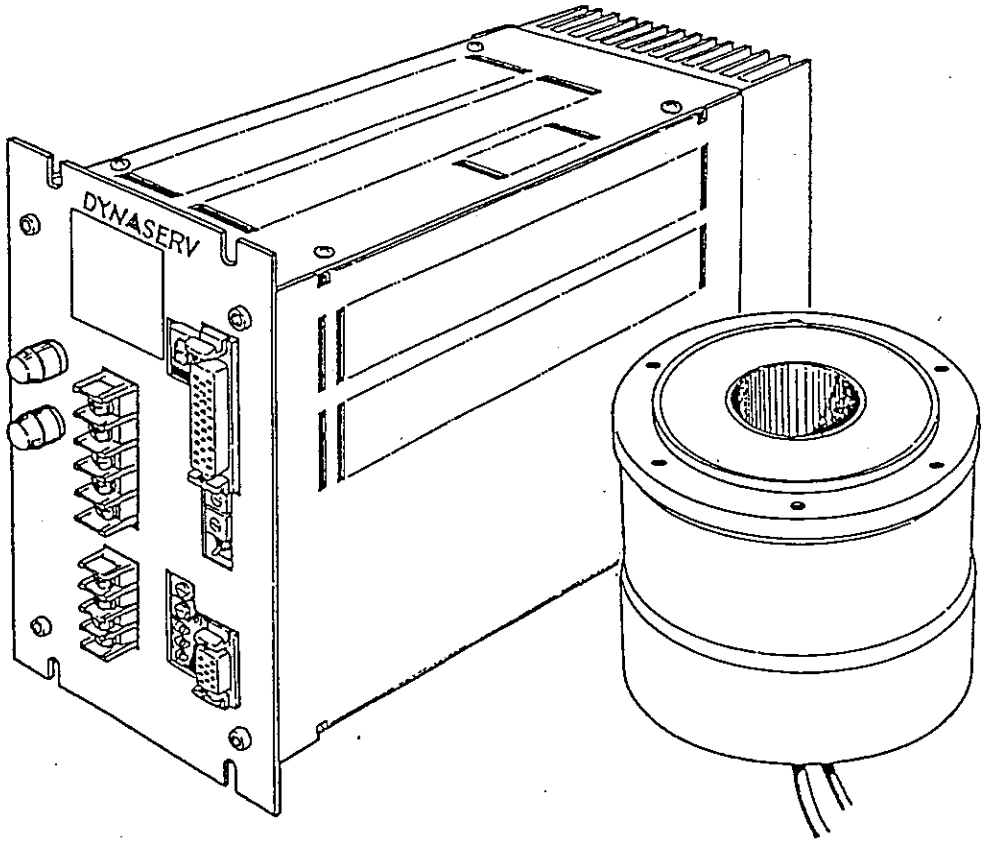
Instruction
Manual

DYNASERV

DD SERVO-ACTUATOR
DR-A/B/E·SR-A/B/E
SERIES

— Serial Pulse Interface Model —



YOKOGAWA ◆
Yokogawa Precision Corporation

IM A201-E
3rd 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.
Be sure to read this instruction manual prior to operating the DYNASERV.

Cautions

- ◆ It is prohibited to reproduce or copy part or whole of the contents of this instruction manual.
- ◆ The contents of this instruction manual may subject to change without notice.
- ◆ If you find an error or if you 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.

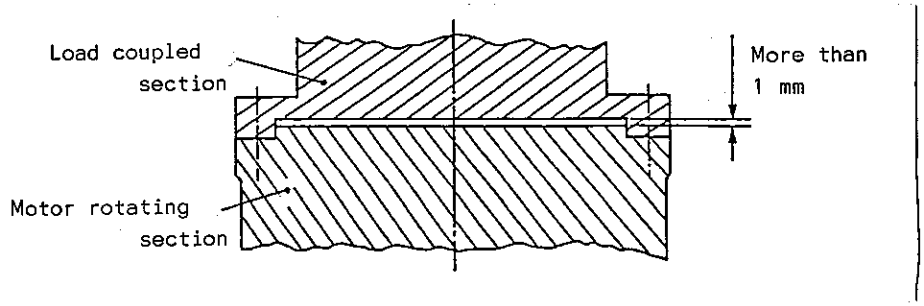
2. Never conduct opposite mounting of rotating the stator with the motor rotor fixed.

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

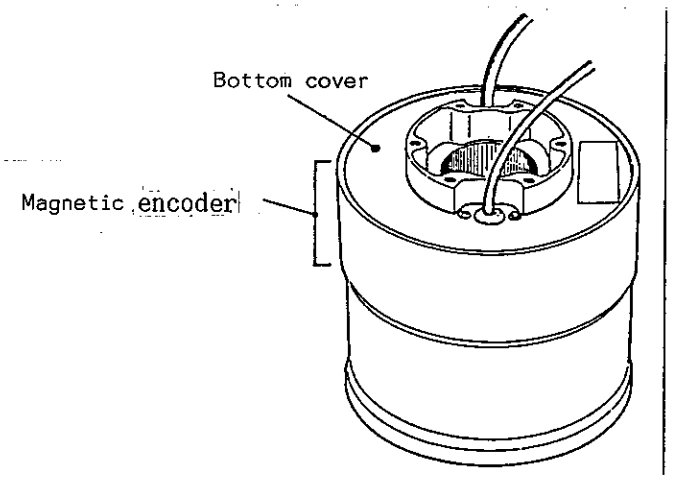
4. This motor rotates at high speed and high torque, so be careful of the rotating radius in order to prevent danger accident when operating with a load connected.

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 motor's upper surface to maintain surface accuracy. (See the Figure shown below.)



7. The magnetic encoder is built into the motor section in the Figure shown below. Therefore, do not apply a strong force, shock and/or a magnetic field to the above section.



8. Do not tighten each load mounting screw beyond the effective threaded depth in the motor section. If so, functions may worsen depending on the Model No.

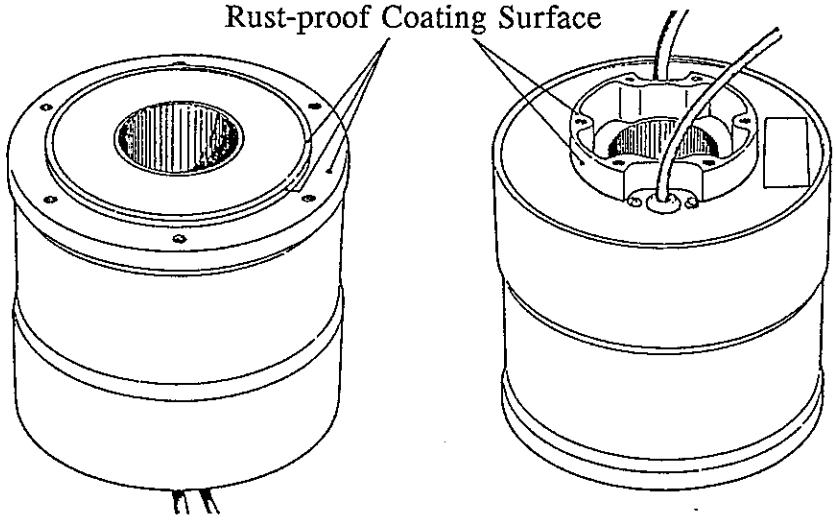
9. Since the motor surface is magnetically charged, do not place any magnetized objects or substances near the surface.

10. The motor is not dust, water or oil proof, so handle it with care.

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

12. 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.

13. Dynaserv DR series motor has rust-proof coating on mounting surfaces as shown in the figures below. Please remove the rust-proof coating before operating the motor by soft cloth or paper with chlorine or petroleum solvent. The coating may be harmful for mechanical accuracy.



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

Contents

1. Product Outline

1.1 DYNASERV, DR/SR Series

The DYNASERV, DR Series are practical DD motors developed to meet new needs based on our experience with the DM Series. The DR Series includes 6 models (50 to 400 N·m) of the A type with an outer diameter of 264 mm (10"), 6 models (70 to 250 N·m) of the E type with an outer diameter of 205 mm (8") and 4 models (15 to 60 N·m) of the B type with an outer diameter of 150 mm (6"), which together, should satisfy any needs.
In addition, DR5000B Series(3 models 30 ~70N·m) are there.
The corresponding driver is called the SR Series and is classified into serial pulse interface and 8-bit bus interface models according to the external control interface used. In addition, both 100 V and 200 V power supply versions of each model are available. (DR5000B Series are 200V only, This instruction manual describes the serial pulse interface model.)

Further, the driver can integrate a mechanical resonance filter selected as an option. Models corresponding to the above are shown on the next page.

In addition to the integrated box type, the module type driver in this Series enables free driver combinations on the user side for each board.

1.2 Standard Product Configuration

The standard product set consists of the following components. When unpacked, make sure that the product is the correct Model, and that the types and quantities of standard accessories are also correct.

Table 1.1

Part name	Q'ty	Remarks
Motor section	1	
Driver section	1	
Connector (for the CN1 terminal)	1	Manufactured by Honda Tsushin Kogyo/ MR-50LM
Connector (for the CN2 terminal)	1	Manufactured by Honda Tsushin Kogyo MR-8LM
Fuse	2	ϕ 6 × 32 mm 15 A

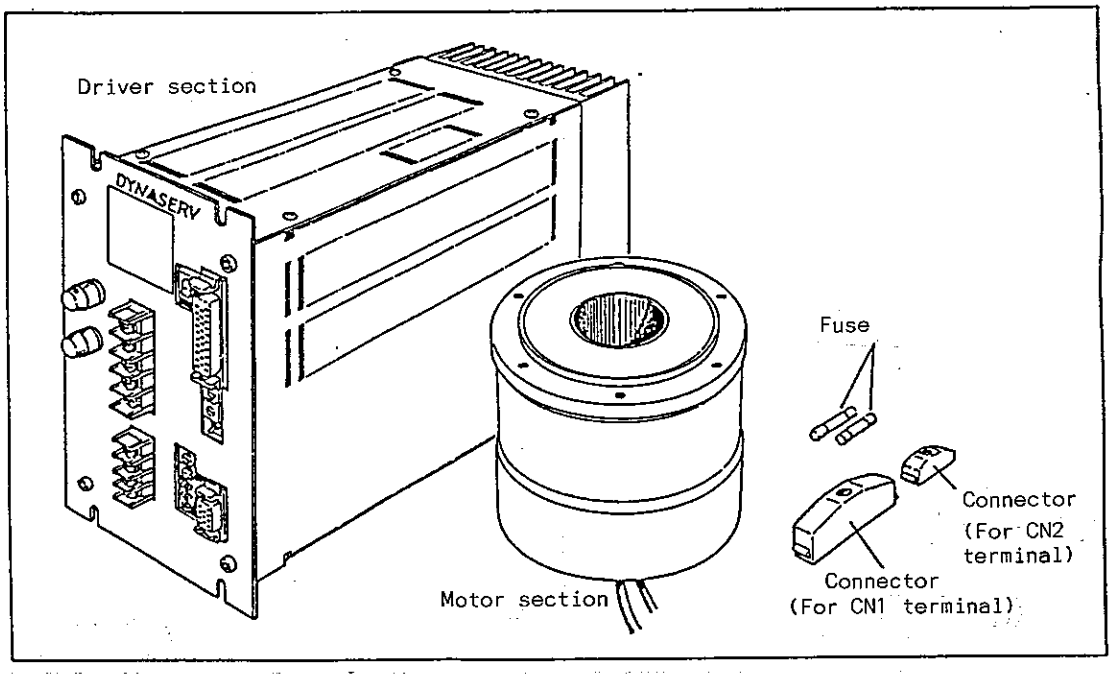
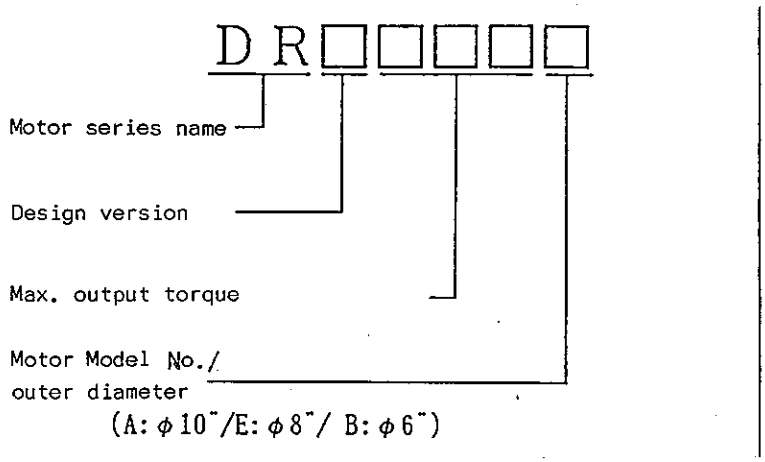

Driver section
DYNASERV
Fuse
Connector
(For CN2
terminal)
Connector
(For CN1 terminal)
Motor section

Figure 1.1

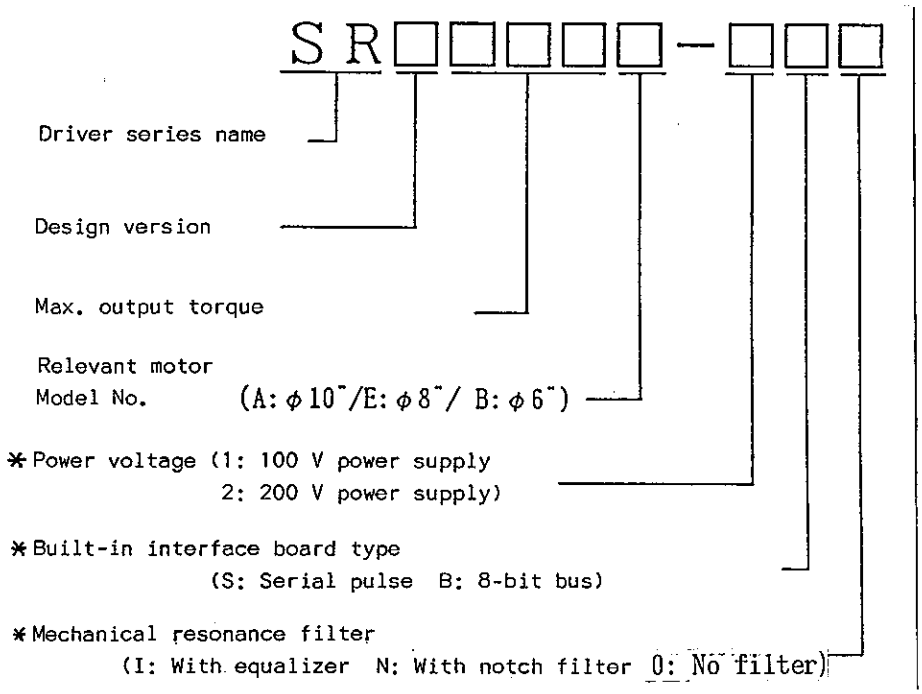
1.3 Model Symbols

The DYNASERV, DR/SR Series motor and driver Model Nos. are as shown in the following.

