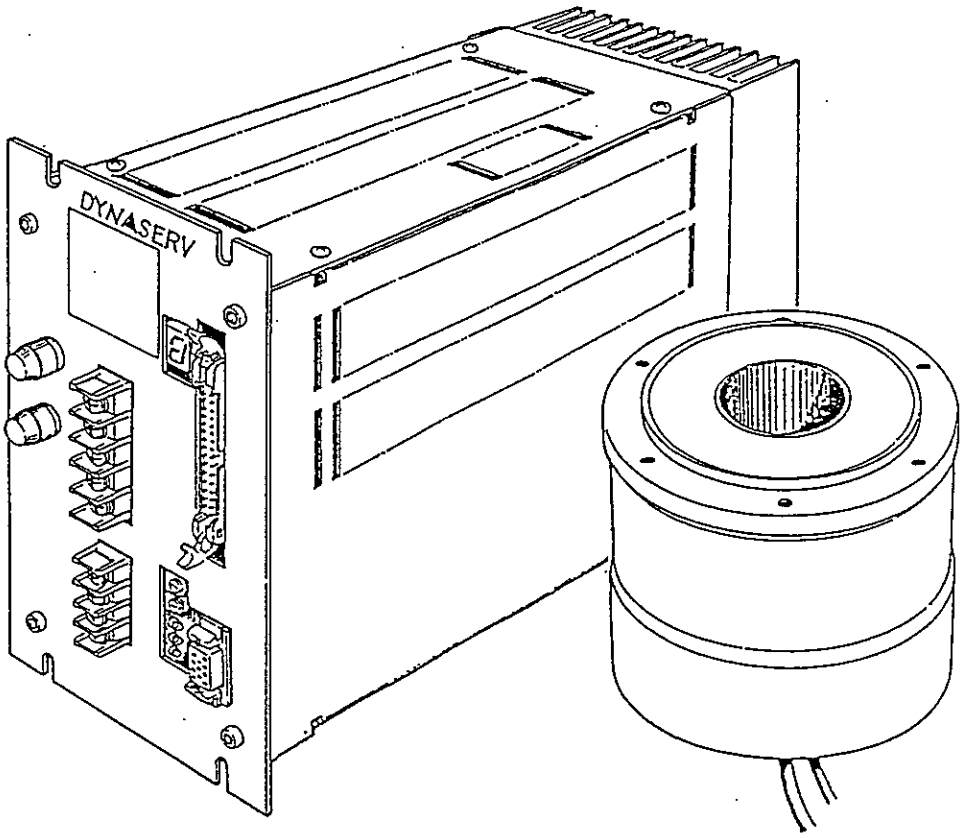
Instruction Manual

DYNASERV

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

— 8-bit Microcomputer Bus Interface Model —



YOKOGAWA ◆
Yokogawa MAT Corporation

IM A202-E
IMar. 16 2000

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.

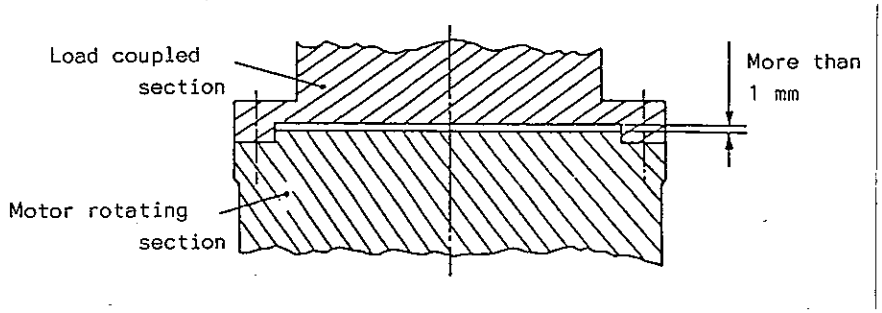
2. Never conduct opposite mounting of rotating the stator with the motor rotor fixed.

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.

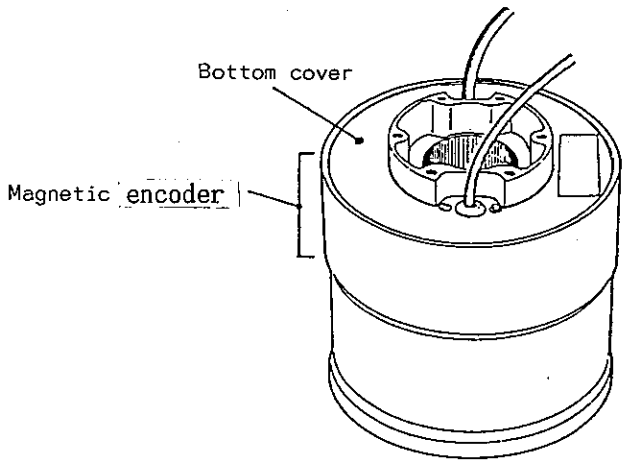
4. This motor rotates at high speed and high torque, so be careful of the rotating radius in order to prevent danger accident when operating with a load connected.

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.

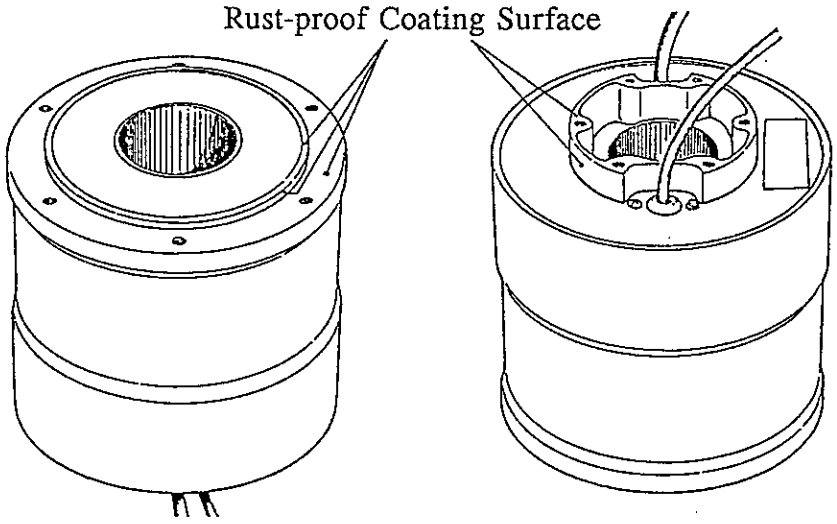
9. Since the motor surface is magnetically charged, do not place any magnetized objects or substances near the surface.

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.

15. When an object is to be introduced inside the central hole of the motor, ensure a minimum gap of 1mm on either side between the object and the motor walls.

Contents

Introduction ····· 1

Operating Cautions ····· 2

1. Product Outline ····· 7
 1.1 DYNASERV, DR/SR Series ····· 7
 1.2 Standard Product Configuration ····· 7
 1.3 Model Symbols ····· 9

2. Functional Description ····· 10
 2.1 Motor Section ····· 10
 2.2 Driver Section ····· 10
 2.3 Driver Panel Surface ····· 11

3. Preparation for Operation ····· 12
 3.1 Initial Setting ····· 12
  (1) Setting sections on the driver printed-circuit board ····· 12
  (2) Jumper settings done prior to shipment ····· 13
  (3) Switch, variable resister settings done prior to shipment ····· 13
 3.2 Setting Procedure and Meaning ····· 14
  (1) Control mode setting ····· 14
  (2) Feedback pulse and position command pulse settings/JI ····· 16
  (3) Velocity signal filter setting/JI ····· 16
  (4) Origin pulse output signal setting/J5 ····· 16
  (5) Positioning completion width setting/S1 ····· 17
  (6) Jumper setting on the 8-bit bus I/F card ····· 18
  (7) Mechanical resonance filter (equalizer type) adjustment ····· 20
 3.3 External Wiring ····· 21
  (1) External connection outline diagram ····· 21
  (2) Connection between the motor and the driver ····· 21
  (3) Connection to external controller ····· 22
  (4) Details of CN1 terminal I/O signals ····· 23
 3.4 Bus Interface Section Electrical Characteristics ····· 24
  (1) Recommended operation condition ····· 24
  (2) I/O capacity ····· 24
  (3) DC characteristics ····· 25
  (4) AC characteristics ····· 25
 3.5 Installation ····· 26
  (1) Motor-section mounting ····· 26
   a) Installation location ····· 26
   b) Mechanical coupling ····· 27

(2) Driver section mounting ····· 27
a) Installation location ····· 27
b) Mounting procedure ····· 27
3.6 Wiring Cables ····· 29
(1) Cable sizes and rated currents ····· 29
(2) Wiring cautions ····· 30

4. Operation Cautions ····· 31
4.1 8-bit Bus I/F Card I/O Part Selection ····· 31
(1) Input port ····· 31
(2) Output port ····· 32
4.2 8-bit Bus I/F Card Pulse Generation Circuit ····· 33
(1) Buffer/Register configuration ····· 33
(2) Status register contents ····· 33
(3) Error occurrence and release ····· 33
(4) Rate and pulse output time calculation formule ····· 34
(5) Pulse output control procedure ····· 35
4.3 8-bit Bus I/F Card Pulse Counter Section ····· 35
(1) Buffer/Register configuration ····· 36
(2) Latch command ····· 36
(3) Counter data read ····· 36
(4) Pulse counter operation mode setting ····· 36
(5) Status register ····· 37
4.4 8-bit Bus I/F Card D/A Circuit ····· 38
(1) Basic specification ····· 38
(2) Register configuration ····· 38
(3) Data output ····· 38
(4) D/A output switching jumper ····· 38
4.5 8-bit Bus I/F Card Control Signal ····· 39
(1) I/O port ····· 39
(2) Driver status register ····· 40
(3) DYNASERV operation mode setting ····· 40
(4) Servo ON signal selection ····· 41

5. Control Mode and Adjustment ····· 42
5.1 Position Control Mode Adjustment ····· 42
(1) I-PD type position control ····· 42
(2) P type position control ····· 43
(3) Position control system adjustment procedure ····· 43
5.2 Velocity Control Mode Adjustment ····· 44
(1) PI type velocity control ····· 45
(2) P type velocity control ····· 45
5.3 Torque Control Mode Adjustment ····· 45

6. Maintenance and Inspection ····· 47
6.1 Motor Section ····· 47
6.2 Driver Section ····· 47

7. Trouble and Measures ····· 48
7.1 Motor Trouble ····· 48
7.2 List of LED Display ····· 51

8. Others ····· 53
8.1 Standard Specification ····· 53
(1) Standard motor/driver combination ····· 53
(2) Standard motor specification ····· 53
(3) Standard driver specification ····· 54
(4) Environmental specification ····· 54
8.2 No. of Revolutions Torque Characteristic ····· 55
8.3 Dimensional Outline Drawing ····· 56
(1) Motor (L: Indicated in motor specification) ····· 56
(2) Driver ····· 57
8.4 Driver Block Diagram ····· 58
8.5 Details of I/O Signals between the Motor and the Driver ···59

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.

The corresponding driver is called the SR Series and is classified into serial pulse interface and 8-bit micro computer bus interface models (Hereinafter, called 8-bit bus I/F) according to the external control interface used. In addition, both 100 V and 200 V power supply versions of each model are available. (This instruction manual describes the 8-bit micro computer bus 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 Nihon Koku Denshi/ PS-50SEN-d4P1-1C, PS-SRN50
Connector (for the CN2 terminal)	1	Manufactured by Honda Tsushin Kogyo MR-8LM
Fuse	2	ϕ 6 × 32 mm 15 A

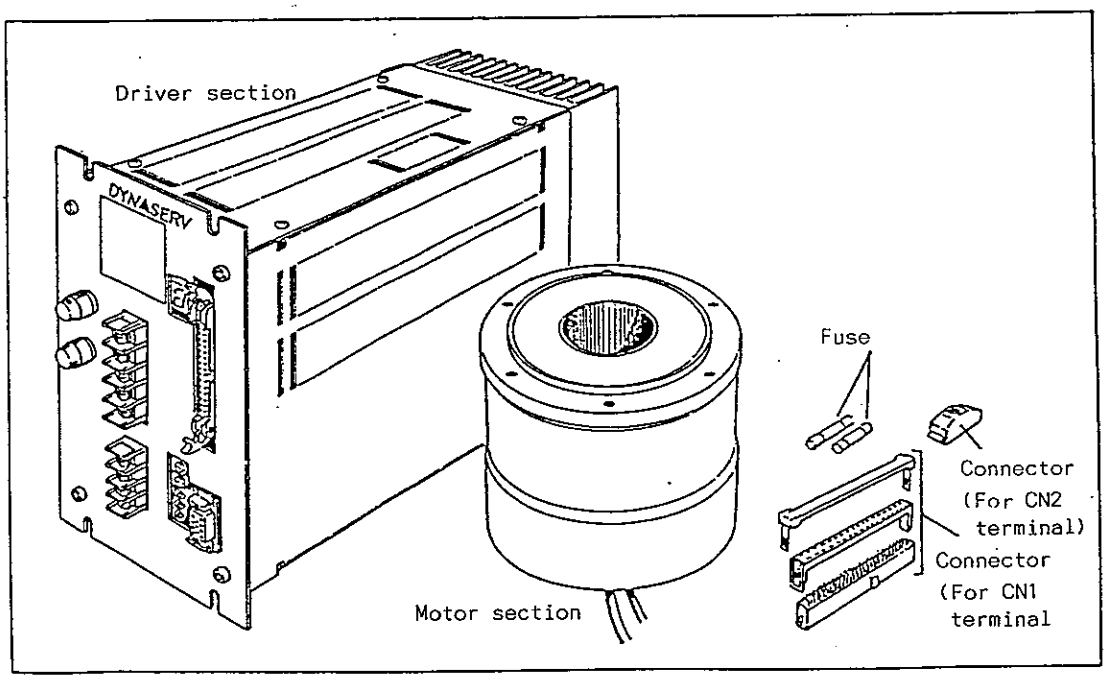
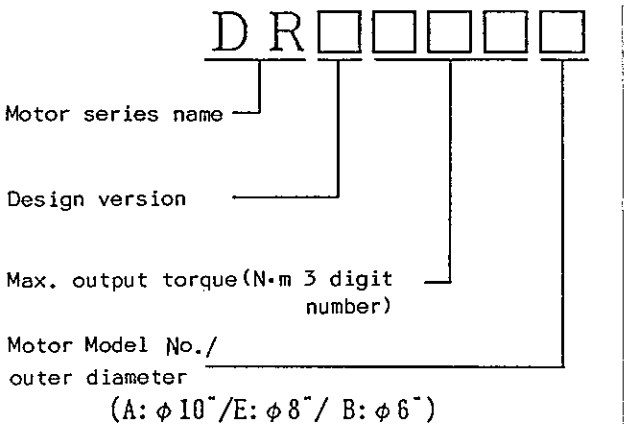

