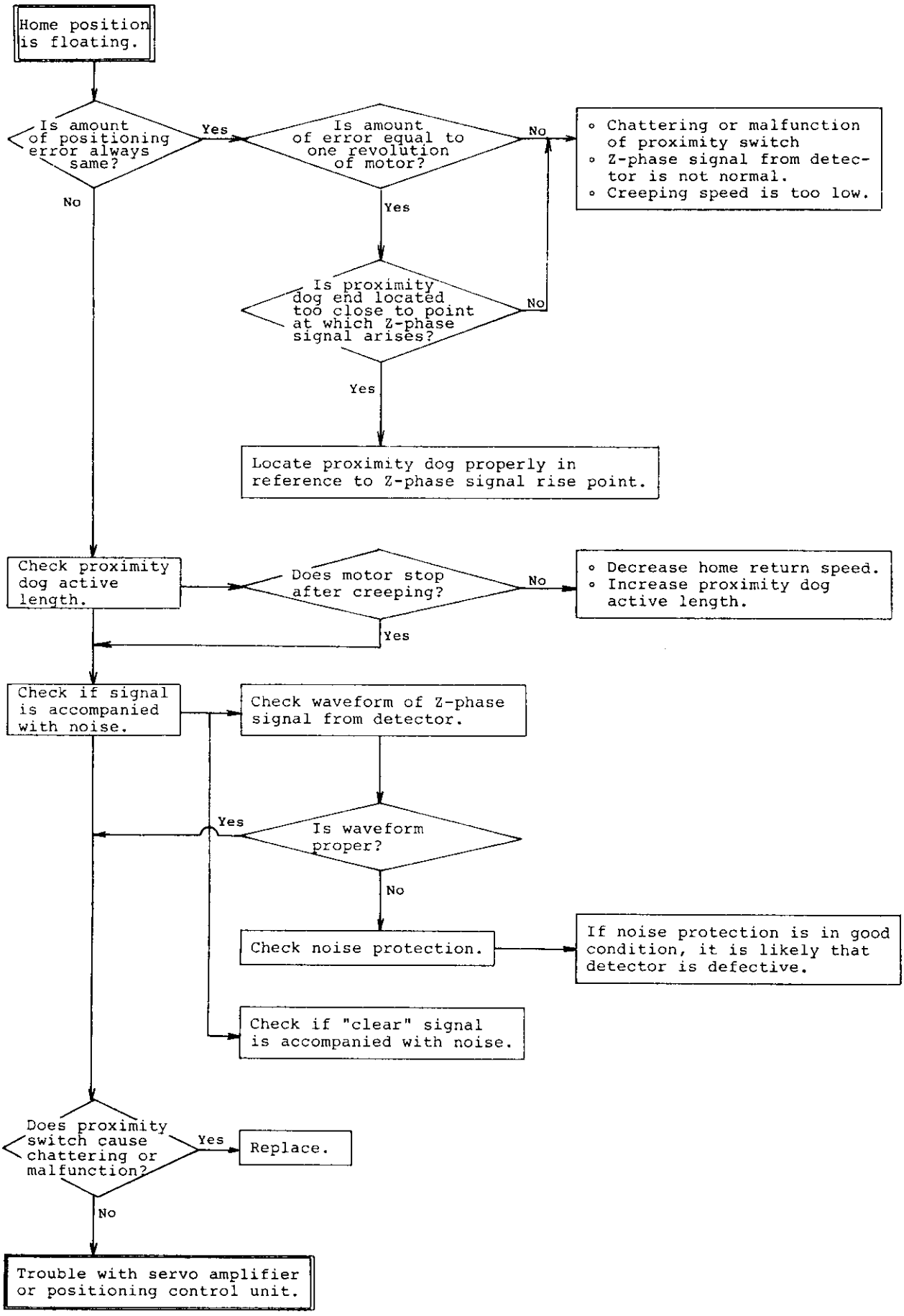



Check signal from detector.
Check phase and waveform of feedback signal from detector. (Check pins: A,B,Z,U,V,W)
Is protection from noise proper?
No
Improve noise protection.
Yes
Are specified cables used?
No
Use specified cables.
Yes
Check load conditions and parameter settings.
control becomes unstable 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-SA 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 under P.C. board) is off.
Parts at upper portion of P.C. board RF08 are at high voltage. During inspection, use care not 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 temperatures of motor and servo amplifier, and ambient temperature usual?
(4) When the trouble occurred (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 remedied in the past?

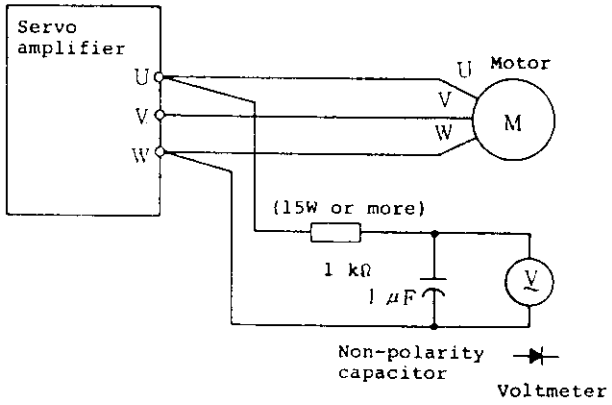
(11) How long have the servo motor and servo amplifier been used?