(1) Motor



(2) Driver (*: Optional)



Note: The DYNASERV motor and driver combination is 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 rating nameplate 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

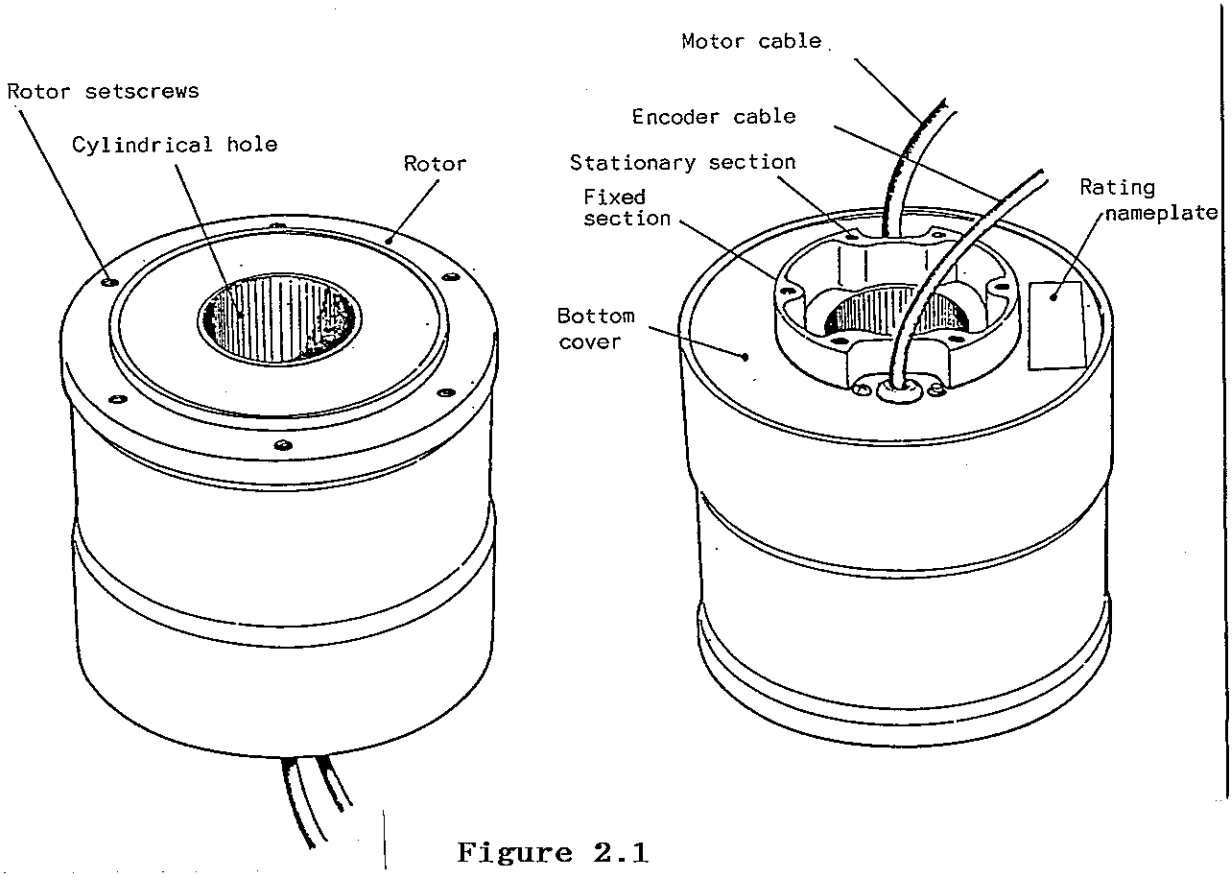


Figure 2.1

2.2 Driver Section

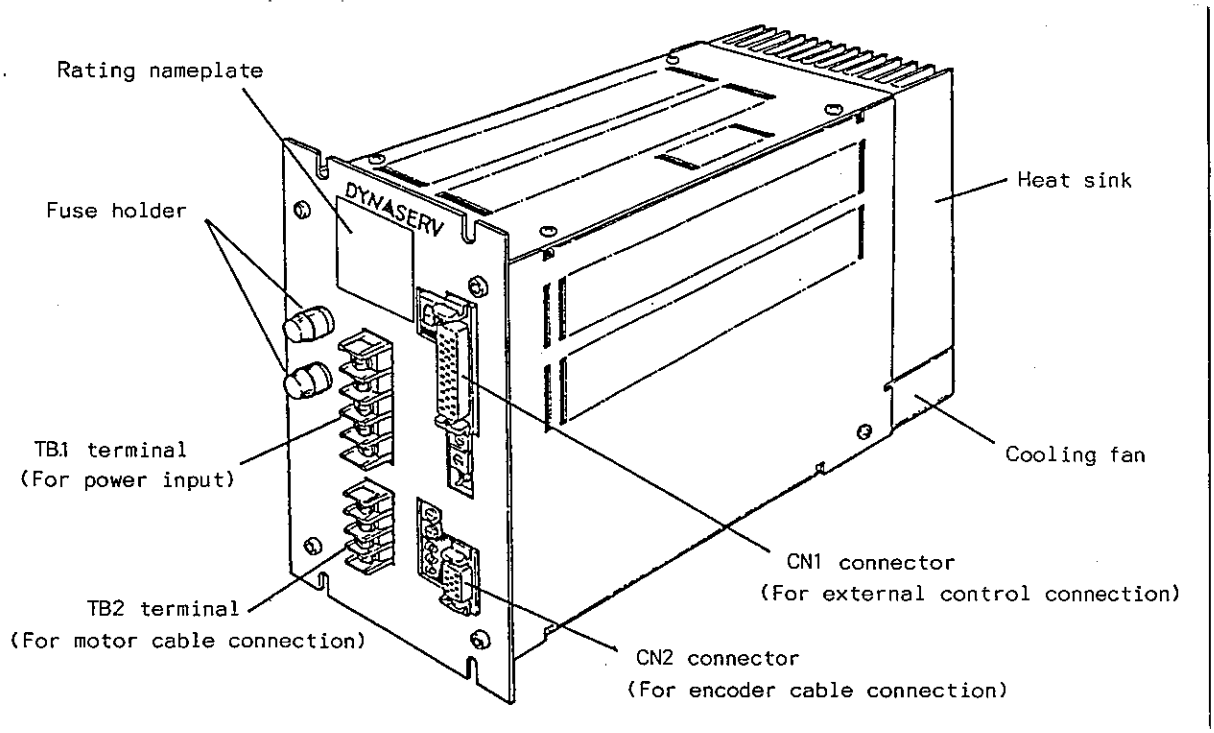
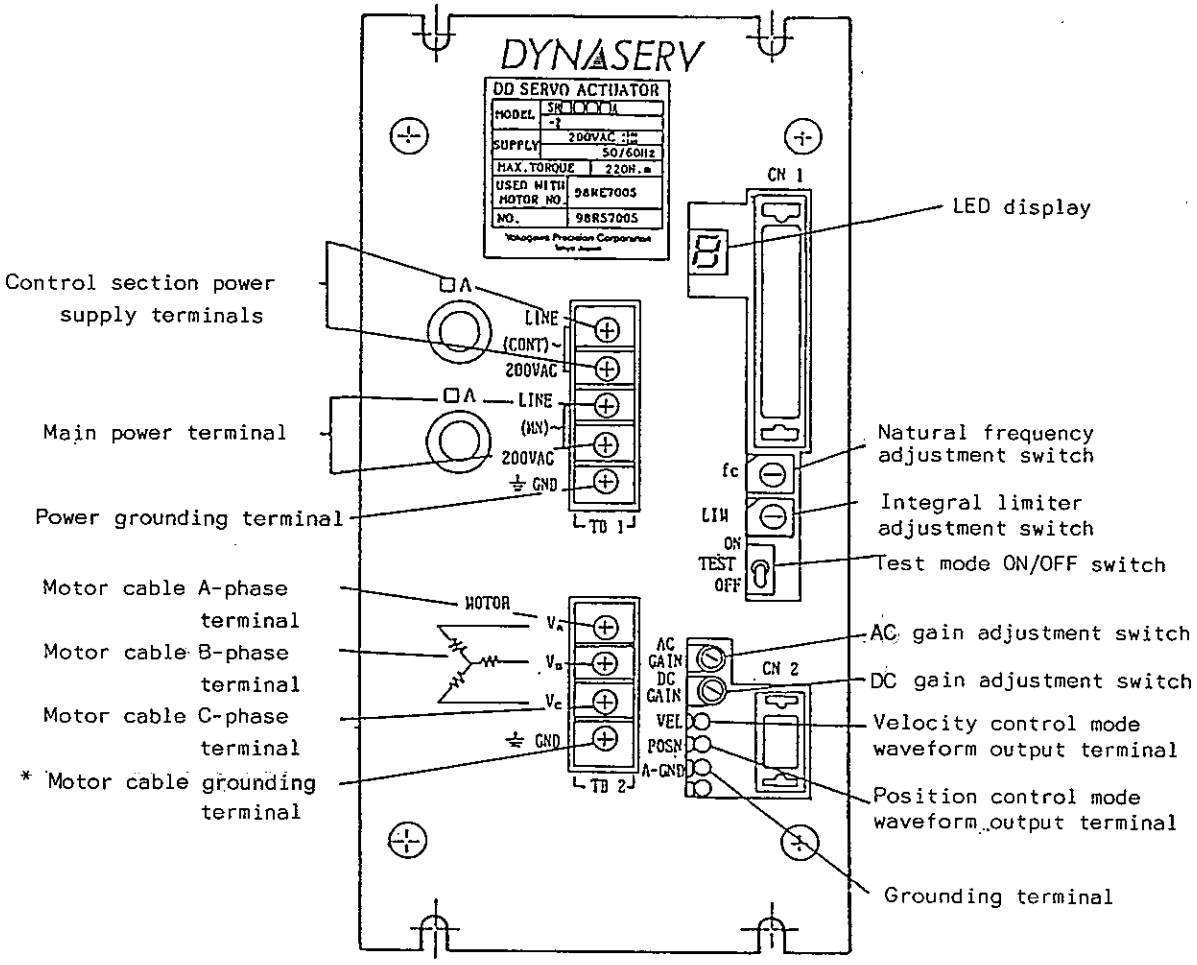


Figure 2.2

2.3 Driver Panel Surface



* Both GND terminals are connected.

Figure 2.3

3. Preparation for Operation

3.1 Initial Setting

(1) Setting sections on the driver printed-circuit board

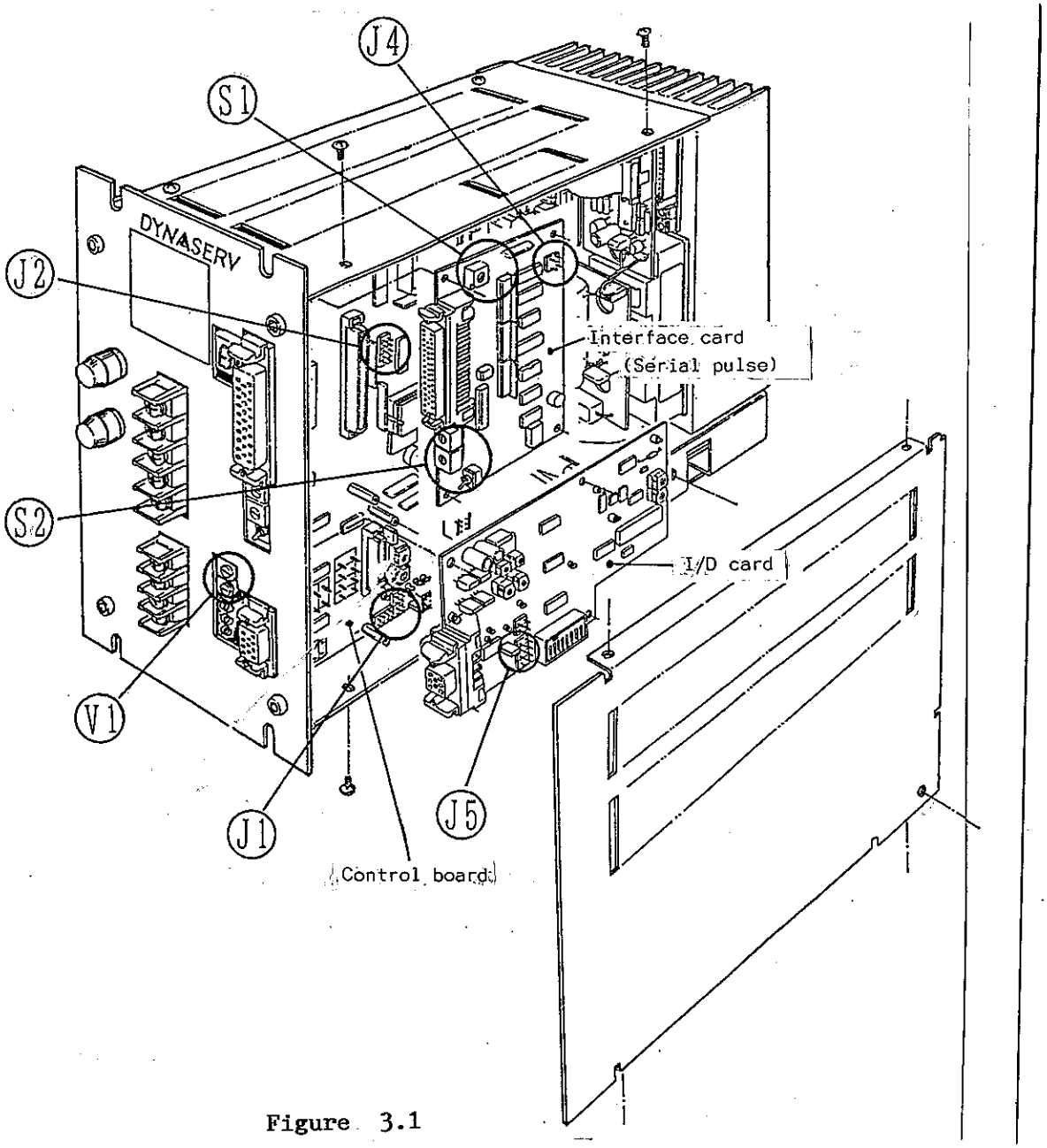


Figure 3.1

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 on the next page. See the above Figure for their locations.

To remove the side plate of the driver box, unscrew the 5 screws shown in the above Figure. However, prior to doing work, always turn OFF the power. Also, never touch the high-voltage generation section, even with the power turned OFF.

