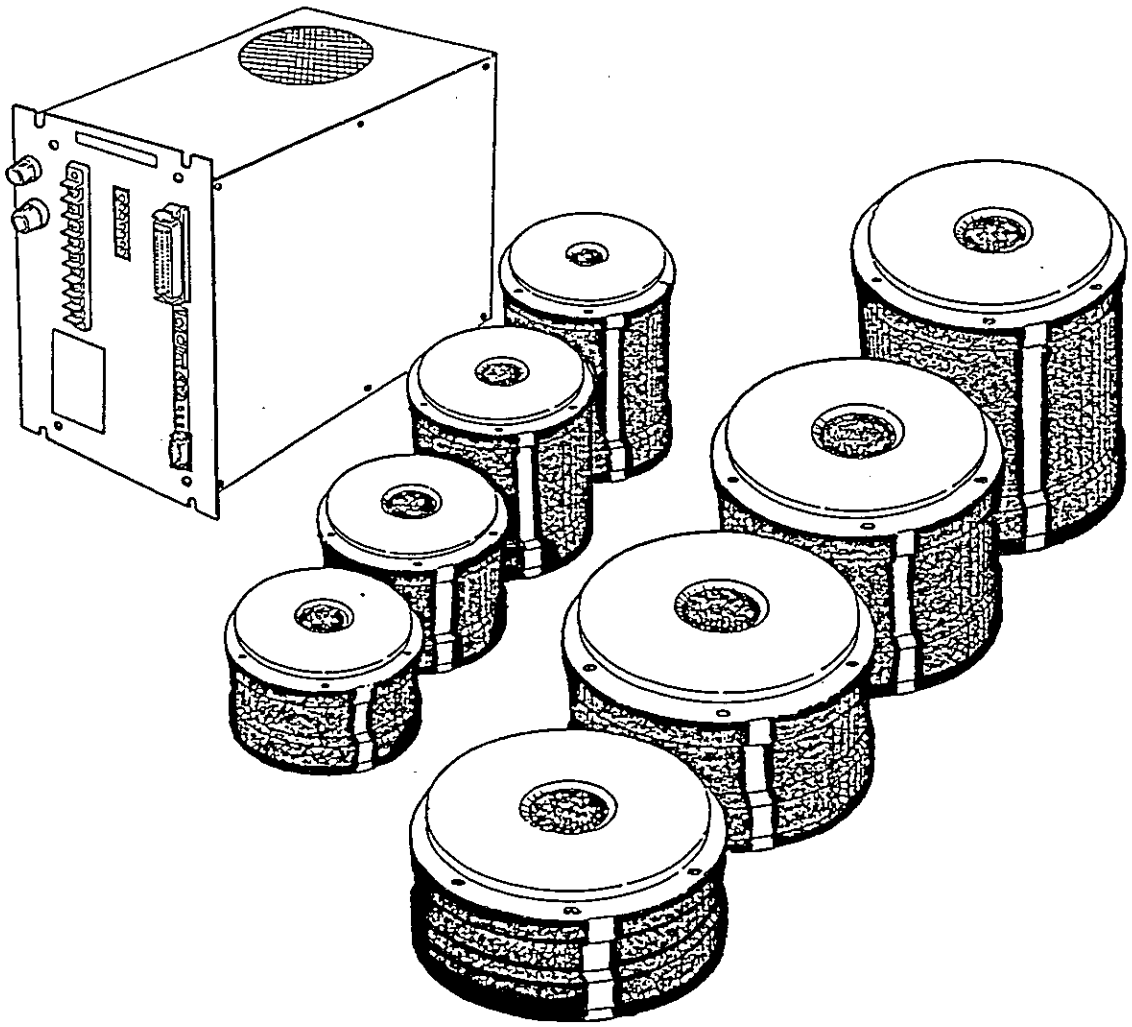
Instruction
Manual

DYNASERV

DD SERVO-ACTUATOR

DM-A/B·SD-A/B SERIES



YOKOGAWA ◆
Yokogawa Precision Corporation

IM A101-E
2nd Edition
JUNE 1,1992

Introduction

Thank you for purchasing our DYNASERV DD servo actuator.
The DYNASERV is a high torque, high speed, highly accurate outer rotor type servo actuator which can be used in a wide range of field applications related to factory automation, including with industrial robots, indexes, etc.
This instruction manual covers the DM/SD series.
Be sure to read this instruction manual prior to operating the DYNASERV.

Cautions

- It is prohibited to reproduce or copy part or the whole of of the contents of this instruction manual.
- The contents of this instruction manual may subject to change without notice.
- If you find any errors in this manual or have any questions regarding the contents, please contact our sales section or the people in charge of service.
- For damage or indirect damage caused by our unintentional error occurring when our product is used, we may not bear the responsibility for the damage.

Operating cautions

1. The driver is adjusted in conjunction with the coupled motor. Therefore, do not change the motor-driver combination.

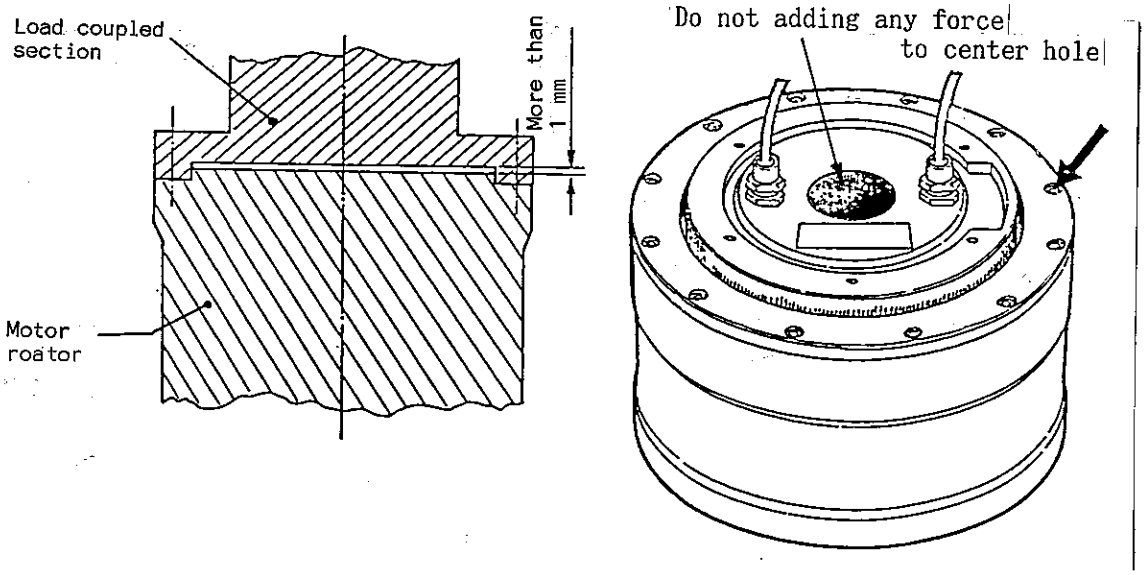
2. Never conduct opposite mounting of rotating the stator with the motor rotor fixed.

3. Always turn the power OFF before removing the driver side plate to set the jumper, since it is dangerous to touch the high-voltage generation section inside the DYNASERV.

4. This motor rotates at high speed and high torque, so be careful of the rotating radius in order to prevent danger accident when operating with a load connected.

5. Always ground the grounding terminal.

6. When coupling the load to the motor rotor, keep a clearance of more than 1 mm between the load and the upper surface of the motor to maintain surface accuracy. (See the Figure below.)



7. Do not touch the bolts (shown by arrow in above Figure) securing the bottom of the motor rotor. Loosening and tightening these bolts may change the commutation angle, resulting in faulty rotation.

8. Since the motor surface is magnetically charged, do not place any magnetized objects or substances near the surface.

9. The motor is not dust-, water- or oil-proof, and should therefor be handled with care.

10. Never disassemble or modify the motor or driver. Contact us if they need to be disassembled or modified, as we take no responsibility for their operation after they have been disassembled and modified without our permission.

11. If the motor is reciprocally operated in succession at an extremely small angle (of less than 1°), perform reciprocal running-in of about 10 times at an angle of more than 10° every 100,000 reciprocal operations in order to prevent the bearing from uneven lubrication.

12. Naver put to the withstanding voltage test for drive. Circuit damage.

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1. Product Outline

1.1 DYNASERV DM/SD Series

The DYNASERV series are high speed, high torque, highly accurate outer rotor type servo actuators which embody the measurement technology and control technology built up during Yokogawa Electric's long experience in the field.

The main features of this series include the following:

- ◆ High-precision rotational positioning ---
  Built-in optical encoder with a resolution of more than 1 million P/rpv, repetitive accuracy of ± 2 sec., absolute positioning accuracy of 30 sec.
- ◆ High torque ---
  Max. output torque/weight: 3 N·m/kg or more
- ◆ Low thermal output design ---
  High efficiency exceeding 70%
- ◆ Smooth rotation, excellent control ---
  Torque ripple: 5% or less; speed ripple: 3% or less
- ◆ Simple operation, resistant to external disturbances ---
  Built-in tuning function, using modern control logic
- ◆ Clean actuator --- Class 10 cleanness

The DYNASERV is composed of a motor section incorporating an encoder, and a driver section.
There are two DYNASERV mode types - the 4 models of A Series with an output torque of 50 - 200 N·m, and 4 models of B Series with an output torque of 15 - 60 N·m. The A and B Series have an outer diameter of 264 mm and 160 mm respectively, and a cylindrical hole of 58 mm and 25 mm diameter respectively.
There is a driver model for each motor, with both 100 V and 200 V power supply versions available.

Table 1.1 DYNASERV Models

Motor Model No.		Driver Model No.		Max. Torque (N.m)	Rated Output (W)	Rated Rotation Speed (rps)
		100 V power	200 V power			
A Series	DM1200A	SD1200A-1	SD1200A-2	200	820	1
	DM1150A	SD1150A-1	SD1150A-2	150	630	
	DM1100A	SD1100A-1	SD1100A-2	100	410	
	DM1050A	SD1050A-1	SD1050A-2	50	220	
B Series	DM1075B	SD1075B-1	SD1075B-2	75	750	2
	DM1060B	SD1060B-1	SD1060B-2	60	450	1.5
	DM1045B	SD1045B-1	SD1045B-2	45	380	2
	DM1030B	SD1030B-1	SD1030B-2	30	250	
	DM1015B	SD1015B-1	SD1015B-2	15	125	

1.2 Standard Product Configuration

The standard product set consists of the following components. When unpacked, check that the product is the correct Model, and that the types and quantities of standard accessories are also correct. (See Figure 1.1.)

Table 1.2

Part Name	Q'ty	Remarks
Motor section	1	
Driver section	1	
Connector (for CN1 terminal)	1	Manufactured by Honda Tsushin Kogyo: MR-50LM
Connector (for CN2 terminal)	1	Manufactured by Honda Tsushin Kogyo: MR-16LM
Fuse	2	ϕ 6 × 32 mm 100 V power supply (15 A) 200 V power supply (10 A)

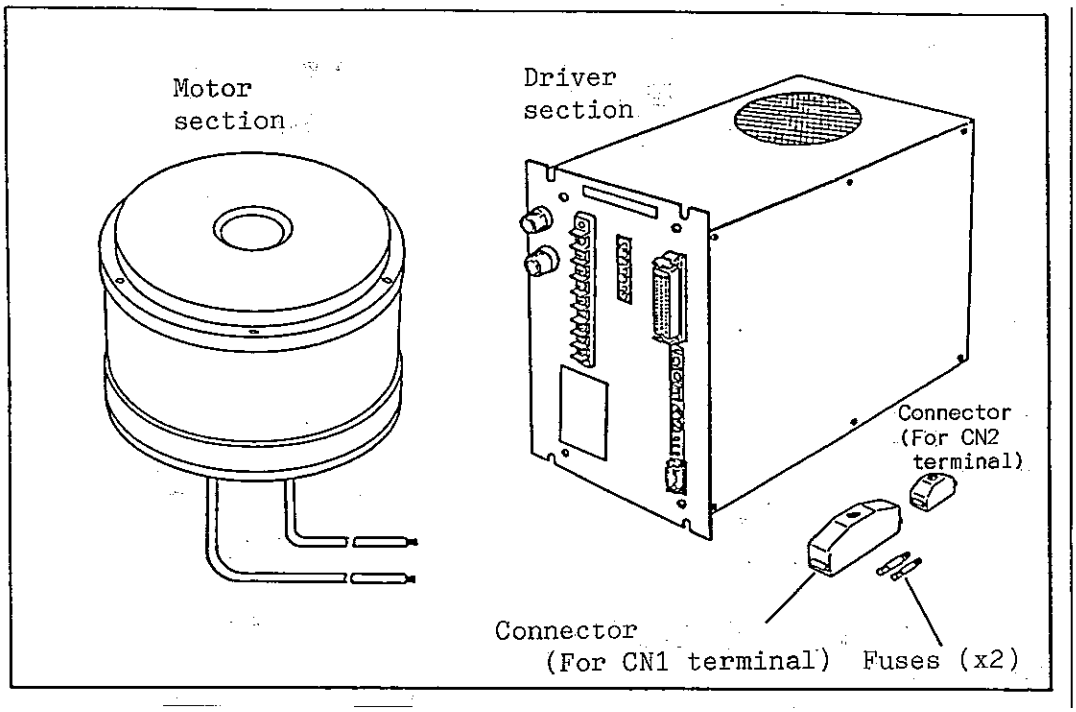
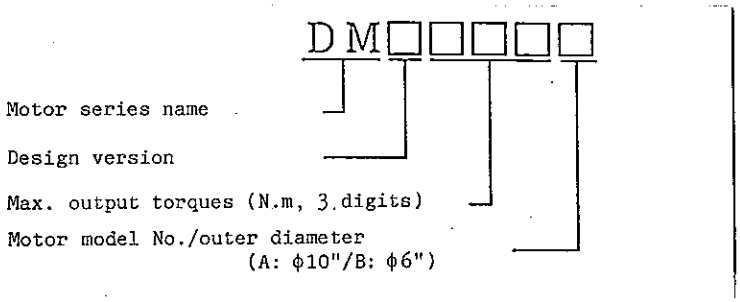


Figure 1.1

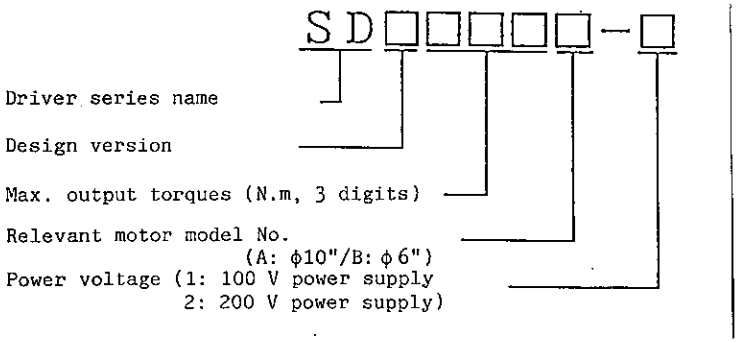
1.3 Model Symbols

The DYNASERV DM/SD Series motor and driver Model Nos. are as shown below.