Driver section
DYNASERV
Fuse
Connector
(For CN2
terminal)
Connector
(For CN1
terminal
Motor section

Figure 1.1

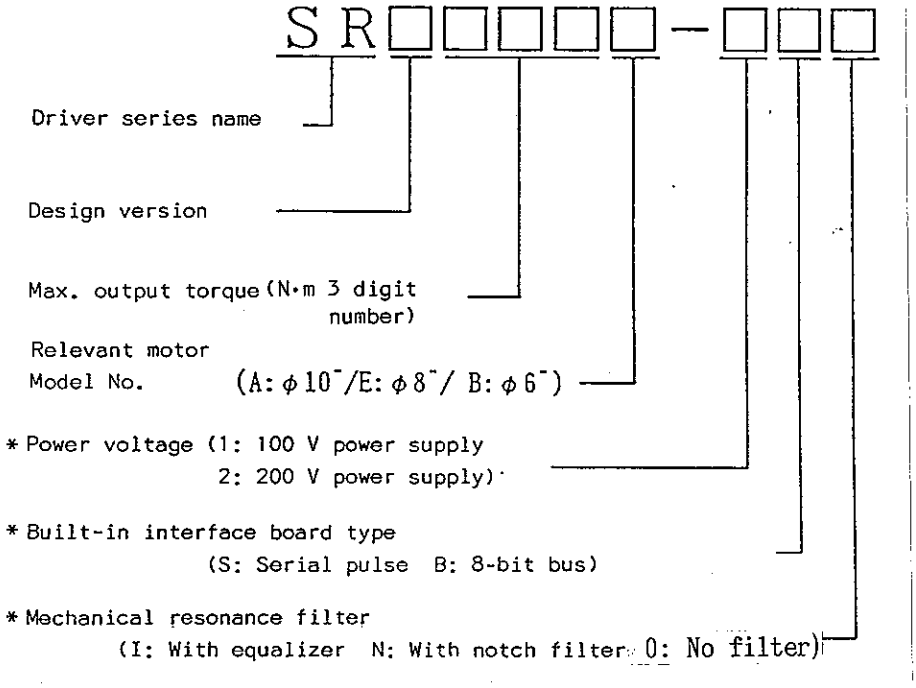
1.3 Model Symbols

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

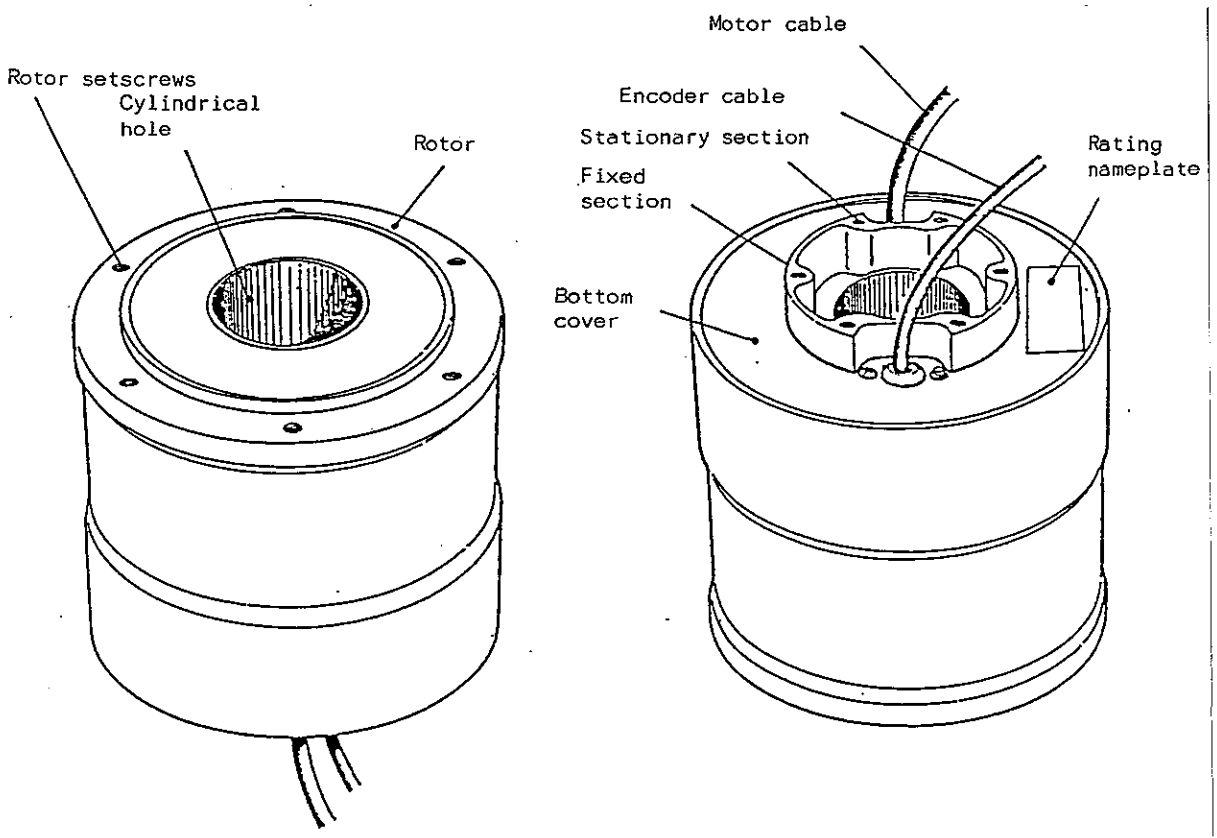


Figure 2.1

2.2 Driver Section

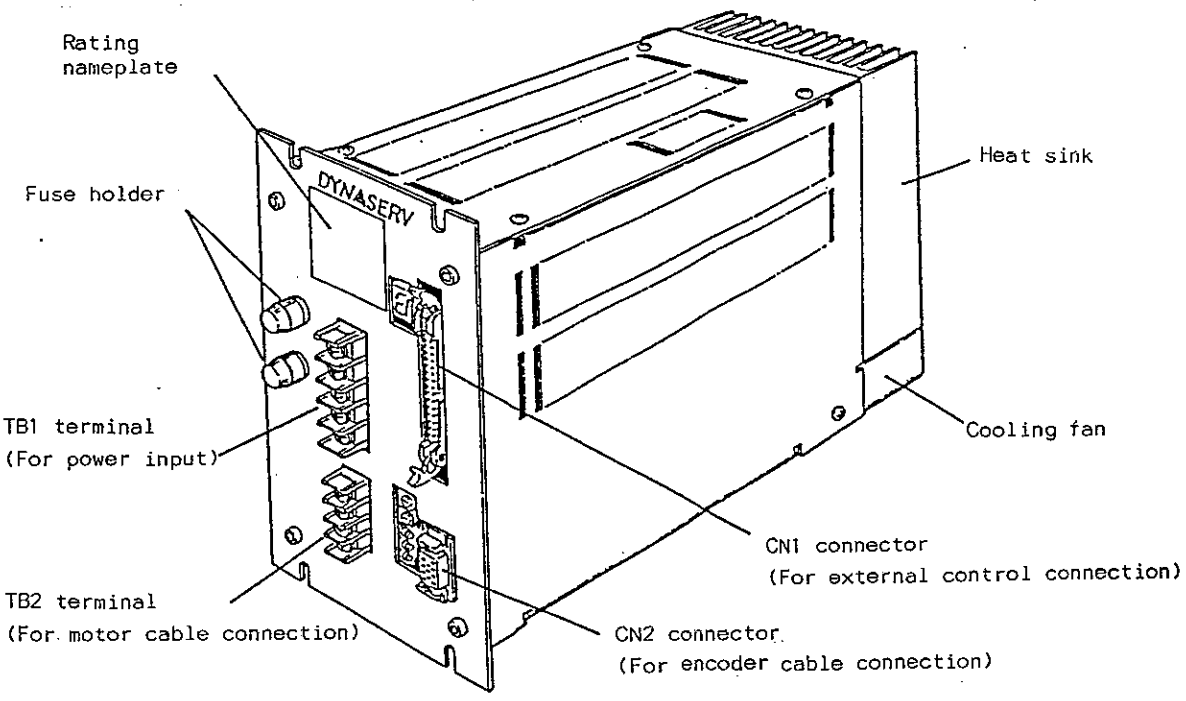


Figure 2.2

2.3 Driver Panel Surface

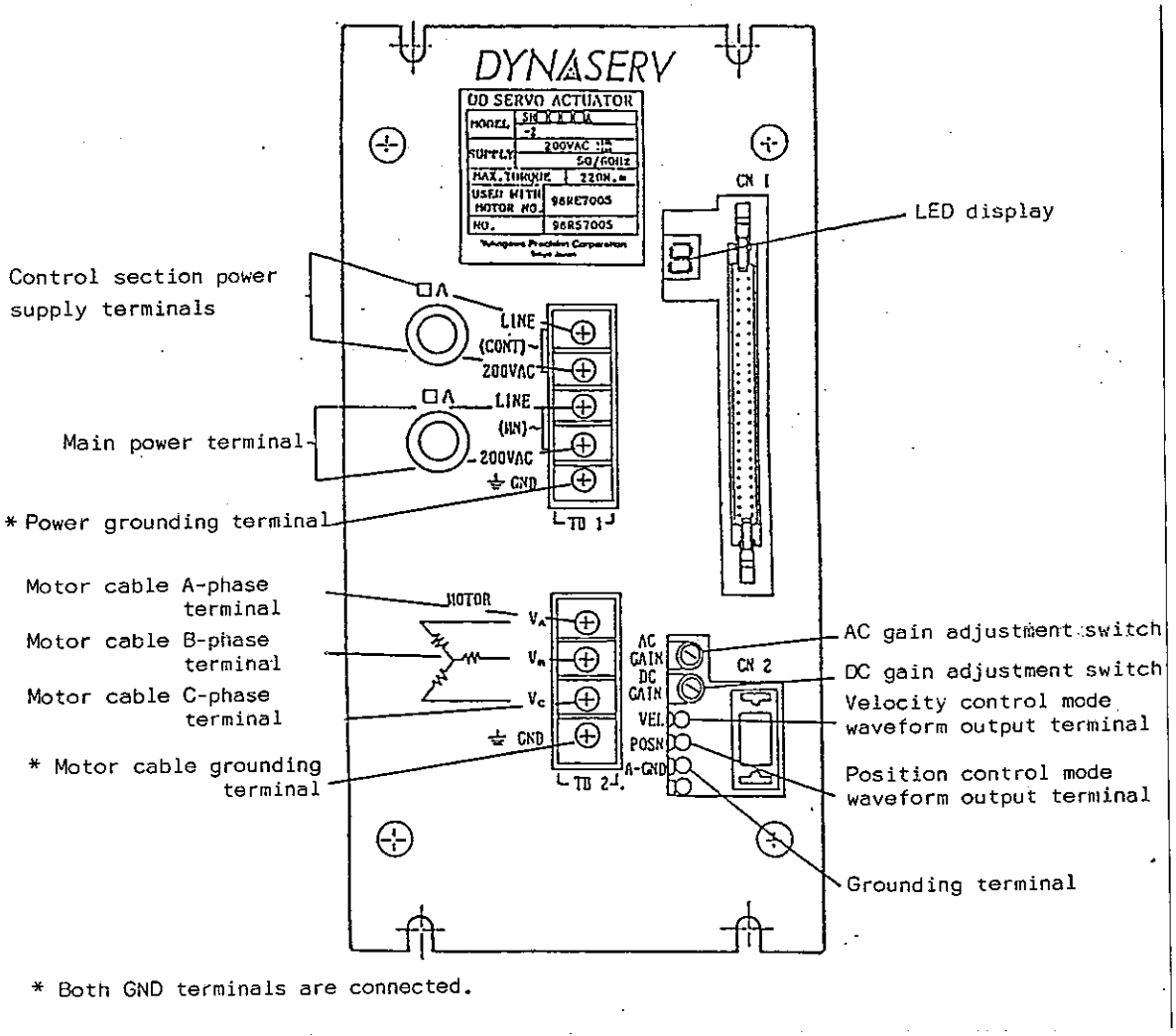


Figure 2.3

3. Preparation for Operation

3.1 Initial Setting

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

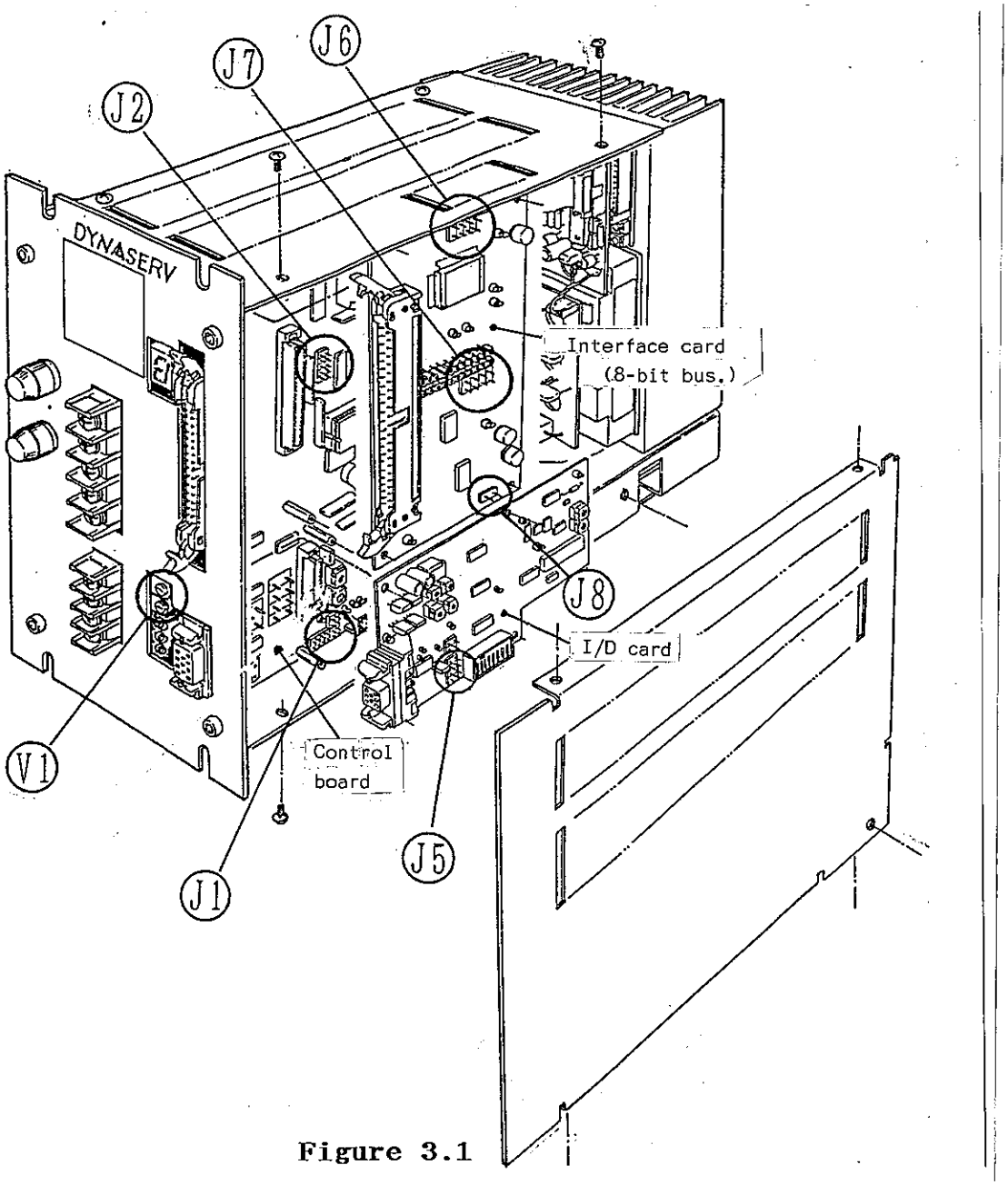


Figure 3.1

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

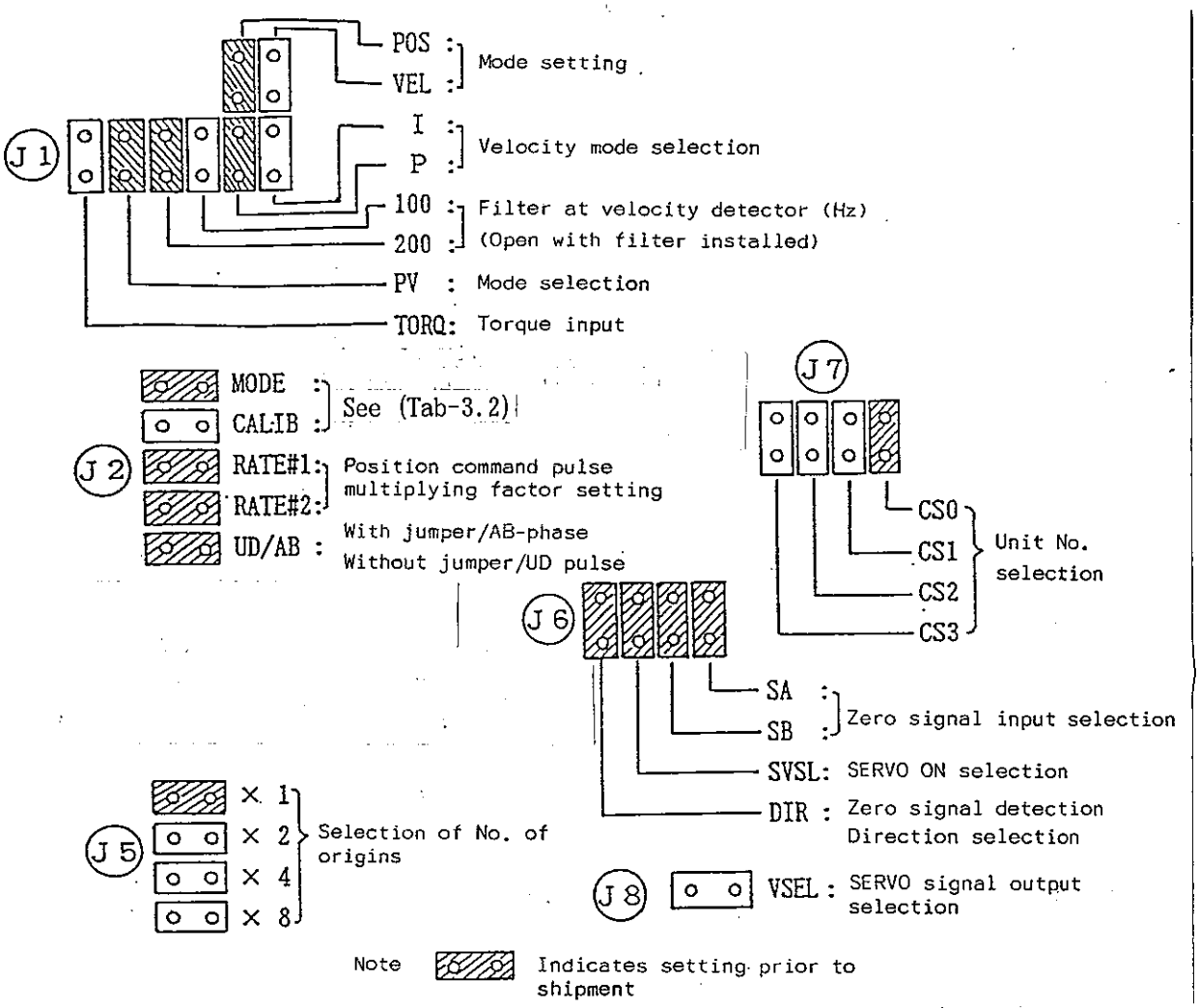


Figure 3.2

(3) Switch, variable resistor settings done prior to shipment

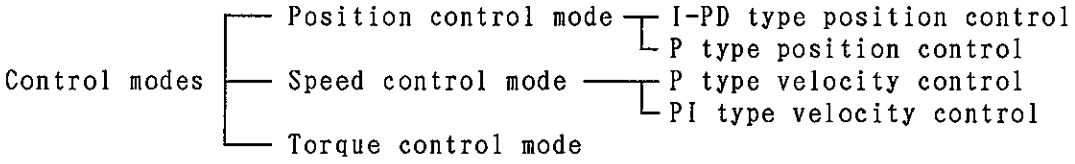
Table 3.1

Relevant board/card	Location	Switch name V.R. name	Setting status
Control board	V1	DC GAIN	Minimum position
		AC GAIN	Minimum position

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 GAIN	×	×	○	×
8-bit bus inter-face card	J8	VSEL	×	Shorted	Shorted	Open
	Port	GAIN	○	○	○	×
		POSW	○	×	×	×
		fn	○	×	×	×
		I_{LIM}	○	×	×	○
		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/JI
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/JI
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.

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.

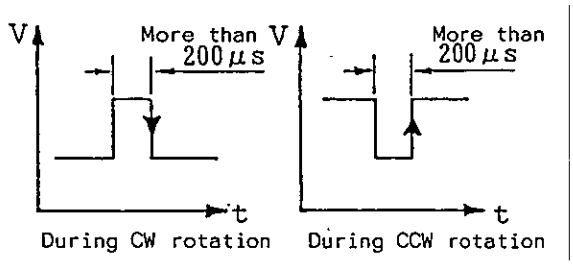


Figure 3.3 Origin signal and zero position

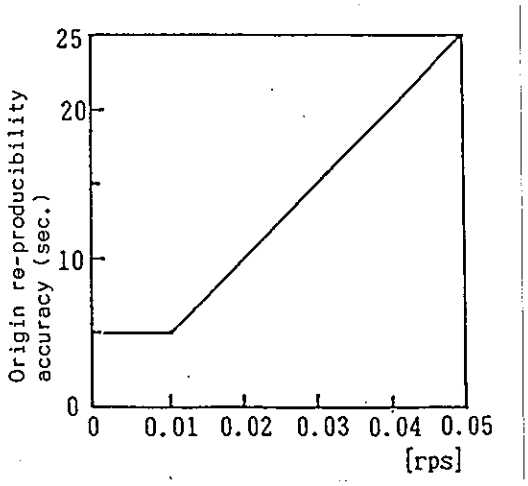


Figure 3.4 Relationship between No. of motor Revolutions and Origin Reproducibility accuracy

Table 3.4

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

(5) Positioning completion width setting
When positioning in the position control mode is completed, the COIN signal is set to ON. This positioning completion width can be selected by the POSW port.

The following table shows the relationship between POSW port data and positioning completion width.

Table 3.5

POSW port data	Positioning completion width (unit: pulse)