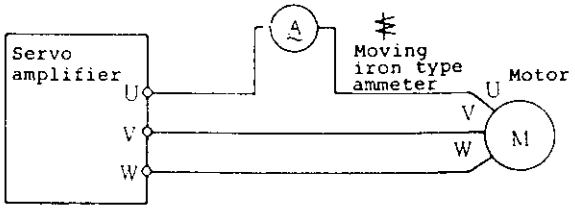
(12) Is the supply voltage proper?
Does voltage regulation change remarkably during operation?

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.
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.
h. Check cables (particularly, detector cable) for condition.

(3) Replacement of componets

The following componets 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) Cooling fan .... The life of the bearings ranges from 100,000 hr to 35,000 hr of operation.

When the fan is operated continuously, it should be replaced in 2-3 years.

The bearings should be replaced if the fan generates foreign sound or intense vibrations.

(2) 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 5 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).

(3) Relays .... Worn out contacts may cause contact failure.
The life of relay will be usually 50,000 cycles of operation (though it largely depends on voltage and current applied).

(4) 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.

Componet	Standard life	Replacement, etc.
Cooling fan	2-3 years	Replace (if judged necessary in check)
Smoothing capacitor	5 years	Replace (if judged necessary in check)
Relays	-	Check and determine.
Motor bearings	-	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 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 inevitable, store it with the following caution.

a. Store it in clean and dry location.

Storage temperature	Storage humidity
-20°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, use care not to allow entrance of dust and foreign matter.

8-5 Layout on the printed circuit board

Short pins, 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 short pins and switches which are designated "maker setting purpose" shall not be operated by the user.

① LEDs

Table 8-1 LED list

Charge lamp (red)	Located under the unit and on the lower side of the printed circuit board. It is lit while the system is energized.
CPU error indication lamp (red)	Located on the printed circuit board RF81. 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	
RF81	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
RF08 (RF18)	CS1	0	Maker setting purpose

③ Short pins

The short pins shown in Fig. 8-1 are provided. Check the mounted state.

④ Check pins

The functions and voltage waveforms of the check pins on the printed circuit board are shown below. The check pin terminals J2 thru J7 are located on the printed circuit board RF81, and CP1 is located on RF08 and RF18. For pin locations, refer to Fig. 7-1.

Table 8-1 Check pin list

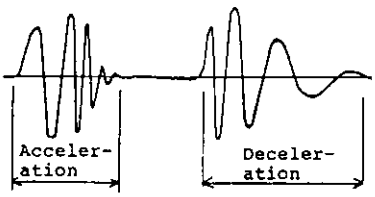
<table>
<tr><th>Terminal name</th><th>Signal name</th><th>Ground terminal</th><th>Signal, content and waveform</th></tr>
<tr><td rowspan="3">J2</td><td>IU</td><td rowspan="3">J2(AG)</td><td>Motor U-phase current</td></tr>
<tr><td>IV</td><td>Motor V-phase current</td></tr>
<tr><td>AG</td><td>Control ground</td></tr>
</table>

Waveform example

IU/IV

The waveform is different depending on the load, etc.

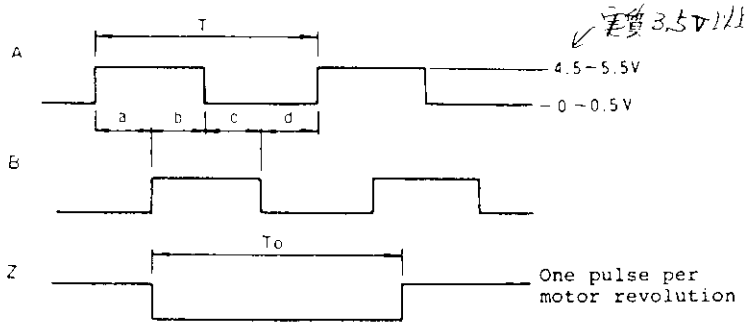
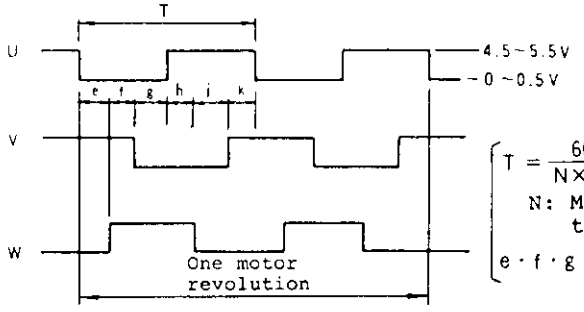
1.14V ぐ定格 300%



