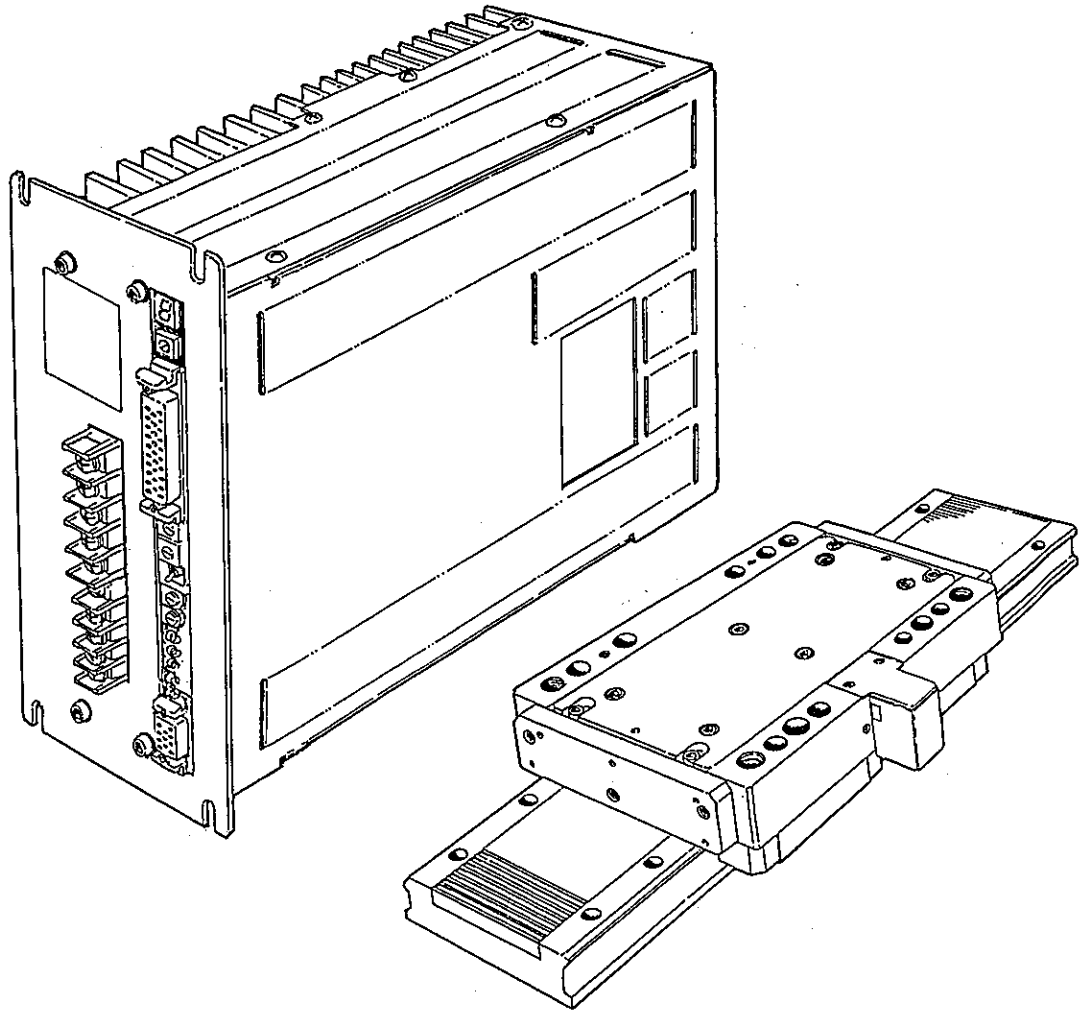
Instruction
Manual

LINEARSERV

DD Servo-Actuator
LR / TR Series



YOKOGAWA ◆
Yokogawa Precision Corporation

IM C131-E
July 21, 1995

INTRODUCTION

Thank you for purchasing our LINEARSERV DD Servo-Actuator.
The LINEARSERV is a high generated force, high speed, highly accurate linear servo-actuator which can be used in a wide range of field applications related to FA (Factory Automation).