F	1
E	5
D	20
C	100
B	2
A	10
9	40
8	200
7	4
6	20
5	80
4	400
3	8
2	40
1	160
0	800

(6) Jumper setting on the 8-bit bus I/F card

a) Mode setting jumper/J6

Table 3.6

Name	No jumper connected	Jumper connected
DIR	Falling zero signal (CW rotation) is detected when use in the mode to clear the pulse counter is used in the counter clear mode during zero signal detection.	Rising zero signal (CCW rotation) is detected when use in the mode to clear the pulse counter is used in the counter clear mode during zero signal is detected.
SVSL	Servo signal output from the output port on the bus.	Servo signal output in accordance with the interface signal.

Table 3.7

SB	SA	Min. pulse width setting for zero signal to be input when the counter is cleared.
Jumper connected	Jumper connected	2.73 ms
Jumper connected	No jumper connected	683 μ s
No jumper connected	Jumper connected	171 μ s
No jumper connected	No jumper connected	2.67 μ s

b) Model selection jumper/J7
When two or more DYNASERVs are connected in parallel, model Nos. are assigned to each driver. At this time, the bus is used in common by using this jumper, enabling the setting of model Nos. 0 to 3.

Table 3.8

Jumper				Details
CS0	CS1	CS2	CS3	
Connected	Not connected	Not connected	Not connected	Model No. 0 selected
Not connected	Connected	Not connected	Not connected	Model No. 1 selected
Not connected	Not connected	Connected	Not connected	Model No. 2 selected
Not connected	Not connected	Not connected	Connected	Model No. 3 selected

(Note) Do not set two or more model Nos. to one drive.
Do not set the same model No. to two or more drives.

c) D/A output selection jumper/J8
This jumper is used to select an output voltage for the command voltage output D/A when DYNASERV is used in the velocity control and torque control modes.

Table 3.9

VSEL jumper	Output voltage	Control mode
Not connected	±8 V	Torque control mode/Calibration mode
Connected	±6 V	Velocity control mode

(7) 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.