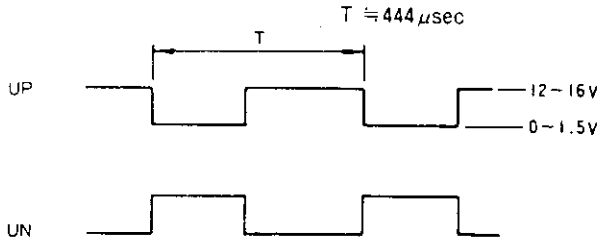
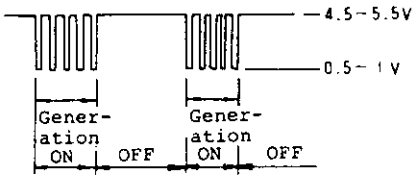
Motor	Converted value
HA-SA22,32,33	3.0(A/V)
HA-SA52,53	6.2
102, 103, 152	10.4
202, 153	15.6
302	20.8
352	20.8
502	31.2
702	41.6

Motor	Rated current (A)		
	Standard 2000 and 3000 rpm	Low inertia	Pancake
HA-SA 22	2	-	-
32	-	-	2.8
33	2	-	-
52	3	3.5	3.5
53	3	-	-
102	5.5	7	7
103	5	-	-
152	8	9.4	-
153	8	-	-
202	10	14	14
302	-	18	18
352	16	-	-
502	24	28	28
702	37	37	-

Continued on the next page.

Terminal name	Signal name	Ground terminal	Signal, content and waveform
J4	A B Z	Below the right of the stud	Encoder Phase A Encoder Phase B Encoder Phase Z Waveform example CCW revolution viewed from the load shaft of the motor.  $T=\frac{60}{N\times 3000}$ (sec) N: Motor revolution [r/min] Encoder : 3000pulse/rev a, b, c, d $=\frac{1}{4}T\pm\frac{1}{8}T$ To=T~3T
	U V W	Below the right of the stud	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·f·g·h·i·k $=\frac{1}{6}T\pm\frac{1}{360}T$

Continued on the next page.

Terminal name	Signal name	Ground terminal	Signal, content and waveform
J5	UP UN VP VN WP WN	Below the right of the stud	U phase, PWM output P side U phase, PWM output N side V phase, PWM output P side V phase, PWM output N side W phase, PWM output P side. W phase, PWM output N side Waveform example When servo is locked, 
J6	5G OR	J6(5G)	Analog ground Regenerative transister off signal Waveform example 
J7	P5 5G P15 N15	J7(5G)	+5V (4.75 to 5.25V) Control ground +15V (14.25 to 15.75V) -15V (-14.25 to -15.75V)
J7	15G AN	J7(15G)	Control ground Analog check terminal

Continued on the next page.

Terminal name	Signal name	Ground terminal	Signal, content and waveform
CP1	VC	LG	◦ Speed command input signal: ±4.4V/rated revolution speed ⊕ for forward revolution (CCW) ⊖ for reverse revoltuion(CW)
	TLP		◦ Torque limit command input signal ⊕ : Reverse revolution powering and Forward revolution regeneration +5V/maximum torque ◦ In torque control mode, this signal indicate torque command ±4V / maximum torque
	TLN		◦ Torque limit command input signal ⊖ : Forward revolution powering and reverse revolution regeneration −5V/maximum torque
	MO		◦ Monitor output signal: ±8V/rated revolution speed or maximum torque Forward or reverse powering and forward revolution regeneration torque for ⊕ Reverse or forward powering and reverse revolution regeneration torque for ⊖ Full scale: ±10V
	PP		◦ Forward pulse series input: Approx. +4.5Vo-p
	NP		◦ Reverse pulse series input: approx. +4.5Vo-p
	PA		◦ Encoder Phase A } Same as the check terminal on the printed circuit board RF08 or RF18
	PB		◦ Encoder Phase B }
	PZ		◦ Encoder Phase Z }
	LG		◦ Control ground
	SG		◦ Contact point input signal common