(1) Motor



(2) Driver



Note: The DYNASERV motor and driver combinations fixed and random combinations are not allowed. Therefore, prior to operating the DYNASERV, check to see that the combination of the driver and the motor described on the nameplate for rating at the front of the driver is correct, as a wrong combination does not allow the DYNASERV to display its full potential.

2. Functional Description

2.1 Motor Section

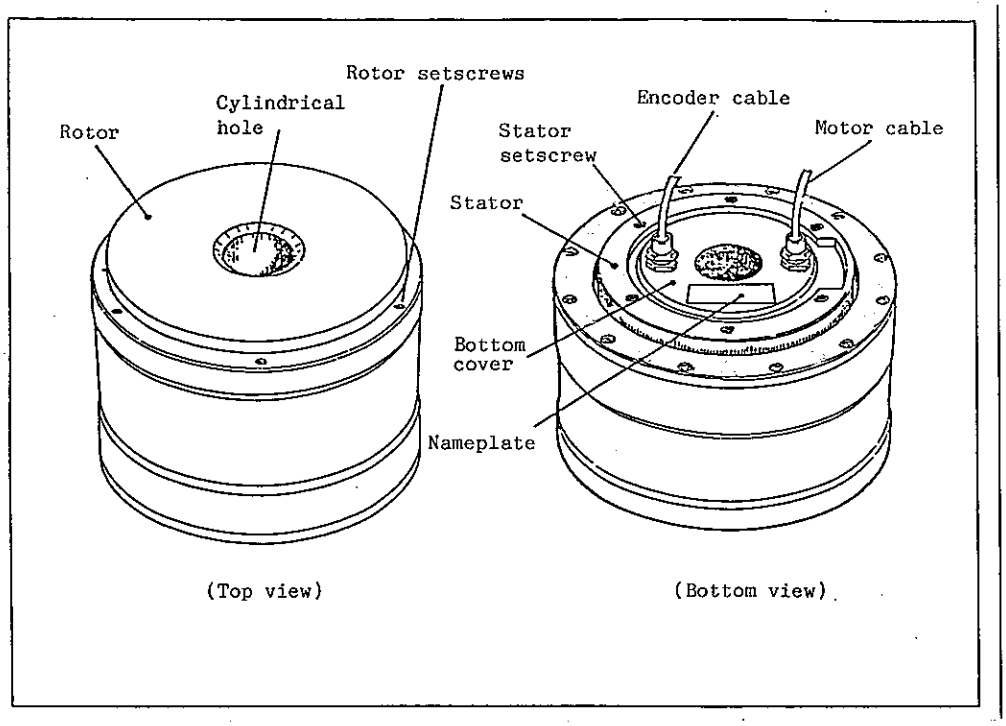


Figure 2.1

2.2 Driver Section

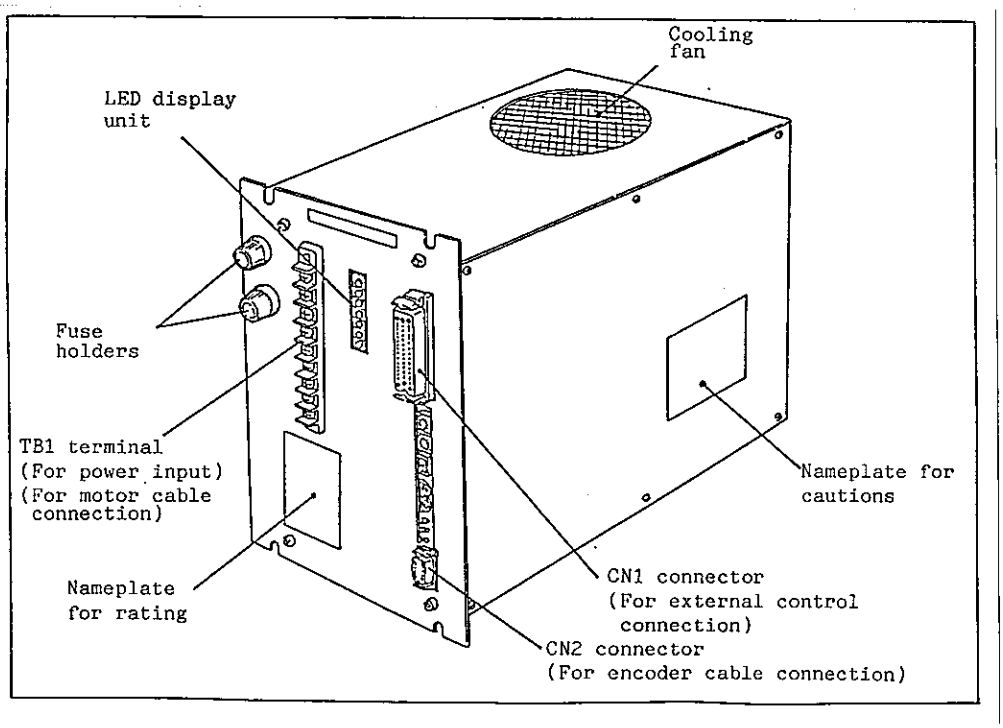
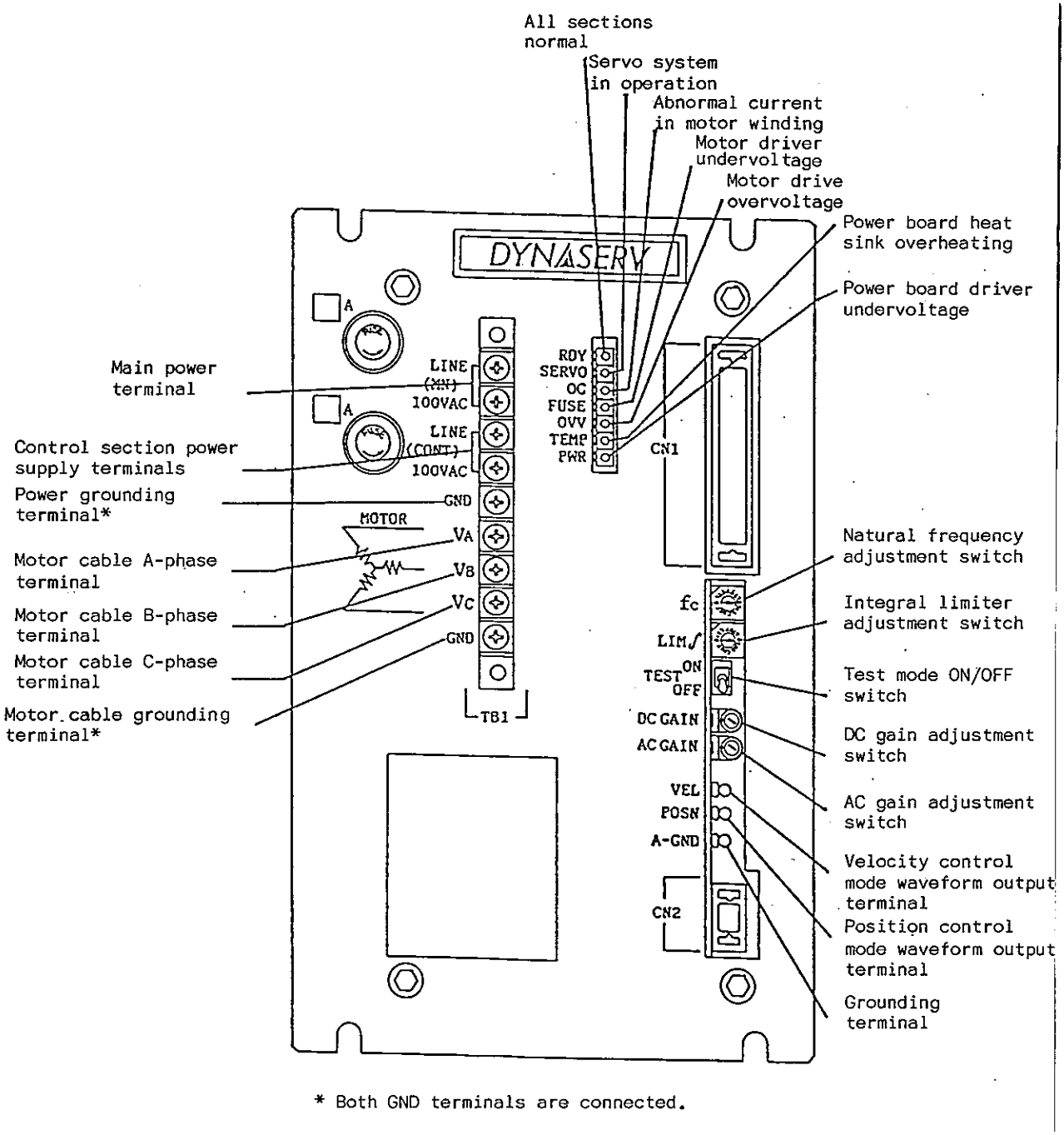


Figure 2.2

2.3 Driver Panel Surface



* Both GND terminals are connected.

Figure 2.3

3. Preparation for Operation

3.1 Initial Setting

Some jumpers, switches and variable resistors within the driver box may need to be set by the customer. However, prior to shipment, they are set as shown below. See Figure 3.1 below for their locations.

To remove the side plate of the driver box, unscrew the 4 screws shown in the figure below. <u>However, always turn OFF the power prior to carrying out any work. Also, never touch the high-voltage generation section, even with the power turned OFF.</u>

For setting and adjustment procedures, see the following pages. Never touch switches or variable resistors other than those specified.

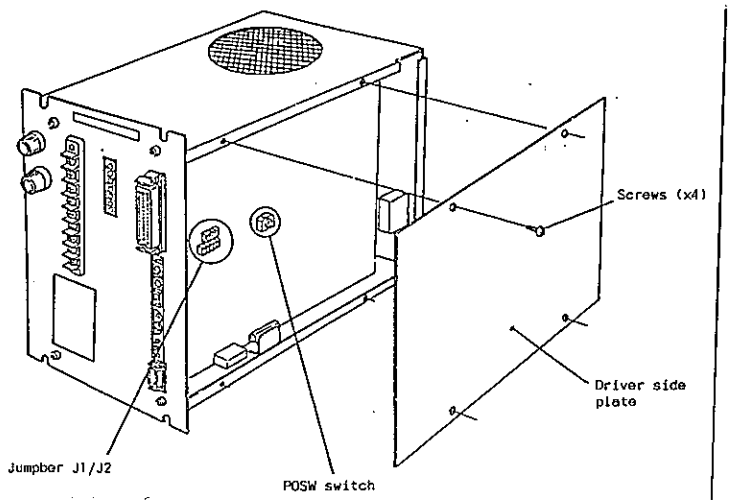


Figure 3.1

(1) Jumper settings prior to shipment

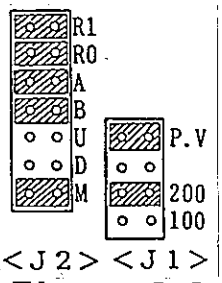


Figure 3.2

(2) POSW switch setting
Set to the zero position

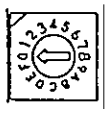


Figure 3.3

(3) Driver panel switch and variable resistor settings

These are all set to zero or the minimum position. The TEST switch is set to the OFF position.

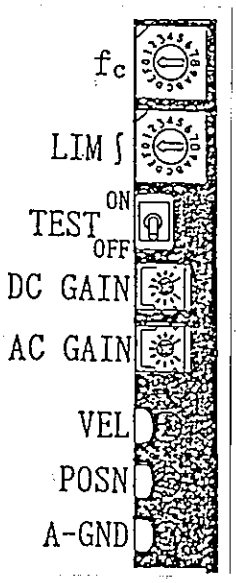


Figure 3.4

3.2 Jumper Settings

The meaning and function of the jumpers on the driver printed circuit board are described below.

(1) R1/R0 <J2>

These jumpers are used to switch the encoder signal resolution to 1, 1/2, 1/4 or 1/8.

The relationship between the jumper position and the encoder resolution, position command input signal frequency, and A-phase/B-phase or UP/DOWN pulse output signal is shown below.

a) A Type

Table 3.1

Jumper		Positioning resolution (P/rev)	Position command pulse (kHz at 1.2 rps)	A-/B-phase, UP/DOWN pulse (at 1.2 rps)	
R1	R0			A-/B-phase [kHz]	UP/DOWN pulse [kHz]
yes	yes	1,024,000	1,229	307	1,229
yes	no	512,000	615	307	1,229
no	yes	256,000	307	307	1,229
no	no	128,000	154	307	1,229

a) B type

Table 3.2

Jumper		Positioning resolution (P/rev)	Position command pulse (kHz at 2.4 rps)	A-/B-phase, UP/DOWN pulse (at 2.4 rps)	
R1	R0			A-/B-phase [kHz]	UP/DOWN pulse [kHz]
yes	yes	655,360	1,572	393	1,572
yes	no	327,680	786	393	1,572
no	yes	163,840	393	393	1,572
no	no	81,920	197	393	1,572

(2) A/B, U/D <J2>

These jumpers select the output mode of the pulse signal which indicates the rotational position of the motor. To select the A-/B-phase mode, A and B are shorted; to select the UP/DOWN pulse mode, U and D are shorted.