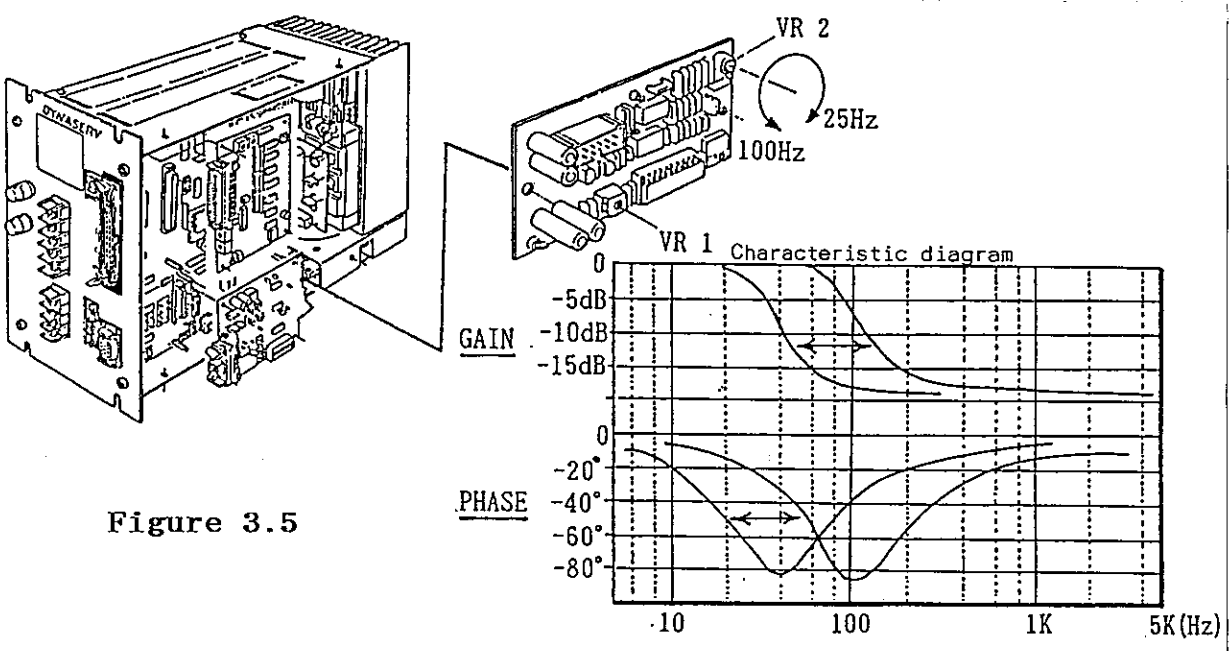


Figure 3.5

Figure 3.6 Characteristic Diagram

3.3 External Wiring

(1) External connection outline diagram

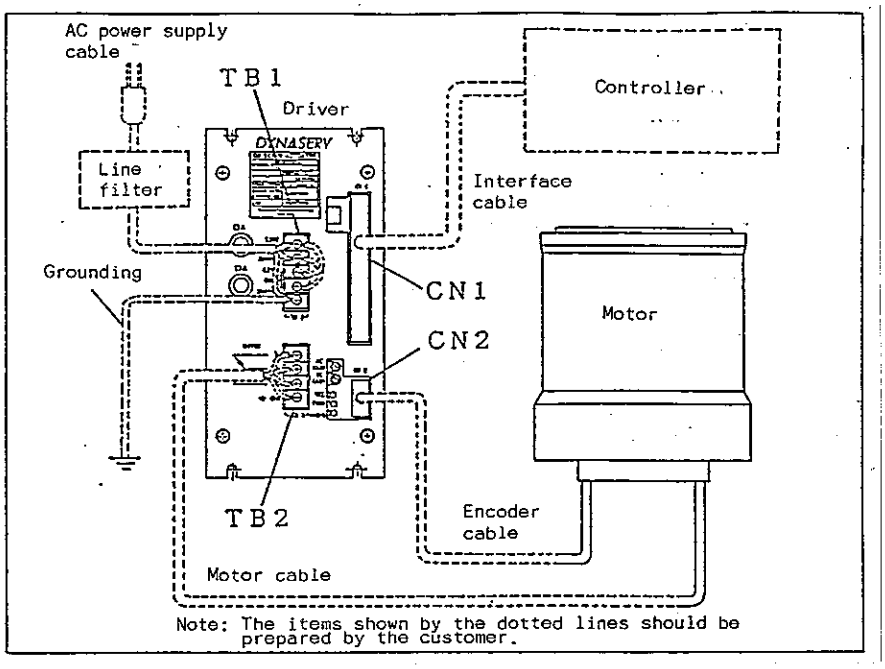


Figure 3.7

(2) Connection between the motor and the driver

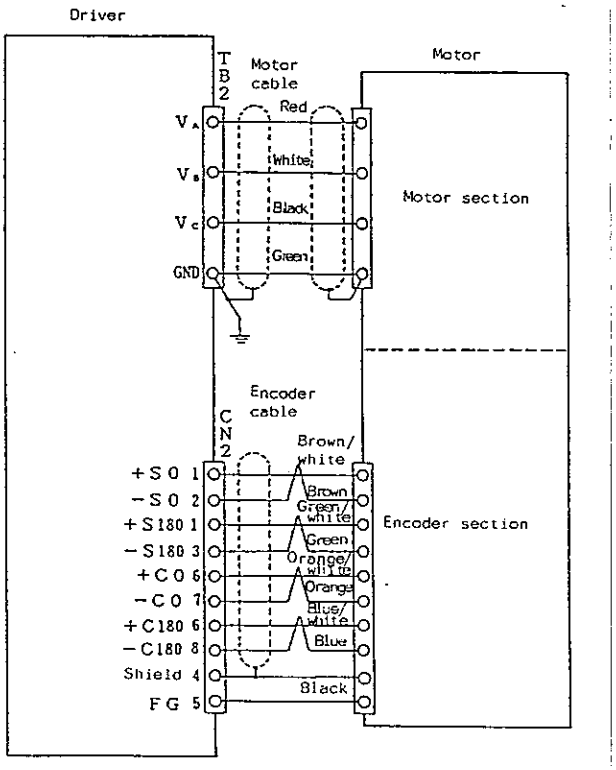
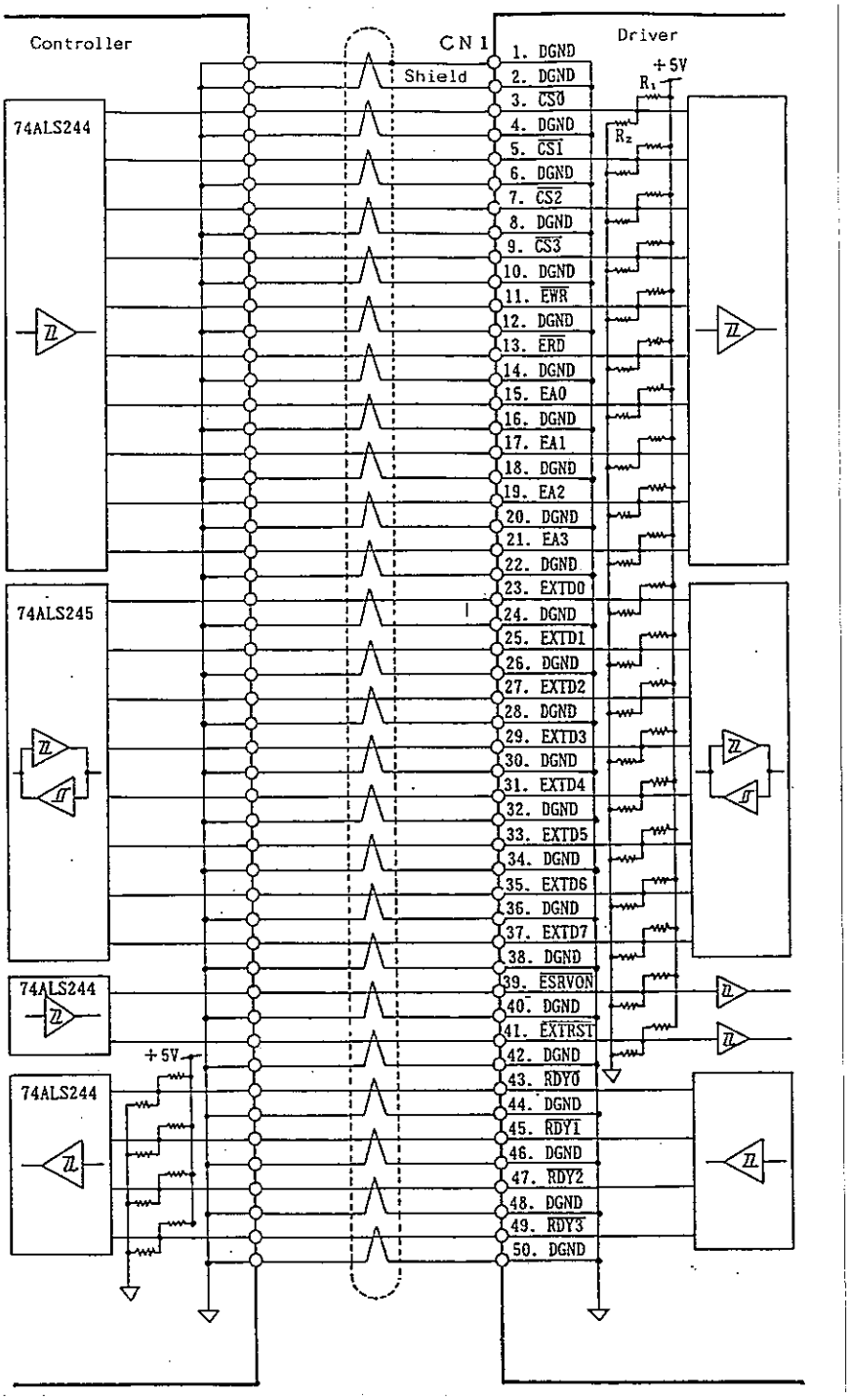


Figure 3.8

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



(Note) Use the following termination resistors R_1 and R_2.
R_1: 390Ω R_2: 680Ω

Figure 3.9

(4) Details of CN1 terminal I/O signals

Table 3.10

Pin No.	Signal name	I/O	Details
1, 2	DGND	I	Digital grounding
3 (4)	$\overline{CS0}$	I	Model No. selection signal 0
5 (6)	$\overline{CS1}$	I	Model No. selection signal 1
7 (8)	$\overline{CS2}$	I	Model No. selection signal 2
9 (10)	$\overline{CS3}$	I	Model No. selection signal 3
11 (12)	$\overline{EWR}$	I	I/O write signal
13 (14)	$\overline{ERD}$	I	I/O read signal
15 (16)	EA0	I	I/O address signal 0
17 (18)	EA1	I	I/O address signal 1
19 (20)	EA2	I	I/O address signal 2
21 (22)	EA3	I	I/O address signal 3
23 (24)	EXTD0	I/O	I/O data bus 0
25 (26)	EXTD1	I/O	I/O data bus 1
27 (28)	EXTD2	I/O	I/O data bus 2
29 (30)	EXTD3	I/O	I/O data bus 3
31 (32)	EXTD4	I/O	I/O data bus 4
33 (34)	EXTD5	I/O	I/O data bus 5
35 (36)	EXTD6	I/O	I/O data bus 6
37 (38)	EXTD7	I/O	I/O data bus 7
39 (40)	$\overline{ESRVON}$	I	External servo On signal When the jumper is connected, the motor is set to the servo ON status after this signal is set to L to set the driver to the command wait status.
41 (41)	$\overline{EXTRST}$	I	External reset signal. The driver control section is initialized when this signal is set to L for more than 50μs.
43 (44)	$\overline{RDY0}$	O	Model No. 0 motor servo ready. Setting this signal to L enables model No. 0 motor to operate.
45 (46)	$\overline{RDY1}$	O	Model No. 1 motor servo ready. Setting this signal to L enables model No. 1 motor to operate.
47 (48)	$\overline{RDY2}$	O	Model No. 2 motor servo ready. Setting this signal to L enables model No. 2 motor to operate.
49 (50)	$\overline{RDY3}$	O	Model No. 3 motor servo ready. Setting this signal to L enables model No. 3 motor to operate.

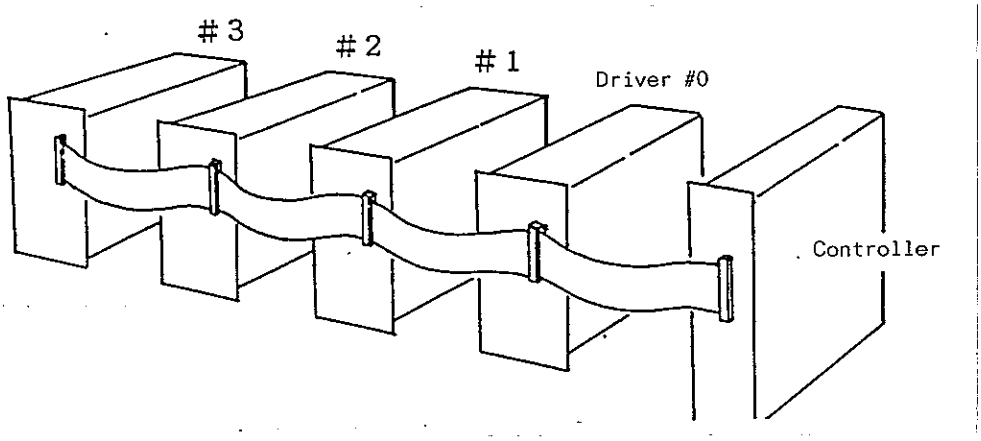


Figure 3.10

(Note) For the 8-bit bus I/F card, connect two or more drivers in parallel series as shown above. Connect the termination resistor to the last driver only.
However, the max. cable length (between terminals) should be 0.4 m.

3.4 Bus Interface Section Electrical Characteristics

(1) Recommended operation condition

Table 3.11

Item	Symbol	Condition		
		Min.	Std.	Max.
H level output current	10H			-8 mA
L level output current	10L			24 mA

(2) I/O capacity

Table 3.12

Item	Symbol	Rating		
		Min.	Std.	Max.
Input terminal	CIN			16 pF
Output terminal	COUT			18 pF
I/O terminal	CO/O			23 pF

(Note) Measurement condition: V_{DD} = V1 = 0V f = 1 MHz

(3) DC characteristics

Table 3.13

Item		Symbol	Condition	Rating		
				Min.	Std.	Max.
Output voltage	H level L level	VOH VOL	IOH = -8 mA IOL = 24 mA	4.0 V Vss		5.25 V_{DD} 0.5 V
Input voltage	H level L level	VIH VIL	TTL level TTL level	2.2 V		 0.8 V
Input leakage current		ILI	VI = 0V to V_{DD}	-10 μA		10 μA
Input leakage current		ILZ		-10 μA		10 μA

(Note) V_{DD} = 5 V ± 5% V_{SS} = 0 V TA = 0 to 70℃
Input leakage current: When input is applied to EXTD 0 to 7 terminals.

(4) AC characteristics

Table 3.14

Item	Abbre-viation	Condition	Min.	Max.
CS setting time (To XEWR↓) CS storage time (To XEWR↑) Address settint time (To XEWR↓) Address storage time (To XEWR↑) Data setting time (To XEWR↑) Data storage time (To XEWR↑) XEWR low level width	t_{SCWR} t_{HWRC} t_{SAWR} t_{HWRA} t_{SDW} t_{HWD} t_{WRL}		10 ns 0 ns 0 ns 0 ns 7 ns 19 ns 31 ns	
CS setting time (To XERD↓) CS storage time (To XERD↑) Address setting time (To XERD↓) Address storage time (To XERD↑) Data delay time (To XERD↑) Data float time (To XERD↑) XERD low level width	t_{SCRD} t_{HRDC} t_{SARD} t_{HRDA} t_{DRDD} t_{FRDD} t_{RDL}		10 ns 0 ns 0 ns 0 ns 6 ns 53 ns	 53 ns 48 ns
ZERO input high level width	t_{ZRH}	SA=L, SB=L SA=H, SB=L SA=L, SB=H SA=H, SB=H	2.73 ms 683 μs 171 μs 1.4 μs	
ZERO input low level width	t_{ZRL}	SA=L, SB=L SA=H, SB=L SA=L, SB=H SA=H, SB=H	2.73 ms 683 μs 171 μs 1.4 μs	

(Note) T_a = 0 to +70℃ , V_{DD} = 5 V± 5%
Output terminal load capacity: C_L = 60 pF

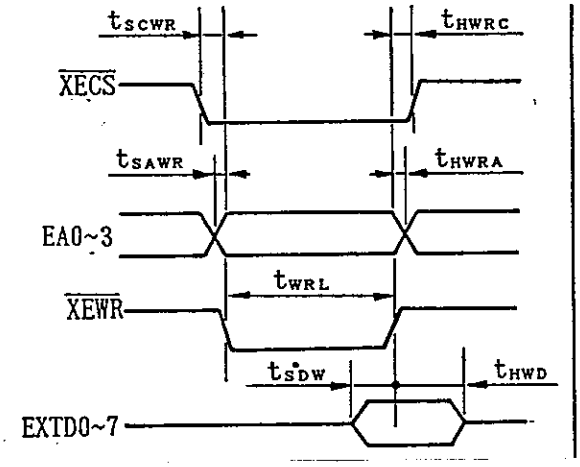


Figure 3.11 Write Cycle

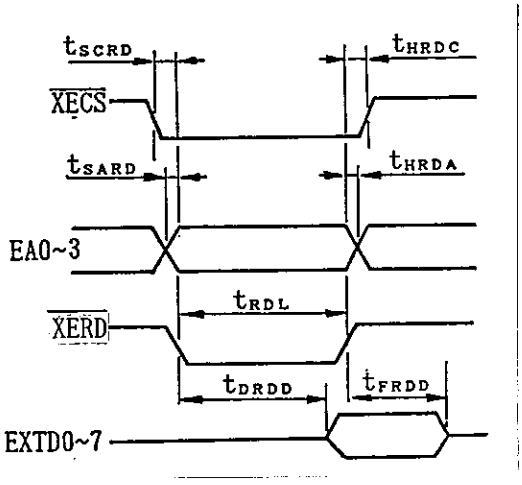


Figure 3.12 Read Cycle

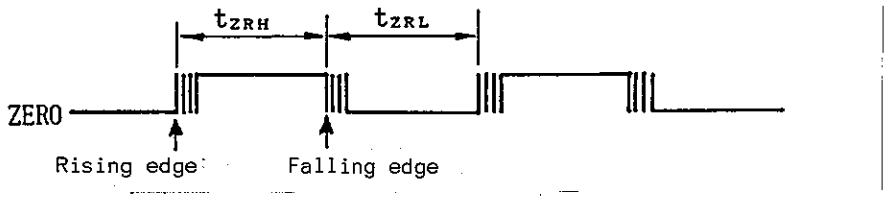


Figure 3.13 ZERO Signal Input (When the Counter is Cleared)

3.5 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 for surface accuracy maintenance.
- 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.