⑤ Layout on the printed circuit board

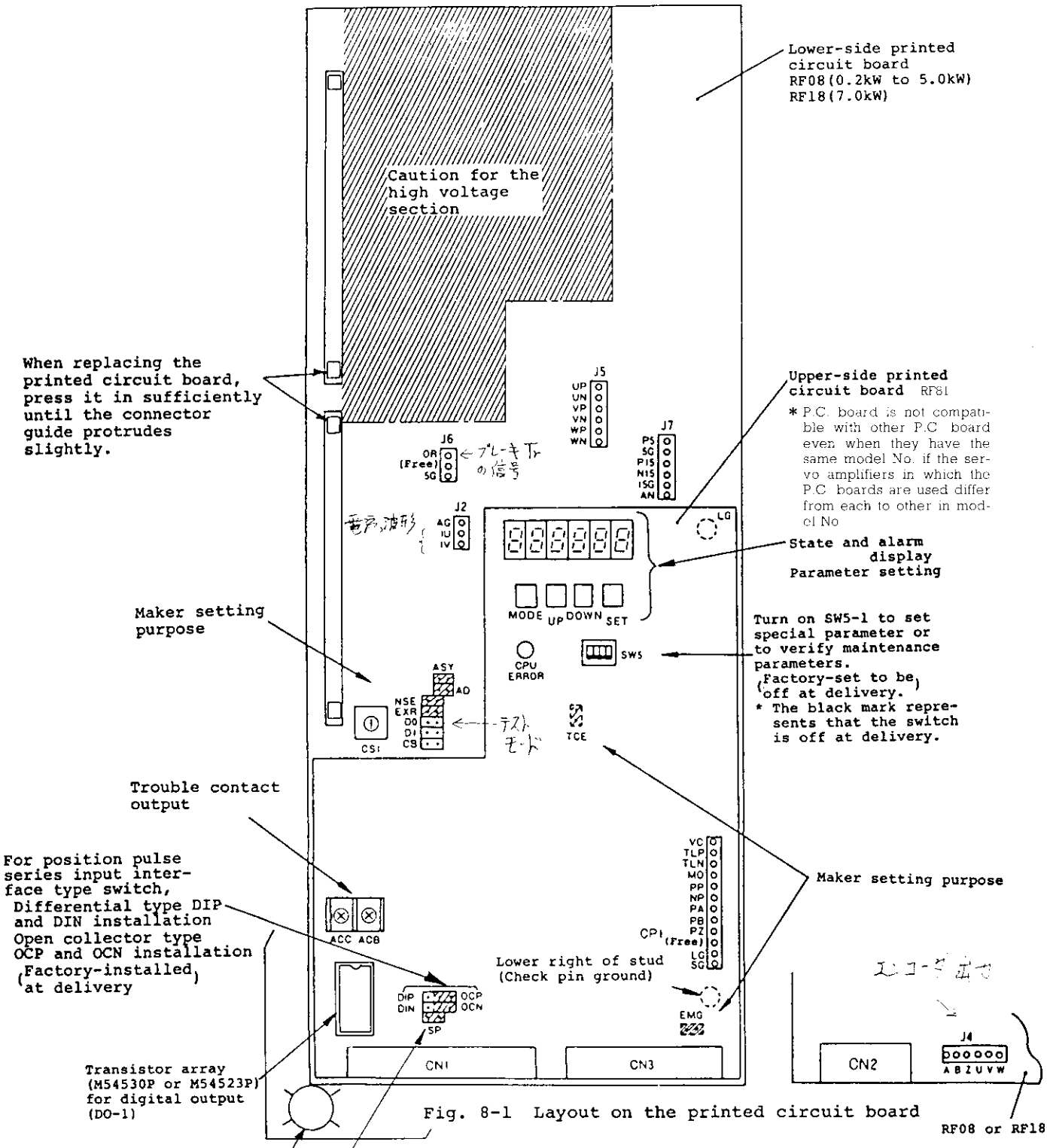


Fig. 8-1 Layout on the printed circuit board

Note: 1. The short pins in the ▨ section are factory-installed at delivery.
2. J2, J4 thru J7 and CP1 represent the check pins.

9. INPUT/OUTPUT TERMINALS

9-1 Description of terminals

(1) Servo amplifier terminals

Table 9-1 Input/output terminal list

Terminal	Symbol	Connector pin No.	Description	I/O	Mode
AC power supply	R,S,T	TE1	Connect to commercial power supply (200V/50Hz or 200/220V/60Hz).		
Emergency stop	B		When external emergency stop circuit is used, disconnect internal jumper (between terminals B and R, red wire) and connect the circuit to this terminal.		
Servo amplifier output	U,V,W		Connect to motor terminals (U,V,W ... phase sequence may not be changed).		
Motor protection	G1,G2		Connect to motor thermal protector terminal (red).		
Discharge resistor for regenerative brake (option)	P,D,C	TE2	Jumper bar has been connected to P and D. When optional discharge resistor is used, remove the jumper bar, and connect the discharge resistor to P and C. Be sure to connect the standard regenerative unit (MR-RB51) in case of the 7.0kW type.		
Error alarm output	ACB, ACC	TE3	If a protective function is activated and transistor base current is shut off, circuit ACB-ACC opens. (Contact capacity: AC230V 0.3A, DC30V 0.3A, resistor load, normal-close)		

Continued on the next page.

Terminal	Symbol	Connector pin No.	Description	I/O	Mode
Ground		⏚	∘ Grounded together with motor at one point. Connected to ground (internally connected to neutral point of power filter, and chassis). ∘ Surely grounded together with motor ground at one point.		
Servo ON	SON	CN1 9	Servo system start signal terminal. When this terminal is connected to SG, dynamic brake becomes inactive and servo system becomes ready for operation.	DI-1	P,S
External torque limit	TL	10	External torque limit signal terminal When this terminal is connected to SG, motor torque is clamped at the lelvel (max. current ±10V) set by torque limit signal (TLAP, TLAN). When this signal is not on, torque limit depends on the maximum output current of amplifier.	DI-1	
Proportional contol	PC	11	When this terminal is connected to SG, speed control mode changes from proportional-integral mode to proportional mode. When it is desirous to minimize hum of energized motor held still in position, the signal is turned on.	DI-1	
Reset	RES	12	The amplifier can be reset by connecting this terminal to SG for 50msec or longer.	DI-1	

Continued on the next page.