This instruction manual covers the LR/TR series Be sure to read this instruction manual prior to operating the LINEARSERV.

CAUTION

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- Yokogawa Precision Corp. shall bear no responsibility for indirect or consequential damages such as, but not so as to limit the foregoing, the loss of profit, or the loss of production, caused by the use of our products in accordance with this manual.

Warning on Installation and Operation

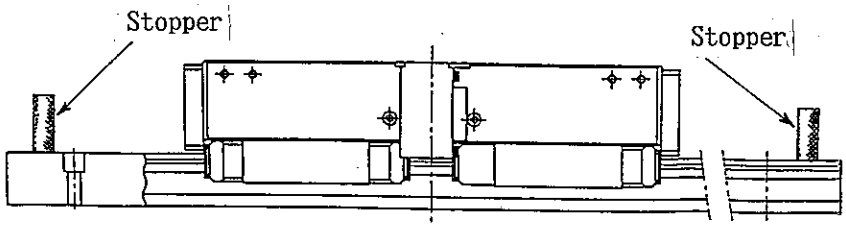
1. The driver is adjusted in conjunction with the coupled motor. Therefore, do not change the motor and driver combination.

2. Never install the motor with the slider fixed and the stator set free for movement.

3. Ensure that the power is switched off when removing the side panel of the driver for jumper setting, etc. Dangerously high voltage is present inside the unit.

4. Ensure adequate grounding at the ground terminal.

5. Certain applications of this system may require the removal of the end-stoppers. However, before removing the end-stoppers in such applications, first check the motor stroke length and ensure safe operation. After removal of the end-stoppers, use appropriate bolts to fit into the recess and lock them tight.



6. Use the screw which shall not exceed the effective screw depth of the motor part in order to fix the load. The use of a too long screw may cause a damage on the motor.

7. Materials easily affected by magnetism must never be brought close to the motor as the surface of the motor is magnetized.

8. Install the motor in an appropriate location as the motor is not dust proof, watertight or oil proof.

9. Never disassemble or modify the motor or the driver. When such disassembling or modification is required, consult Yokogawa Precision Corp. or its authorized agency. Yokogawa Precision Corp. or its authorized agency, accepts no responsibility for disassembled or modified motor and driver.

CONTENTS

1. PRODUCT OUTLINE

1.1 LINEARSERV PRODUCT PROFILE:

Linearserv is a directly driven motor for linear actuation. The characteristic features of the direct drive include compact and simple construction, maintenance free design, etc,. The built-in high precision magnetic resolver inside the motor, enables highly accurate positioning coupled with smooth movement even at high velocities. As a linear actuator, possible applications include the Semiconductor production equipment, Factory automation & assembly equipment, Positioning equipment requiring high resolution etc,.

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 Standard Products

Part Name		Q'ty	Remarks
Motor section		1	
Driver section		1	
Connector (CN 1 terminal)		1	Catalog parts # MR-50LM
Connector (CN 2 terminal)		1	Catalog parts # MR-16LM
Connector of Motor section	LR 106 LR 115	1	Catalog parts # DAP15S
	LR 130	1	Catalog parts # JR15PK-16S