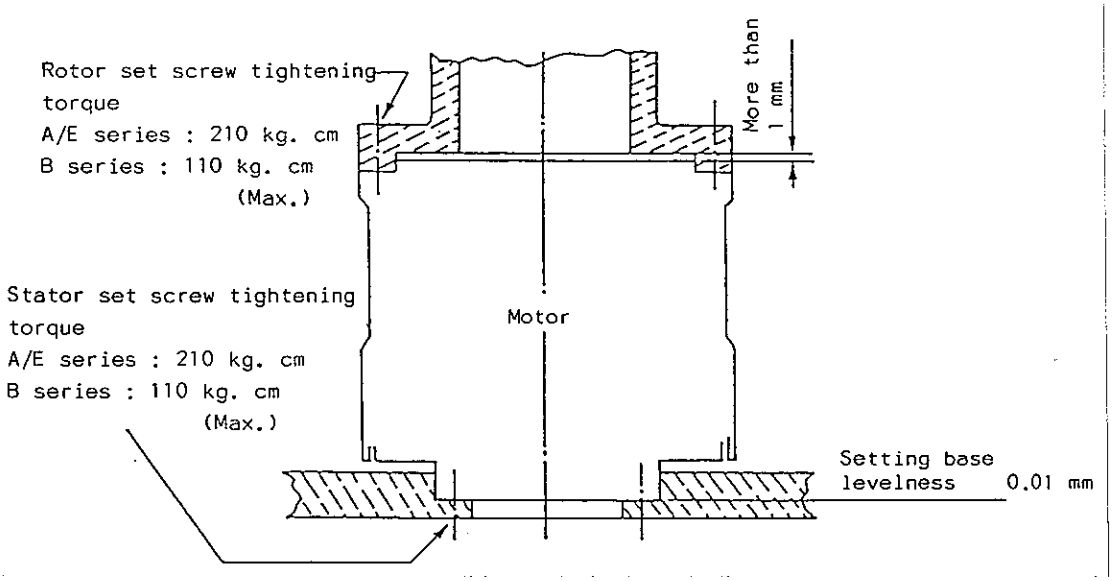


Figure 3.14

(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 the following figures)

■ 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 the following figures

■ Mount the driver using 4 holes at the top and bottom of the front plate.

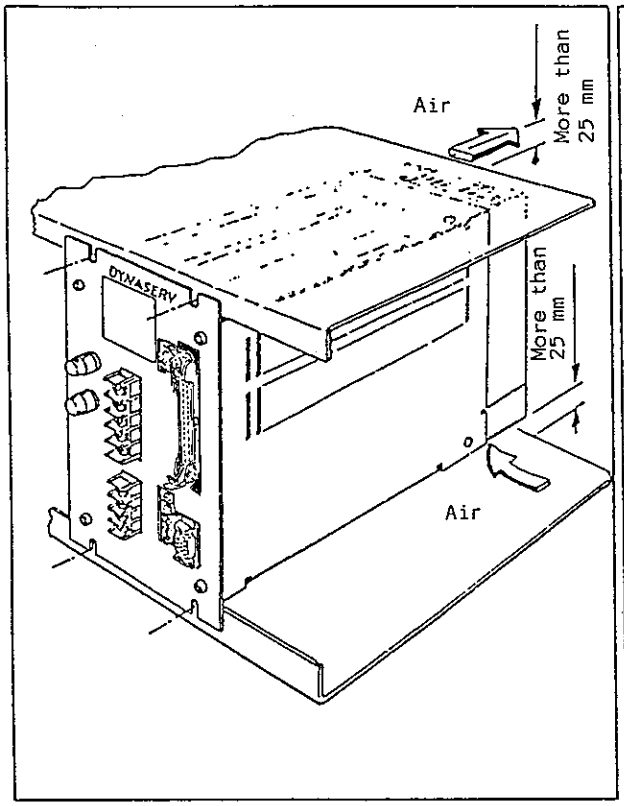


Figure 3.15

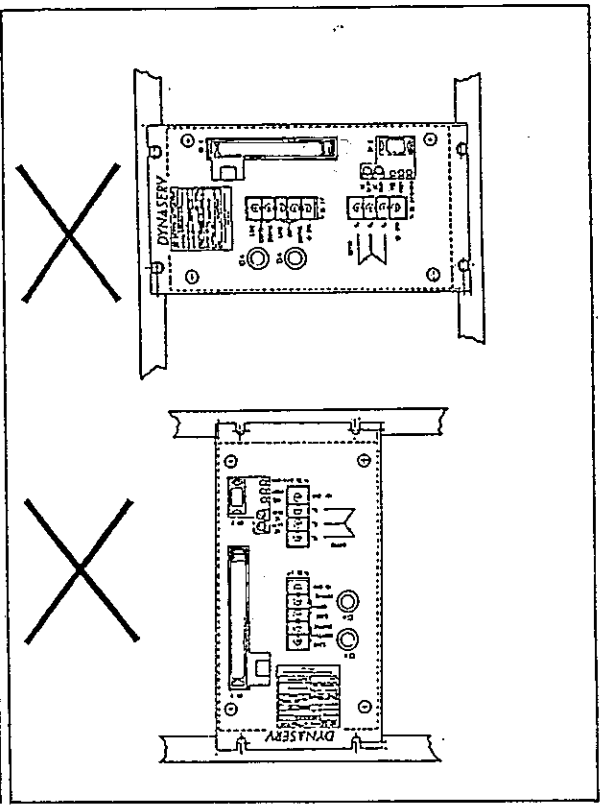


Figure 3.16

3.6 Wiring Cables

(1) Cable sizes and rated currents

Table 3.15

			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	Shielded 50 cores flat cable 28AGW/UL2682, Length: within 0.4 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 tin-plated twisted wire
4. Outer sizes of the cables used for CN2: Less than ϕ 9 mm
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.

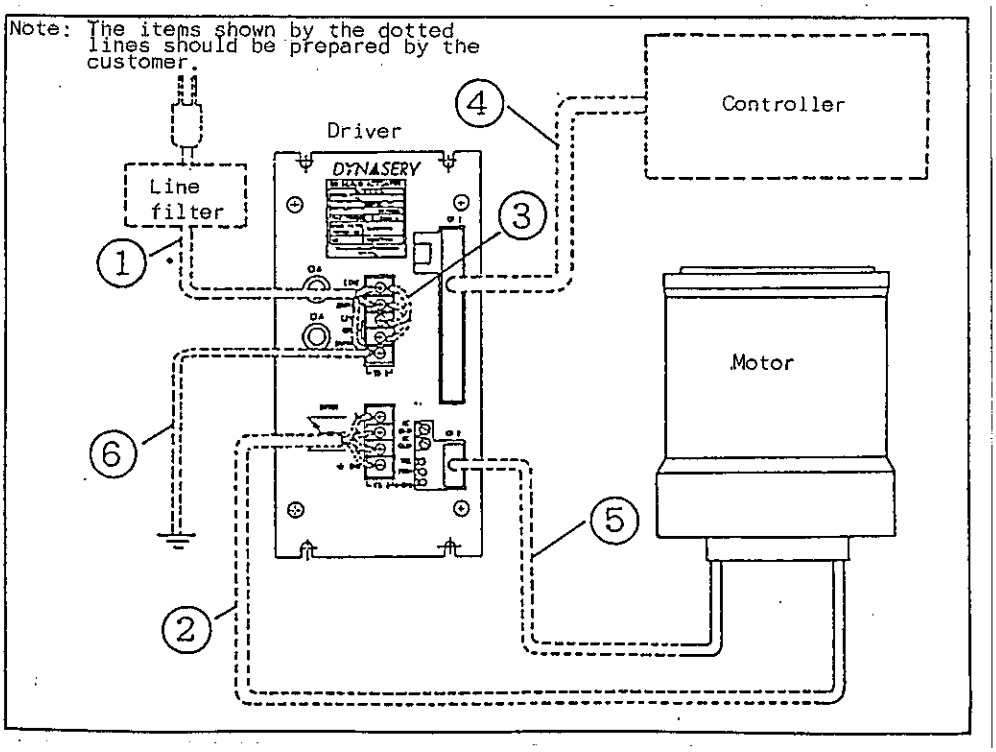


Figure 3.17

(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 .
- Use the grounding and jumper cables as short as possible.
- Since high voltage large current flows through motor and AC power cables, make sure that their wirings are correct.

4. Operation Cautions

4.1 8-bit Bus I/F Card I/O Port Selection

(1) Input port

Table 4.1

ECS	EWR	ERD	EA3	EA2	EA1	EA0	Port name	Bit	Details
L	H	L	L	L	L	L	PSTS	0-2	Pulse generation circuit status register
L	H	L	H	L	L	L	TMON	0-7	Torque monitor
L	H	L	H	L	L	H	DSTS	0-7	Driver status buffer
L	H	L	H	L	H	H	CSTS	0-1	Pulse counter status register
L	H	L	H	H	L	L	CDTL	0-7	Pulse counter lower level data
L	H	L	H	H	L	H	CDTM	0-7	Pulse counter middle level data
L	H	L	H	H	H	L	CDTH	0-7	Pulse counter higher level data

(2) Output port

Table 4.2

ECS	EWR	ERD	EA3	EA2	EA1	EA0	Port name	Bit	Details
L	L	H	L	L	L	L	RDTL	0-7	Pulse generation circuit rate: Lower level data setting
L	L	H	L	L	L	H	RDTH	0-6	Pulse generation circuit rate: Higher level data setting
L	L	H	L	L	H	L	PDTL	0-7	Pulse generation circuit pulse: Lower level data setting
L	L	H	L	L	H	H	PDTH	0-5	Pulse generation circuit pulse: Higher level data setting
							SIGN	7	Rotation direction command signal L = CCW H = CW
L	L	H	L	H	L	L	PWML	0-7	PWM: Lower level data setting
L	L	H	L	H	L	H	PWMH	0-5	PWM: Higher level data setting
L	L	H	H	L	L	L	fn	0-3	fn setting signal
							GAIN	4-6	Gain setting signal
L	L	H	H	L	L	H	POS	0-3	COIN width setting signal
							LIM	4-7	Integral limiter setting signal
L	L	H	H	L	H	L	MODSET	0-7	DYNASERV operation mode setting signal
L	L	H	H	L	H	H	CLCH		Pulse counter latch operation command
L	L	H	H	H	L	L	CSET	0-2	Pulse counter operation mode setting signal

4.2 8-bit Bus I/F Card Pulse Generation Circuit

(1) Buffer/Register configuration

Table 4.3

ECS	EWR	ERD	EA3	EA2	EA1	EA0	Bit	Details
L	L	H	L	L	L	L	0-7	Rate lower level data
L	L	H	L	L	L	H	0-6	Rate higher level data
L	L	H	L	L	H	L	0-7	Lower level data on No. of pulses
L	L	H	L	L	H	H	0-5	Higher level data on No. of pulses
							7	Rotation direction command L: CW H: CCW
L	H	L	L	L	L	L	0-2	Status register

(2) Status register contents

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
×	×	×	×	×	END	BUFRDY	ERR

ERR	
0	No error occurs when the data is written in the rate and pulse buffers.
1	An error occurs when the data is written in the rate and pulse buffers.

BUFRDY	
0	No data can be written in the rate and pulse buffers.
1	The data can be written in the rate and pulse buffers.

END	
0	During pulse output
1	Pulse output end

(3) Error occurrence and release

Data write to the rate and pulse buffers during pulse output operation results in BUFRDY = L, and the processing of data within the buffers (pulse output start) results in BUFRDY = H

to enable the next data write to the buffers pulse or rate data write to the buffers at BUFRDY = L causes an error to be set to ERR = H. For error release, it is necessary to turn ON the power again or conduct initialize by EXTRST.

(4) Rate and pulse output time calculation formula
If the data to be written in the rate buffer is set to F, one cycle time T for the pulse to be output is obtained by the following formula.

$$T = \frac{2^{15}}{6\times 10^{6}\times F}\ (\text{sec})\quad 0001H \leqq F \leqq 4000H$$

If the data to be written in the pulse buffer is set to N (No. of output pulses = N), the time t from the pulse output start to end is obtained by the following formula.

$$t = N\times T = N\times \frac{2^{15}}{6\times 10^{6}\times F}\ (\text{sec})\quad 0001H \leqq N \leqq 3FFFH$$