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

(2) Jumper settings done prior to shipment

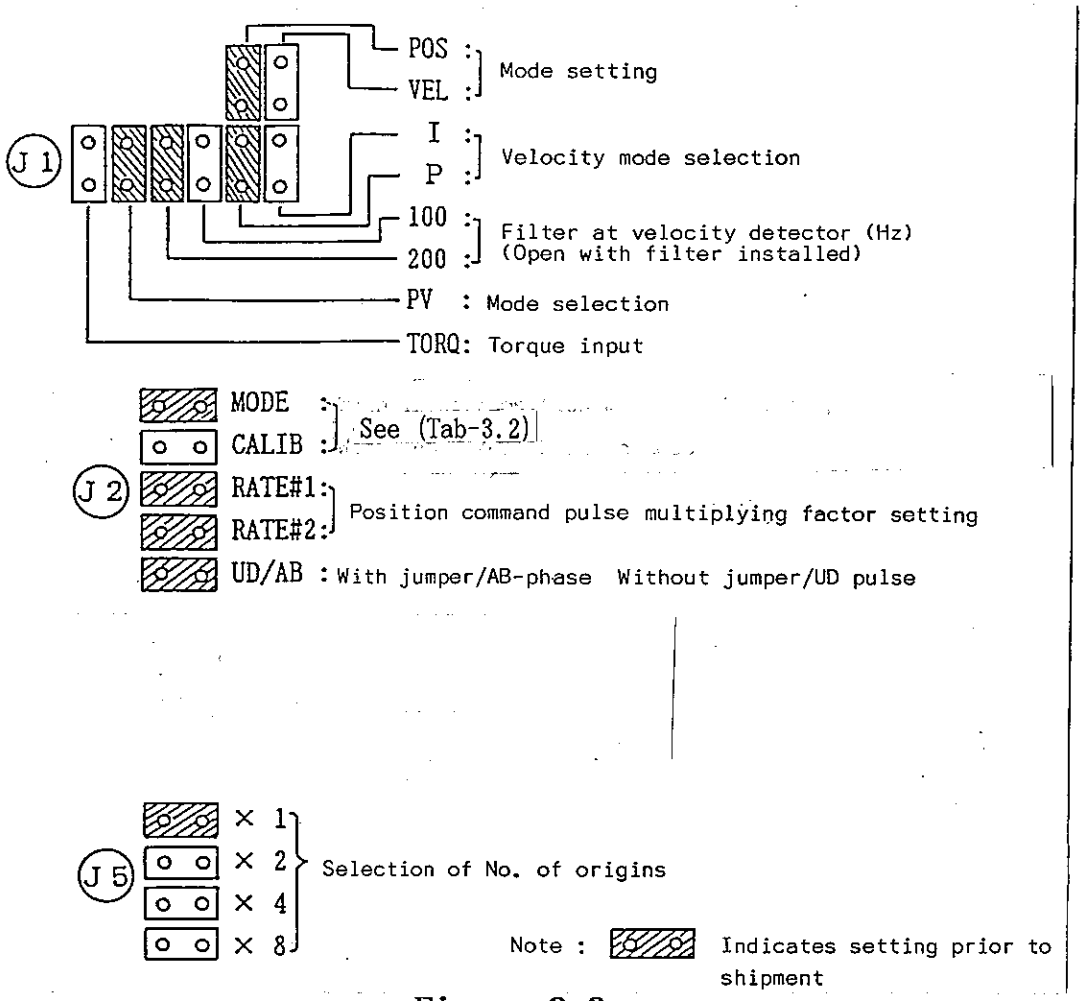


Figure 3.2

(3) Variable resistor settings done prior to shipment

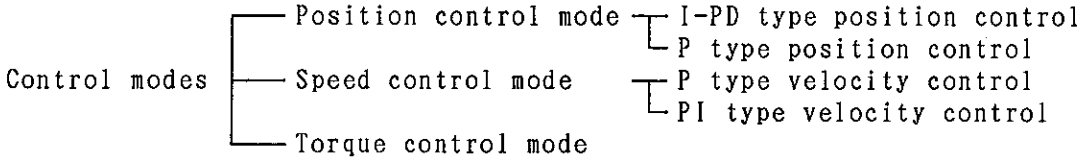
Table 3.1

Relevant board/card	Location	Switch name V.R. name	Setting status
Control board	(V1)	DC GAIN	Minimum position
		AC GAIN	Minimum position
I/F (Interface) card	(S1)	POSW	Set to "8"
	(S2)	fc	Set to "0"
		I-LIM	Set to "0"
		TEST	Set to "OFF"

3.2 Setting Procedure and Meaning

(1) Control mode setting

The following 5 control modes are available for the DYNASERV DR Service.



The following table shows the validity or invalidity of the switches and variable resistors related to the control mode and the jumper pin settings and each control mode.

Table 3.2 List of Control Modes and Jumper Pin and Switch Settings

Relevant board/ card	Location	Jumper name Switch name	Position control mode	Velocity control P mode	Velocity control PI mode	Torque control mode
Control board	J1	TRQ	Open	Open	Open	Shorted
		PV	Shorted	Shorted	Shorted	Open
		200 *	○	○	○	×
		100 *	○	○	○	×
		P	Shorted	Shorted	Open	Either one
		I	Open	Open	Shorted	Open
		VEL	Open	Shorted	Shorted	Either one
		POS	Shorted	Open	Open	Open
	J2	MODE	Shorted	Open	Open	Open
		CALIB	Open	Open	Open	Shorted
		RATE #1	○	○	○	○
		RATE #2	○	○	○	○
		UD/AB	○	○	○	○
	V1	DC GAIN	○	○	○	×
		AC AIN	×	×	○	×
Serial pulse interface card	J4	TRQ	×	Open	Open	Shorted
		VEL	×	Shorted	Shorted	Open
	S1	GAIN	○	○	○	×
		POSW	○	×	×	×
	S2	fn	○	×	×	×
		ILIM	○	×	×	×
		TEST	○	×	×	×
ID card	J5	No. of origins	○	○	○	○

(Note) ○: Validity : When the set value exerts an influence on motor operation.
×: Invalidity: When the set value does not exert an influence on motor operation

(2) Feedback pulse and position command pulse settings/J1
The servo driver receives a signal from the encoder built into the motor, then outputs an A/B phase or UP/DOWN pulse signal to a higher-level controller. Jumper pins related to the feedback pulse signal are <RATE#1 to 2> and <UD/AB>.

In addition, the position command pulse signal multiplication factor is determined by the setting of <RATE#1 to 2>.

a) <RATE#1 to 2> jumpers
The adjustment of these jumpers can change the position command pulse signal by 1 to 1/8 times. (See the Figure at right.) However, changes in the multiplication factor also change the resolution.

Table 3.3

Set value		Multiplying factor
<RATE#1>	<RATE#2>	
Shorted	Shorted	1
Open	Shorted	1/2
Shorted	Open	1/4
Open	Open	1/8

b) <UD/AB> jumpers
The selection of these jumpers enables the selection of the A/B phase and the UP/DOWN phase. The shorted jumper results in the A/B phase, and the open jumper, the UP/DOWN phase.

(3) Velocity signal filter setting/J1
These jumpers are used to select velocity signal filter cut-off frequency. The cut-off frequency is set to 100 Hz with <100> shorted, and it is set to 200 Hz with <200> shorted. However, they are all opened when the resonance filter is connected.

(4) Origin pulse output signal setting/J5
When the original position is detected by the original positions detection signal set to the positions obtained by dividing one motor revolution equally. When the original position is detected, the following pulse signal is output. The point at which H changes to L when the motor rotates in the CW direction, or L changes to H when the motor rotates in the CCW direction, corresponds to the original position. The CW and CCW directions are when the motor is viewed from the load side.

Origin reproducibility accuracy depends on the number of motor revolutions.

It is about ± 5 sec. at 0.01 rps (DR Std'Series)

The Figure at right shows its characteristic.

The number of origins per revolution can be selected using the origin select switch (4 interlocked jumpers) on the ID card.

The following table shows the relationship between the set values and the number of origins.

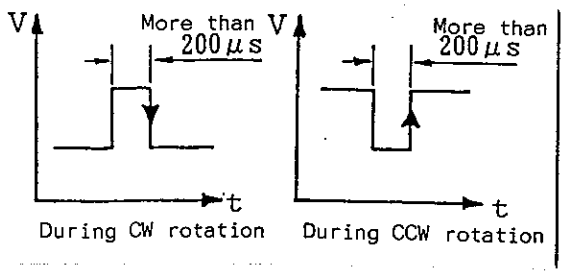


Figure 3.3 Origin signal and zero position

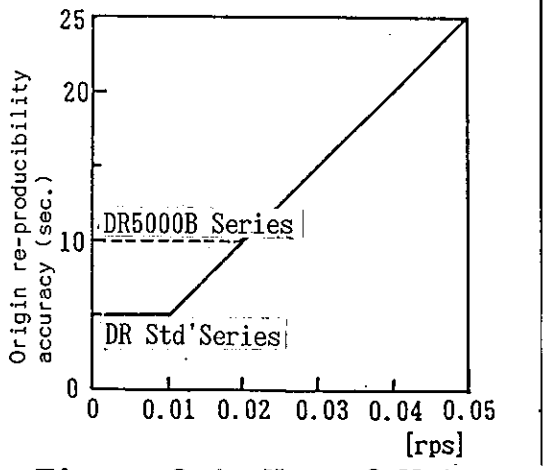


Figure 3.4 No. of Motor Revolutions

Table 3.4

	A type	B type	E type	DR5000B Series
×1 shorted with the others open	200	124	150	68
×2 shorted with the others open	400	248	300	136
×4 shorted with the others open	800	496	600	272
×8 shorted with the others open	1600	992	1200	544

(5) Positioning completion width setting/S1

When positioning in the position control mode is completed, the CN1 connector COIN signal is set to L. This positioning completion width can be selected by the POSW switch on the I/F card.

The following table shows the relationship between POSW switches with POSW 0 to 1 of the CN1 connector set to H and

positioning completion widths.

Table 3.5

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

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 3.5
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.

(6) Mechanical resonance filter (equalizer type) adjustment
This section is for adjustment when the mechanical resonance filter (equalize type) is built into the DYNASERV as an option. Therefore, this adjustment is not required for the standard type.
There are two variable resistors <VRs 1 and 2> on the mechanical resonance filter (equalizer type) board. Although you should not touch <VR 1>, turning <VR 2> can adjust corner frequency from 25 Hz to 100 Hz. Prior to shipment, this <VR 2> is set so that the corner frequency is 100 Hz.

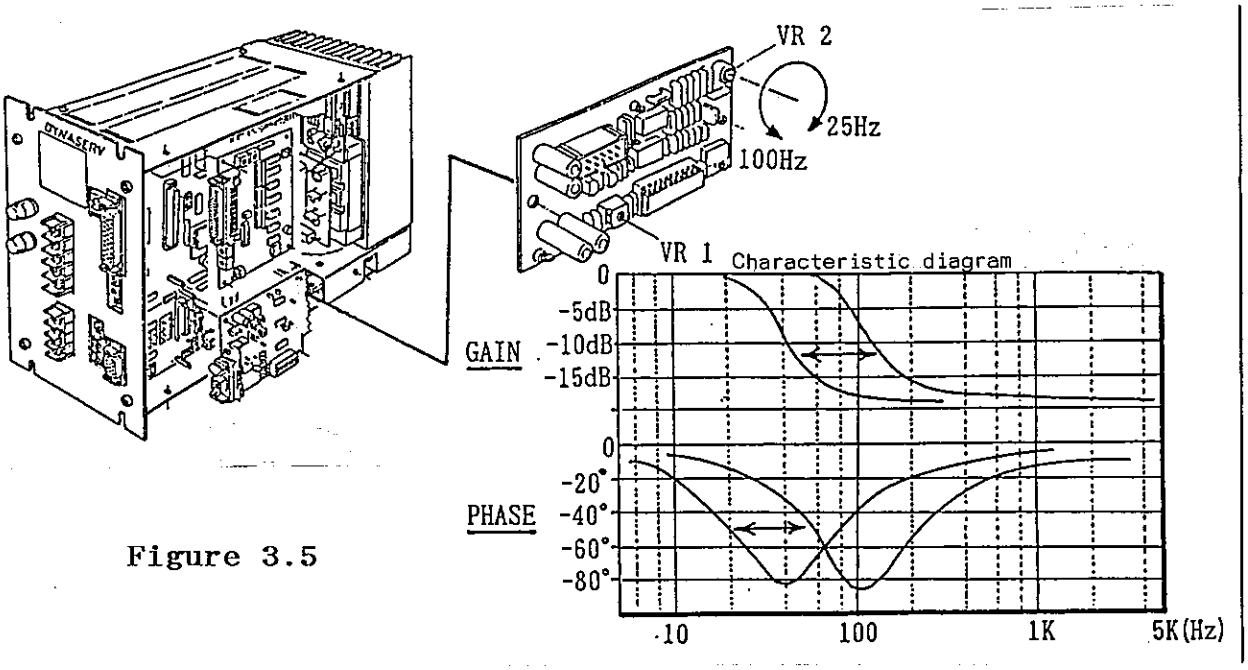


Figure 3.5

Figure 3.6 Characteristic Diagram

3.3 External Wiring

(1) External connection outline diagram

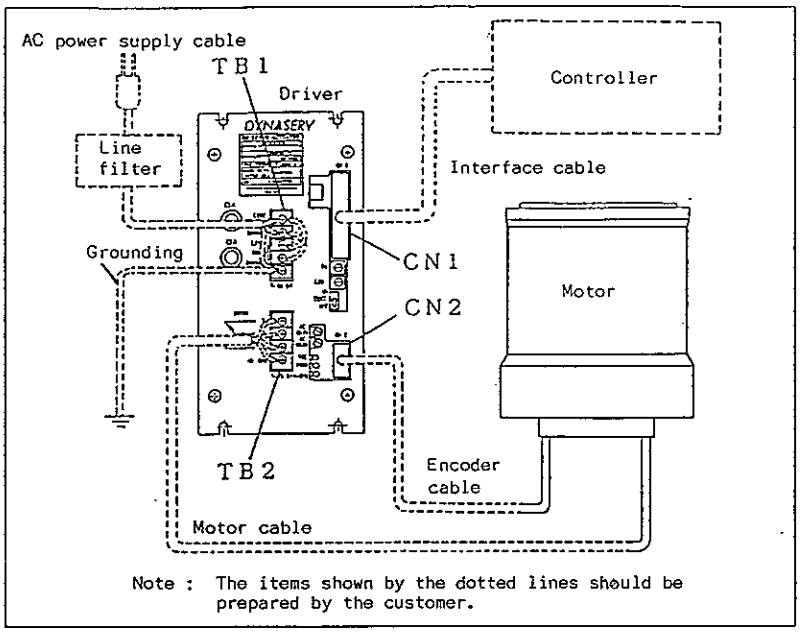


Figure 3.7

(2) Connection between the motor and the driver

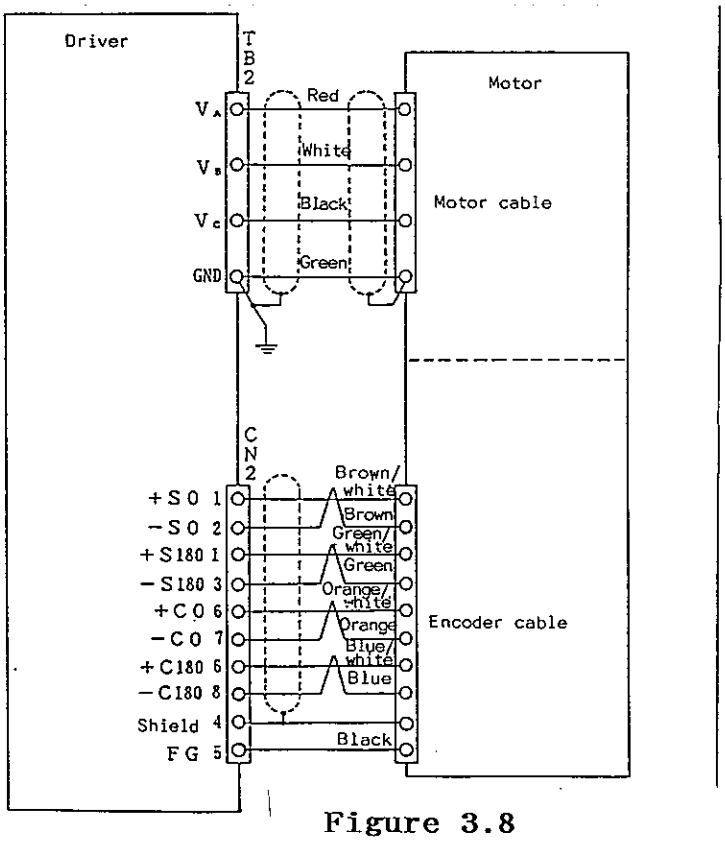


Figure 3.8

(3) Typical wiring example (In the position control mode)