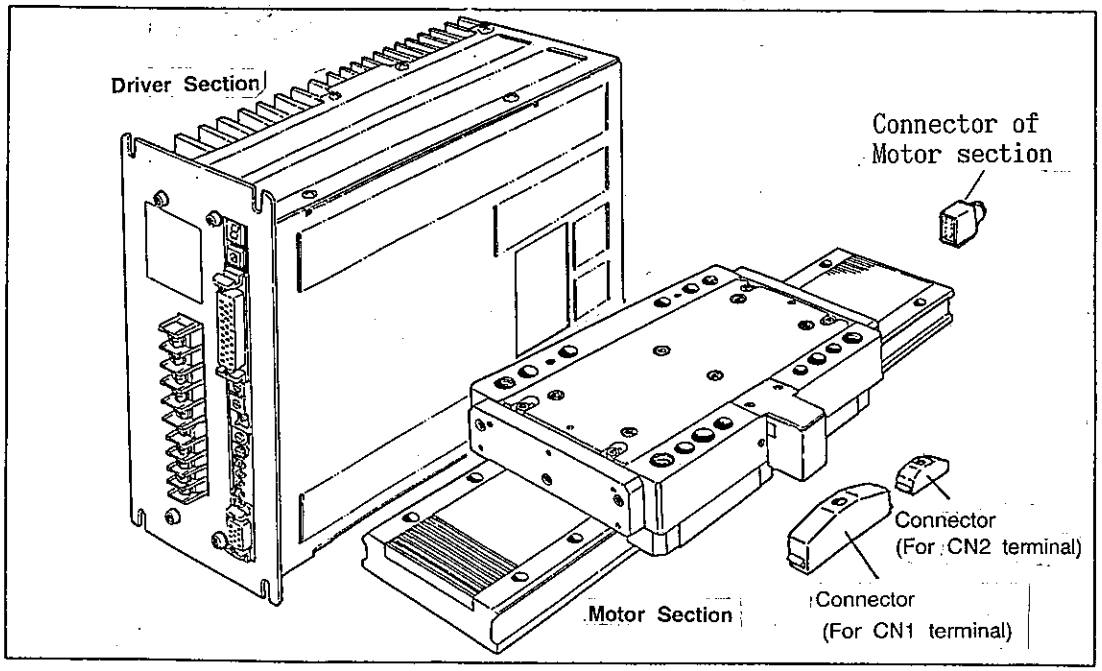
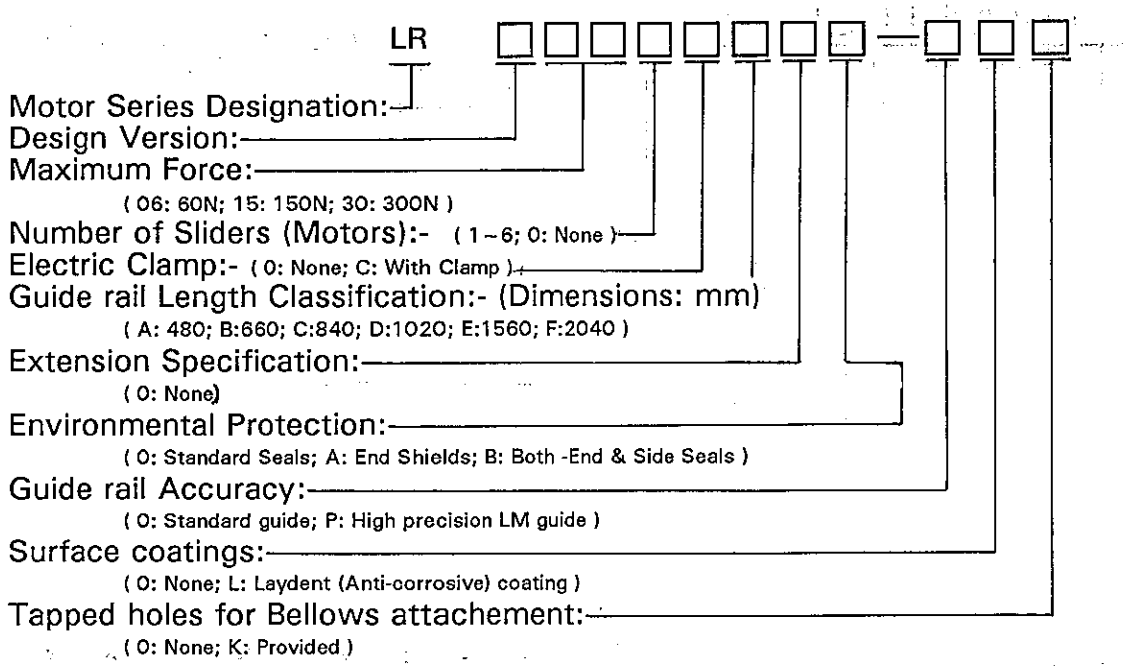