Terminal	Symbol	Connector pin No.	Description	I/O	Mode
Forward stroke end	LSP	24	When this terminal is not connected to SG, moter forward operation cannot be started. However, motor can be run in reverse direction. For forward operation, use a stroke end limit switch and short-circuit LSP and SG. The function is invalid during torque control operation.	DI-1	
Reverse stroke end	LSN	25	When this terminal is not connected to SG, moter reverse operation cannot be started, but motor can be started in forward direction. For reverse operation, use a stroke end limit switch and short-circuit LSN and SG. The function is invalid during torque control operation.	DI-1	
Clear (Counter reset)	CR	27	When this terminal is connected to SG, position control counter is reset. Assure a pulse width of 10ms or more.	DI-1	P
Operation ready signal	RD	49	when servo system becomes ready for operation, signal from this terminal turns on.	DO-1	
In-position/ up to speed signal	PF	48	Signal from this terminal turns on when motor is positioned within specified range, in position control mode, or motor speed reaches about ±15% of reference speed in speed control mode.	DO-1	
Torque limit "ON"/ speed limit "ON"	TLC	44	When mtoor torque reaches torque clamp range, signal from this terminal turns on in position or speed control mode. When motor speed reaches speed clamp range, signal from this terminal turns on in torque control mode.	DO-1	

Continued on the next page.

Terminal	Symbol	Connector pin No.	Description	I/O	Mode
Creeping speed detect	ZSP	45	Signal from this terminal turns on when motor speed goes down below 50 r/min.	DO-1	
Control mode select	DIO	23	When this terminal is connected to SG, control mode changes from position control to speed control, or speed control to torque control (see Table 6.5, parameter No.01).	DI-1	
Speed I select	DI1	42	When this terminal is connected to SG, motor can be operated at speed set by parameter SC1.	DI-1	S,C
Speed II select	DI2	43	When DI2 is connected to SG, motor can be operated at speed set by parameter SC2. When DI1 and DI2 are connected to SG, motor can be operated at speed set by parameter SC3. When external speed reference signal is used to control motor, disconnect DI1 and DI2 from SG.	DI-1	S,C
Forward start signal	DI3	28	When DI3 is connected to SG in speed control mode, motor forward operation starts.	DI-1	S,C
Reverse start signal	DI4	29	Motor reverse operation starts when DI4 is connected to SG. When DI3 and DI4 are disconnected from SG, motor is stopped and held stopped. In torque control mode, torque type (fwd./rev., run/regenerative brake) can be determined by signals from these terminals. If two signals turn off, motor does not start.	DI-1	S,C

Continued on the next page.

Terminal	Symbol	Connector pin No.	Description	I/O	Mode
Driver power supply	VDD	46,47	Interface driver power supply at about 24VDC is output. Allowable maximum current: 200mA (total current to control unit and relays should be less than 200mA)		
Common	SG	13,14, 26,30	Input contact signal common terminal It is not connected to internal control circuit common.		
Forward pulse train	PP	18	Used to input forward pulse train from pulse train generator (MR-PO, AD71, etc.).	DI-2	P
	PG	17	Used to input forward pulse train differential signal.		
Reverse pulse train	NP	16	Use to input reverse pulse train from pulse train generator (MR-PO, AD71, etc.).	DI-2	P
	NG	15	Used to input reverse pulse train differential signal.		
Pulse train common	LG	4,5	Pulse train common terminal.		
Speed reference signal	VC	33	Speed reference signal 0 to ±10VDC is input. Motor rotates at rated speed when signal is at ±10V. Input resistance: 10 to 12kohm In torque control mode, speed limit is set.	Analog input	S,C

Continued on the next page.

Terminal	Symbol	Connector pin No.	Description	I/O	Mode
External torque limit signal(+)	TLAP	35	This signal is used in forward regenerative braking and reverse run (0 to +10VDC). When signal is +10VDC and TL (external torque limit) is on, torque is clamped at the maximum current. Input resistance: 10 to 12kohm	Analog input	S,C
External torque limit signal(-)	TLAN	38	This signal is used in reverse regenerative braking and forward run (0 to -10VDC). Input resistance: 10 to 12kohm Not used in torque control mode. In torque control mode, torque signal ranging from 0V to ±8VDC is input.	Analog input	S,C
Monitor	MO	40	Either motor speed or torque can be monitored. Max. ±10V, 1mA (±8V at rated speed, or ±8V at max. torque)	Analog input	S,C
DC power supply	P15R	1	This power supply can be used for speed reference signal power supply (±15VDC). Allowable max. current: 30mA		
	N15R	2	This power supply can be used for speed reference signal power supply (-15VDC). Allowable max. current: 30mA		
Control	15G	35,36, 39,41	Control signal common terminal It is not connected internally to SG, but connected to pulse train common (LG).		

Continued on the next page.