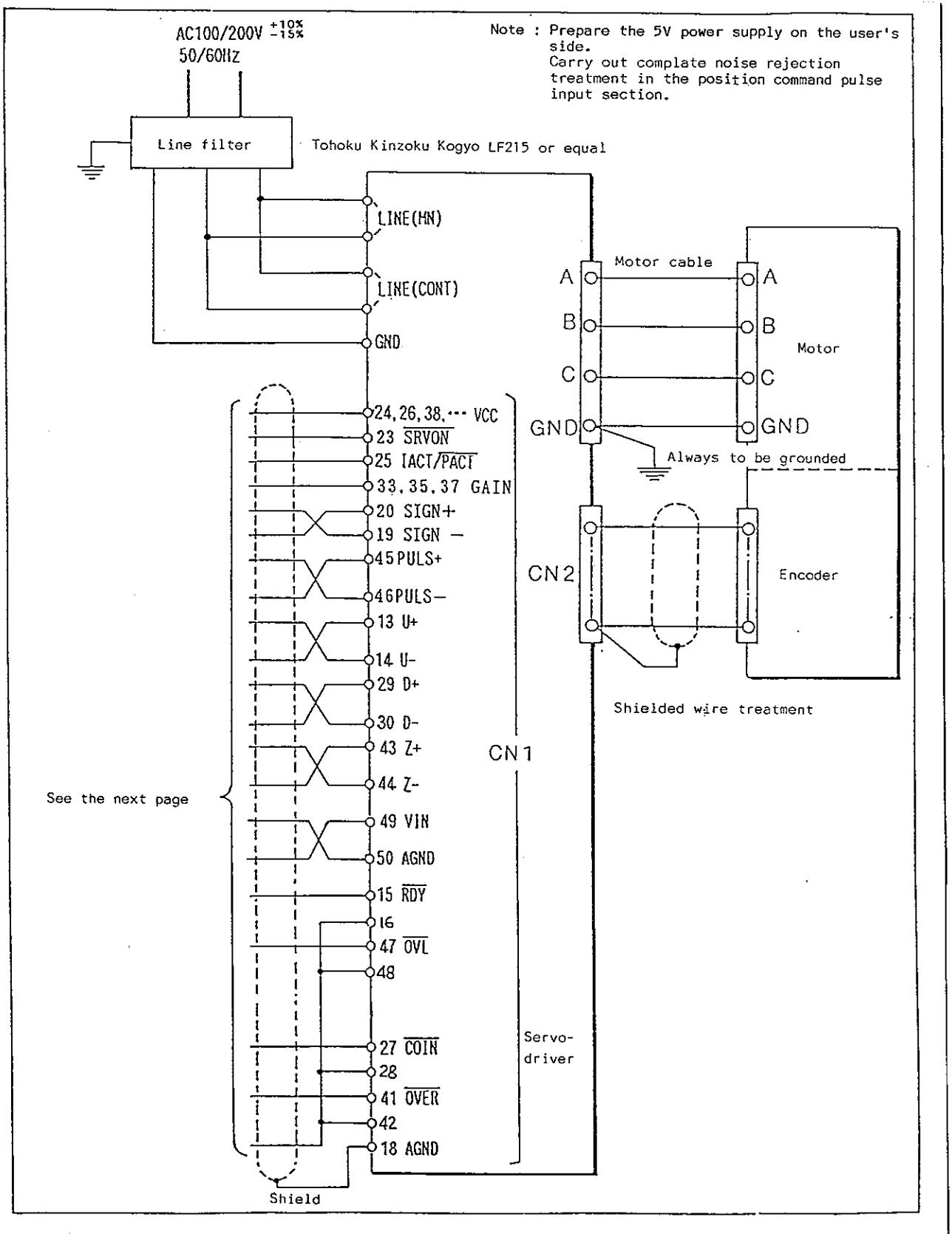


Figure 3.9

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

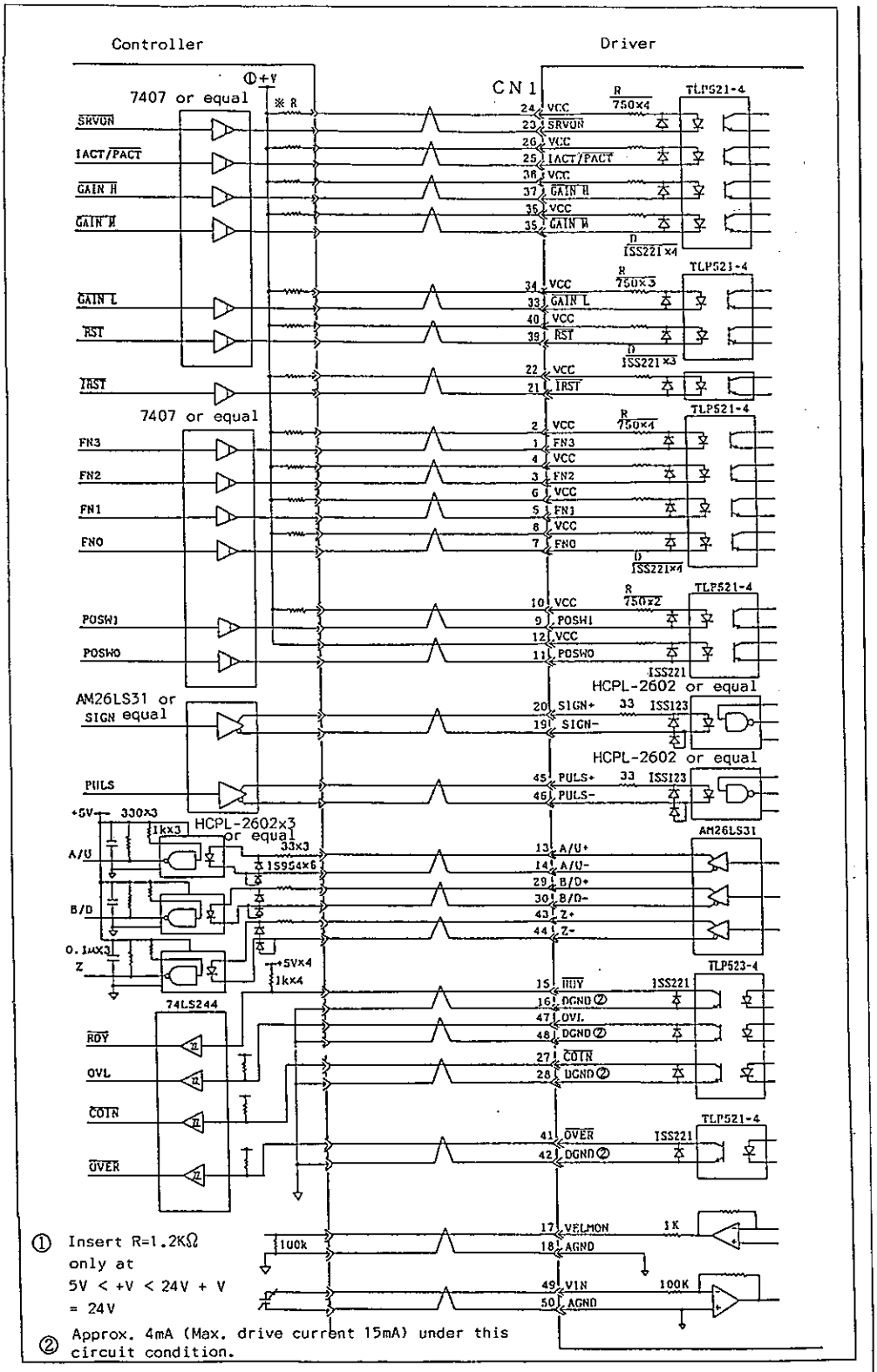


Figure 3.10

(5) Details of CN1 terminal I/O signals

a) Input <Note>: ( ) Indicates Vcc signal power input.

Table 3.6

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 Note 1.)
POSW 1 POSW 0	9 (10) 10 (12)	Positioning completion pulse width end	Signal of setting a deviation counting value for outputting the positioning completion pulses. Four step setting 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.
SIGN+ SIGN-	20 19	Rotating direction command	The motor rotates CW with this signal set to H and CCW with the same signal set to L. (When viewed from the load side, it is the same hereafter.)
IRST	21 (22)	Integral capacitor reset	The integral capacitor in the velocity loop is shorted.
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/ 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 H GAIN M GAIN L	37 (38) 35 (36) 33 (34)	Gain selection	Signal to select the variable DC gain range. DC gain can be varied in the range of 0.5 to 110 times. Set by the variable resistor. (See Note 2.)
RST	39 (40)	CPU reset	The driver control section is initialized with this signal set to L for more than 50μ sec.
PULS+ PULS-	45 46	Position command pulse	Driver position command pulse signal
VIN	49 (50)	Velocity command input Torque command input	Set to the maximum number of revolutions at $\pm$6 V input. CW direction/+6 V, CCW direction/-6 V. #50 pin: GND For torque command: $\pm$8 V
AGND	50	Analog input GND	Velocity/torque input analog GND

(Note) FN 0 ~3 and POSW 0 to 1 are wired-ORed with the rotary switch on the interface card.

b) Output <Note>: ( ) Indicates GND signal output.

Table 3.7

Signal name	Pin No.	Meaning	Details
A+/U+ A-/U- B+/D+ B-/D-	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.
RDY	15 (16)	Servo ready	The motor is ready to operate with this signal set to L. This signal is set to the H level about 3 sec. after driver power-ON.
VELMON	17 (18)	Velocity monitoring	Signal for monitoring the number of motor revolutions to output positive voltage for CW rotation and negative voltage for CCW rotation. Velocity detection sensitivity is as shown on the following table. (See Note 3.) Velocity detection sensitivity is not guaranteed for the number of motor revolutions in the range exceeding ±7.5 V.
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.
OVER	41 (42)	Deviation counter overflow or overspeed	Deviation counter overflow signal is output only in the position control mode, and this signal is set to L when the deviation counter value exceeds 32767. The overspeed signal is set to L when feedback pulse output frequency becomes greater than about 3 MHz. It is set to L if the number of motor revolutions exceeds ±7.5 V in the position control or velocity control mode.
Z+ Z-	43 44	Origin pulse	Signal for detecting the original positions obtained by equally dividing motor 1 revolution (200 for the A series, 150 for the E series and 124 for the B series), and 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, it simultaneously reduces motor current automatically to 1/3.

(Note 1) **Table 3.8**

FN 3	FN 2	FN 1	FN 0	fcSW position	fc (Hz)
H	H	H	H	0	1
H	H	H	L	1	2
H	H	L	H	2	3
H	H	L	L	3	4
H	L	H	H	4	5
H	L	H	L	5	6
H	L	L	H	6	7
H	L	L	L	7	8
L	H	H	H	8	9
L	H	H	L	9	10
L	H	L	H	A	11
L	H	L	L	B	12
L	L	H	H	C	13
L	L	H	L	D	14
L	L	L	H	E	15
L	L	L	L	F	16

(Note 2) **Table 3.9**

G H	G M	G L	Gain ※
H	H	H	1
H	H	L	4
H	L	H	7
H	L	L	10
L	H	H	13
L	H	L	16
L	L	H	19
L	L	L	22

(Note : The product of this GAIN value and the varriable resistor position (0.5 to 5) becomes the total gain.

(Note 3) **Table 3.10**

Model	Velocity detection sensitivity (V/rps)	No. of detection limit revolutions (rps)
DR1015B ~1060B、DR1070E、DR1100E	5/2.0	3.0
DR1050A	5/1.5	2.3
DR1130E ~1250E、DR1100A ~1400A	5/1.0	1.5
DR5030B, 5050B, 5070B	1/1.0	7.5

3.4 Installation

When the product is delivered, first check the product type and Model No. as well as for the presence or absence of accessories and the combination of the motor and the driver.

(1) Motor-section mounting

The motor-section can be mounted vertically or horizontally. However, incorrect mounting and unsuitable mounting location may shorten motor service life and cause trouble. Therefore, always observe the following.

a) Installation location

The motor section is designed for indoor use. Therefore, the installation location must be where:

- There are no corrosive and explosive gases.
- Ambient temperature is between 0 and 45℃
- Dust concentration is low, air ventilation is good and humidity is low.

(Note) The DYNASERV is not drip proof or oil proof, so it should be covered by a suitable drip proof and oil proof cover.

b) Mechanical coupling

- When coupling a load with the motor rotor section, make sure there is a clearance of more than 1 mm between the motor upper surface and the load.
- Secure the motor rotor and stator by tightening the set screw with torques of less than the following values.
- Set the motor setting base level to less than 0.01 mm.

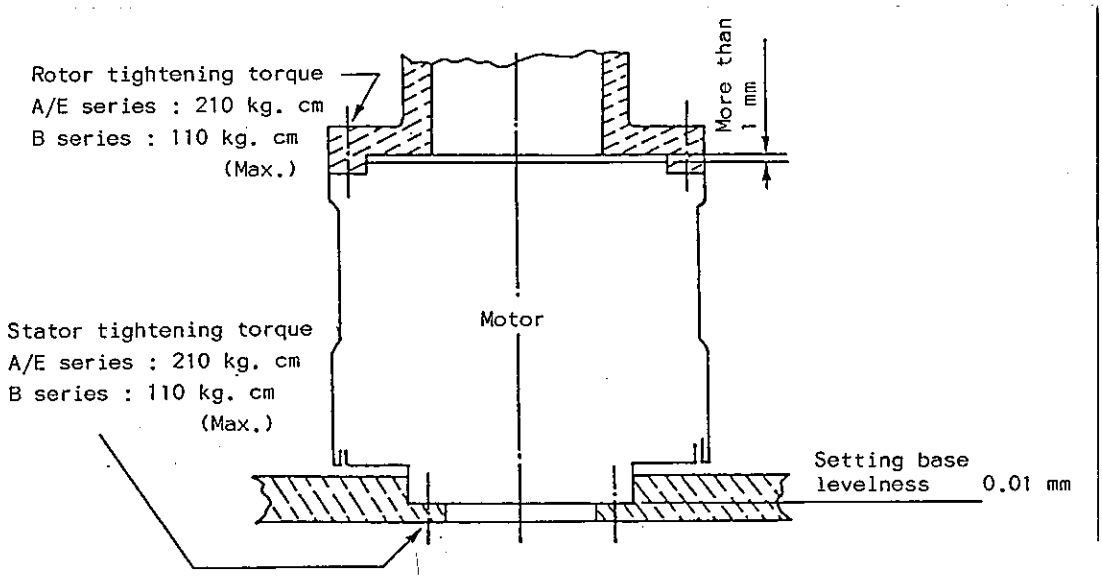


Figure 3.11

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

(2) Driver section mounting

The standard driver is rack mounted.

a) Installation location

- When there is a heat generation body near the installation location, make sure that temperature does not exceed 50℃ near the driver by providing a heat shield or cover, etc.
- When 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 powder and corrosive gases.

b) Mounting procedure

- Normally, the driver 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 up ward. Always avoid mounting it with its panel surface facing sideways or upside down. (See Figure 3.13.)
- A self-cooling driver box with a built-in fan is employed, so it is necessary to have a ventilation space above the box. (See Figure 3.12.)
- Mount the driver using 4 holes at the top and bottom of the front plate.