(3) P·V <J1>, M <J2>

These jumpers are used to select the driver operating mode. To use the driver in the position control mode, the P·V and M jumpers are shorted. To use the driver in the velocity control mode, the P·V jumper only is shorted.

(4) 200/100 <J1>

These jumpers are used to switch the velocity signal filter cut-off frequency. Shorting 200 sets the cut-off frequency to 200 Hz; shorting 100 sets the frequency to 100 Hz.

3.3 External Wiring

(1) External connection outline diagram

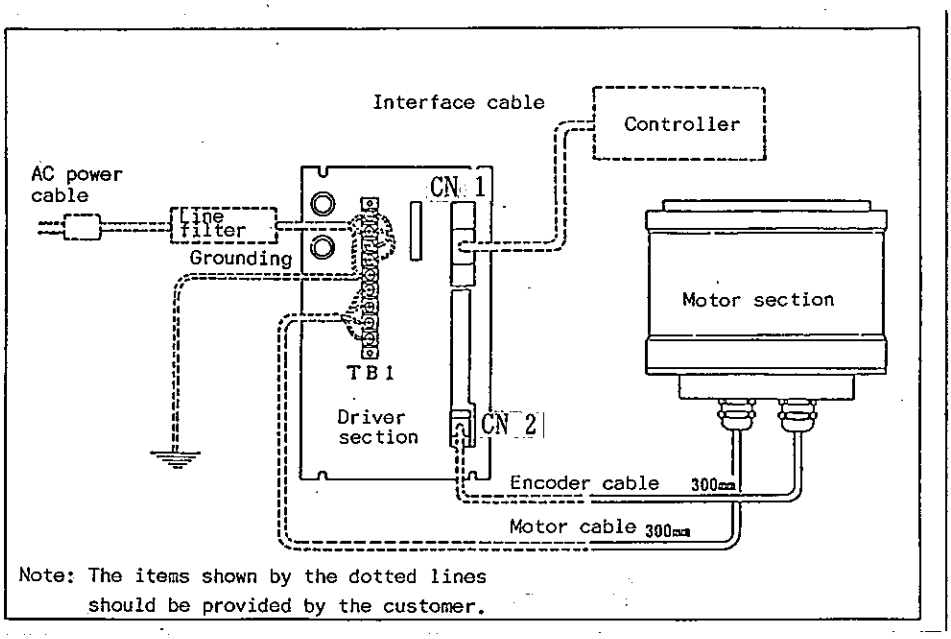


Figure 3.5

(2) Connection between the motor and the driver

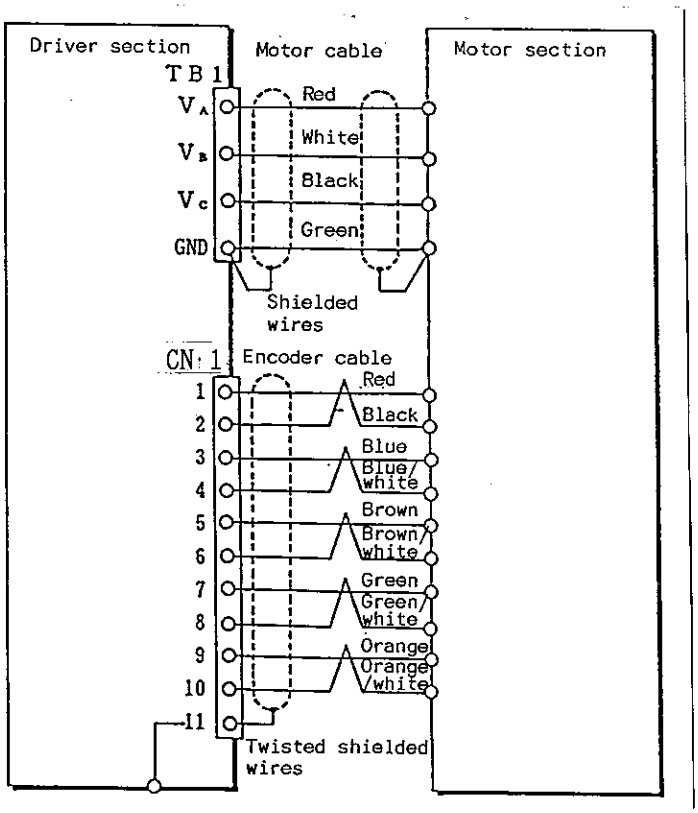
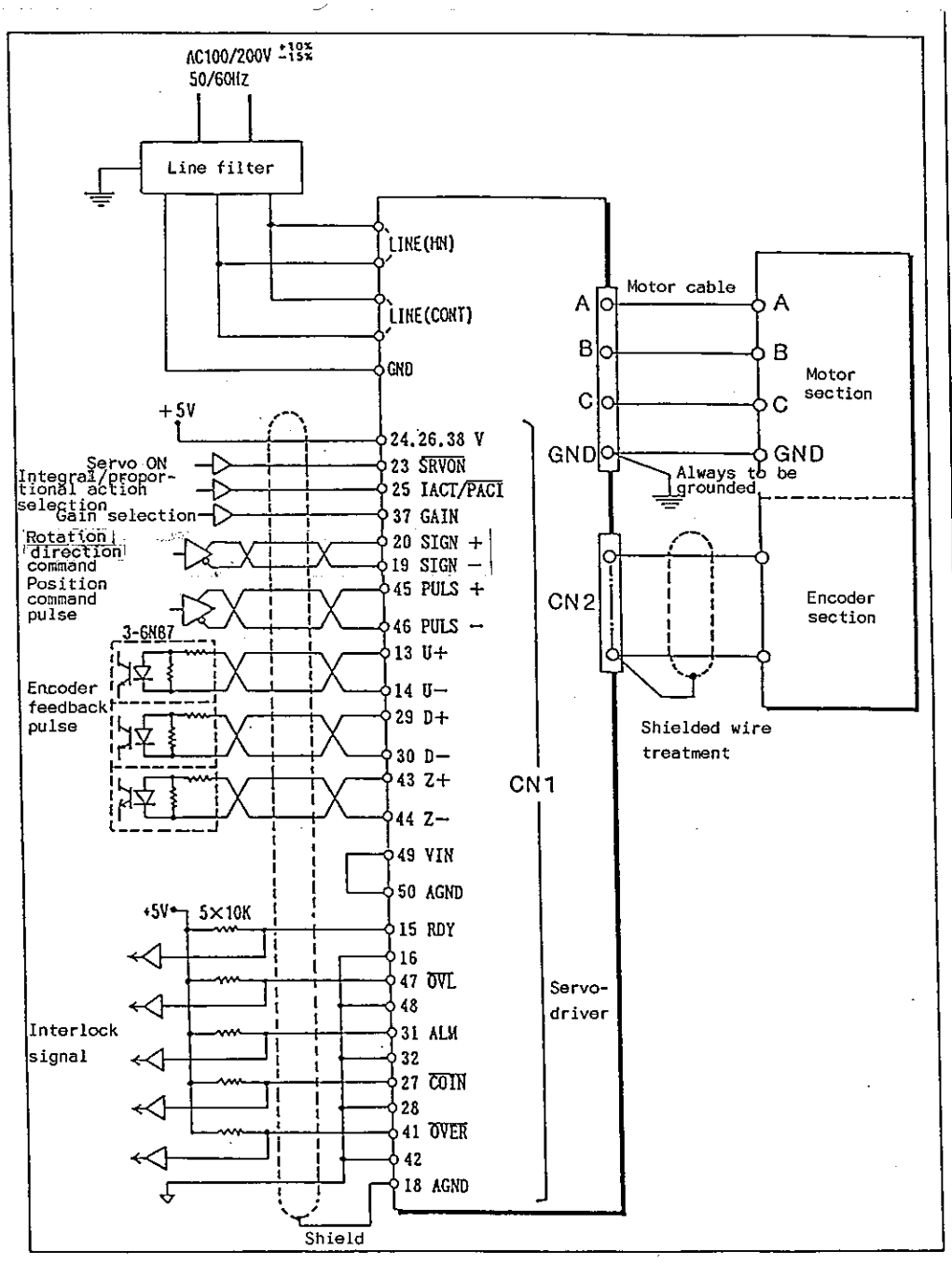


Figure 3.6

(3) Typical wiring examples

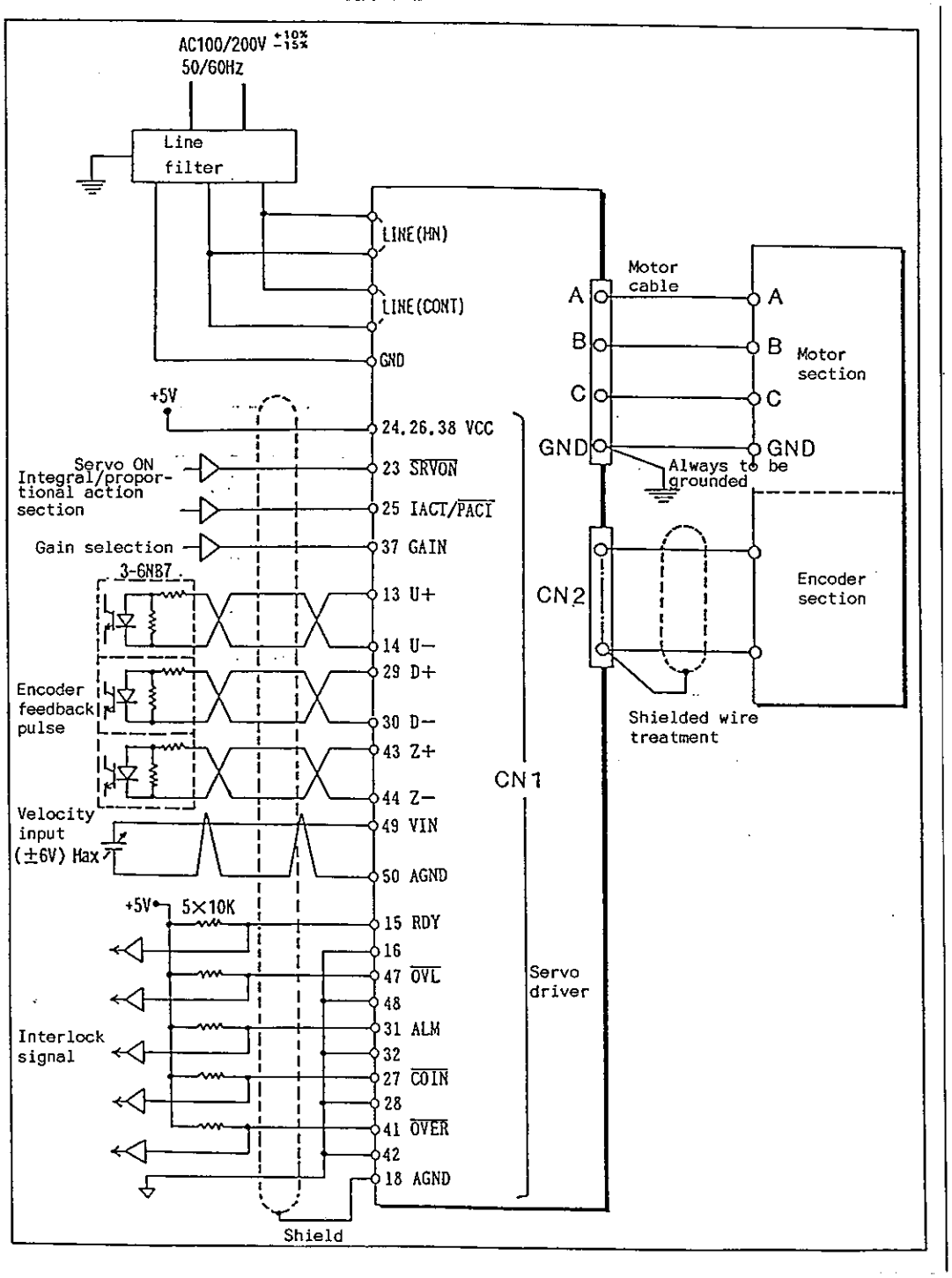
a) In the position control mode



(Note) Prepare the 5 V power supply on the user's side.
Carry out complete noise rejection treatment in the input section.

Figure 3.7

b) In the velocity control mode



(Note) Prepare the 5 V power supply on the user's side.
Carry out complete noise rejection treatment in the input section.