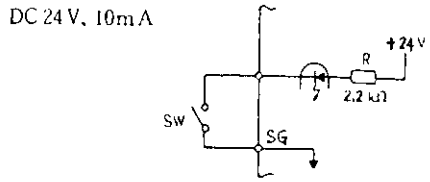
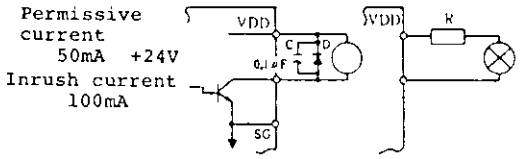
Terminal	Symbol	Connector pin No.	Description	I/O	Mode
Shield	SD	6,37	One end of wire shielding braid is connected to this terminal.		
Encoder output (Differential line driver type)	LA LAR LB LBR LZ LZR	21 22 19 20 7 8	For LA, LAR, LB and LBR, one revolution of motor causes output of 3000 pulses. For LZ and LZR, one revolution of motor causes output of 1 pulse. During motor forward rotation, phase of LA advances π/2 from phase of LB. Division of 1/1, 1/2 or 1/4 is made possible by setting the parameter.	DO-2	
Encoder output (Open collector type)	FPA FPB OP	32 31 50	For FPA and FPB, one revolution of motor causes output of 3000 pulses. For OP, one revolution of motor causes output of 1 pulse. During motor forward rotation, phase of FPA advances π/2 from phase of FPB. Division of 1/1, 1/2 or 1/4 is made possible by setting the parameter.	DO-2	
Pulse train common	LG	4, 5	Control signal common terminal It is not connected to SG.		
Detector signal		CN2	Connected to motor detector.		

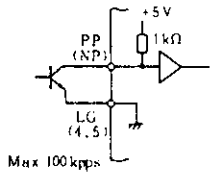
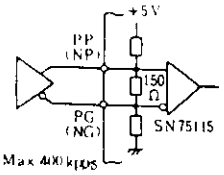
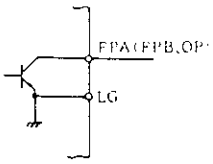
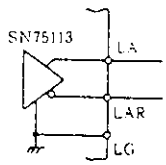
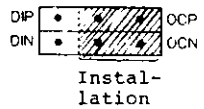
Note: "P", "S" and "C" in the mode column stand for "position" control, "Speed" control and "Torque" control respectively.

Other terminals are common to "P", "S" and "C".

9-2 Input/output interface

Table 9-2 Input/output interface

<table>
<tr><th>Input interface (DI-1)</th><th>Output interface (DO-1)</th></tr>
<tr><td>Use miniature relay or open collector transistor for signal.
 
</td><td>Lamp, relay or photocoupler can be driven.
 

Note:
•Output transistor is broken if polarity is mistaken.
•Use absorber (D.C.) for inductive load and inrush current control resistor (R) for lamp load.</td></tr>
<tr><td colspan="2">Pulse train input interface (DI-2)</td><td colspan="2">Pulse train output interface (DO-2)</td></tr>
<tr><td>•+5V level
Threshold level:
About 2.5V</td><td>•Differential receiver</td><td>•Open collector
Output current:
Max. 50mA</td><td>•Differential driver
Output current:
Max. 35mA</td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td>•Short pin setting on the printed circuit board
(Factory-set at delivery)
 

Instal-lation</td><td>•Short pin setting on the printed circuit board
 

Instal-lation</td><td></td><td></td></tr>
</table>

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 (DI3, DI4), and direction of rotation of motor in speed control operation is listed below.

Ext. speed reference (VC) polarity	Fwd start DI3 ON	Rev. start DI4 ON
⊕ plus	Fwd run	Rev run
⊖ minus	Rev run	Fwd run

④ Speed selection

Relationship between speed range 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 (DI3, DI4) and torque control signal (TLAP), and torque type in torque control operation is listed below.

Torque reference TLAP polarity	Operation mode	
	DI3 ON	DI4 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 (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. (3000 x 4 = 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] [ ][ ][ ][ ][0] [9][9][9][9][9][9] (Reverse rotation) (Forward rotation)
Motor speed	r	−2000 r/min to 2000 r/min, or −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] [r][ ][ ][ ][0] [r][ ][2][0][0][0] (Reverse rotation) (Forward rotation)

Continued on the next page.

Name	Symbol	Range/unit	Description (display example)
Remaining pulses	E	-99999 pulses to 99999 pulses	Remaining pulses are displayed. For reverse rotation, all displayed numerals are accompanied with decimal point. E9.9.9.9.9. (Reverse rotation) E 0 (Forward rotation) E99999
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. P9.9.9.9.9. (Reverse rotation) P 0 (Forward rotation) P99999
Reference pulse train frequency	PA	-400kpps to 400kpps	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-40.0. (Reverse rotation 400kpps) PA.100 (Forward rotation 100pps) PA 400. (Forward rotation 400kpps)

Continued on the next page.

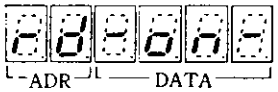
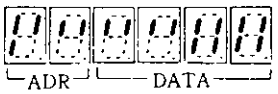
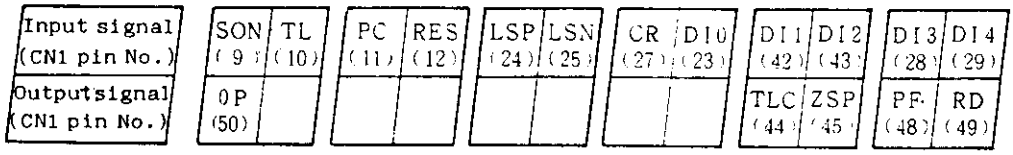
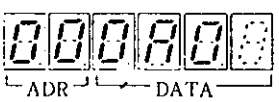
Name	Sym-bol	Range/unit	Description (display example)
Speed reference signal voltage	F	0 to ±10V	Speed reference signal (speed limit) voltage is displayed. It is 10V at full range. F -100 (Reverse rotation) F 000 F 100 (Forward rotation)
Reverse torque limit signal voltage	UP	0 to 10V	Reverse torque limit signal voltage is displayed. UP100
Forward torque limit signal voltage	Un	0 to -10V	Forward torque limit signal voltage is displayed. Un-100
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 400%	Continuous and effective load torque is displayed. JA 100
Peak load ratio	Jb	0 to 100%	Peak torque during acceleration or deceleration is displayed in %. The maximum motor torque is assumed 100%. Jb 100

Continued on the next page.