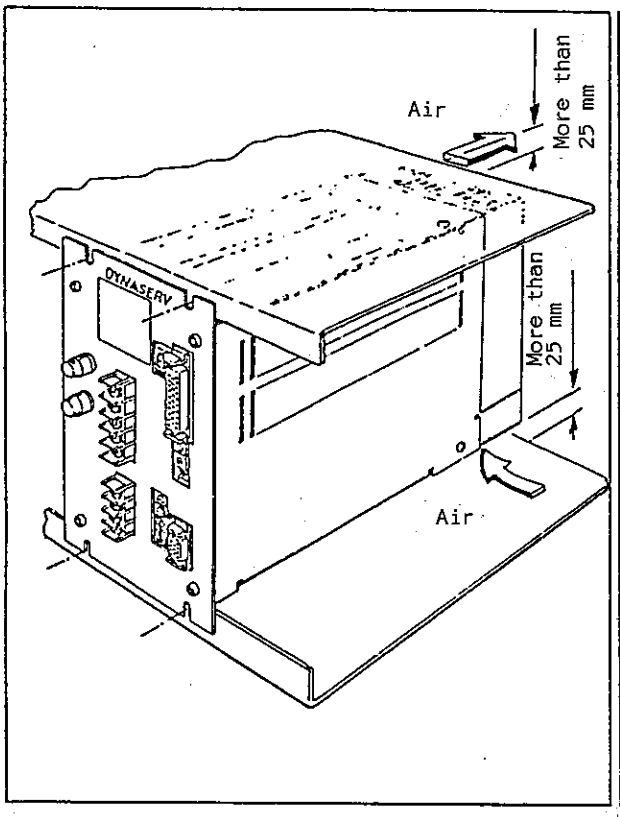


Figure 3.12

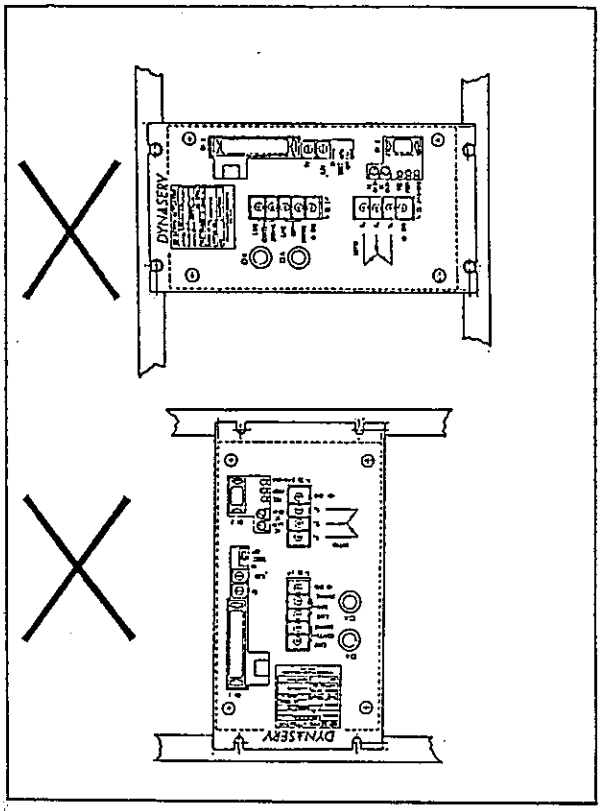


Figure 3.13

3.5 Wiring Cables

(1) Cable sizes and rated currents

Table 3.11

			A type	B type	E type
Input	① AC power cable	Current (A)	20	15	20
		Cable size	HIV: More than 2.0, Length: Within 30 m		
	② Motor cable	Current (A)	20	15	20
		Cable size	HIV: More than 2.0, Length: Within 30 m		
	③ Jumper wire	Current (A)	20	15	20
		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 ambient temperature is 40℃ and the rated current flows through 3 bundled leadwires.
6. HIV: Special heat-insulation wire
Allowable conductor temperature of 75℃ .
7. With a 200 V power supply, the current value becomes half the above value in the same wiring.

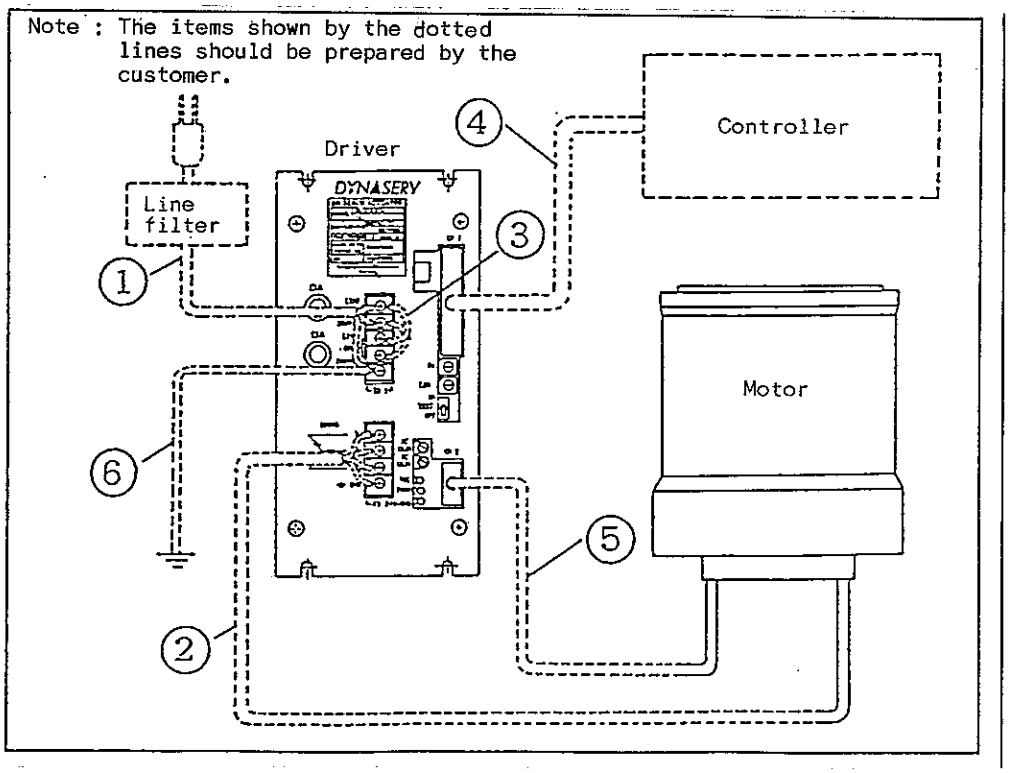


Figure 3.14

(2) Wiring cautions

- 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 100 Ω .
- Since high voltage large current flows through motor and AC power cables, make sure that their wirings are correct.

4. Operation Cautions

4.1 Input and Output Signal Cautions

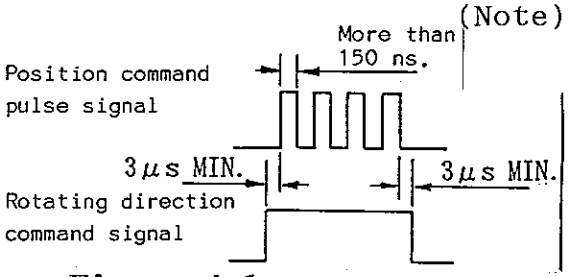
(Note) See the lists on pages to for items other than the following.

(1) Position command pulse input signal (PULS±)

This is a drive position command pulse signal. The pulse signal is in positive logic and its minimum pulse width is 150 ns.

(2) Motor rotating direction command input signal (SIGN±)

A signal to indicate the motor rotating. The motor rotates in the CW direction with this signal set to H and CCW direction with this signal set to L.



(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 4.1

(3) Velocity command input (VIN)

An analog input signal which gives the motor rotating velocity command value. The maximum velocity in the CW direction at +6 V, and the maximum velocity in the CCW direction at -6 V (DR Std'Series)

(In the -6 V to +6 V, input range, input impedance is 100 kΩ)

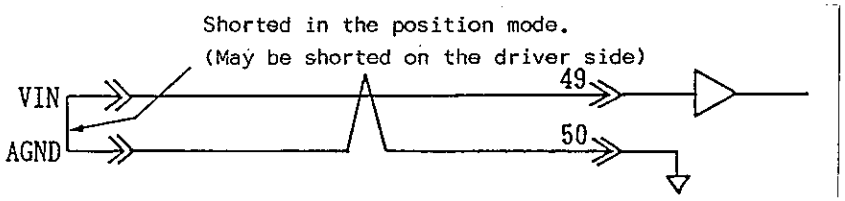


Figure 4.2

(4) Velocity monitoring output (VELMON)

Motor analog velocity monitoring output

Output voltage: At maximum velocity +6 V (CW)

At maximum velocity -6 V (CCW)

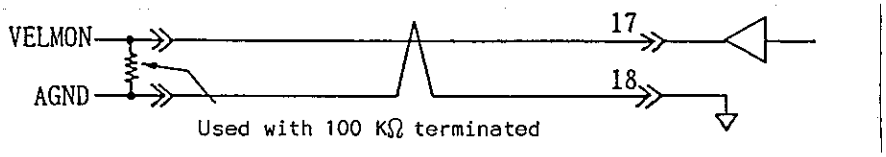


Figure 4.3

(5) A/B phase, UP/DOWN pulse output signals (A/U± , B/D±)
Pulse signals to indicate the motor position. The following 2 pulse output statuses can be selected by jumpers on the controller board.

a) A/B phase output pulse
The following pulse signal is output with the jumper <UD/AB> on the controller board shorted.

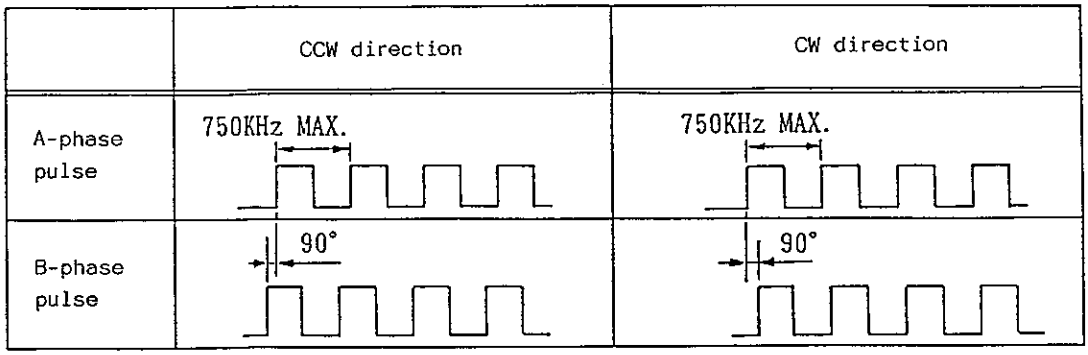


Figure 4.4

b) UP/DOWN output pulse
The following pulse signal is output with the jumper <UD/AB> on the controller board opened.

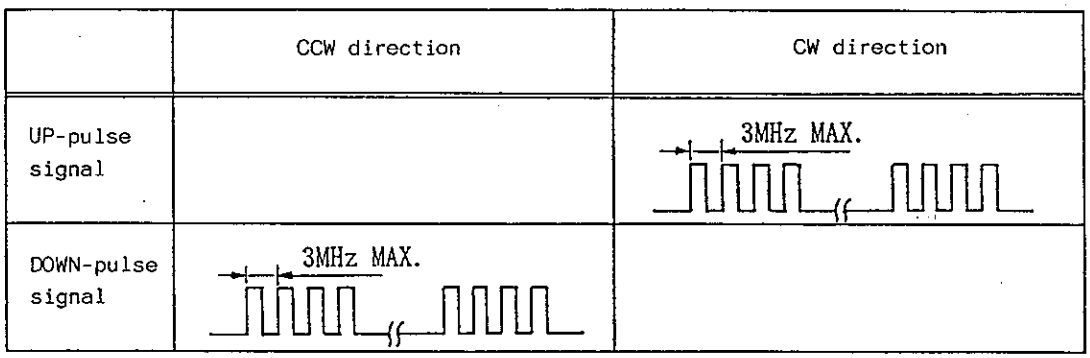


Figure 4.5

4.2 Power ON/OFF
Pay attention to the following when the power is turned ON.

(1) When turning ON the main and control circuit power supplies, turn them ON simultaneously or turn ON the control circuit power first.
(2) When turning them OFF, turn them OFF simultaneously (including after instantaneous power failure), or turn OFF the main circuit power first.
(3) Rush current in both the main and control power circuits is about 25 A peak.
(4) The motor is set to the servo status about 200 ms after SRVON is set to L.

(5) When the main power circuit is active, RDY = H indicates driver trouble. Therefore, use a sequence circuit to turn OFF the main power circuit at RDY = H.
However after the control and main circuit power supplies are turned ON, the RDY = H condition is maintained for up to 3 sec. Therefore, hold the power-ON signal for more than 3 sec.

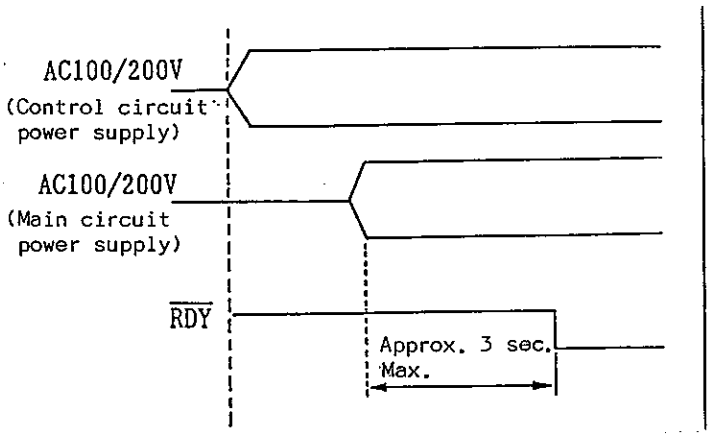


Figure 4.6

4.3 Restrictions on Cyclic Operating Frequency (DR5000B Series only)

Cyclic operating frequency of the DYNASERV DR5000B Series (DR5030B/SD5030B-2), DR5050B/SD5050B-2 and DR5070B/SD5070B-2) may be restricted because of the DYNASERV motor and driver characteristics resulting from the high rated number of revolutions.
Therefore, please use our DYNASERV in due consideration of the above restrictions.

(1) Restriction on Motor Operation

Motor operating conditions are set assuming that the motor is operated at an ambient temperature of 45℃ with the motor mounted on a metal base.
If motor load conditions and operating intervals are set as shown in the following figure (Figure 4.7) under cyclic motor operations of acceleration, constant velocity, deceleration and stop, the following equations must be satisfied.
Also, if either motor average velocity (No. of revolutions) or current duty is known, it is possible to obtain either of them in a simplified manner from the graph shown in the following (Figure 4.8).
For current I_1, I_2 or I_3, the respective voltage is measured on the monitor terminals (V_{TR}) of the driver front panel and then is multiplied by <1.875>, thereby obtaining the respective current [A].

$$\eta_s = \frac{N_R}{2}(t_1 + 2t_2 + t_3) \times \frac{1}{5t_{CY}} \times 100 \quad (1)$$

$$\eta_c = (t_1 I_1^2 + t_2 I_2^2 + t_3 I_3^2) \times \frac{1}{15^2 t_{CY}} \times 100 \quad (2)$$

$$\eta_s + 2.6 \cdot \eta_c < 103 \quad (3)$$

η_s = Velocity duty
η_c = Current duty
I_1, I_2, I_3 = Current (A)
N_R = No. of revolutions (rps)
t_{CY} = Cyclentime (msec)
t_1 t_2 t_3 = Time (msec)

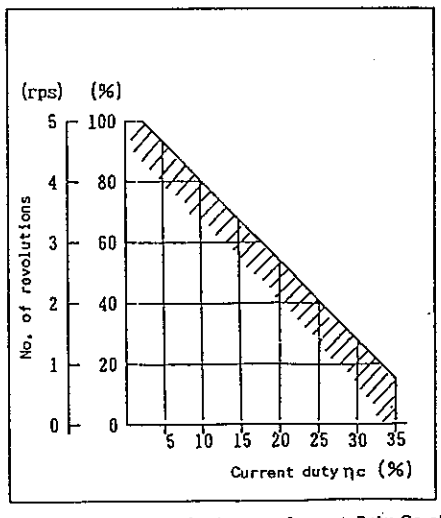


Figure 4.8 Average Velocity vs. Current Duty Graph (For quick reference)

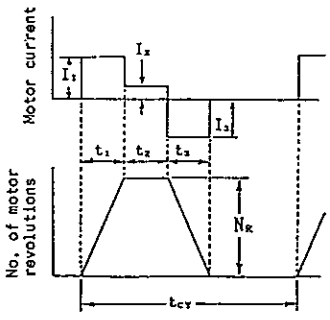


Figure 4.7

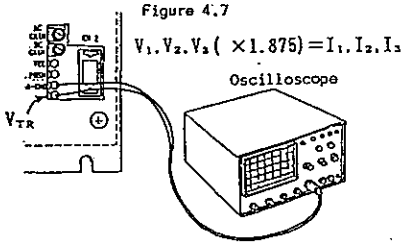


Figure 4.9

< Example > $N_R = 4$ (rps)

$I_1 = I_3 = 9$ (A)

$I_2 = 3$ (A)

$t_1 = t_2 = t_3 = 1/4\ t_{CY}$

From the above, ηB and ηc are obtained.

$$\eta_B = \frac{4}{2}\left(\frac{1}{4}t_{CY}+\frac{2}{4}t_{CY}+\frac{1}{4}t_{CY}\right) \times \frac{1}{5t_{CY}} \times 100$$

$$= \frac{2}{5} \times 100 = 40$$

$$\eta_C = \left(\frac{81}{4}t_{CY}+\frac{9}{4}t_{CY}+\frac{81}{4}t_{CY}\right) \times \frac{1}{225\,t_{CY}} \times 100$$

$$= \frac{17100}{900} = 19$$

For Equaiton (3),

$40 + 2.6 \times 19 = 98 < 103$

Thus it is found that Equation (3) is satisfied, resulting in the correct settings.