(5) Pulse output control procedure

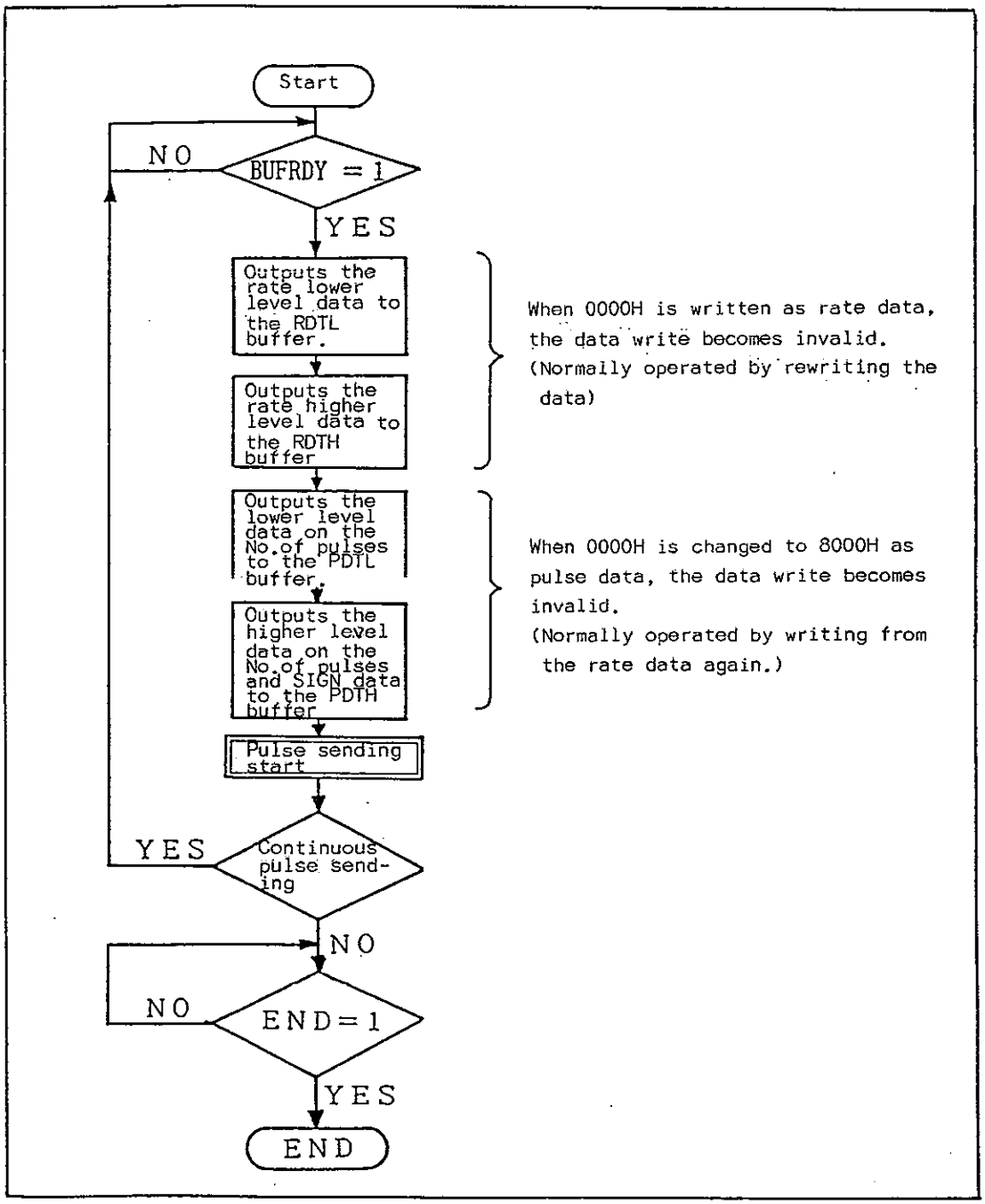


Figure 4.1

4.3 8-bit Bus I/F Card Pulse Counter Section

(1) Buffer/Register configuration

Table 4.4

ECS	EWR	ERD	EA3	EA2	EA1	EA0	Bit	Details
L	H	L	H	L	H	H	0-1	Pulse counter status register
L	H	L	H	H	L	L	0-7	Pulse counter lower level data
L	H	L	H	H	L	H	0-7	Pulse counter middle level data
L	H	L	H	H	H	L	0-7	Pulse counter higher level data
L	L	H	H	L	H	H		Pulse counter latch command signal
L	L	H	H	H	L	L	0-2	Pulse counter operation mode setting signal

(2) Latch command

Latch the counter before the counter data is read. The counter is latched by writing any data to the pulse counter latch command signal port.

(3) Counter data read

The counter data is read through pulse counter lower, middle and higher level registers. If the counter is not latched before the counter data read, the data latched previously remains.

(4) Pulse counter operation mode setting

a) Register setting

D_7 D_6 D_5 D_4 D_3 D_2 D_1 D_0

× × × × × PM Z1 Z0

Z1	Z0	
0	0	No operation
0	1	Counter clear: Invalid
1	0	Counter cleared by the zero signal to be input next: Valid once
1	1	Counter clear: Valid every time

PM	
0	Standard mode (Up/down)
1	4 times mode (A/B-phase)

b) Zero signal input

◆ Detection direction

Sets whether the counter is cleared by the zero signal rising or falling.

DIR = L (DIR jumper is connected) : Cleared by rising signal.

DIR = H (DIR jumper is not connected): Cleared by falling signal.

◆ Zero signal pulse width setting

The chattering prevention circuit, which detects the signal rising and falling correctly, even if a zero signal contains chattering, is built into the zero signal input section. Therefore, it is necessary to set the min. pulse width of the zero signal to be input when the counter is cleared. The min. pulse width is set in accordance with the <SA> and <SB> jumpers as shown below.

Table 4.5

SB	SA	Zero signal pulse width	Zero signal cycle
Connected	Connected	2.73 ms or more	5.46 ms or more
Connected	Not connected	683 μs or more	1.37 ms or more
Not connected	Connected	171 μs or more	342 μs or more
Not connected	Not connected	1.3 μs or more	2.6 μs or more

(5) Status register

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
×	×	×	×	×	×	CFLG	ZMON

ZMON:ZERO signal input monitor	
0	ZERO signal input = L
1	ZERO signal input = H

CFLG: Counter clear flag	
0	Counter clear incomplete
1	Counter clear complete

(Note) CFLG: Flag to check that the counter is clear. When the "Counter clear once" (command register) is set, this flag is set to 0. When the counter is cleared, this flag is set to 1.

4.4 8-bit Bus I/F Card D/A Circuit

(1) Basic specification

Basic frequency: 24 MHz

Resolution: 14 bits

Method : The 12 higher level bits are used to control the pulse width and then the lower 2 bits are used to divide 1-bit variation (the 12 higher level bits) into 4.

Output :

Table 4.6

Data	Positive pulse width	Output voltage
0000H	0	$-V_{MAX}$
2000H	85.33μ s	0 V
3FFFH	170.66μ s	$+V_{MAX}$

Pulse cycle: 170.7μ s

(2) Register configuration

Table 4.7

ECS	EWR	ERD	EA3	EA2	EA1	EA0	Bit	Details
L	L	H	L	H	L	L	0-7	PWM: Lower level data setting
L	L	H	L	H	L	H	0-5	PWM: Higher level data setting

(3) Data output

PWM D/A part data is output from the lower level data to the higher level data. When the higher level data is output, D/A output is changed.

(4) D/A output switching jumper

Jumper to switch D/A output V_{MAX}

VSEL jumper connected: V_{MAX} = 6 V (Velocity mode)

VSEL jumper connected: V_{MAX} = 8 V (Torque mode)

4.5 8-bit Bus I/F Card Control Signal

(1) I/O port

Most control signals are exchanged from/to DYNASERV through the I/O port on the I/F bus.

a) Input port

Table 4.8

$\overline{ECS}$	$\overline{EWR}$	$\overline{ERD}$	EA3	EA2	EA1	EA0	Bit	Details
L	H	L	H	L	L	L	0-7	Torque monitor
L	H	L	H	L	L	H	0-7	Driver status

b) Output port

Table 4.9

$\overline{ECS}$	$\overline{EWR}$	$\overline{ERD}$	EA3	EA2	EA1	EA0	Bit	Details
L	L	H	H	L	L	L	0-3	fn setting signal (Note 1)
							4-6	GAIN setting signal (Note 2)
L	L	H	H	L	L	H	0-3	COIN width setting signal
							4-7	Integral limiter setting signal
L	L	H	H	L	H	L	0-7	DYNASERV operation mode setting signal

(Note 1: FN setting)

FN 3	FN 2	FN 1	FN 0	fc(Hz)
1	1	1	1	1
1	1	1	0	2
1	1	0	1	3
1	1	0	0	4
1	0	1	1	5
1	0	1	0	6
1	0	0	1	7
1	0	0	0	8
0	1	1	1	9
0	1	1	0	10
0	1	0	1	11
0	1	0	0	12
0	0	1	1	13
0	0	1	0	14
0	0	0	1	15
0	0	0	0	16

(Note 2: GAIN setting)

GAIN 6	GAIN 5	GAIN 4	Gain
1	1	1	1
0	1	1	4
1	0	1	7
0	0	1	10
1	1	0	13
0	1	0	16
1	0	0	19
0	0	0	22

(Note)

Gain× Volume pos.(0.5~5)=Total gain

(2) Driver status register

Table 4.10

Bit	Signal name	Meaning	Details
0	$\overline{\text{COIN}}$	Position completion signal	This bit is set to L when the deviation counter value becomes less than the POSW port set-value.
1	$\overline{\text{OVER}}$	Deviation counter overflow	This bit is set to L when the deviation counter value exceeds 32767.
2	OVL	Overload	Set to H when the motor stops rotating mechanically and it simultaneously reduces motor current to 1/3.
3-7		Unused	

(3) DYNASERV operation mode setting

Table 4.11

Bit	Signal name	Meaning	Details
0	IACT/ $\overline{\text{PACT}}$	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.
1	IRST	Integral capacitor reset	The integral capacitor in the velocity loop is shorted with this bit set to H.
2	NORM/ $\overline{\text{TEST}}$	Test mode	DYNASERV is set to the test mode with this bit set to L.
3	SEVON	Servo On signal	The motor is set to the servo ON status after this bit is set to H to set the driver to the command wait status.
4-7		Unused	

(4) Servo ON signal selection
Servo ON signal input selection is made by the SVSL jumper. When the jumper is not connected, the signal from the internal input port is selected. When the jumper is connected, the external input signal is selected.
I/O signal theory is described below.

Table 4.12

SVSL jumper	SERVO ON input		SERVO ON output
	Output port MODSET bit	External input signal	
Not connected	L		H
	H		L
Connected		L	L
		H	H

(Note) When two or more DYNASERVs are connected in parallel, the external input servo ON signal is used as a common signal.
Therefore, use a signal from the output port when each unit is used independently.

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 <MODSET port> 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 port>, <ILIM port> and <DC gain variable resistor> becomes necessary.

a) <fc port>

The 1 to 16 Hz position control system band is selected <from data of F to 0>.

b) <ILIM port>

This prevents the wind-up phenomenon by limiting the output of the digital integrator during software servo computation. The smaller the data to the port, 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 port> signals results in an adjustment range of from 0.5 to 100 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.

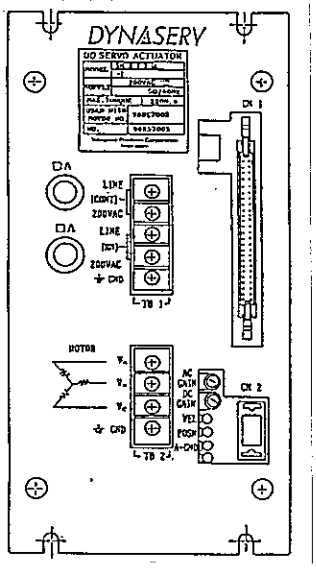


Figure 5.1

(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 port> 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. Writing L to NORM/TEST bit of MODSET port 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 ON.

Step 3: Write L to NORM/TEST bit of MODSET port.

Step 4: Adjust the <fc port data>. 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 port data> to a small value within the range in which there is no hunting.
Select GAIN port data bit 4 to 6 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: Write H to NORM/TEST bit of MODSET port.

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

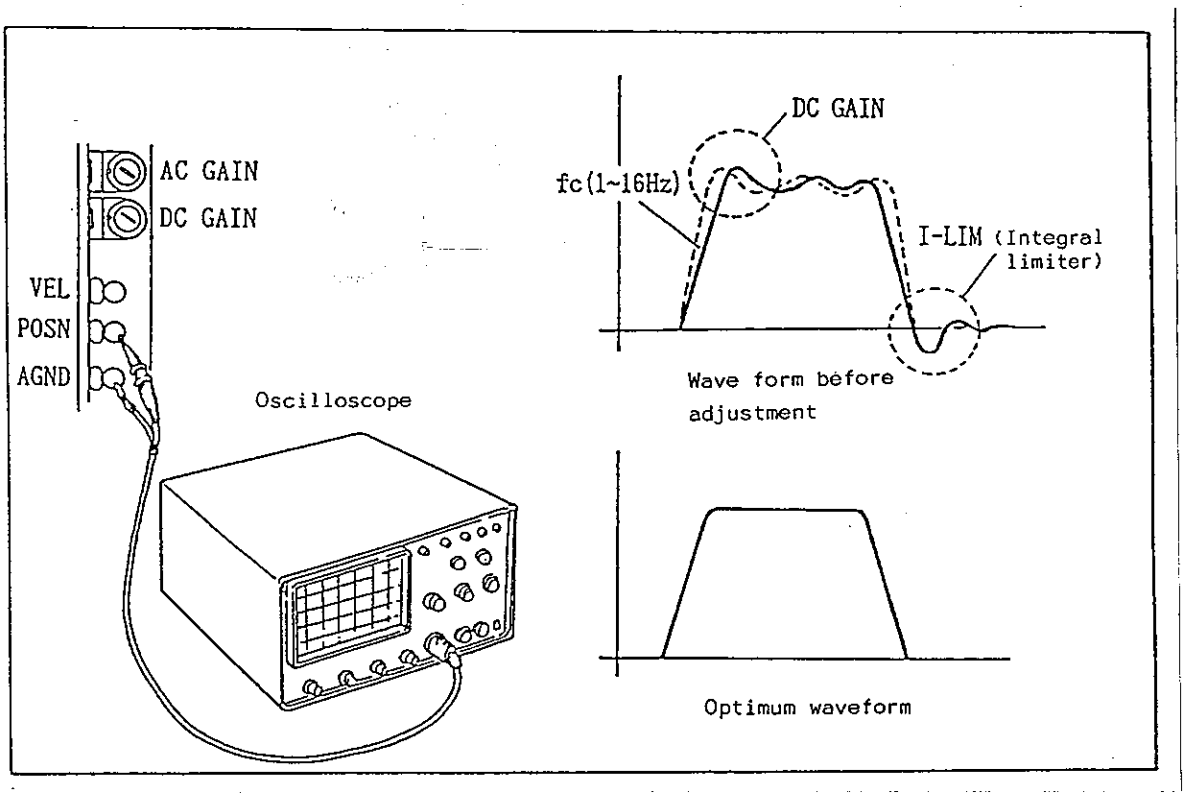


Figure 5.2

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]
DR1015B to 1060B, DR1070E, DR1100E	2/5
DR1050A	1.5/5
DR1130E to DR1250E, DR1100A to 1400A	1/5

(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.