10-2 Diagnosis indication

This display mode is selected to check external control sequence.

Table 10-2 Diagnosis display list

Name	Display	Description
Control sequence		The system is not ready for operation. This display appears during initialization after or before servo ON, or during alarming.
		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.
External I/O signals		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.
		
Software version		For manufacturer's control

Continued on the next page.

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 tripped (error cide No. 33), its parameter is displayed. In the example shown to the left, parameter No.3 is out of order.

10-3 Alarm indication

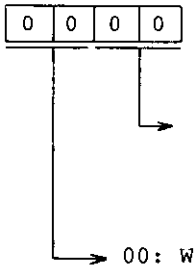
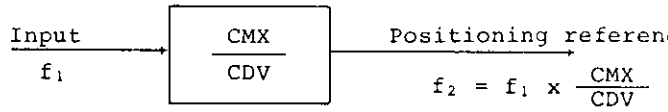
Alarm history or parameter error is displayed.

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 to the left, the alarm immediately before the current alarm is "33" (overvoltage). During alarm, the decimal point at the top digit (A) flickers (flickering occurs only in alarm condition).

10-4 User parameter setting data

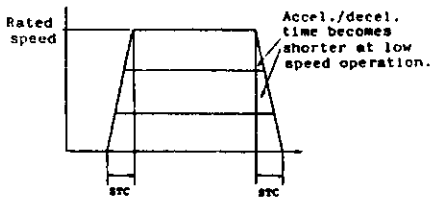
Table 10-4 User parameter setting

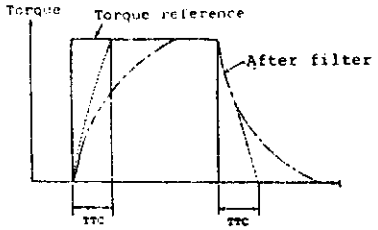
<table>
<tr><th>No.</th><th>Abbr.</th><th>Description</th><th>Control mode</th><th>Initial setting</th><th>Unit</th><th>Range</th></tr>
<tr><td>01</td><td>STY</td><td>Servo loop (control mode) selection:
Servo loop (control mode) can be selected and optional discharge resistor unit can be used.
 
</td><td></td><td>0000</td><td></td><td></td></tr>
<tr><td>02</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
 

Note: $\frac{CMX}{CDV}$ should be larger than $\frac{1}{50}$, but smaller than 50.</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>
<tr><td>05</td><td>PGN</td><td>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.
<table><tr><td colspan="2">J_L/J_M</td><td>0</td><td>1</td><td>3</td><td>5</td></tr><tr><td rowspan="2">Setting</td><td>Standard</td><td>35</td><td>25</td><td>25</td><td>15</td></tr><tr><td>Maximum</td><td>100</td><td>80</td><td>40</td><td>25</td></tr></table></td><td>P</td><td>25</td><td>rad/sec</td><td>5 to 150</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.

Continued on the next page.

<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>06</td><td>VGN</td><td>
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.
<table>
<tr><td colspan="3">JL/JM</td><td>0</td><td>1</td><td>3</td><td>5</td></tr>
<tr><td rowspan="4">Setting</td><td rowspan="2">Standard</td><td>0.2, 0.3kW</td><td>70</td><td>70</td><td>150</td><td>200</td></tr>
<tr><td>0.5 to 7.0kW</td><td>100</td><td>100</td><td>200</td><td>300</td></tr>
<tr><td rowspan="2">Low inertia and pancake</td><td>0.3 to 3.0kW</td><td>30</td><td>30</td><td>60</td><td>100</td></tr>
<tr><td>5.0, 7.0kW</td><td>50</td><td>50</td><td>100</td><td>150</td></tr>
</table>
</td><td>P,S</td><td>100</td><td>Set for JL/JM ≒1</td><td>20 to 2000</td></tr>
<tr><td>07</td><td>VIC</td><td>
Speed integral compensation:
Time constant for speed integral compensation is set.
<table>
<tr><td>JL/JM</td><td>0</td><td>1</td><td>3</td><td>5</td></tr>
<tr><td>Setting</td><td>20</td><td>20</td><td>30</td><td>40</td></tr>
</table>
</td><td>P,S</td><td>20</td><td>msec</td><td>1 to 1000</td></tr>
<tr><td>08</td><td>SC1</td><td>
Speed reference (1)
1st speed range (speed reference or speed limit) of internal 3-speed setting is selected.
</td><td>S,C</td><td>100</td><td>r/min</td><td>0 to 5000</td></tr>
<tr><td>09</td><td>SC2</td><td>
Speed reference (2)
2nd speed range (speed reference or speed limit) of internal 3-speed setting is selected.
</td><td>S,C</td><td>1000</td><td>r/min</td><td>0 to 5000</td></tr>
<tr><td>10</td><td>SC3</td><td>
Speed reference (3)
3rd speed range (speed reference of speed limit) of internal 3-speed setting is selected.
</td><td>S,C</td><td>2000</td><td>r/min</td><td>0 to 5000</td></tr>
<tr><td>11</td><td>STC</td><td>
Acceleration/deceleration time constant:
Time for acceleration to rated speed specified by speed reference signal (internal 3-speed setting or external signal) is set.