(2) Restrictions on Driver Operation

DYNASERV cyclic operating frequency is also restricted by the calorific value generated from the regenerative resistor built in the driver. This means that if DYNASERV is operated in a repetitive pattern shown in Figure 4.10, cyclic operating frequency, as shown in Figure 4.11, is restricted by load inertia with the number of revolutions set as a parameter.

If the load inertia exceeds 1 kgm^2 or if DYNASERV must be used beyond the rated load inertia, please contact us.

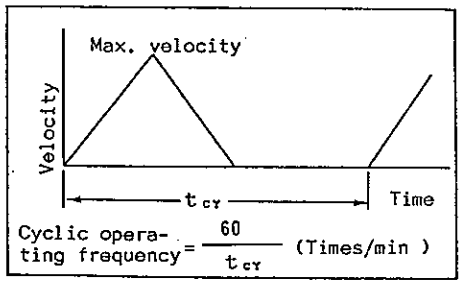


Figure 4.10

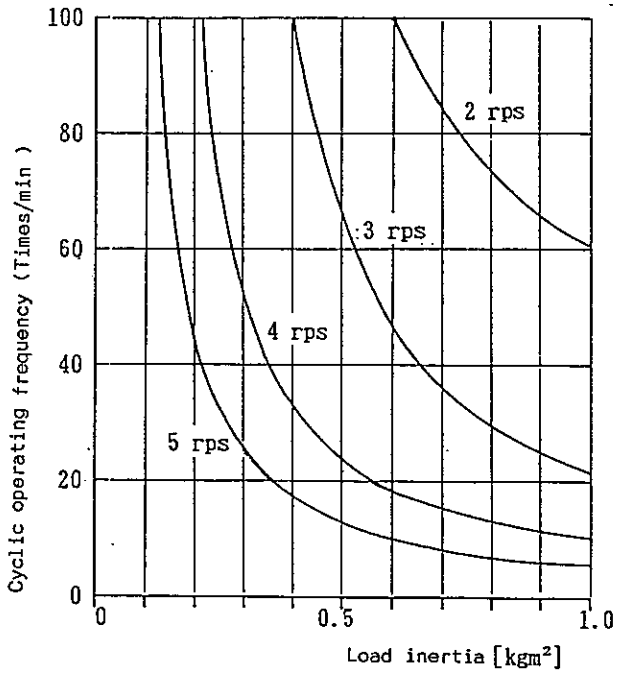


Figure 4.11

5. Control Mode and Adjustment

5.1 Position Control Mode Adjustment

In the position control mode, motor positioning control is performed according to the command position sent from the higher-level controller. Two control methods are available in the velocity control mode: the I-PD type control system is selected with the CN1 connector <IACT/PACT> signal set to H, and the P type control system, with the same signal set to L. Usually, the I-PD type control system is selected in the positioning operation.

(1) I-PD type position control

This method uses position integral feedback and is suitable for highly accurate positioning. A stable control characteristic is also achieved even under load variation. In this mode, the adjustment of <fc switch>, <ILIM switch> and <DC gain variable resistor> becomes necessary.

a) <fc switch>

The 1 to 16 Hz position control system band is selected from a scale of 0 to F. However, in this case CN1 connectors FN 0 to FN 3 must all be set to H.

b) <ILIM 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 switch value large within the no wind-up range. The final adjustment is performed during the acceleration/deceleration operation.

c) <DC gain variable resistor>

The combination of driver CN1 connector GAIN H to L signals results in an adjustment range of from 0.5 to 110 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 load.

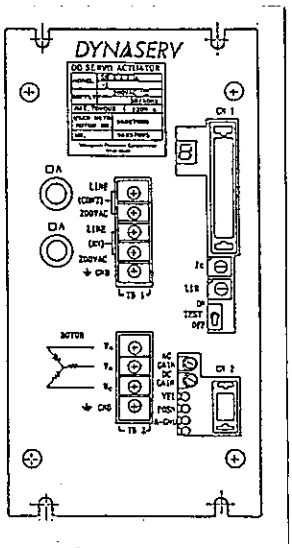


Figure 5.1

(2) P type position control

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

In this control mode, only <fc switch> and <DC gain variable resistor> are adjusted.

(3) Position control system adjustment procedure (See Figure 5.2)

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 POSW signal terminals. At this time, make sure 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.

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 1 to 16 Hz 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 <ILIM switch> GAIN H to L signal so that they match the load condition.
Fine adjustment is done by the <DC gain variable resistor>.
Do the above adjustments so that the POSN signal becomes a square wave.

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

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

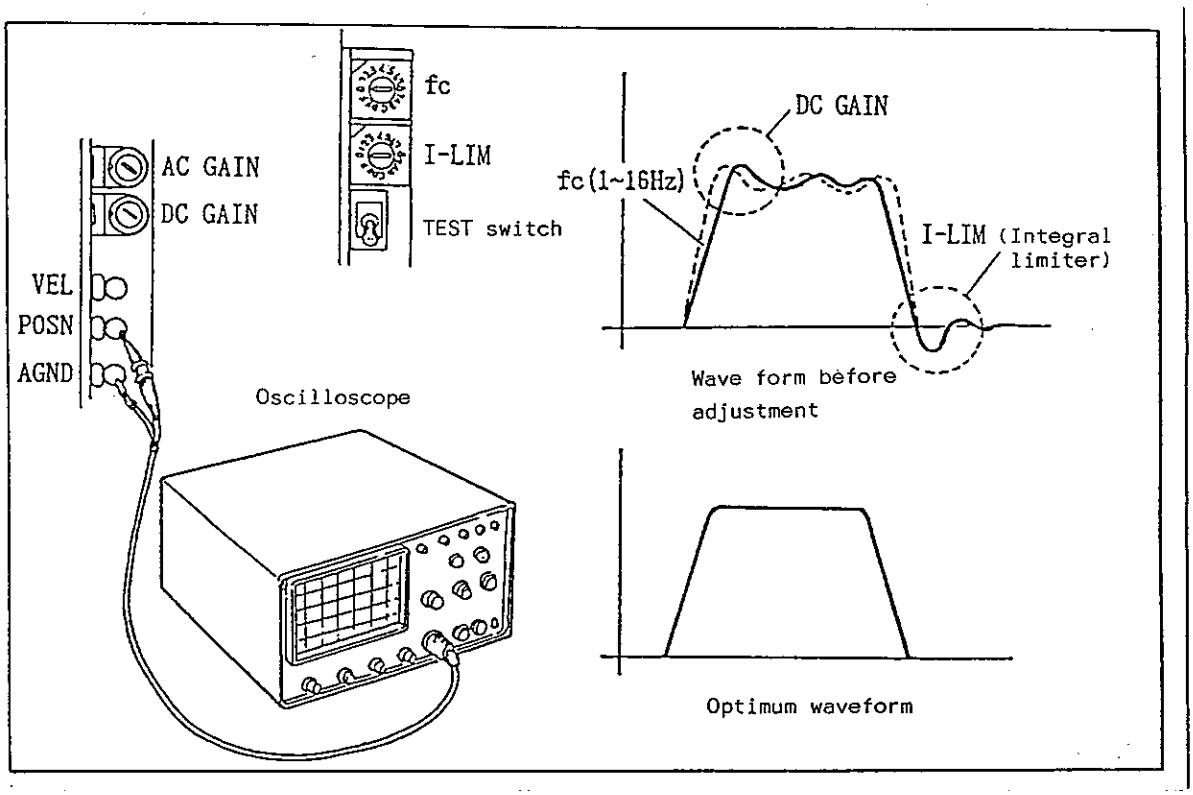


Figure 5.2

5.2 Velocity Control Mode Adjustment

In the velocity control mode, the motor rotating angle is controlled to correspond to the velocity command voltage (-6 V to + 6 V) from the higher-level controller.

The two control methods can both be selected in the velocity control mode.

The following table shows the relationship between velocity command voltage and motor r.p.m.

Table 5.1

Model	No. of revolutions/Input voltage [rps/V]
DR1015 to 1060B, DR1070E, DR1100E	2/5
DR1050A	1.5/5
DR1130E to DR1250E, DR1100A to 1400A	1/5
DR5030B, 5050B, 5070B	1/1.0

(Note) The above table shows operation with a 200 V power supply.

(1) PI type velocity control

The use of integral/proportional action in velocity control achieves smooth, disturbance-resistant control. This is the same control as conventional DC/AC servo motor control. In this control mode, only the two <DC gain> and <AC gain> variable resistors are adjusted.

a) <DC gain>

The combination of the driver CN1 connector GAIN H to L signals results in an adjustment range of from 0.5 to 110 times.

b) <AC gain>

Velocity loop band damping is adjusted.

The velocity loop block diagram is shown on the next page. Sections enclosed by double frames in the Figure show the locations of the jumpers, switches, and variable resistors.

(2) P type velocity control

Since velocity control is effective only in proportional action, response is fast but is strongly influenced by disturbances in the controlled result. In this control mode, only the <DC gain> variable resistor at the front of the driver is adjusted, while in this velocity mode, the test switch becomes invalid.

5.3 Torque Control Mode Adjustment

In the torque control mode, current flows through the motor corresponding to current command voltage (-8 V to +8 V) from the higher-level controller is controlled. Motor output torque depends on current. Therefore, torque is 0 at 0 V of command voltage, and maximum torque is produced at 8 V.

(Note) When the torque mode is used, velocity and position control and interlock are designed and practiced so as to meet applications.
When this mode is used, study the safety aspects carefully.

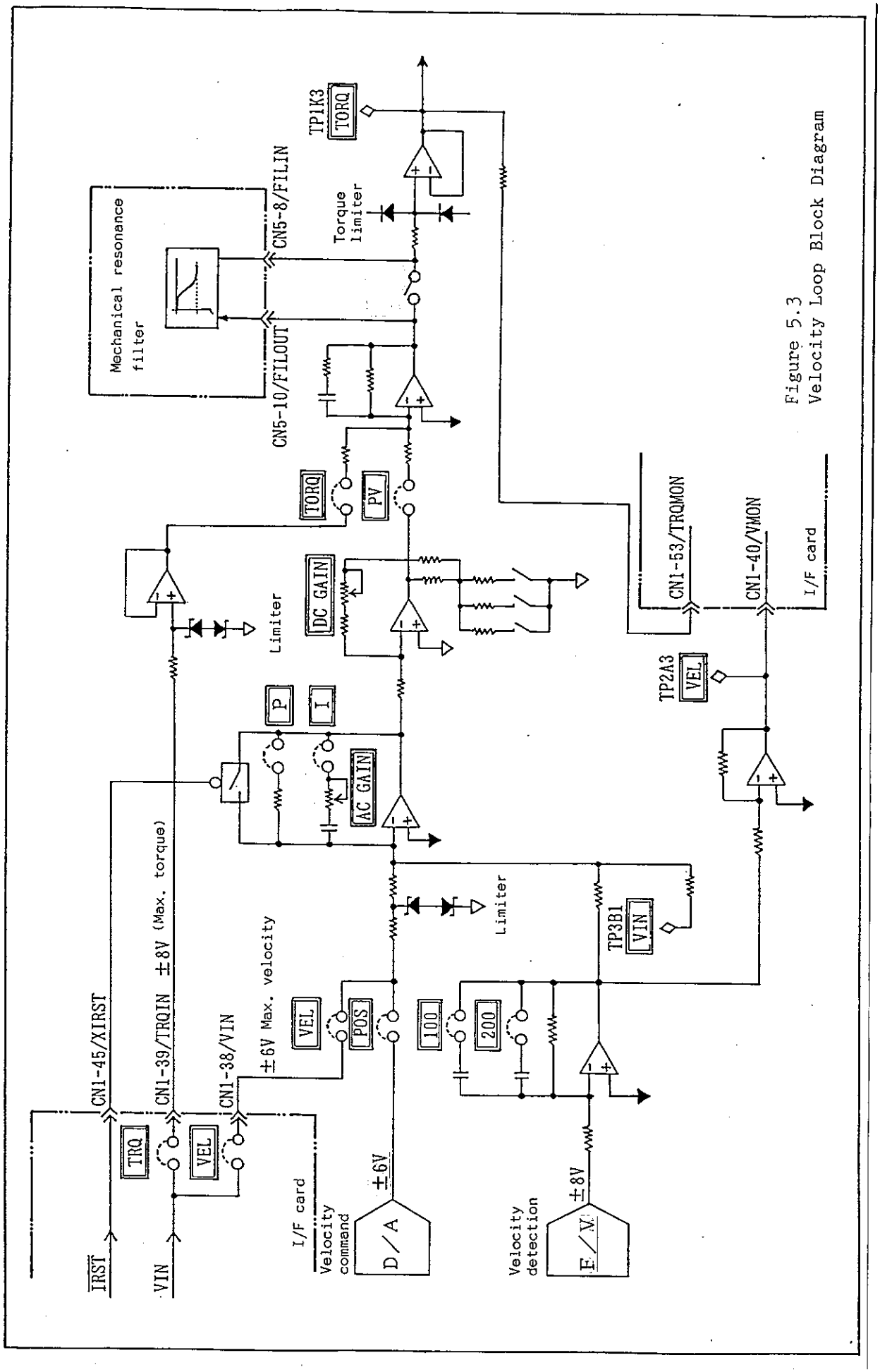


Figure 5.3
Velocity Loop Block Diagram

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 disassemble is required, contact us.

Table 6.1

Inspection Item	Period	Inspection Details	Evaluation
Sound and Vibration check	Daily	Widen the motor rotating range as much as possible when the motor is checked audibly and by touching.	No change is found under 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 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

When trouble occurs during motor operation, take the appropriate measures in accordance with the following. When the motor does not work normally, even after the following measures have been taken, immediately stop operation and contact us.

Table 7.1

Trouble	Estimated cause	Inspected Item	Measures
The motor is not servo locked.	◆No AC power is fed.	Wiring inspection	Apply the specified AC power
	◆Fuse has burned out.	Fuse inspection	Fuse replacement
	◆The servo ON (SRVON) terminal is set to H.	Inspection	Set to L.
	◆The CPU reset (RST) terminal is set to L.	Inspection	Set to H.
	◆The integral capacitor reset (IRST) terminal is set to L.	Inspection	Set to H.
	◆Fc, ILIM, DC gain is small.	Inspection	To be adjusted to an appropriate value.
The motor does not start.	◆Under overload	Under no load	When starting the motor, lighten the load or replace the motor with a large output motor.
	◆In correct external wiring	Inspect the wiring.	Re-wire correctly by referring to the connection diagram.
Motor rotation is unstable	◆Imperfect connection	Check the connection of each phase of A, B and C and GND.	Re-wire correctly by referring to the connection diagram.
	◆The motor and driver combination is wiring.	Check the combination Nos. on the nameplate.	If the combination is wrong, return it to the correct combination.