Figure 3.8

(4) Connection to external controller
(CN1 terminal I/O signal connection and external signal processing)

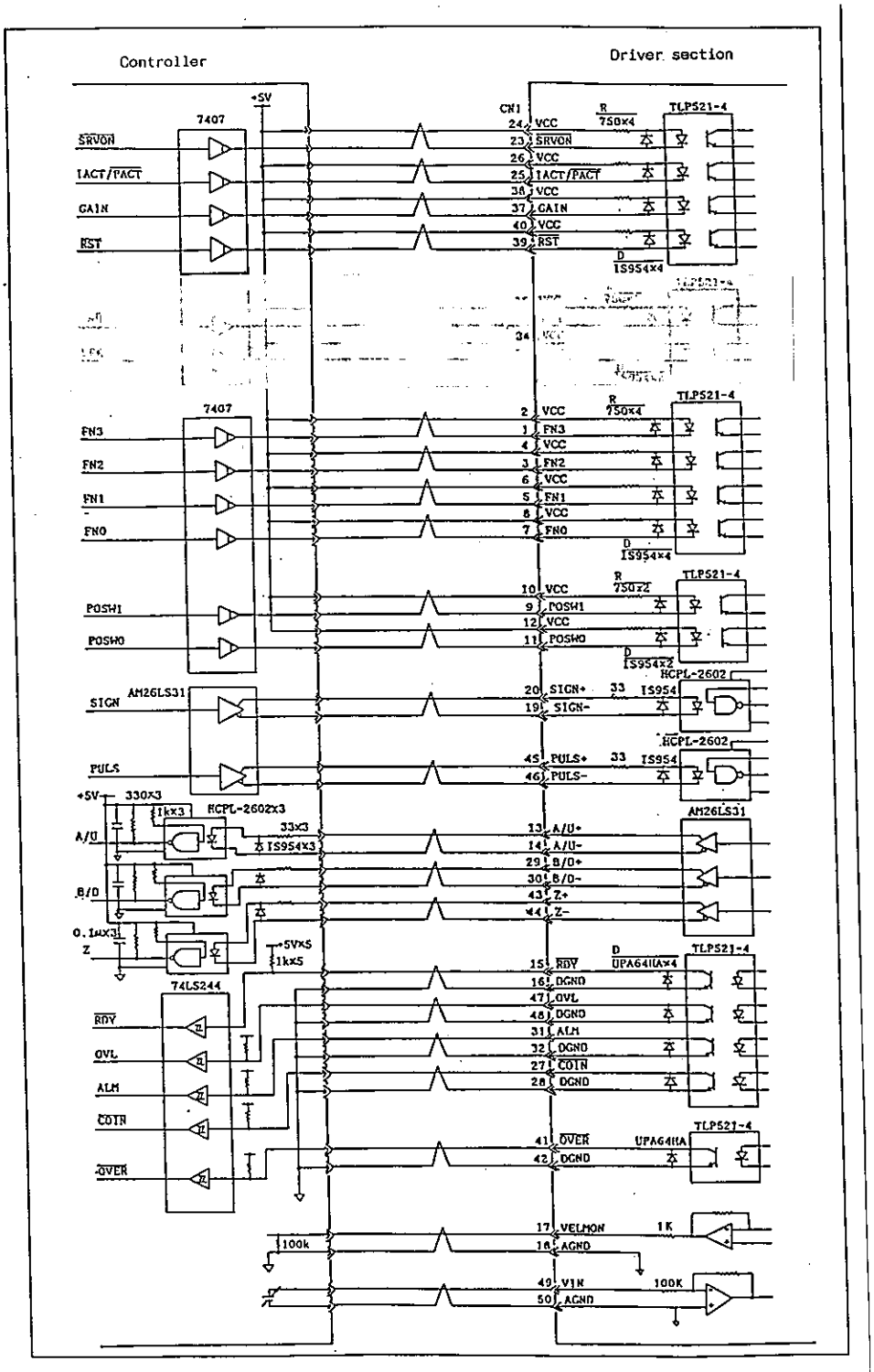


Figure 3.9

(5) Details of CN1 terminal I/O signals

a) Input

Table 3.3

Note: ( ) indicates Vcc signal power input.

Signal name	Pin No.	Meaning	Details
FN 3 FN 2 FN 1 FN 0	1 (2) 3 (4) 5 (6) 7 (8)	Compliance setting (Servo stiffness setting)	The signal for setting the <fc> switch on an interface is a 4-bit positive logic binary number which can be set in 16 steps of fc = 1 to 16 Hz. (see P-26)
POSW 1 POSW 0	9 (10) 11 (12)	Positioning completion pulse width end	Signal for setting the deviation couting value for outputting the positioning completion pulses. Four step settings can be made in any range of 1 to 100, 2 to 200, 4 to 400, and 8 to 800 together with POSW switch setting. (see P-27)
SIGN+ SIGN-	20 19	Rotation direction command	The motor rotates CW with this signal set to H, and CCW with the signal set to L. (When viewed from the load side, it is the same hereafter.) (see P-24)
$\overline{\text{SRVON}}$	23 (24)	Servo ON	The motor is set to the servo ON status 0.2 sec. after this signal is set to L to set the driver to the command wait status.
IACT/ $\overline{\text{PACT}}$	25 (26)	Integral/ Proportional action selection	Integral action is selected when this signal is set to H and proportional action is selected when this signal is set to L in the position control mode.
GAIN	37 (38)	Gain selection	Signal to select the variable DC gain range. DC gain can be varied in the range of 0.5 to 5 times when the signal is set to H, and in the range of 5 to 50 times when set to L.
$\overline{\text{RST}}$	39 (40)	CPU reset	The driver control section is initialized when this signal is set to L for more than 50μ sec.
PULS+ PULS-	45 46	Position command pulse	Driver position command pulse signal. To rotate the motor once, a 1,024,000-pulse signal (A type) or 655,360-pulse signal (B type) is required. The pulse frequency is 1024 kHz (A type) or 655.36 kHz (B type), corresponding to 1 rps. The pulse signal is a positive logic with a minimum pulse width of 300 ns.
VIN	49 50	Velocity command input	Set to the maximum number of revolutions at ±6 V input. CW direction/ +6 V, CCW direction/ -6 V In the position control mode, pins 49 and 50 should be shorted.

b) Output

Table 3.4

Note: ( ) indicates GND signal output.

Signal name	Pin No.	Meaning	Details
A+/U+ A-/U- B+/D+ B-/B-	13 14 29 30	Position feedback pulse signal	Pulse signal to indicate the motor rotating position. Either A/B phase or UP/DOWN phase pulse can be selected by the jumper on the board.
$\overline{\text{RDY}}$	15 (16)	Servo ready	The motor is ready to operate with this signal is set to L. This signal is set to the H level about 1 sec. after the driver is powered-ON.
VELMON	17 (18)	Velocity monitor	Analog monitoring signal which outputs ±6 V at the maximum number of revolutions. Outputs a positive voltage for CW rotation and a negative voltage for CCW rotation.
$\overline{\text{COIN}}$	27 (28)	Positioning completion signal	This signal is set to L when the deviation counter value becomes less than the POSW switch set-value. Pulses of 0 to 15 can be set with the POSW switch. The switch settings 0 to F correspond to the number of pulses.
ALM	31 (32)	Alarm	Set to H on detection of an abnormal condition. (see P-24)
$\overline{\text{OVER}}$	41 (42)	Deviation counter overflow	The deviation counter overflow signal is output only in the position control mode. This signal is set to L when the deviation counter value exceeds 32767.
Z+ Z-	43 44	Origin pulse	Signal for detecting the origin position obtained by equally dividing 1 motor revolution (100 for the A series, 60 for the B series). Changes from H to L during CW rotation and from L to H during CCW rotation.
OVL	47 (48)	Overload	Set to H during overload (in case of mechanical constraint for more than 30 sec.) It simultaneously reduces motor current automatically to 1/3.

3.4 Installation

When the product is delivered, first check the product type and Model No., the type and quantity of accessories, and of the motor and driver.

(1) Motor section mounting

The motor section can be mounted vertically or horizontally. As incorrect mounting or an unsuitable mounting location may shorten the motor service life and cause faulty operation, always observe the following.

a) Installation location

The motor section is designed for indoor use, and therefore the installation location must satisfy the following conditions:

- No corrosive or explosive gases
- Ambient temperature between 0 and 45° C
- Low dust concentration, good air ventilation, and low humidity

(Note): The DYNASERV is not drip-proof or oil-proof, and should therefore be protected by a suitable drip- and oil-proof cove where necessary.

b) Mechanical coupling

- When coupling the load to the motor rotor, ensure that there is a clearance of more than 1 mm between the upper surface of the motor and the load to maintain surface accuracy.
- Secure the motor rotor and stator by tightening the setscrews with torques of less than the values shown below.
- Set the motor setting base level to less than 0.01 mm.

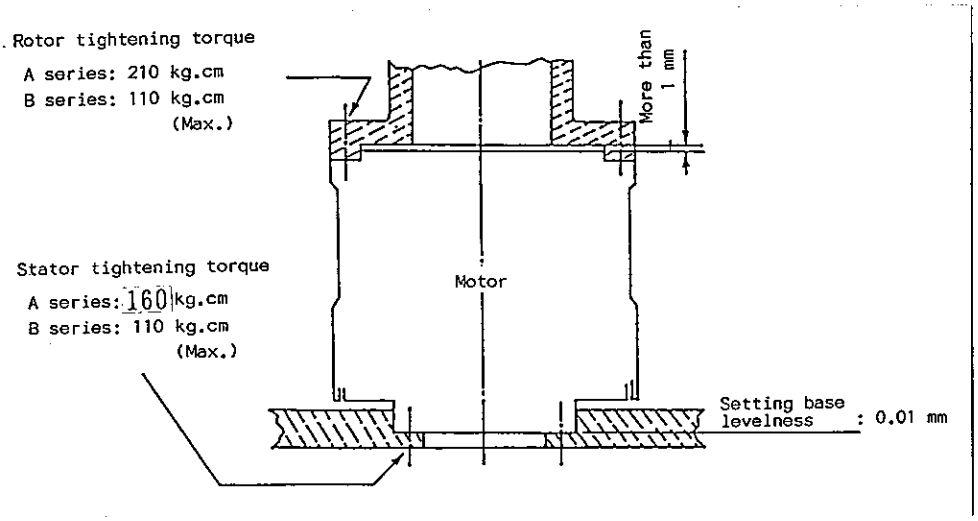


Figure 3.10

(Note) When tightening the screws, always apply LOCKTITE 601 or the equivalent to the screws to lock them.

(2) Driver section mounting

The standard driver is rack mounted.

a) Installation Location

- If there is a heat-generating body near the installation location, ensure that the temperature does not exceed 50° C near the driver by providing a heat shield or cover, etc.
- If there is a vibration source near the driver, mount the driver to the rack with vibration insulators.
- In addition, avoid humidity high temperature environments containing dust, metal power and corrosive gases.

b) Mounting procedure

- Normally, the drive is mounted with its front panel facing forward and its top and bottom surfaces horizontal. However, it may be mounted with its front panel facing upward. It should not, however, be mounted with the front panel on its side or upside down. (See Figure 3.12.)
- As a self-cooling driver box with a build-in fan is used, a ventilation space of more than 25 mm must be left below and above the box. (See Figure 3.11.)
- Mount the driver using the 4 holes at the top and bottom of the front plate.

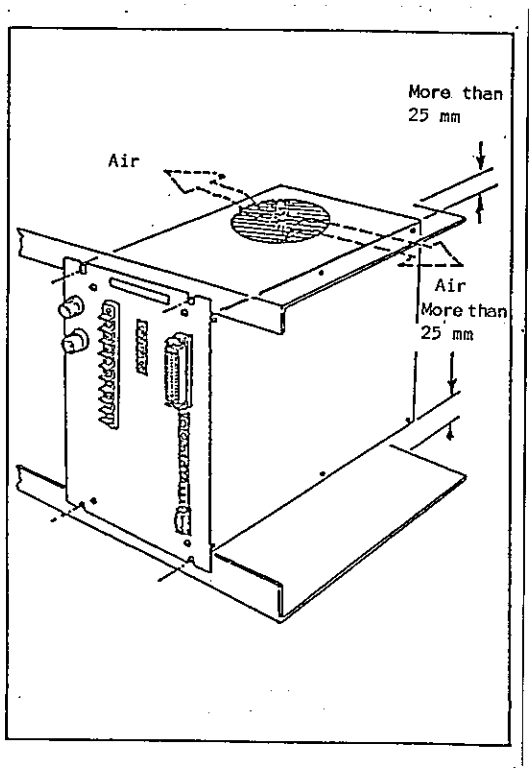


Figure 3.11

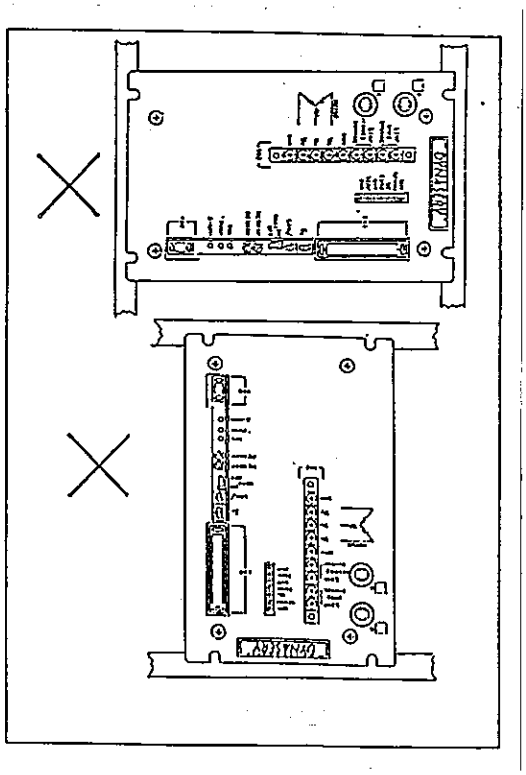


Figure 3.12

3.5 Wiring Cables

(1) Cable sizes and rated currents

Table 3.5

			A type	B type
Input	① AC power cable	Current (A)	20	15
		Cable size	HIV: More than 2.0, length: Within 30 m	
	② Motor cable	Current (A)	20	15
		Cable size	HIV: More than 2.0, length: Within 30 m	
	③ Jumper wire	Current (A)	20	15
		Cable size	HIV: More than 2.0	
Output	④ Interface cable	Current (A)	100 mA DC Max.	
		Cable size	* Twisted pair collectively shielded wire Length: Within 3 m	
	⑤ Encoder cable	Current (A)	150 mA DC Max.	
		Cable size	* Twisted pair collectively shielded wire Length: Within 30 m	
	⑥ Grounding	Cable size	HIV: More than 2.0	

(Notes)
1. Current values: r.m.s. of rated currents
2. Cable size: Cross-Sectional area in mm^2
3. Cross-sectional area of conductor marked with *: More than 0.2 mm^2 tin-plated twisted wire
4. Outer sizes of the cables used for CN1 and CN2; Less than ϕ 14 mm or ϕ 9 mm, respectively
5. Cable size is obtained under the condition that the ambient temperature is 40° C and the rated current flows through 3 bundles lead wires.
6. HIV: special heat-insulation wire
   Allowable conductor temperature of 75° C
7. With a 200 v power supply, the current values are half the above values with the same wiring.