</td><td>S</td><td>0</td><td>10 msec</td><td>0 to 5000</td></tr>
<tr><td>12</td><td>TTC</td><td>
Torque filter time constant:
When all-pass filter is inserted to provide delay for torque reference, time constant is set.


</td><td>S,C</td><td>0</td><td>10 msec</td><td>0 to 2000</td></tr>
</table>

Continued on the next page.

No.	Abbr.	Description	Control mode	Initial setting	Unit	Range
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
24	DMD	Display mode: 0 0 0 0 →(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

10-5 Special parameter data

Table 10-5 Special parameter data

Special	No.	Abbr.	Description	Loop	Initial setting	Unit	Range
Special	25		Maker setting purpose		0000		
	26		Maker setting purpose		0		
	27		Maker setting purpose		0000		
	28		Maker setting purpose		65		
	29		Maker setting purpose		256		
	30	VCM	Revolution speed for 10V command: The revolution speed for 10V command is set.	S	2000	r/min	0 to 5000
	31	VDC	Speed proportional control gain: The proportional gain near the stop of the speed loop is set. 1000 is set for ordinary proportional/integral control. As the value is smaller, the proportional control range is wider. Approx. 980 is ordinarily used.	P,S	980		0 to 1000
	32		Maker setting purpose		50		
	33	TLL	Torque limit value: Set at maximum torque = 100 as described in the catalog. When the external control limit is effective, torque is limited at either low level. When the peak torque of the speed reducer is limited, the torque limit is set to be low.	P,S	100	%	0 to 100
			Torque control command full scale value: In the torque control mode, the level of the generated torque outputted at the TALP input level ±8V is set. For example, if the parameter is set at 50%, the output torque becomes (maximum torque)/2 when TLAP is made 8V.	C			
	34		Maker setting purpose		210		
	35		Maker setting purpose		600		
	36		Spare				
	38	VCG	VC full scale value switch: 0: 10V/rated revolution speed 1: 6V/rated revolution speed To gain the rated revolution speed at 6V with the external speed command (VC), set 1 at the parameter.	S	0		0, 1
	39	ENR	Encoder output division rate: 0: 1/1 1: 1/2 division 2: 1/4 division The number of pulses per revolution of the motor for the encoder output (open collector type) is set. A division rate of 1/1 corresponds to 3000 pulses/rev.	P,S, C	0		0, 1, 2
	40		Maker setting purpose		0		
	41 to 48		Spare				

10-6 Parameter setting value entry table

Before operation, set the parameters according to the operation purpose and specifications. As shown in the Table 10-6, there are user parameters, special parameters and maintenance parameters.
As a rule, the user parameters alone are set by the user.

Table 10-6 Parameter setting value entry table

Table 10-6 Parameter setting value entry table

Division	No.	Abbr.	Description	Loop	Initial setting	Unit	User setting value
User parameter	*01	STY	Servo loop type	-	0000		
	02	CMX	Command pulse multiplication numerator (Electronic gear)	P	1		
	03	CDV	Command pulse multiplication 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	SCI	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		(Spare)				
	24	DMD	Indication mode (Initial state display setting)	-	0000		
Special parameter	25		Maker setting purpose		0000		
	26				0		
	27				0000		
	28				65		
	29				256		-
	30	VCM	10V command revolution speed	S	2000	r/min	
	31	VDC	Speed proportional control	P,S	980		
	32		Maker setting purpose	P,S,C	50		-
	33	TLL	Torque limit value (internal) [max. torque 100%]	P,S	100	%	
	34		Torque command full scale value	C	210		-
	35		Maker setting purpose		600	%	-
	36, 37		(Spare)				
	38	VCG	VC full scale value switch	S	0		
	39	ENR	Encoder output division rate	P,S,C	0		
	40		Maker setting purpose		0		-
	41		Maker setting purpose				
	42		Maker setting purpose				
	43 to 48		(Spare)				
Maintenance parameter	*49		Maker setting purpose		0		
	*50				***		
	52				1024/2048		
	53				2 0 4 8		
	54				128/200/256/512		
	55				256/512		
	56				5		
	64		(Spare)		0		

Note: 1. To set the * marked parameter, turn off the power supply once after entry. When the display goes out after the power supply is once turned off, turn on the power again, and the parameter will be completely set.
2. In the control mode, P is a parameter effective for position control, S is effective for speed control and C is for torque control.
3. *** represents the 3-digit number of the motor type.

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