Trouble	Estimated cause	Inspected Item	Measures
The motor overheats	◆Ambient temperature is high.	Check to see if ambient temperature is more then 45℃.	Lower the temperature to below 45℃.
	◆The motor is overloaded.	Operate the motor under no load.	When starting the motor, lighten the load, or replace it with a large output motor.
Abnormal sound is produced.	◆Incorrect mounting	Loose set screws.	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.
Position is dislocated.	◆Incorrect A/B-phase and U/D-pulse jumper selection.	To be inspected.	
	◆Command pulse rate and width are not as specified.	Check the command pulse width (160 n sec. Min.)	
	◆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.	
	◆Both ends of the feedback pulse transmission cable shield are not connected to the earth.	If so, connect the driver to AGND and the controller to SG.	

7.2 List of LED Displays

A seven segment LED is mounted on the front panel of the driver to display the normal/abnormal status of the motor and driver. Display details are as shown in the following table.

Table 7.2

LED Display	Display Details	Cause/Measures
0	Servo OFF, normal status	
0.	Servo ON, normal status	
1	Servo OFF status after overspeed occurrence	◎Encoder malfunction ◎Command input trouble/command input check
1.	Servo ON status after overspeed occurrence	
2	RAM error occurrence	◎Control board trouble/requirement for repair
3	Encoder error occurrence	◎Encoder malfunction/encoder cable wiring check ◎Connector trouble/encoder cable connector check
5	Power supply error occurrence	◎Control power supply voltage trouble ◎Connector trouble/requirement for repair
6.	Counter overflow occurrence	◎High acceleration/deceleration ◎High revolution/command input check
7	ROM error occurrence	◎Control board trouble/requirement for repair
8	Main power supply trouble occurrence	◎Decrease in main power supply voltage ◎Fuse burnt out/fuse replacement
8.	CPU stop	◎Control board trouble/requirement for repair ◎Driver reset status
9	WDT error occurrence, Illegal interrupt, Computation overflow occurrence	◎Control board trouble/encoder cable wiring check

LED Display	Display Details	Cause/Measures
A	Power amp. error occurrence	◎High main power supply voltage ◎Imperfect connector contact/ requirement for repair ◎Power board trouble/requirement for repair
C.	Overload occurrence (Servo ON status)	◎Heavy load operation/load check, operation procedure review ◎Motor locked status/locked status release ◎Excessively high ambient temperature Lower environmental temperature
C	Overload occurrence (Servo OFF status)	
Other than the above	Trouble of elements relating to LED output	◎Control board trouble/requirement for repair

(Note) For "requirement for repair" (trouble of control board/power board), contact us.

8. Others

8.1 Standard Specification

(Values shown are typical and at 200 V AC power unless otherwise specification.)

Series				"B" Series				"E" Series					
Model				DR1015B	DR1030B	DR1045B	DR1060B	DR1070E	DR1100E	DR1130E	DR1160E	DR1220E	DR1250E
Motor & servo driver coupling	Max. output torque		N·m (lb·ft)	15 (11.1)	30 (22.2)	45 (33.3)	60 (44.4)	70 (51.8)	100 (74)	130 (96.2)	160 (118.4)	220 (162.8)	250 (185)
	Max. speed, 200 V/100 V		rps	2.4/2.4		2.4/1.8	2.4/1.4	2.4/2.0	2.4/1.5	1.2/1.2	1.2/1.0	1.2/0.7	
	Rated speed, 200 V/100 V		rps	2.0/2.0	2.0/1.5	2.0/1.0	1.5/1.0	2.0/1.5	1.5/1.0	1.0/0.5			
	Positioning	Encoder resolution	p/rev	507,904				614,400					
		Positioning accuracy	arc-sec	±45				±45					
		Repeatability	arc-sec	±5				±5					
Motor section	Rotor inertia		kg·m² (lb·ft·sec)	21×10^{-3} (15×10^{-3})	24×10^{-3} (18×10^{-3})	26×10^{-3} (19×10^{-3})	33×10^{-3} (24×10^{-3})	85×10^{-3} (63×10^{-3})	100×10^{-3} (74×10^{-3})	125×10^{-3} (92×10^{-3})	140×10^{-3} (103×10^{-3})	170×10^{-3} (125×10^{-3})	185×10^{-3} (136×10^{-3})
	Rated maximum load	Axial load kgf (lb)	Compression	3.0×10^{4} (6.6×10^{4})				4.0×10^{4} (8.8×10^{4})					
			Tension	1.0×10^{4} (2.2×10^{4})				2.0×10^{4} (4.4×10^{4})					
		Overhung load	N·m (lb·ft)	200 (148)				400 (296)					
	Torsional stiffness	Axial stiffness mm/kgf (in/lb)	Compression	3.0×10^{-6} (2.2×10^{-7})				2.0×10^{-6} (1.47×10^{-7})					
			Tension	4.0×10^{-6} (2.96×10^{-7})				3.0×10^{-6} (2.2×10^{-7})					
		Radial stiffness rad/kgf·m (rad/lb·ft)		2.0×10^{-6} (1.45×10^{-5})				4.0×10^{-7} (2.9×10^{-6})					
	Weight		kg (lbs)	9.0 (20)	11 (24.4)	13 (28.9)	15.5 (34.4)	22 (48.9)	26 (57.8)	32 (71.1)	36 (80)	44 (97.8)	48 (106.7)
	Dimension (Dia.×L±1 mm)		mm (in)	ϕ150×123 (ϕ5.9×4.8)	ϕ150×151 (ϕ5.9×5.9)	ϕ150×179 (ϕ5.9×7.0)	ϕ150×207 (ϕ5.9×8.1)	ϕ205×183 (ϕ8.1×7.2)	ϕ205×210 (ϕ8.1×8.3)	ϕ205×243 (ϕ8.1×9.6)	ϕ205×271 (ϕ8.1×10.7)	ϕ205×327 (ϕ8.1×12.9)	ϕ205×355 (ϕ8.1×14.0)
	Common Items			Motor insulation: Class F (JIS C 4003) Withstanding voltage: 1500 V AC. 1 min				Insulation resistance: 10 MΩ Min. (500 V DC) Color: Black Excitation: 3 Phase					
Servo driver section	Model	For 100 V AC		SR1015B-1	SR1030B-1	SR1045B-1	SR1060B-1	SR1070E-1	SR1100E-1	SR1130E-1	SR1160E-1	SR1220E-1	SR1250E-1
		For 200 V AC		SR1015B-2	SR1030B-2	SR1045B-2	SR1060B-2	SR1070E-2	SR1100E-2	SR1130E-2	SR1160E-2	SR1220E-2	SR1250E-2
	Input signal	Serial pulse and analog I/F	Speed input signal	Analog voltage: ±6 V DC Max.									
			Positioning input signal	Serial pulse 1.6 MHz Max.									
			Torque input signal	Analog voltage: ±8 V DC Max.									
			Rotation direction command signal	H: CW L: CCW									
		8-bit bus I/F		<Bi-directional 8 bit bus I/F>									
	Output signal	Speed output		+6 V (CW) to −6 V (CCW)									
		Encoder output		Track A, Track B, (400 kHz Max.) Zero position signal (124 p/rev)				Track A, Track B, (400 kHz Max.) Zero position signal (150 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			100/200 V AC $^{+10\%}_{-15\%}$ 50/60 Hz									
	Power consumption (Max.)		KVA	1.2	1.7	1.7	1.8	2.0	2.3	2.3	2.3	2.3	2.3
	Weight		kg (lbs)	6 (13.3)									

3.2 Environmental Specifications

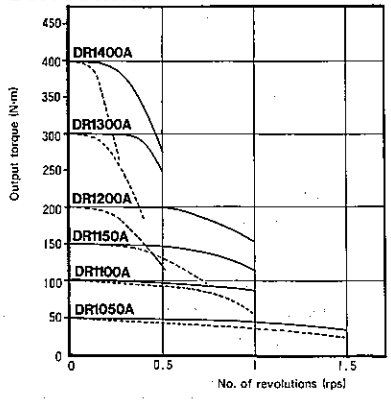
		Motor	Driver	Remarks
During operation	Temperature	0 to 45°C	0 to 50°C	
	Humidity	20 to 85% R.H.	20 to 90% R.H.	Non condensing
During storage	Temperature	−20 to 85°C	−20 to 85°C	
	Humidity	20 to 85% R.H.	20 to 90% R.H.	Non condensing
Environment		No corrosive gases, Dust-free atmosphere		

3.3 Torque vs. Speed Characteristic

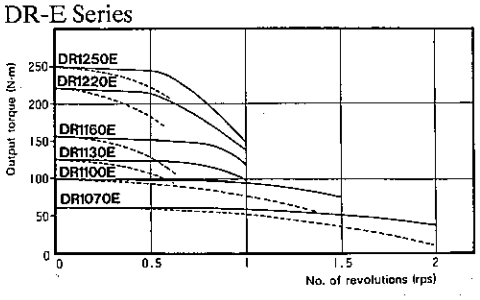
—— 200 V AC Power Supply

------- 100 V AC Power Supply

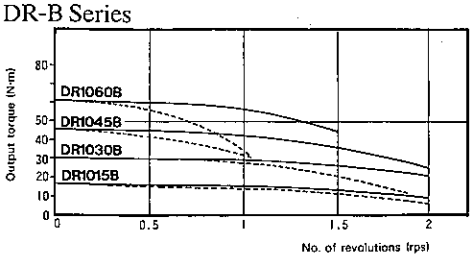
DR-A Series



DR-E Series

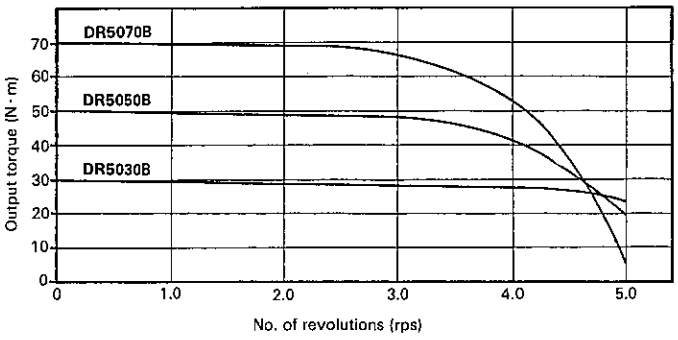


DR-B Series



"A" Series						5000B Series		
DR1050A	**DR1100A**	**DR1150A**	**DR1200A**	**DR1300A**	**DR1400A**	**DR5030B**	**DR5050B**	**DR5070B**
50 (37)	100 (74)	150 (111)	200 (148)	300 (222)	400 (296)	30 (22.2)	50 (37)	70 (51.8)
1.8/1.8	1.2/1.2	1.2/1.0	1.2/0.8	1.0/0.5	0.8/0.4	5.0		
1.5/1.5	1.0/1.0	1.0/0.5		0.5/0.25		4.0		
819,200						278,528		
±30						±90		
±5						±10		
180×10^{-3} (132×10^{-3})	200×10^{-3} (147×10^{-3})	230×10^{-3} (169×10^{-3})	285×10^{-3} (210×10^{-3})	340×10^{-3} (250×10^{-3})	400×10^{-3} (294×10^{-3})	26×10^{-3} (19.2×10^{-3})	33×10^{-3} (24.4×10^{-3})	36×10^{-3} (26.6×10^{-3})
4.0×10^{-4} (8.8×10^{-4})						3.0×10^{-4} (6.6×10^{-4})		
2.0×10^{-4} (4.4×10^{-4})						1.0×10^{-4} (2.2×10^{-4})		
400 (296)						200 (148)		
2.0×10^{-6} (1.47×10^{-7})						3.0×10^{-6} (2.2×10^{-7})		
3.0×10^{-6} (2.2×10^{-7})						4.0×10^{-6} (2.96×10^{-7})		
4.0×10^{-7} (2.9×10^{-6})						3.0×10^{-6} (1.45×10^{-5})		
26 (57.8)	31 (68.9)	36 (80)	45 (100)	56 (124.4)	65 (144.4)	13 (28.9)	15.5 (34.4)	17.5 (38.9)
ϕ264×158 (ϕ10.4×6.2)	ϕ264×185 (ϕ10.4×7.3)	ϕ264×212 (ϕ10.4×8.3)	ϕ264×250 (ϕ10.4×9.8)	ϕ264×304 (ϕ10.4×11.97)	ϕ264×358 (ϕ10.4×14.1)	ϕ150×179 (ϕ5.9×7.0)	ϕ150×207 (ϕ5.9×8.1)	ϕ150×235 (ϕ5.9×9.3)
Motor insulation: Class F (JIS C 4003) Withstanding voltage: 1500 V AC. 1 min					Insulation resistance: 10 MΩ Min. (500 V DC) Color: Black Excitation: 3 Phase			
SR1050A-1	**SR1100A-1**	**SR1150A-1**	**SR1200A-1**	**SR1300A-1**	**SR1400A-1**			
SR1050A-2	**SR1100A-2**	**SR1150A-2**	**SR1200A-2**	**SR1300A-2**	**SR1400A-2**	**SR5030B-2**	**SR5050B-2**	**SR5070B-2**
Analog voltage: ±6 V DC Max.								
Serial pulse 1.6 MHz Max.						Serial pulse 1.4 MHz Max.		
Analog voltage: ±8 V DC Max.								
H: CW						L: CCW		
<Bi-directional 8 bit bus I/F>								
+6 V (CW) to −6 V (CCW)								
Track A, Track B, (400 kHz Max.) Zero position signal (200 p/rev)						Track A, Track B, (400 kHz Max.) Zero position signal (68 p/rev)		
Over-current, Over-voltage, Heat sink Temperature alarm, Voltage low alarm Encoder abnormal, CPU abnormal								
2.5 Hz Step response output (Test mode)								
100/200 V AC $^{+10\%}_{-15\%}$ 50/60 Hz						200 V AC $^{+10\%}_{-15\%}$ 50/60 Hz		
2.0	2.3	2.5	2.7	3.0	3.0	2.0	3.0	4.0
6 (13.3)								