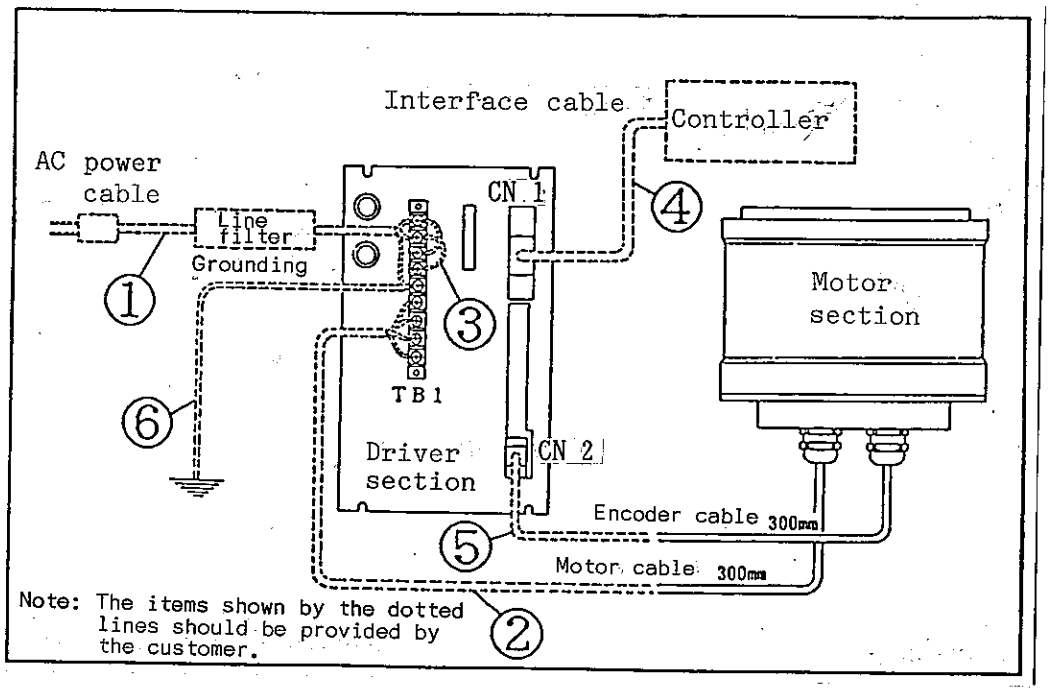


Figure 3.13

(2) Wiring precautions

- Use specified multi-core twisted pair cables with collective shielding for interface and encoder cables. Be sure conduct shield end treatment correctly.
- Use thick conductors as grounding cables as much as possible. Ground the DYNASERV through a resistance of less than 100Ω .
- Since a high voltage large current flows through the motor and AC power cables, ensure that their wirings are correct.

4. Operation Cautions

4.1 External Controller Input/Output Signals

(Note: See pages 16 and 17 for items other than the following.)

(1) Alarm output signal (ALM, Pin No. 31 (32))

If any of the error shown below occurs, this signal is set to H and the amplifier is turned OFF, and at the same time LEDs on the front panel are lit or extinguished to indicate the error occurrence.

Table 4.1

Error (Cause)	LED lit	LED extinguished
Abnormal current flowing in the motor winding	OC	RDY, SERVO
Motor drive supply voltage exceeds 360 V.	OVV	RDY
Motor drive supply voltage falls below 140 V.	FUSE	RDY
Power board heat sink exceeds 85°C.	TEMP	RDY
Power board 15 V supply voltage falls below 12 V.	PWR	RDY
Control board 15 V supply voltage falls below 12 V.		RDY
Encoder waveform is interrupted. (cable disconnection, etc.)		RDY
SERVO READY not sent from driver. (driver fault)		RDY
CPU trouble (noise, etc.)		RDY

The following indications are used to confirm the statuses.

Table 4.2

Confirmed status	LED lit
Motor is in normal operation.	RDY
Motor is in normal operation and is in Servo ON status.	SERVO

(2) Origin pulse output signal (Z+/Z-, Pin Nos. 43 and 44)

This signal detects the zero position obtained by equally dividing 1 motor revolution into 100 (for the A series) or 60 (for the B series). The point at which this signal changes from H to L during CW rotation or from L to H during CCW rotation is that at the "zero position passing" time. Rotation is referred to as clockwise or counterclockwise as seen from the load side.

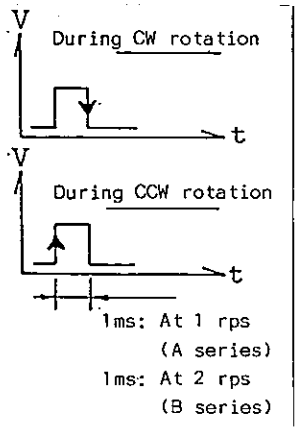


Figure 4.1

(3) Velocity monitoring output signal
(VELMON, Pin Nos. 17 and 18)
Motor analog velocity monitoring output
Output voltage: At maximum velocity +6 V (CW)
At maximum velocity -6 V (CCW)

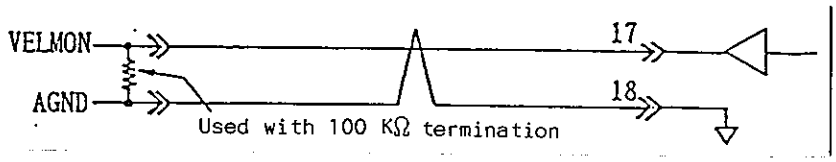
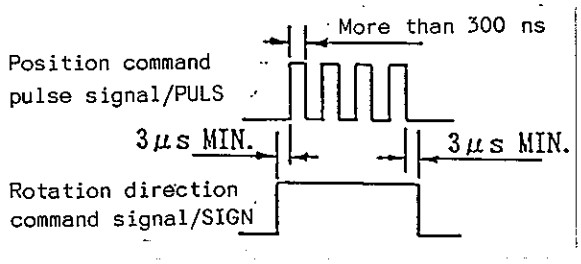


Figure 4.2

(4) Motor rotation direction command input signal (SIGN+/SIGN-, Pin Nos. 20 and 21)
Signal to indicate the direction in which the motor rotates. The motor rotates in the CW direction with this signal set to H, and in the CCW direction with this signal set to L. The output timing for this signal and the position command pulse signal is shown below.



(Note) The pulse should be set to active H. This means that current does not flow through the driver photocoupler when the pulse is not output.

Figure 4.3

(5) Compliance setting input signal (FN 3 - FN0, Pin Nos. 1 - 8)
The signal for setting the fc switch on the interface.
This signal is a 4-bit (FN0 - FN3) signal, and its relationship with the fc switch is as follows.
When fc is controlled by this signal, the fc switch should be set to the "0" position.
Table 4.3 shows the relationship between the fc switch and fc.

Table 4.3

FN3	FN2	FN1	FN0	fc switch position	fc (Hz)
H	H	H	H	0	5
H	H	H	L	1	6
H	H	L	H	2	7
H	H	L	L	3	8
H	L	H	H	4	9
H	L	H	L	5	10
H	L	L	H	6	11
H	L	L	L	7	12
L	H	H	H	8	13
L	H	H	L	9	14
L	H	L	H	A	15
L	H	L	L	B	16
L	L	H	H	C	17
L	L	H	L	D	18
L	L	L	H	E	19
L	L	L	L	F	20

(6) Positioning completion pulse width setting input signal (POSW 1/POSW 0, Pin Nos. 9 to 12)
The signal for setting the deviation count value when the positioning completion pulses are output.
One of 16 deviation count values can normally be set by the POSW switch on the control board, but if this switch is set to any of 0, 4, 8 or C, then switching operations are possible by means of this signal as shown in Table 4.4.
For example, setting the POSW switch to 0, POSW 1 to H and POSW 0 to L gives the same set-value as setting the POSW switch to 1.

Table 4.4

POSW switch setting	POSW 1	POSW 0	POSW switch position	Set pulse position
0	H	H	0	1
	H	L	1	5
	L	H	2	20
	L	L	3	100
4	H	H	4	2
	H	L	5	10
	L	H	6	40
	L	L	7	200
8	H	H	8	4
	H	L	9	20
	L	H	A	80
	L	L	B	400
C	H	H	C	8
	H	L	D	40
	L	H	E	160
	L	L	F	800

(7) Velocity command input (VIN, Pin Nos. 49 and 50)
An analog signal which gives the motor rotation velocity command value; the maximum velocity in the CW direction at +6 V and the maximum velocity in the CCW direction at -6 V. (Input range: -6 V to +6 V)

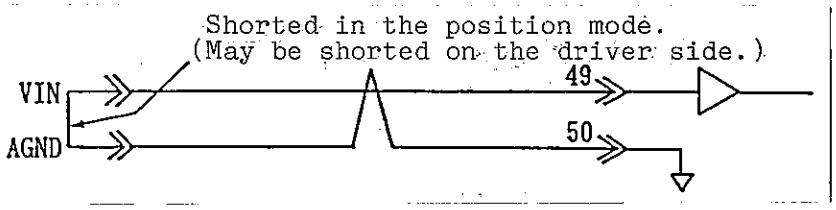


Figure 4.4

(8) Position feedback pulse signal

A-phase/UP pulse output signal (A+/U+·A-/U-,Pin Nos. 13 and 14)

B-phase/DOWN pulse output signal (B+/D+·B-/D-, Pin Nos. 29 and 30)

This is the signal which indicates the motor position. Either of two pulse output formats can be selected by using the jumper on the control board, as shown below.

a) A-/B-phase output pulse

Shorting jumpers A and B on the control board outputs the following pulse signal.

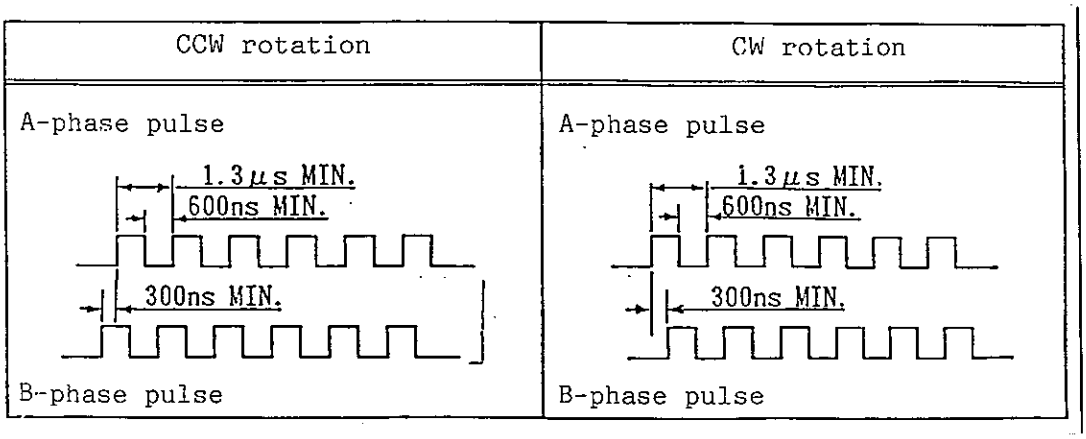


Figure 4.6-1

b) UP/DOWN output pulse

Shorting jumpers U and D on the control board outputs the following pulse signal.

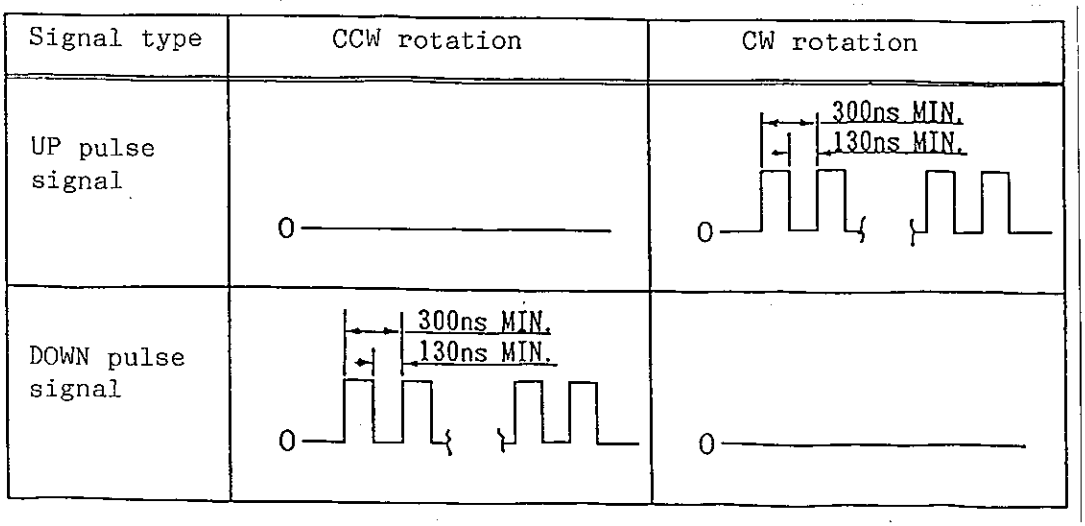


Figure 4.6-2

4.2 Power ON/OFF

(1) The main circuit power (MN) and control circuit power (CONT) should be turned ON simultaneously.

(2) When turning these power supplies OFF, turn them OFF simultaneously (including after instantaneous power failure), or turn OFF the main circuit power first.

(3) When turning ON the control circuit power (CONT), an alarm signal is output for a maximum of about 1 second due to internal servo-driver initialization.

(4) Rush current in both the main and control power circuits is about 15 A peak.

(5) The motor is set to the servo status about 200 ms after SRVON is set to L.

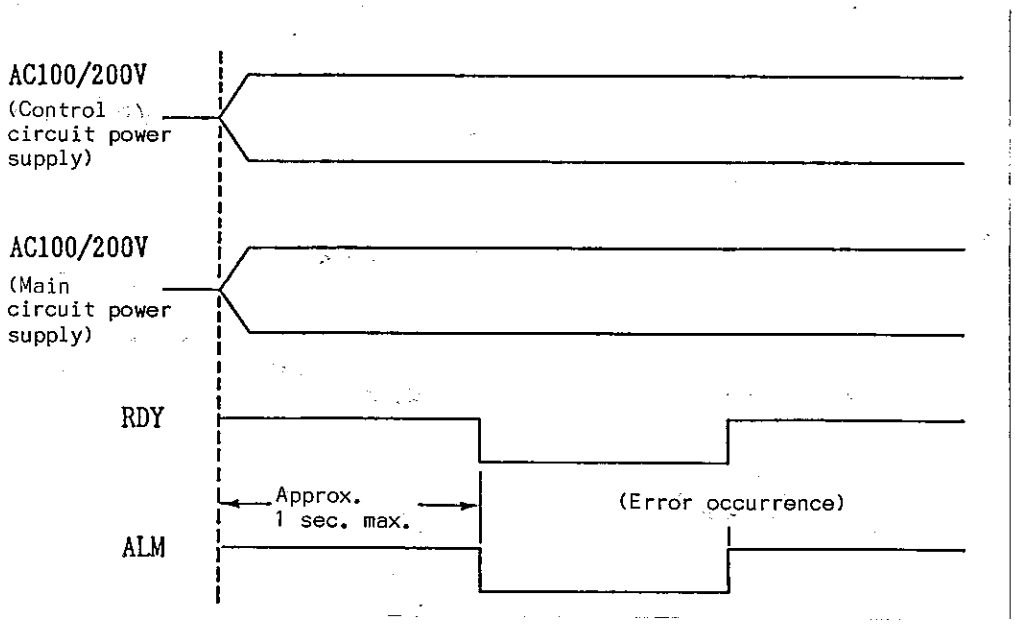


Figure 4.7 Power ON/OFF Timing

4.3 Notes on Load Setting

When operating the DYNASERV with a load mounted, the load inertia (J_L) is calculated centered on the motor and up to 30 times the rotor inertia of the DYNASERV itself (J_M) is an appropriate range for securing a fast start-up time. If used with a load greater than this, the stabilization period is increased to more than 150 msec. If the load multiplying-factor K obtained by dividing the load inertia by the rotor inertia exceeds a certain limit, the stabilization period is drastically increased and the limits of use are exceeds. The maximum usable load multiplying-factors for each model are shown in the following table. These should only be taken as a guideline, however.