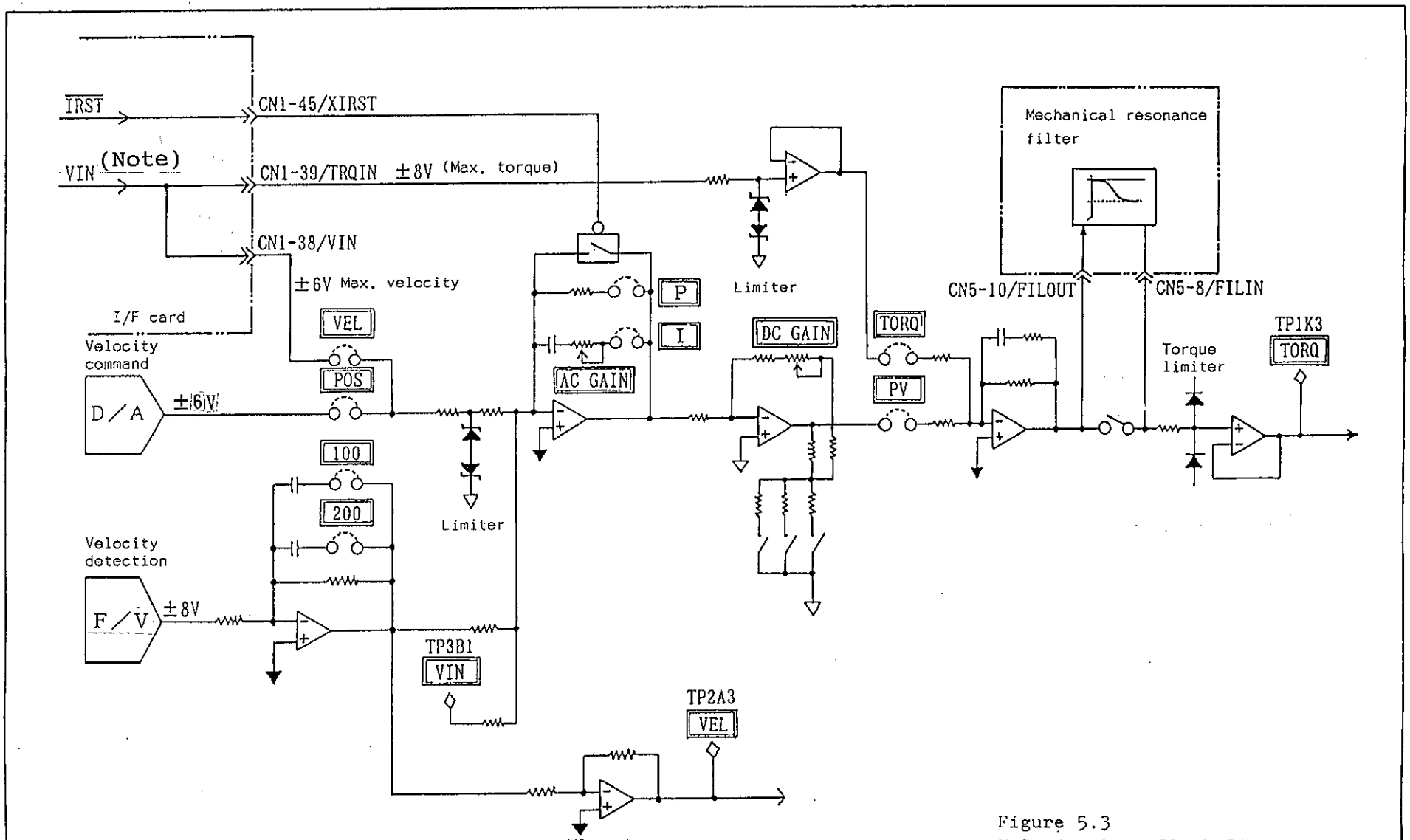
a) <DC gain>
The combination of the driver CN1 connector GAIN port bit 0 to 2 results in an adjustment range of from 0.5 to 110 times.

b) <AC gain>
Velocity loop band damping is adjusted.

(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 control mode, the MODSET port NORM/TEST becomes invalid.
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.

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.



(Note) To set servo signal output selection
± 6V or ± 8V by <VSEL> jumper.(see p-13)

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) signal is set to L. (When I/O port signal is used.)	Inspection	Set to H.
	◆The CPU reset (EXTRST) terminal is set to L.	Inspection	Set to H.
	◆The integral capacitor reset (IRST) signal 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.	
	◆The setting value for No. of the command pulses is incorrect.	Check the setting value for No. of the command pulses.	

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 malfunction/Encoder cable wiring check

LED Display	Display Details	Cause/Measures
	Power amp. error occurrence	◎High main power supply voltage ◎Imperfect connector contact/ Requirement for repair ◎Power board trouble/Requirement for repair
	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
	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.

(1) Standard motor/driver combination specification (Note : Numberical values shown below : Typical values) (Table 8.1)

Series Model No.	A type (1 0 ")						E type (8 ")						B type (6 ")			
Motor Model No.	DR1400A	DR1300A	DR1200A	DR1150A	DR1100A	DR1050A	DR1250E	DR1220E	DR1160E	DR1130E	DR1100E	DR1070E	DR1060B	DR1045B	DR1030B	DR1015B
Max. output torque N.m(Kgf.m)	400 (40)	300 (30)	200 (20)	150 (15)	100 (10)	50 (5)	250 (25)	220 (22)	160 (16)	130 (13)	100 (10)	70 (7)	60 (6)	45 (4.5)	30 (3)	15 (1.5)
Rated No. of revolutions ① rps *	0.5		1.0			1.5	1.0				1.5	2.0	1.5	2.0		
Encoder revolution p/rev	819,200						614,400						507,904			
Absolute positioning accuracy	±30						±45						±45			
Repetitive reproducibility accuracy sec.	±5						±5						±5			
Velocity ripple ② %	3						3						3			

(2) Standard motor specification (Tab-8.2)

Rotor inertia Kg.m^2	400X10^{-3}	340X10^{-3}	285X10^{-3}	230X10^{-3}	200X10^{-3}	180X10^{-3}	185X10^{-3}	170X10^{-3}	140X10^{-3}	125X10^{-3}	100X10^{-3}	85X10^{-3}	33X10^{-3}	26X10^{-3}	24X10^{-3}	21X10^{-3}
Axial load N Direct Axial load (Kgf) Reverse	4 ×10^4 (4 ×10^3) 2 ×10^4 (2 ×10^3)						4 ×10^4 (4 ×10^3) 2 ×10^4 (2 ×10^3)						3 ×10^4 (3 ×10^3) 1 ×10^4 (1 ×10^3)			
Moment load N.m(Kgf.m)	400 (40)						400 (40)						200 (20)			
Axial stiffness mm/N Direct Axial stiffness (mm/Kgf) Reverse	2 ×10^{-8} (2 ×10^{-5}) 3 ×10^{-8} (3 ×10^{-5})						2 ×10^{-8} (2 ×10^{-5}) 3 ×10^{-8} (3 ×10^{-5})						3 ×10^{-8} (3 ×10^{-5}) 4 ×10^{-8} (4 ×10^{-5})			
Moment stiffness rad/N.m (rad/Kgf.m)	4 ×10^{-7} (4 ×10^{-6})						4 ×10^{-7} (4 ×10^{-6})						2 ×10^{-8} (2 ×10^{-5})			
Weight ③ Kg	68	57	46	37	31	26	48	44	36	32	26	22	15.5	13.0	11.0	9.0
Length (L) mm	358	304	250	212	185	158	355	327	271	243	210	183	207	179	151	123
Common specification	Insulation class: F	Dielectric strength	1 min. at 1500 V AC	Insulation resistance	More than 10 KΩ	Construction:	Fully closed self cooling	Coupling method	Direct coupling	Exciting method	3-phase					

①: Indicates when power supply is 200 V AC.
②: When mechanical resonance filter is built in the DYNASERV
③: Light weight type is also available.

(3) Standard driver specification

(Table 8.3)

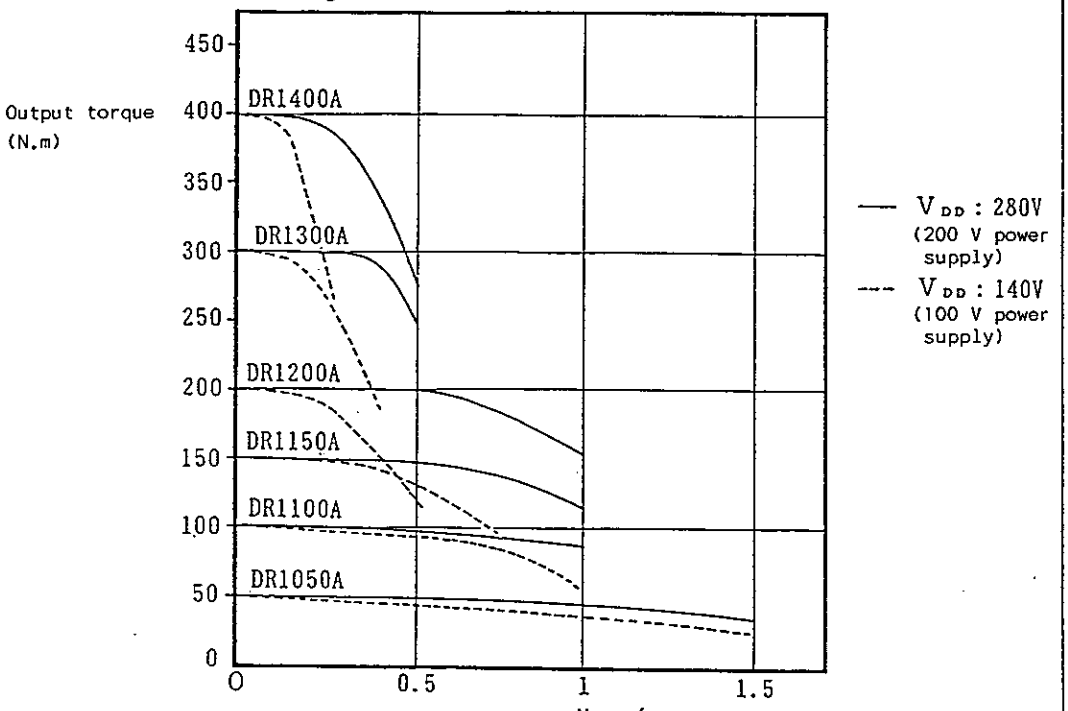
Series Model No.		A type (1 0 ")						E type (8 ")						B type (6 ")			
Motor Model No.		DR1400A	DR1300A	DR1200A	DR1150A	DR1100A	DR1050A	DR1250E	DR1220E	DR1160E	DR1130E	DR1100E	DR1070E	DR1060B	DR1045B	DR1030B	DR1015B
Driver Model No.		SR1400A	SR1300A	SR1200A	SR1150A	SR1100A	SR1050A	SR1250E	SR1220E	SR1160E	SR1130E	SR1100E	SR1070E	SR1060B	SR1045B	SR1030B	SR1015B
8-bit bus interface I/O signal	Model type selection	CS0~CS3 Input : TTL level															
	Address bus	A0~A3 Input : TTL level															
	Date	D0~D7 I_{OL} MAX.=24mA Input : TTL level															
Power consumption (At 200 V)																	
Input power supply		AC100V$^{+10\%}_{-15\%}$ or AC200V$^{+10\%}_{-15\%}$ 50/60Hz															
Weight (Kg)		100 V power supply type : 5 Kg / 200 V power supply type : 6 Kg															

(4) Environmental specification

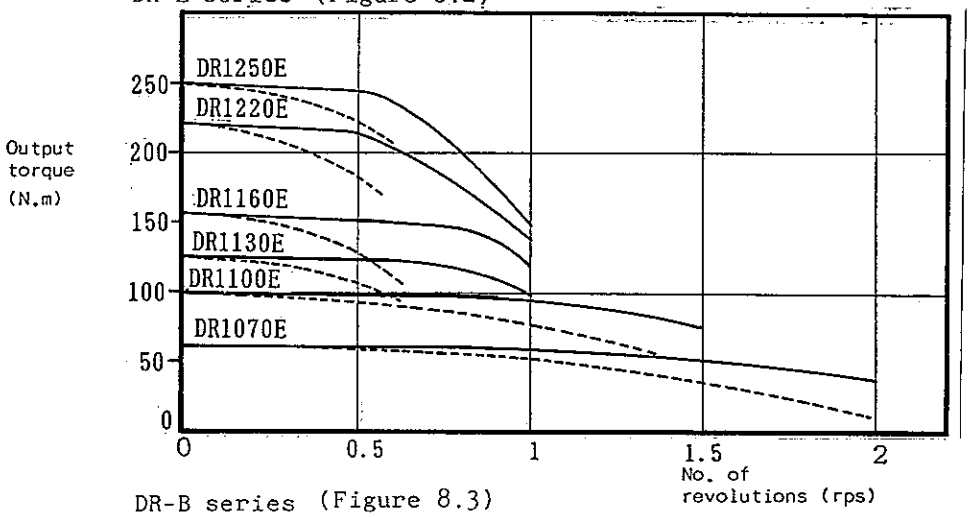
		Motor	Driver	Remarks
Under operation	Temperature	0~45℃	0~50℃	
	Humidity	20~85% R.H	20~90% R.H	No dew condensation
Under storage	Temperature	-20~85℃	-20~85℃	
	Humidity	20~85% R.H	20~90% R.H	No dew condensation
Environment		No corrosive gas and dust should exist.		

8.2 No. of Revolutions/Torque Characteristic

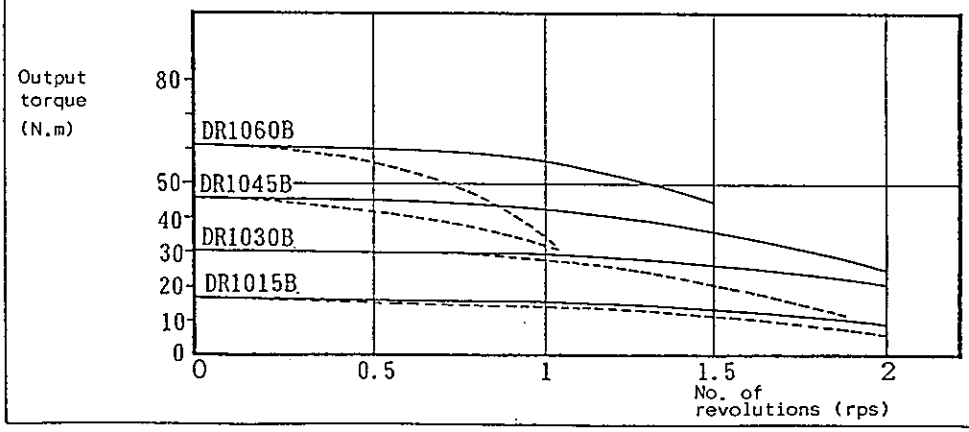
DR-A series (Figure 8.1)



DR-E series (Figure 8.2)