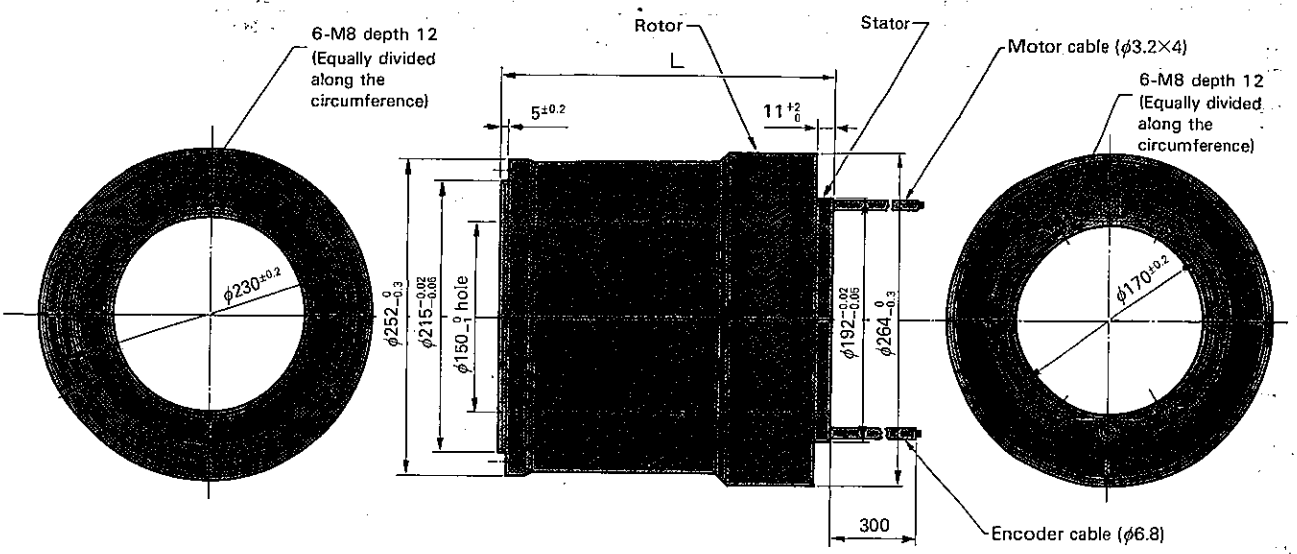
DR5000B Series



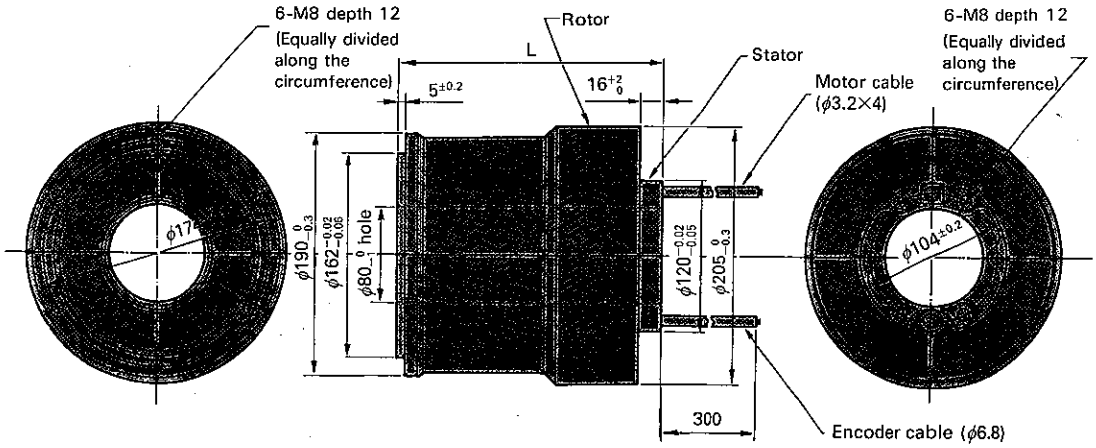
8.3 Dimensional Outline Drawing Unit: mm

(1) Motor (L: Indicated in motor specification)

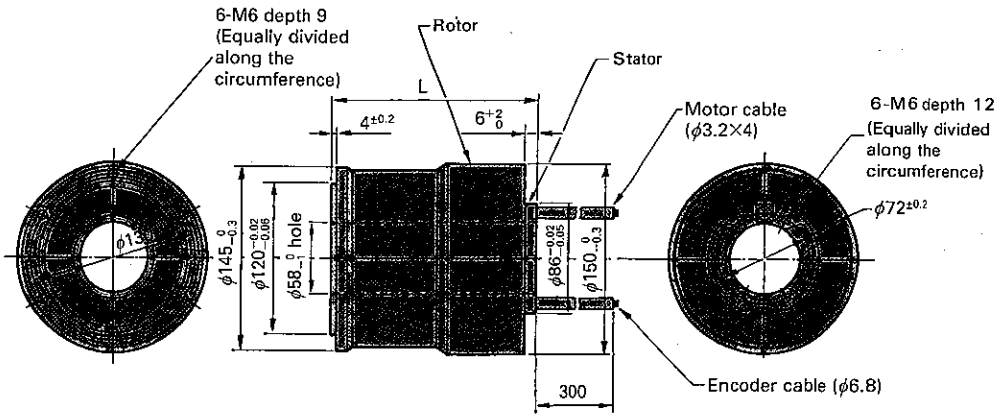
(1) Type A



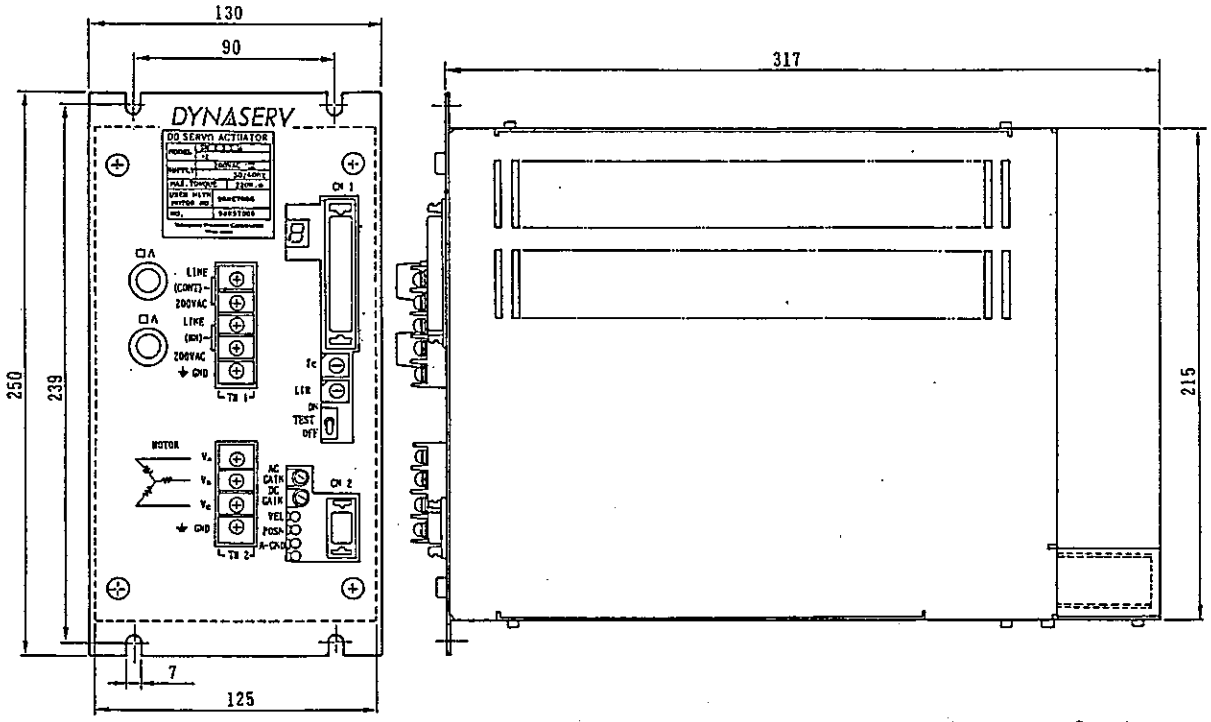
(2) Type E



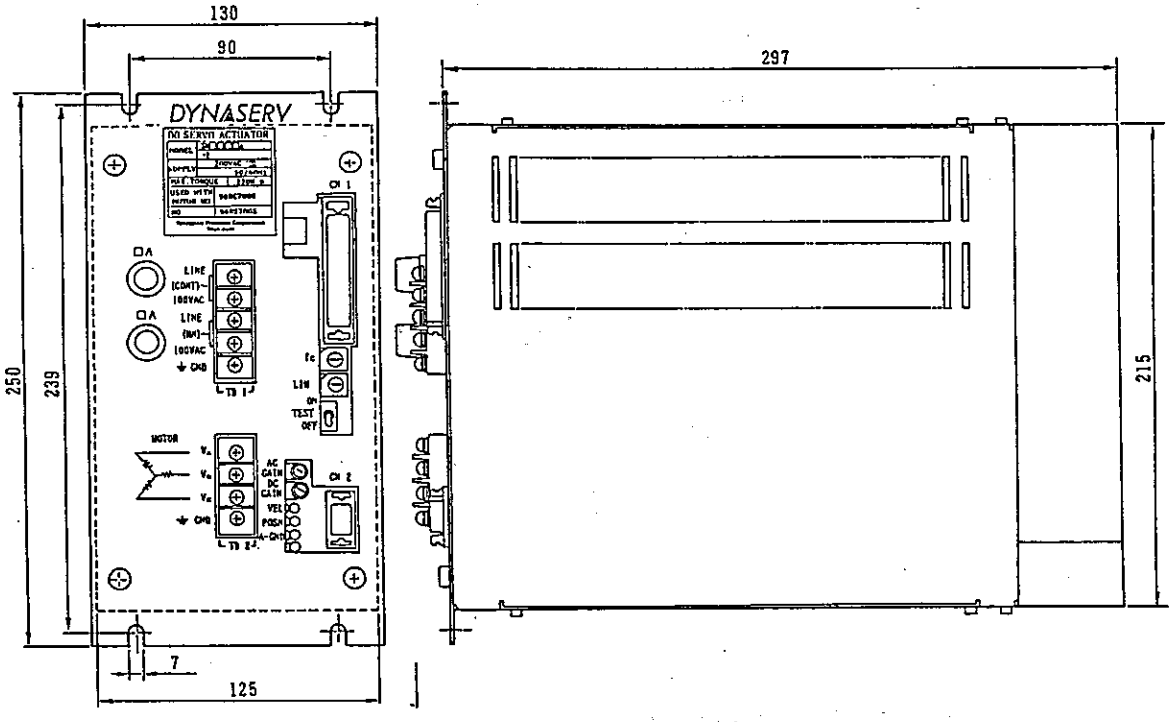
(3) Type B



(2) Driver



200 VAC power supply type (Figure 8.7)



100 VAC power supply type (Figure 8.8)

8.4 Driver Block Diagram

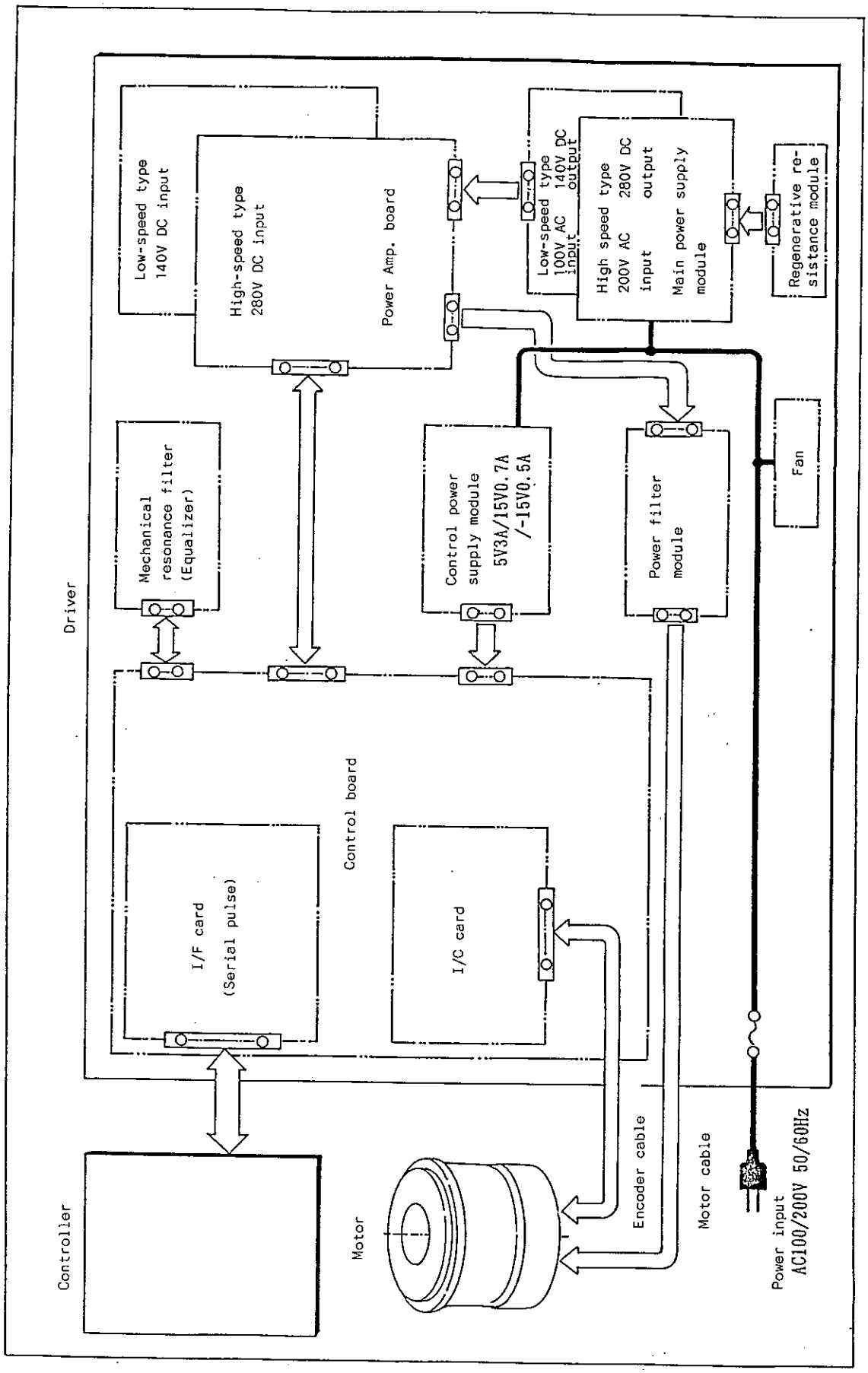


Figure 8.9

8.5 Details of I/O Signals between the Motor and the Driver

(1) TB1 connection signal
(For 100 V specification)

Table 8.5

Signal name	Meaning
LINE (MN)	AC input for motor drive power
100 V AC	AC input for motor drive power
LINE (CONT)	AC input for control circuit power
100 V AC	AC input for control circuit power
GND	Frame ground

(2) TB2 connection signal

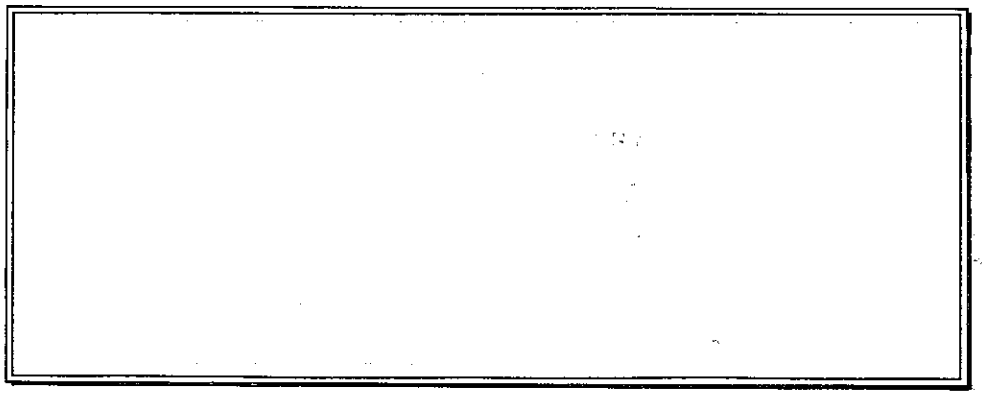
Table 8.6

Signal name	Meaning
V_A	Motor A-phase output
V_B	Motor B-phase output
V_C	Motor C-phase output
GND	Frame ground

(3) CN2 connection signal

Table 8.7

Signal name	Connector pin No.	Meaning
+S0	1	Excitation signal output (Sin phase)
-S0	2	Detection signal input (Sin 0°)
-S180	3	Detection signal input (Sin 180°)
SHIELD	4	Shield
FG	5	Frame ground
+C0	6	Excitation signal output (Cos phase)
-C0	7	Detection signal input (Cos 0°)
-C180	8	Detection signal input (Cos 180°)



Feb. 1991