Table 4.5

Series	Model	Max. load multiplying-factor	Rotor inertia (J_M)/kg·m²
A series	DM1200A	150	167×10^{-3}
	DM1150A	130	142×10^{-3}
	DM1100A	100	119×10^{-3}
	DM1050A	60	96×10^{-3}
B series	DM1075B		27×10^{-3}
	DM1060B	165	23×10^{-3}
	DM1045B	150	19×10^{-3}
	DM1030B	125	15×10^{-3}
	DM1015B	80	12×10^{-3}

5. Control and Adjustment

There are 4 control modes for control of the DYNASERV DM/SD series, as follows.

- Position control
  - I-PD type position control (high-precision positioning)
  - P type position control (compliance control)
- Velocity control
  - P type velocity control
  - PI type velocity control (high-precision velocity control)

In addition to the above normal modes, there is also a test mode used for tuning. In the test mode, a 2.5 Hz step input is applied as command position/velocity inside the driver, and the position response is output to the VEL pin. In tuning, adjustment is performed to minimize the overshoot of these responses.

5.1 Position Control

This is input control using input of a serial pulse train.

(1) I-PD type position control

This control uses position integral feedback, allowing positioning up to the final pulse. Stable control is also possible for inertia fluctuations. The adjustment locations are as follows.

<fc switch>

The switch which determines the band. The band fc can be selected in the range from 5 to 20 (Hz) with this switch. (fc = Switch No. +5 Hz) (Example: Switch No. 8 = 13 Hz)

<LIM ∫ switch>

This prevents the wind-up phenomenon by limiting the output of the digital integrator during software servo computation. The larger the switch No., the larger the limited value. The smaller the limited value, the smaller the wind-up and the shorter the setting time.

However, if the limited value becomes too small, the motor output torque is limited. Therefore, it can be said that it is better to make the LIM ∫ switch value large within the no wind-up range. The final adjustment is performed during the accelatoration/deceleration operation.

<DC gain>
Used to adjust the P type velocity loop band. The adjustment ranges are as follows:

When GAIN = H: 0.5 to 5 times
When GAIN = L: 5 to 50 times

The DC gain should be as large as possible. When there is inertia change, adjust the gain so that it becomes optimum at the maximum inertia.

(2) P type position control

Proportional control is used for position feedback, since positioning accuracy is not very good. However, since torque output proportional to position error is obtained, compliance control is possible.

The position control transmission characteristic is secondary. The adjustment locations are the same as for the I-PD type, but as the LIM ∫ switch is not involved, its setting is arbitrary.

5.2 Velocity Control

This is velocity control using analog voltage (± 6 V) input.

(1) PI type velocity control

Integral/proportional action is used in velocity control, and the velocity command transmission characteristic is secondary. As a strong velocity feedback loop can be formed, smooth disturbance-resistant velocity control can be achieved. This is the same as conventional DC/AC servo motor control.

<fc switch>	:	Arbitrary
<LIM ∫ switch>	:	Arbitrary
<DC gain>	:	Used to adjust the P type velocity loop band. The adjustment ranges are as follows: When GAIN = H: 0.5 to 5 times When GAIN = L: 5 to 50 times
<AC gain>	:	Used to adjust velocity loop band damping.

(2) P type velocity control

Since response is fast but loop gain is low, it is strongly influenced by disturbances in the controlled result. Adjustment locations are the same as for the P type, except that the AC gain setting is arbitrary.

5.3 Test Mode

When the TEST switch on the front panel of the driver is turned ON, in the position control mode the position step response signal is generated, and in the velocity control mode the velocity step response signal is generated. By adjusting the DC gain or AC gain control while monitoring this signal on an oscilloscope, optimum adjustment of the response can be achieved. (See Section 5.4 below.)

The relationship between the control modes, relevant switches, setting points and adjustment items is shown in the following table.

Table 5.1

		Jumper setting		Adjustment switch /variable resistor				Interface	
		J2/M	J1/PV	fc	LIM ∫	DC GAIN	AC GAIN	Gain	IACT /PACT
Position mode	I-PD type	Shorted	Shorted	○	○	○		○	H
	P type	Shorted	Shorted	○		○		○	L
Velocity mode	PI type	Open	Shorted			○	○	○	H
	P type	Open	Shorted			○		○	L

○: Can be adjusted.

5.4 Position Control System Adjustment (tuning) Procedure

The position control system can be adjusted in the test mode. Turning ON the test switch at the front of the driver-generates a 2.5 Hz square-wave position command signal inside the driver to output the motor position to the POSN signal terminals.

At this time, note that the motor exhibits reciprocal action at very small rotating angles.

The adjustment procedure in the test mode is as follows.

Step 1: Connect an oscilloscope to the POSN signal terminals. (POSN signal live at test mode only)

Step 2: Set the CN1 connector SERVO signal to L. At this time, set the TEST switch to OFF.

Step 3: Set the TEST switch at the front of the driver to ON.

Step 4: Adjust the fc switch. Its variable range is from 5 to 20Hz(scale 0 to F), and it should be set to about 10 Hz (scale graduation 9) under normal load conditions. Set the ILIM switch to a large value within the range in which there is no hunting.

Select the DC Gain range GAIN H to L signal to match the load condition.

Fine adjustment is performed using the DC gain variable resistor.

The above adjustments should be carried out so that the POSN signal becomes a square wave.

This step ends when the optimal waveform is obtained.

Step 5: Set the TEST switch at the front of the driver to OFF.

Step 6: Set the CN1 connector SERVO signal to H.

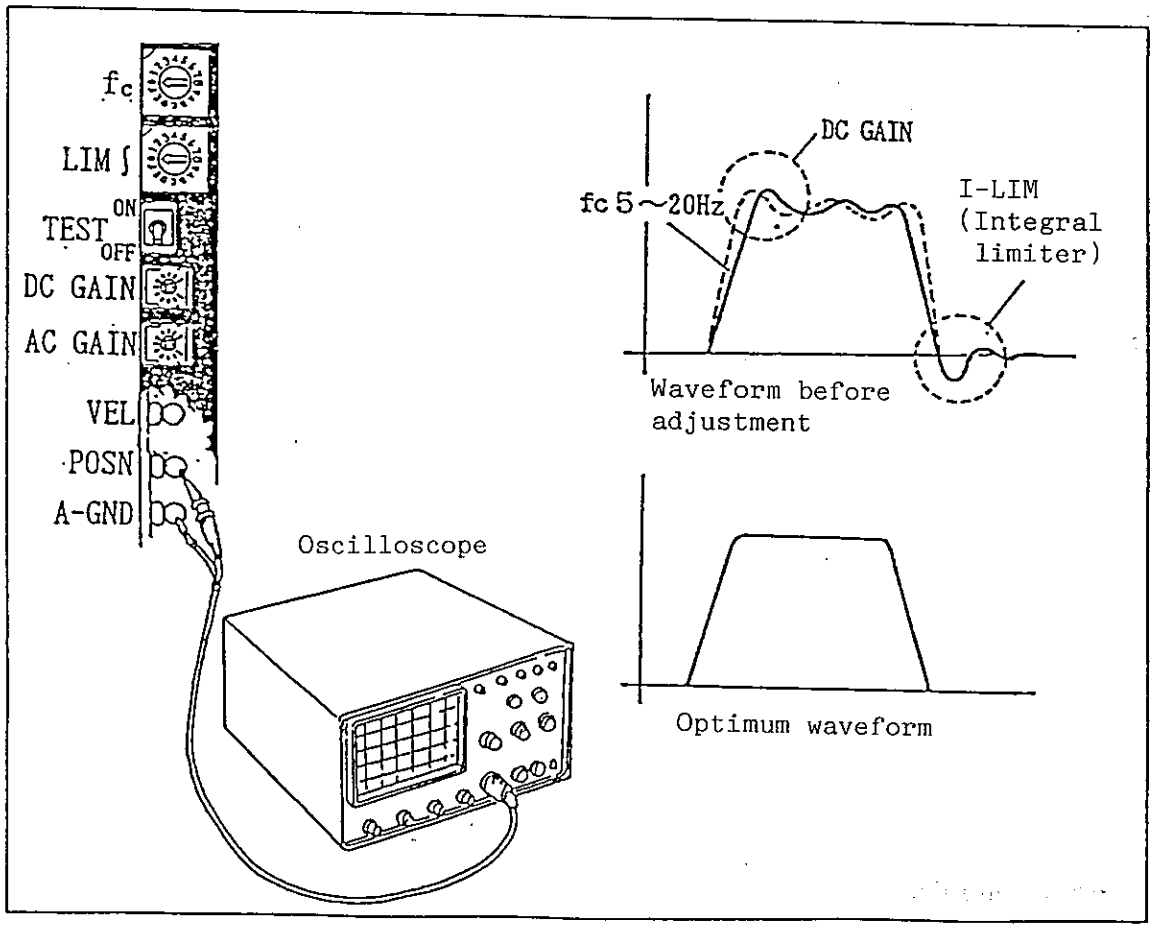

fc
LIM ∫
TEST ON
OFF
DC GAIN
AC GAIN
VEL
POSN
A-GND
Oscilloscope
DC GAIN
fc 5～20Hz
I-LIM
(Integral
limiter)
Waveform before
adjustment
Optimum waveform

Figure 5.1

5.5 Tuning (Adjustment) Without Measuring Instrument

The procedure for tuning without using any kind of measuring equipment is explained below. This adjustment method can only be used in the position control mode (I-PD type, with factory settings).

(1) Calculation or confirmation of the load inertia. To use this adjustment method, the load inertia (J_L: unit = $kg \cdot m^2$) is divided by the motor (DYNASERV) rotor inertia (J_M) to give the load multiplying-factor (K).

(2) Set the TEST switch on the front panel of the driver to ON.

(3) The calculated load multiplying-factors are as shown in the tables below (adjustment settings given separately for the A and B series). For example, taking a value of 10 for K on the DM1200A, the range 5 row is applicable. Next, look along the right-hand set-value columns at the same level.

(4) First, look at the figure in the first DC GAIN column. This is "30", so turn the DC GAIN variable resistor to "30".

Also, if ranges 1 or 2 are applicable for both the A and B series (i.e. the DC GAIN to be set is 5 or less), setting should be performed after first selecting the DC GAIN selection signal to H. (See Figure 5.2.)

(5) In the same way, select the figure in the first fc column and the first LIM $\int$ column on the same line, and adjust the relevant variable resistors to those settings.

(6) On completion of the above settings, turn the TEST switch OFF. This completes the adjustment procedure.

Table 5.2 DYNASERV Adjustment Settings (A Series)

Range	Load multiplying-factor (K)				Set values		
	DM1200A	DM1150A	DM1100A	DM1050A	DC GAIN	f_c	LIM ∫
1	~0.5	~0.3	No load		4	F	3 (5)
2	0.6 ~1.3	0.4 ~1.0	~0.6	No load	5	E	2 (5)
3	1.4~3.5	1.1~3.0	0.7 ~2.2	~ 1.0	10	C	2 (5)
4	3.6 ~7.3	3.1~6.4	2.3~4.9	1.1~2.6	20	A	1 (4)
5	7.4~14.9	6.5~13.1	5 ~10.2	2.7~5.9	30	8	0 (3)
6	15~38	13.2~33	10.3~26	6 ~ 15	55	5	1 (3)
7	39~53	34~46	27~36	16~ 22	55	4	1 (3)
8	54~75	47~66	37~52	23~ 32	55	2	2 (4)
9	76~113	67~100	53~79	33~ 49	55	0	3 (6)

Table 5.3 DYNASERV Adjustment Settings (B Series)

Range	Load multiplying-factor (K)				Set values		
	DM1060B	DM1045B	DM1030B	DM1015B	DC GAIN	f_c	LIM ∫
1	~1.2	~1	~0.7	No load	4	F	4 (6)
2	1.3 ~2.3	1.1 ~2	0.8 ~1.5	~0.6	5	E	3 (6)
3	2.4 ~5.6	2.1 ~5	1.6 ~4	0.7 ~ 2	10	C	3 (6)
4	5.7 ~11	6 ~10	5 ~8	2.1 ~4	20	A	2 (5)
5	12~22	11~20	9 ~16	4.1 ~10	30	8	1 (4)
6	23~55	21~50	17~40	11~ 25	55	5	2 (4)
7	56~77	51~70	41~60	26~ 36	55	4	2 (4)
8	78~110	71~100	61~80	37~ 50	55	2	3 (5)
9	111~165	101~150	81~125	51~ 80	55	0	4 (7)

(Notes) ① Figures in ( ) in the LIM ∫ columns should be selected to maximize the holding torque.
If the LIM ∫ value is made small, speed responsiveness is good but overshooting occurs. Also, if the value is raised above the value in ( ), low frequency vibration known as the "wind-up" phenomenon may occur, and thus the value in ( ) should not be exceeded.

② In the case of large load fluctuations, please consult us.

③ Abnormal noise or vibration does to cease even if the specified DC GAIN value is set, please consult us.