Figure 1.1 Standard Products

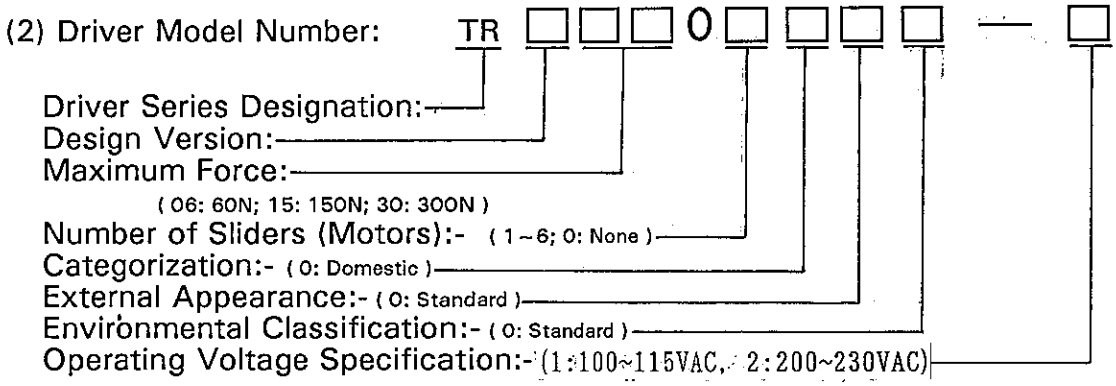
1.3 Model and Specification Code

The DYNASERV, DR / SR Series motor and driver Model Nos. specification code of the rating nameplate are as shown in the following.

(1) Motor Section and Specification Code.



(2) Driver Section and Specification Code



Note: The LINEARSERV motor and driver combination is fixed and random combinations are not allowed. Therefore, prior to operating the LINEARSERV, 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 LINEARSERV to display its full potential.