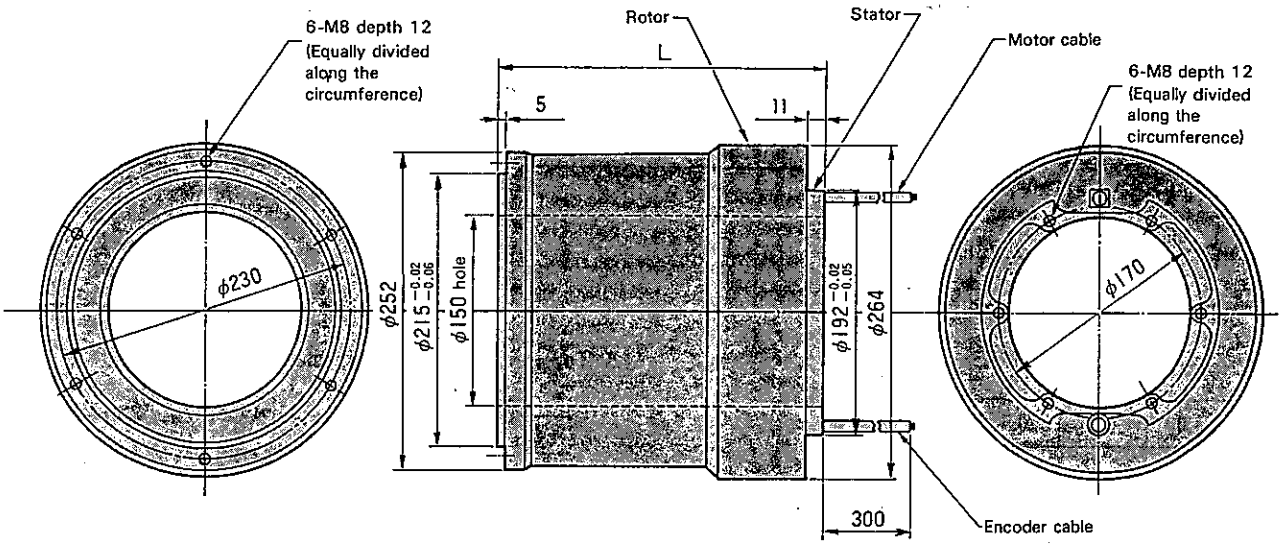
DR-B series (Figure 8.3)



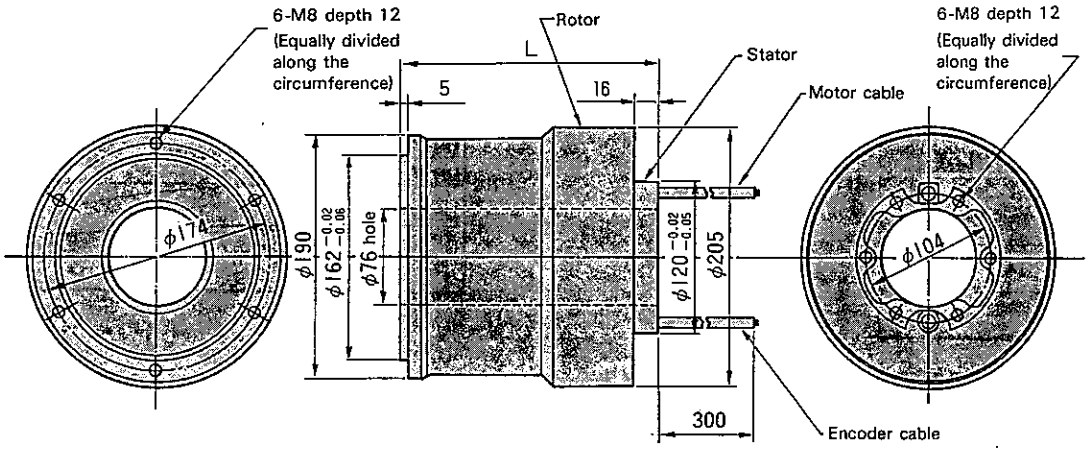
8.3 Dimensional Outline Drawing Unit: mm

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

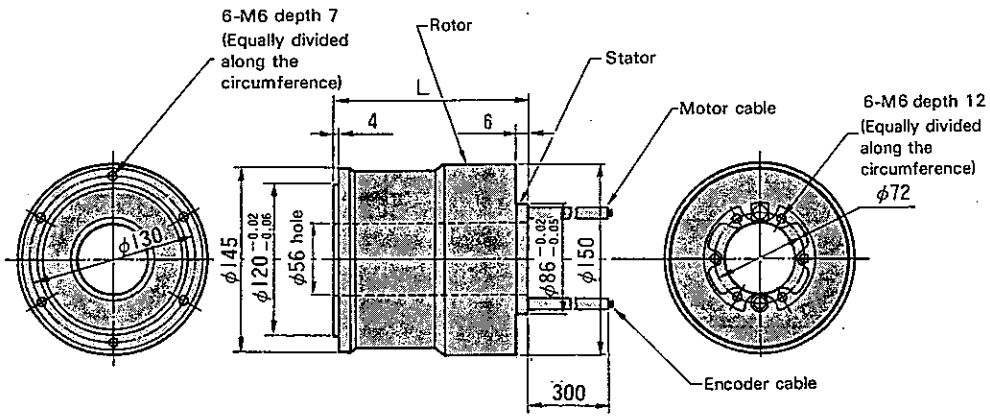
(1) Type A (Figure 8.4)



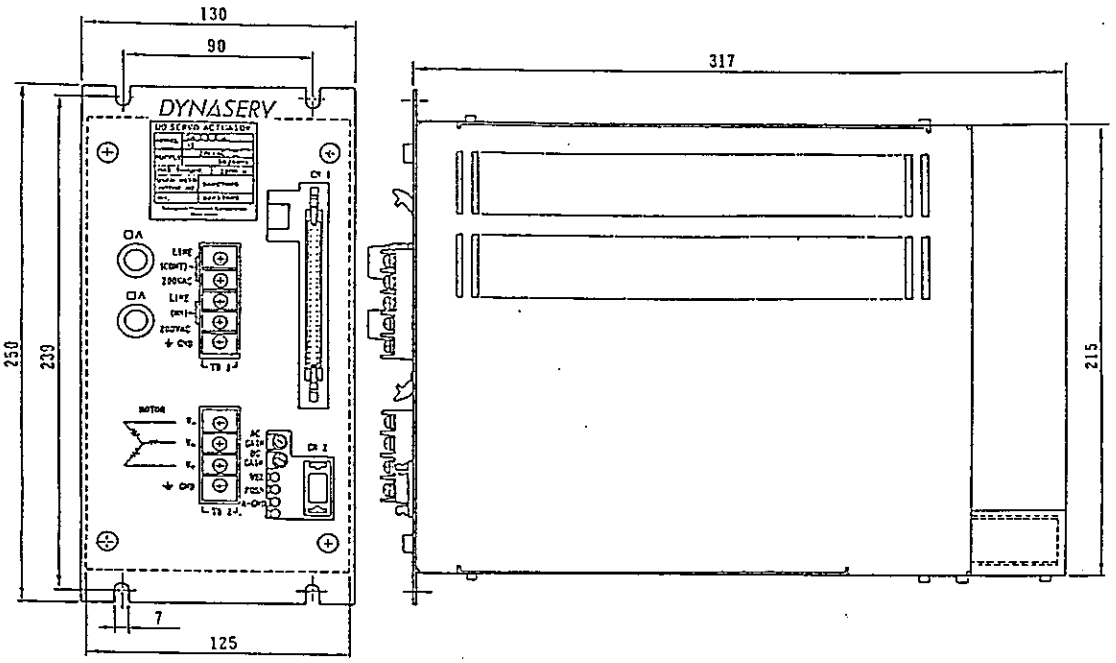
(2) Type E (Figure 8.5)



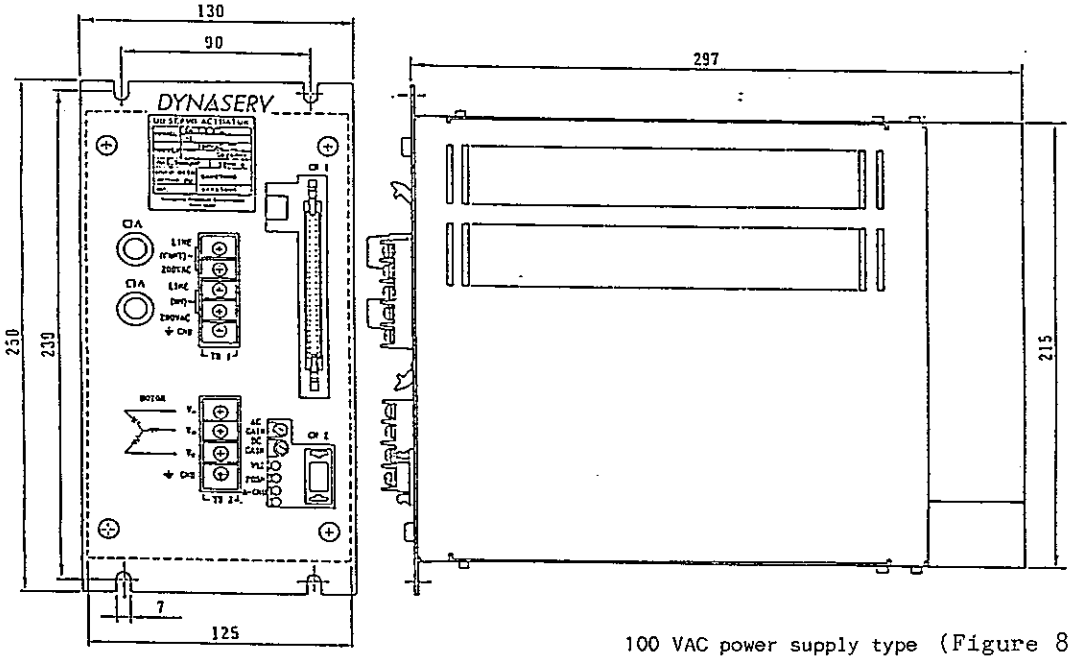
(3) Type B (Figure 8.6)



(2) Driver



200 VAC power supply type (Figure 8.7)



100 VAC power supply type (Figure 8.8)

8.4 Driver Block Diagram

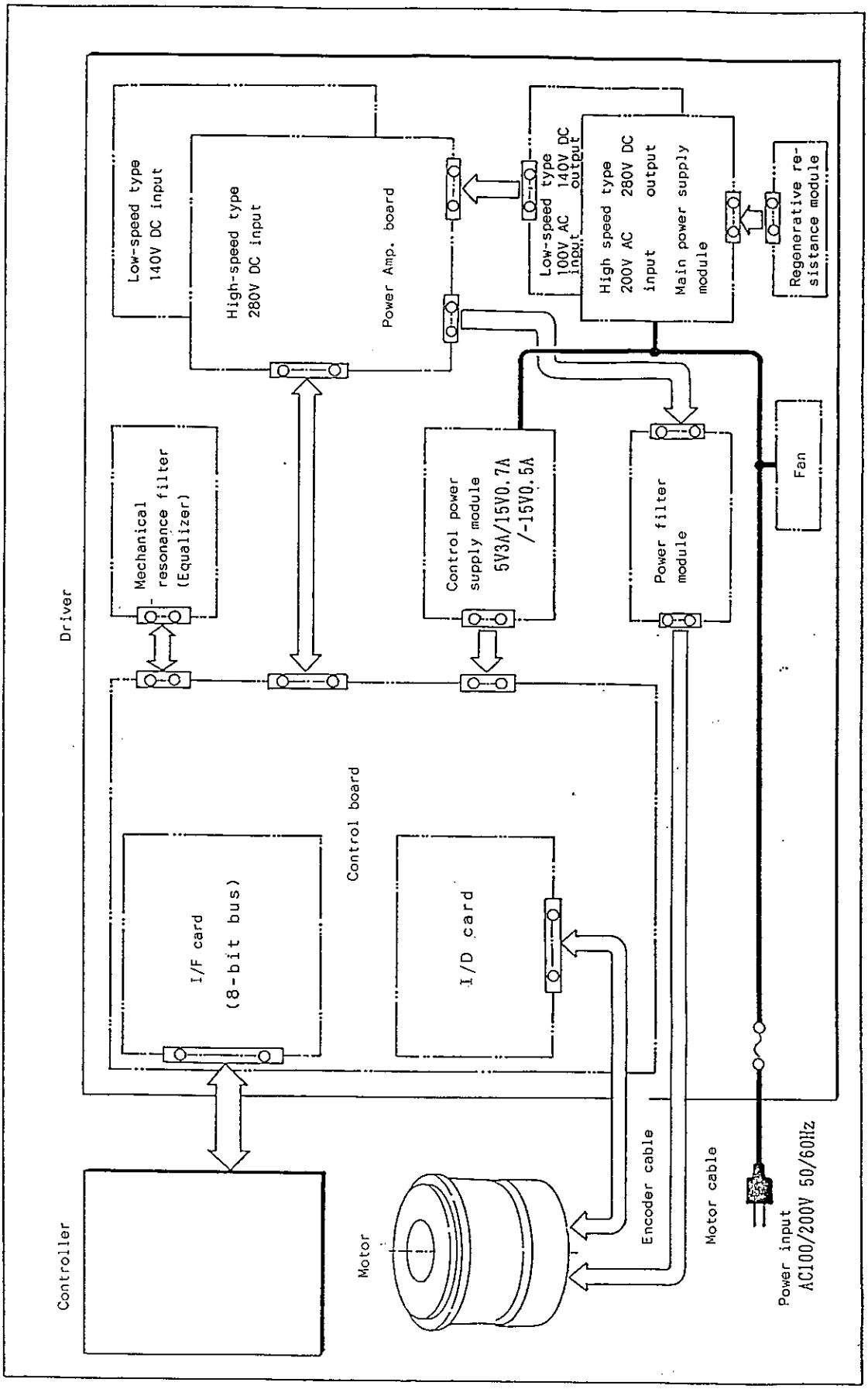


Figure 8.9

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

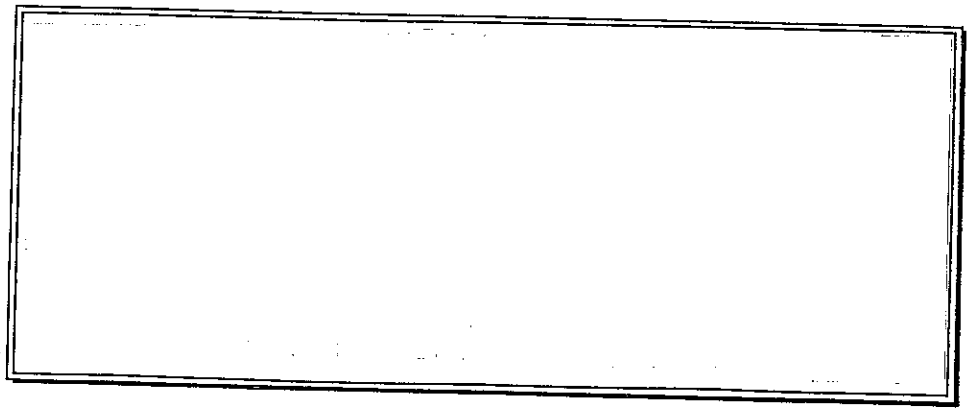
Table 8.6

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°)



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