④ Setting fc to a large value gives a faster response; that is, the stabilization time is reduced.
Increasing fc only without increasing DC GAIN may result in unstable control and vibration.

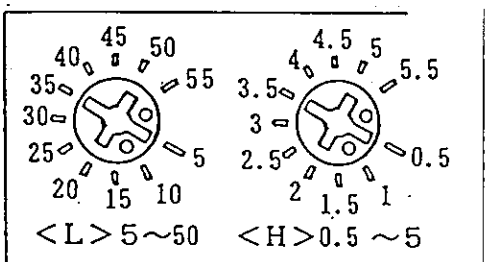
⑤ DYNASERV rotor inertia (J_M) (for reference)

Table 5.4

Series name	Model	Rotor inertia (kg·m2)
A series	DM1200A	0.167
	DM1150A	0.142
	DM1100A	0.119
	DM1050A	0.096
B series	DM1075B	0.0027
	DM1060B	0.023
	DM1045B	0.019
	DM1030B	0.015
	DM1015B	0.012

⑥ Load multiplying-factor (K)

$$= \frac{\text{Load inertia } (J_L)}{\text{Rotor inertia } (J_M)}$$



(Figure 5.2) DC GAIN Range Selection

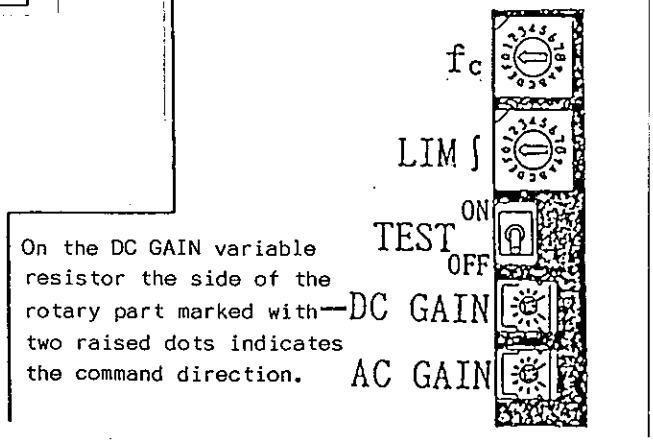


Figure 5.3

6. Maintenance and Inspection

6.1 Motor Section

Since this motor does not use wear prone parts, the following daily inspection is sufficient. Each inspection period is only for reference and varies with the environment and operating conditions.

In addition, some parts which have been used for 20,000 hours or 5 years may need replacement, requiring an overhaul if there are a lot of them. When an overhaul or motor disassembly is required, please contact us.

Table 6.1

Inspection item	Period	Inspection details	Evaluation
Sound and vibration check	Daily	Widen the motor rotation range as much as possible when the motor is checked audibly and by touching.	No change is found in daily inspection.
Insulation resistance measurement	Once a year	Separate the coupling from the driver, then measure the insulation resistance between the coil terminal and stator housing with a 500 V megger.	If it is more than 10 MΩ it is OK. Otherwise contact us.

6.2 Servo Driver Section

Although the servo driver does not require daily maintenance and inspection, it is advisable to clean it and check for loose screws periodically.

Overhaul the driver in the same way as the motor, i.e. after 20,000 hours or 5 years.

7. Trouble and Measures

7.1 Motor Trouble

If trouble occurs during motor operation, first check the LED indications on the front panel of the driver (Table 7.2). If the cause of the trouble cannot be determined from the LED indications, take appropriate measures in accordance with the following table. When the motor does not work normally, even after the following measures have been taken, stop operation immediately and contact us.

Table 7.1

Trouble	Estimated cause	Inspection item	Measures	Page reference
Motor is not servo locked	◆ No AC power is fed.	Wiring inspection	Supply specified AC power.	P.14/15
	◆ Fuse has burned out.	Fuse inspection	Fuse replacement	P.9
	◆ Servo ON (SERVO) terminal is set to H.	Inspection	Set to L.	P.17
	◆ CPU reset (RST) terminal is set to L.	Inspection	Set to H.	P.17
	◆ Fc, ILIM, DC gain is small	Inspection	Adjust to appropriate value.	P.34 to 38
Motor does not start.	◆ Motor is overloaded.	Operate under no load.	Lighten the load when starting the motor, or replace it with a large output motor.	
	◆ Incorrect external wiring	Inspect the wiring.	Re-wire correctly in accordance with connection diagram.	P.14 to 16
	◆ Fc, ILIM, DC gain is small.	Inspection	Adjust to appropriate value.	P.34 to 38
Motor rotation is unstable.	◆ Imperfect connection	Check the connection of motor's A, B and C phases and GND.	Re-wire correctly in accordance with connection diagram.	P.14 to 16
	◆ Incorrect motor/driver combination.	Check the combination Nos. on the name plate.	If the combination is wrong, provide the correct combination	P.8

Trouble	Estimated cause	Inspection item	Measures	Page reference
Motor overheats	◆ Ambient temperature is high.	Check to see if the ambient temperature exceeds 45°C.	Lower the temperature to below 45°C.	
	◆ Motor is overloaded.	Operate the motor under no load.	Lighten the load when starting the motor, or replace it with a large output motor.	
Abnormal sound is produced.	◆ Incorrect mounting	Loose setscrews.	Tighten the screws.	
	◆ Bearing trouble	Check for sound and vibration near the bearing	Motor replacement. (Contact us.)	
	◆ Mounting base vibration	Check the mounting base.	Reinforce the mounting base.	
Abnormally small motor torque	◆ Incorrect motor/driver combination.	Check the combination number on the nameplate.	If the combination is wrong, provide the correct combination	P.8
	◆ Motor is overloaded.	Check the OVL signal.	Recheck the operation. Lighten the load.	P.18 to 19
	◆ Fc, ILIM, DC gain is small.	Inspection	Adjust to appropriate value.	P.34 to 38
Motor runs out of control.	◆ Incorrect motor/driver combination	Check the combination number on the nameplate.	If the combination is wrong, provide the correct combination	P.8
	◆ Inappropriate jumper setting.	Inspection	Perform correct jumper setting.	P.11 to 12
	◆ Imperfect connection	Check motor/encoder connections.	Re-wire correctly in accordance with connection diagram.	P.14 to 16

Trouble	Estimated cause	Inspection item	Measures	Page reference
Position is dislocated.	◆ Incorrect A-/B-phase and U-/D-pulse jumper selection	Inspection		P.11 to 12
	◆ Command pulse rate and width are not as specified.	Check the command pulse width.		P.26 to 28
	◆ Feedback pulse rate and receive circuit response speed are not as specified.	Check the feedback pulse rate (3 MHz max.) and receive circuit response speed.		P.26 to 28
	◆ Both ends of the feedback pulse transmission cable shield are not connected to the earth.	If so, connect the driver to AGEN and controller to SG.		

7.2 Driver Panel LED Error Indications

If an abnormal condition occures in the motor or driver sections, it is indicated by the LEDs on the driver panel (5 of the 7 LEDs at the top of the panel, and 3 LEDs at the rear of the TEST switch). When any of these LEDs lights, appropriate measures should be taken as shown in the following table.
If normal operation is not recovered even after the specified measure have been taken, stop using the equipment and contact us immediately.

(1) LEDs on front driver Panel

Table 7.2

LED lit	Error indicated	Cause	Measures
<OC>	Current in FET module exceeds 50 A.	◆ FET failure ◆ Current detection circuit failure ◆ Motor coil short	◇ If not restored by powering-ON again, repair driver. ◇ Replace motor.
<OVV>	Main power supply voltage exceeds 360 V.	◆ Regeneration processing circuit failure ◆ High input voltage	◇ Repair driver. ◇ Reduce input voltage.
<FUSE>	Main power supply voltage is less than 140 V.	◆ Burned fuse ◆ Low input voltage	◇ Replace fuse. ◇ Increase input voltage.
<TEMP>	Heat sink temperature exceeds 85°C.	◆ FET failure ◆ Gate circuit failure ◆ Fan stoppage ◆ Ambient temperature exceeds 50°C.	◇ Cut power, wait a while, then power-ON again. ◇ Replace fan. ◇ Adjust ambient temperature to less than 50°C.
<PWR>	Servo amp. power supply 15 V voltage is less than 12 V, or 5 V voltage is less than 2.5 V	◆ Power supply circuit failure ◆ Gate circuit failure ◆ Instantaneous power failure	◇ If not restored by powering-ON again, repair driver.

(2) LEDs at rear of TEST Switch

Table 7.3

LED lit			Error indicated	Cause	Measure
0	1	2			
○			±15 V power supply voltage is less than ±12 V.	◆ Low input voltage ◆ Power supply circuit fault	◇ If not restored by powering-ON again, repair driver.
	○		Overspeeding Actual speed exceeds 1.5 times command speed.	◆ Speed detection circuit fault ◆ Faulty encoder operation ◆ Encoder disconnection ◆ Incorrect encoder cable wiring	◇ If not restored by powering-ON again, repair driver. ◇ Check wiring. ◇ Check connection diagram.
○	○		Encoder error Interruption of encoder waveform	◆ Faulty encoder operation ◆ Encoder power supply circuit fault ◆ Encoder disconnection ◆ Faulty encoder cable wiring	◇ If not restored by powering-ON again, repair driver. ◇ Check wiring.
		○	Eccentricity compensation operation error	◆ Degree of eccentricity has exceeded limit. ◆ Faulty operation due to noise ◆ Faulty encoder cable wiring	◇ Replace motor. ◇ Power-ON again ◇ Check connection diagram.
○		○	Overload error Motor lock status continues beyond specified time.	◆ Motor is locked.	◇ Release lock status.
	○	○	Counter overflow Pulse difference between command position and current position exceeds 32,767	◆ Fast acceleration/deceleration ◆ Command position changed with motor locked ◆ Motor rotated by external force without change in command position	◇ Reduce acceleration/deceleration ◇ Release lock status. Reset CPU using RST signal.
○	○	○	CPU error	◆ Control board fault ◆ Faulty operation due to noise	◇ Repair driver. ◇ Reset CPU.