2. FUNCTIONAL DESCRIPTION

2.1 Motor Section

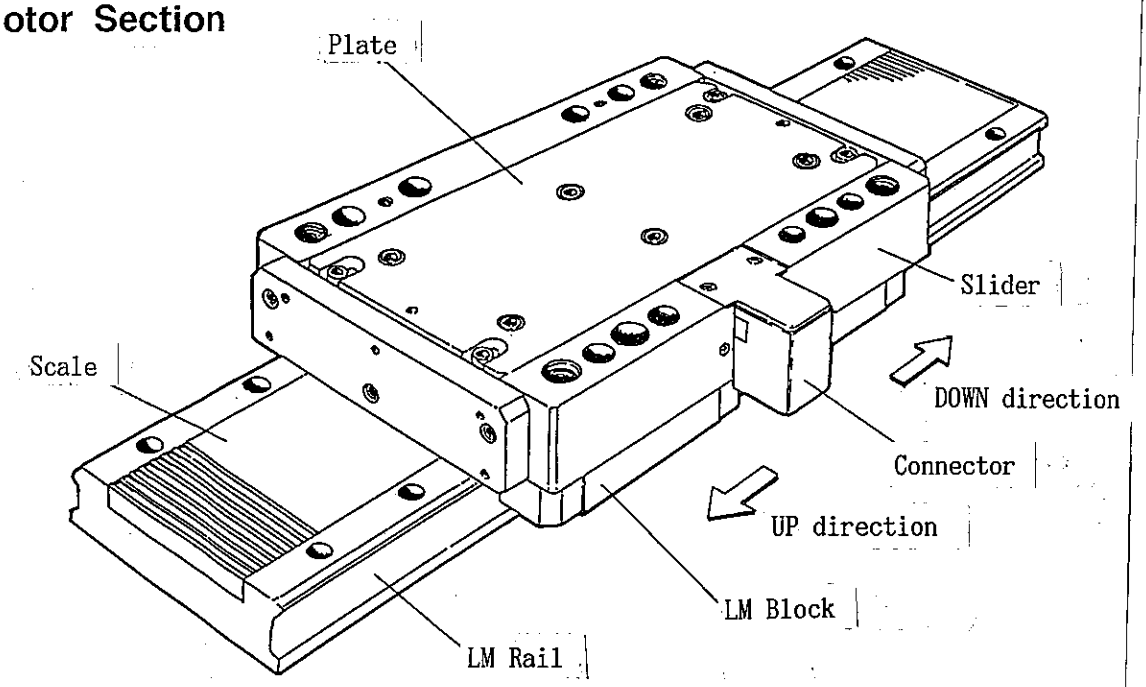


Figure 2.1 Parts Name of the Motor

2.2 Driver Section

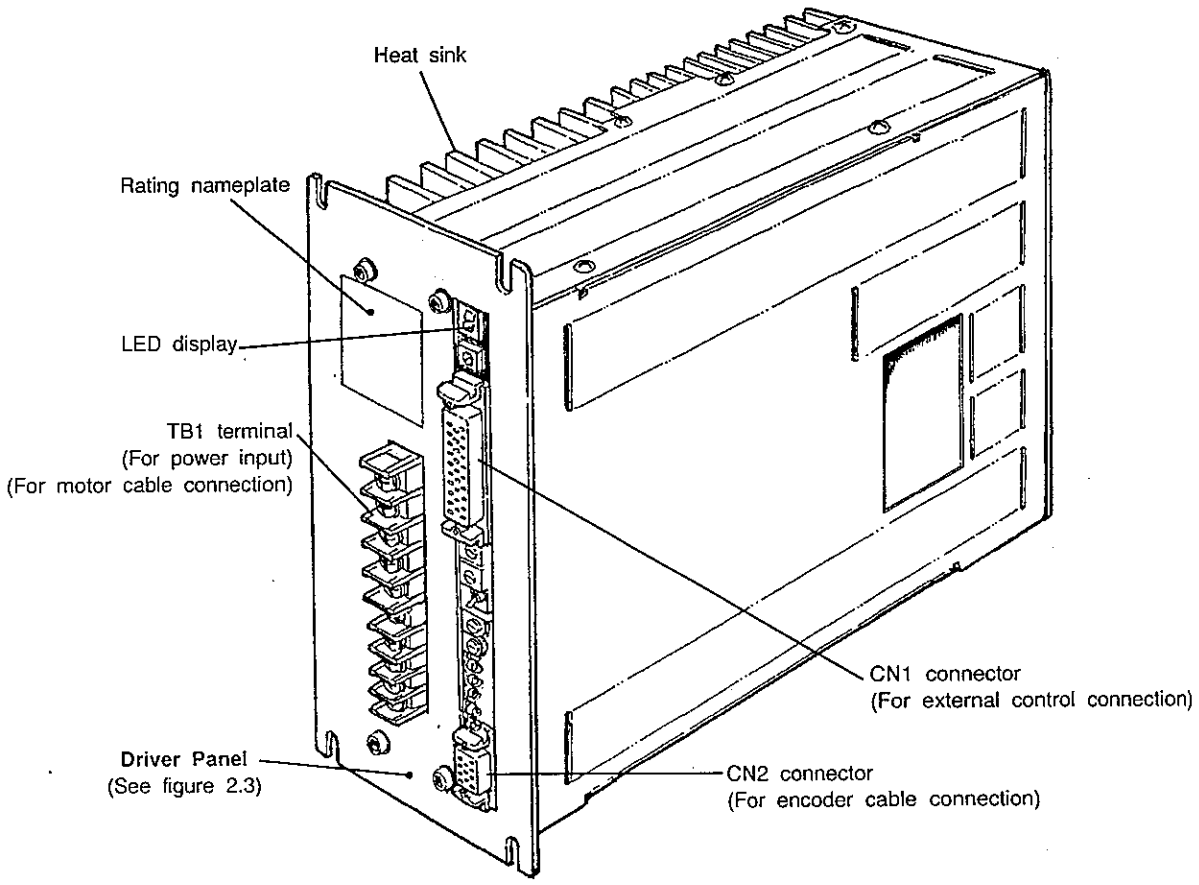