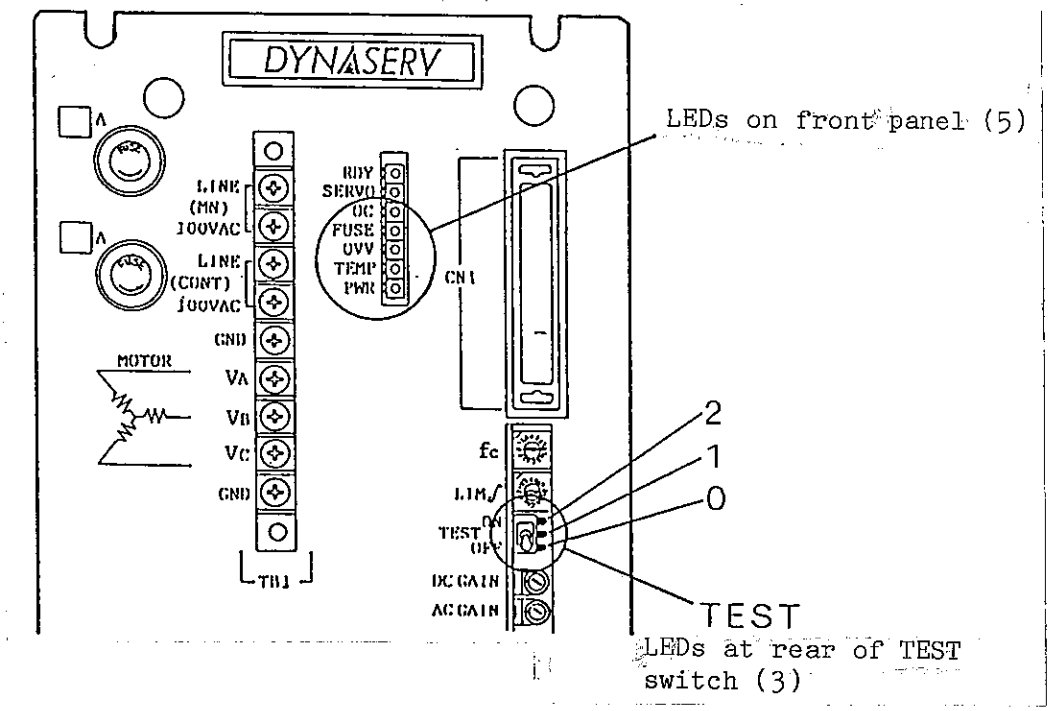


Figure 7.1 LED Locations

8. Others

8.1 Specifications

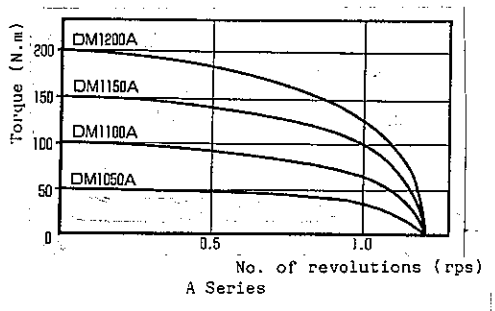
(1) Standard Specifications

Series				"A" Series				"B" Series				
Model				DM1200A	DM1150A	DM1100A	DM1050A	DM1075B	DM1060B	DM1045B	DM1030B	DM1015B
Motor & servo driver coupling	Rated output		W (HP)	820 (1.10)	630 (0.84)	410 (0.55)	220 (0.30)	750 (1.0)	450 (0.6)	380 (0.51)	250 (0.34)	125 (0.17)
	Rated torque		N·m (lb·ft)	130 (96)	100 (74)	65 (48)	35 (26)	60 (44)	48 (35)	30 (22)	20 (15)	10 (7.4)
	Rated speed		rps	1.0				2.0	1.5	2.0		
	Max. output torque		N·m (lb·ft)	200 (148)	150 (111)	100 (74)	50 (37)	75 (55)	60 (44)	45 (33)	30 (22)	15 (11)
	Max. speed		rps	1.2				2.4				
	positioning	Encoder resolution	p/rev	1,024,000				655,360				
		Positioning accuracy	arc-sec	±15								
		Repeatabilty	arc-sec	±2								
Motor section	Rotor inertia		kg·m² (lb·ft·sec²)	167×10⁻³ (123×10⁻³)	142×10⁻³ (104×10⁻³)	119×10⁻³ (88×10⁻³)	96×10⁻³ (71×10⁻³)	27×10⁻³ (20×10⁻³)	23×10⁻³ (17×10⁻³)	19×10⁻³ (14×10⁻³)	15×10⁻³ (11×10⁻³)	12×10⁻³ (9×10⁻³)
	Rated maximum load	Axial Load	Compression	4.0×10³ (8.8×10³)				3.0×10³ (6.6×10³)				
		kgf (lb)	Tension	2.0×10³ (4.4×10³)				1.0×10³ (2.2×10³)				
		Overhung load N·m (lb·ft)		400 (296)				200 (147)				
	Torsional stiffness	Axial stiffness	Compression	2.0×10⁻⁵ (1.8×10⁻⁶)				2.5×10⁻⁵ (2.2×10⁻⁶)				
		mm/kgf (in/lb)	Tension	3.0×10⁻⁵ (2.6×10⁻⁶)				3.0×10⁻⁵ (2.2×10⁻⁶)				
		Radial stiffness rad/kgf·m (rad/lb·ft)		4.0×10⁻⁶ (29×10⁻⁶)				1.0×10⁻⁵ (7.2×10⁻⁵)				
	Weight		kg (lbs)	29 (64)	24 (53)	19 (42)	14.5 (32)	14 (31)	12 (27)	9.5 (21)	7.5 (17)	5.5 (12)
	Dimension (Dia.×H)		mm (in)	φ264×188 (φ10.4×7.4)	φ264×163 (φ10.4×6.4)	φ264×138 (10.4×5.4)	φ264×113 (φ10.4×4.4)	φ160×194 (φ6.3×7.6)	φ160×168 (φ6.3×6.6)	φ160×143 (φ6.3×5.6)	φ160×118 (φ6.3×4.6)	φ160×92.5 (φ6.3×3.6)
	Common Items			Motor insulation: Class F (JIS C 4003) Withstanding voltage: AC 1500V. 1 min				Insulation resistance: 10MΩ Min. (DC 500V) Color: Black Excitation: 3 Phase				
Servo driver section	Model	For 100V AC		SD1200A-1	SD1150A-1	SD1100A-1	SD1050A-1	SD1075B-1	SD1060B-1	SD1045B-1	SD1030B-1	SD1015B-1
		For 200V AC		SD1200A-2	SD1150A-2	SD1100A-2	SD1050A-2	SD1075B-2	SD1060B-2	SD1045B-2	SD1030B-2	SD1015B-2
	Input signal	Speed Input signal		Analog voltage: DC±6V								
		Positioning input signal		Serial pulse 1.229 MHz Max.				Serial pulse 1.572 MHz Max.				
		Rotation direction command signal		H: CW L: CCW								
	Output Signal	Speed output		+6V (CW) to −6V (CCW)								
		Encoder output		Track A, Track B, (307 kHz Max.) Zero position signal (100 p/rev)				Track A, Track B, (393 kHz Max.) Zero position signal (60 p/rev)				
		Alarm output		Over-current, Over-voltage, Heat sink Temperature alarm, Voltage low alarm Encoder abnormal, CPU abnormal								
		Monitor output		2.5 Hz Step response output (Test mode)								
	Power source			AC 100/200V, +10 to −15%, 50/60 Hz								
	Power consumption (Max)		KVA	3.0	2.7	2.5	1.5	2.5	1.8	1.7	1.7	1.2

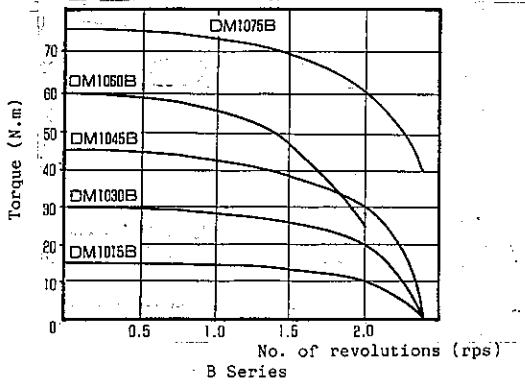
(2) Environmental Specification

			Motor Section	Servo Drive Section	Notes
Ambient operating conditions	Temperature	°C	0 to 45	0 to 50	
	Humidity	%R.H.	20 to 85	20 to 90	Non condensing
Storage conditions	Temperature	°C	−20 to 85	−20 to 85	
	Humidity	%R.H.	20 to 85	20 to 90	Non condensing
Atmosphere			No corrosive gases, Dust-free atmosphere		

8.2 No. of Revolutions/Torque Characteristic



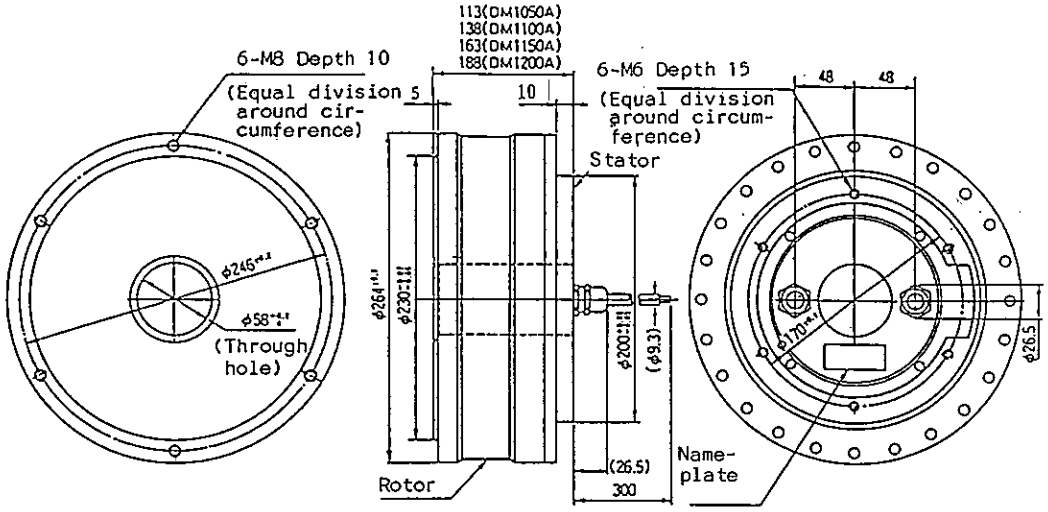
A Series



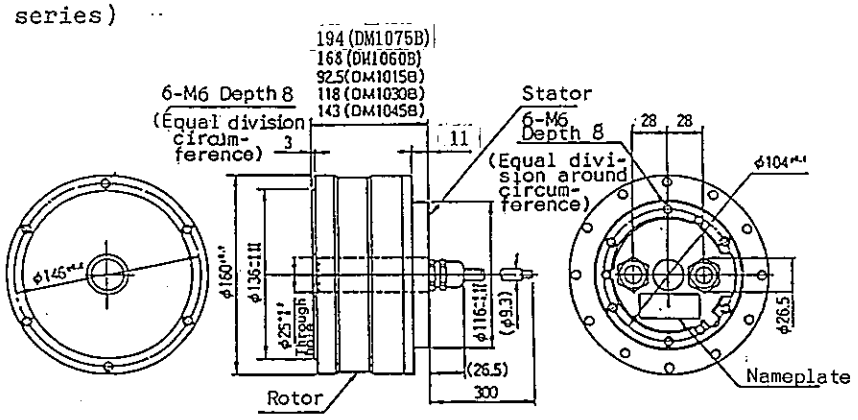
B Series

8.3 Dimensional Outline Drawing (Unit: mm)

1. Motor (A series)



2. Motor (B series)



3. Driver box (Box A and B series)

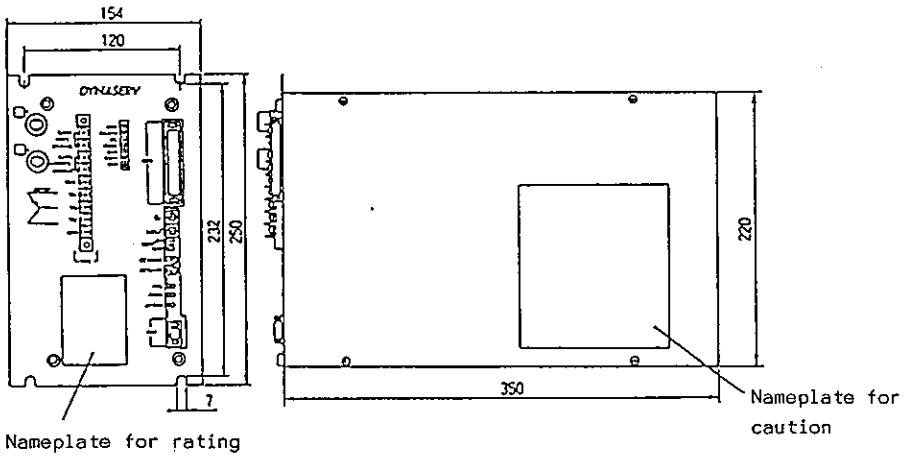
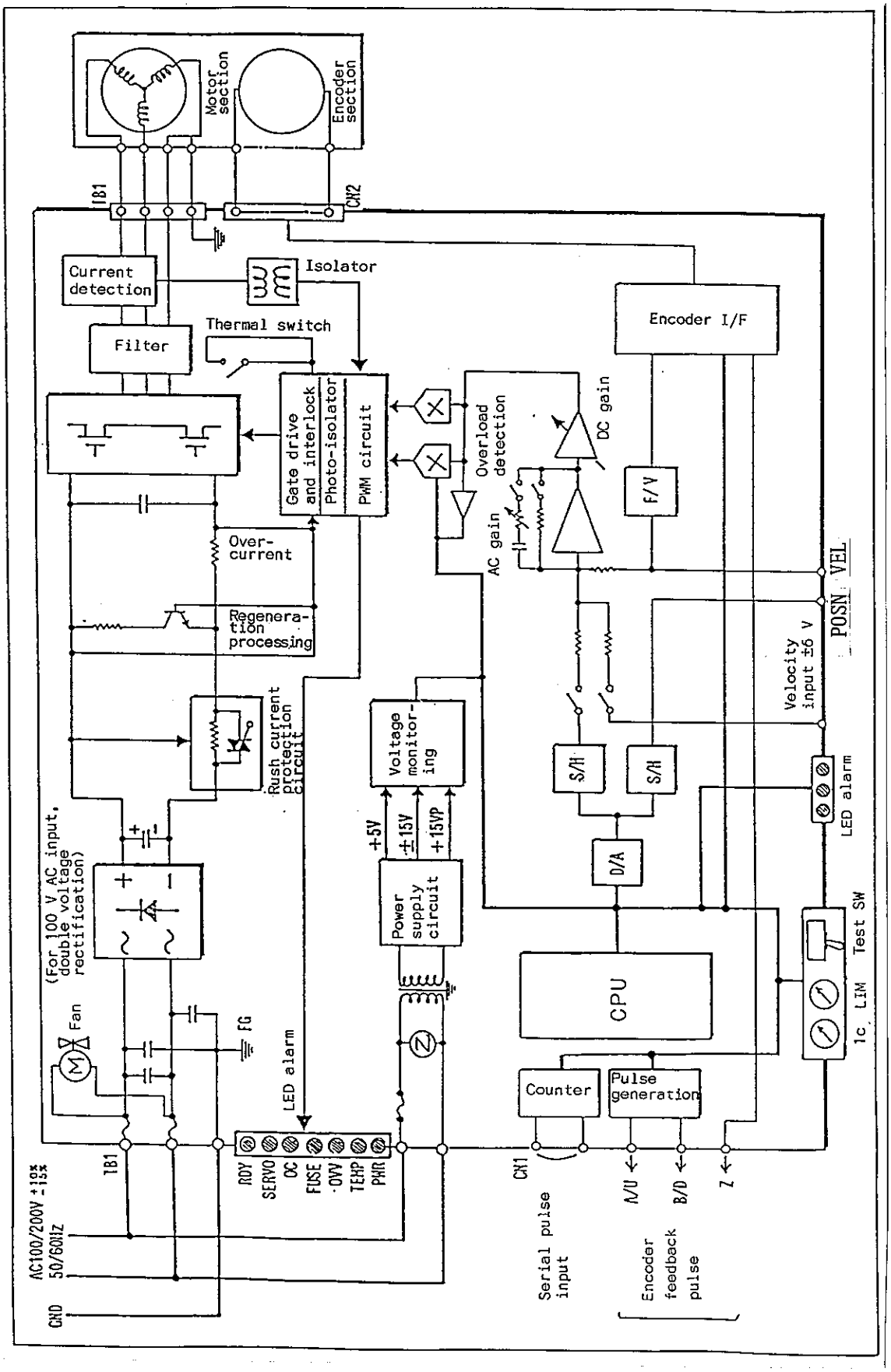
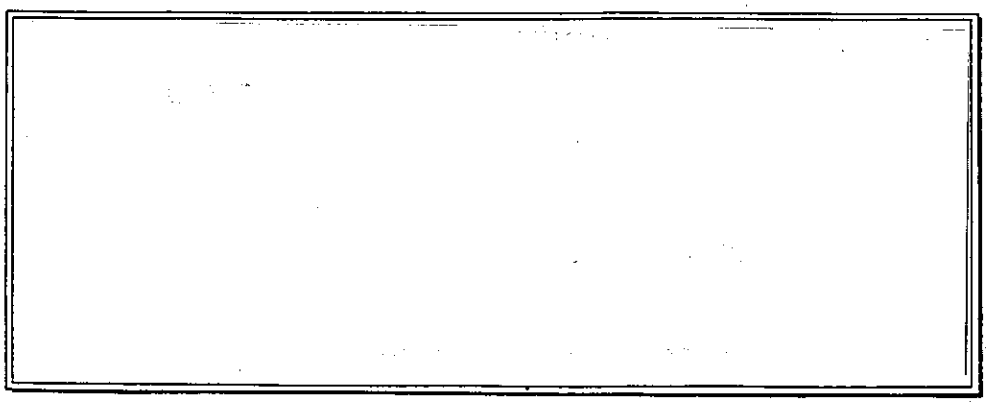


Figure 8.3

8.4 Block Diagram





Sep. 1990