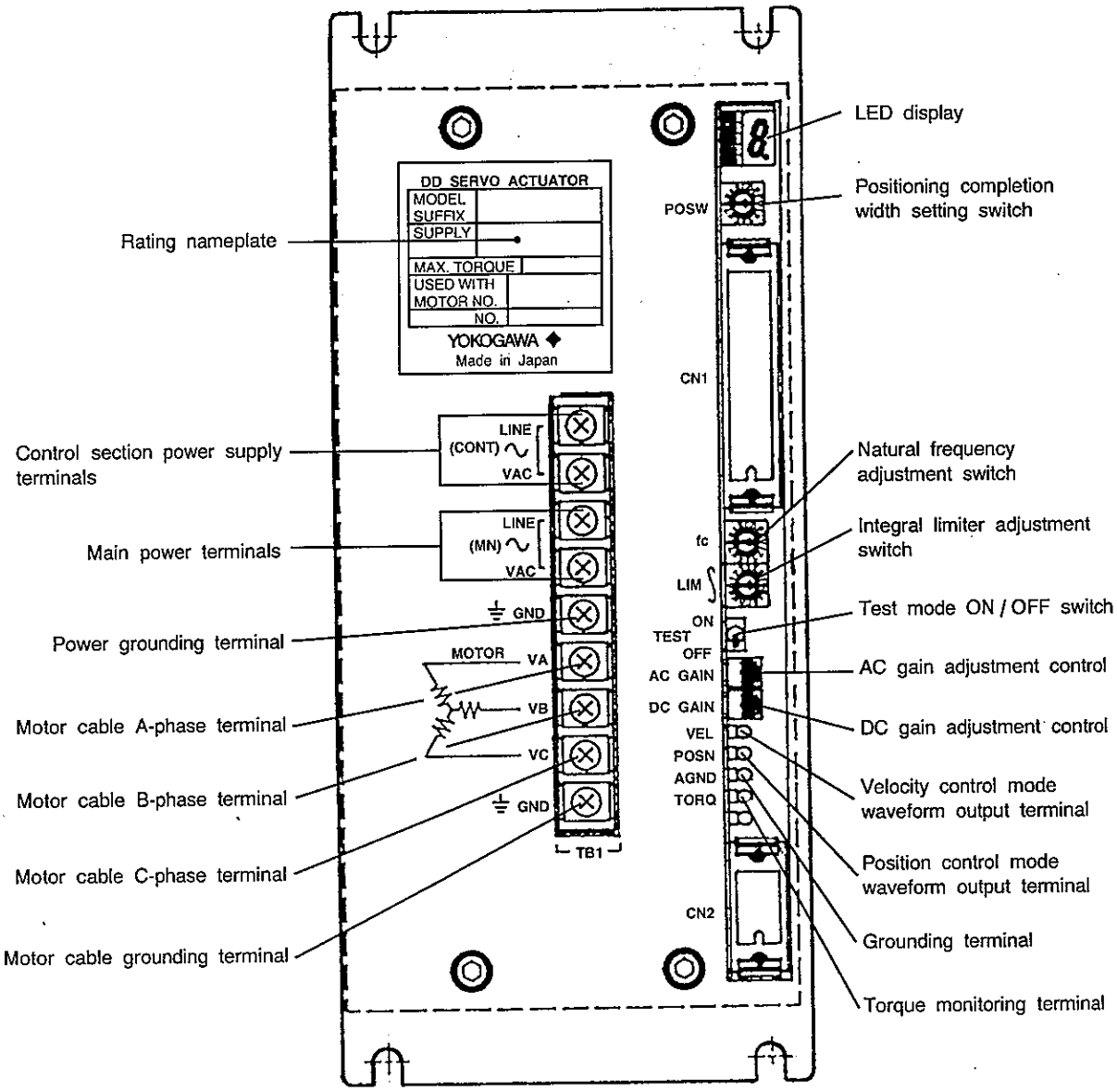


Figure 2.2 Parts Name of the Driver

2.3 Driver Panel Surface



∗ : Both GND terminals are connected.

Figure 2.3 Name of the Controls and Terminals on the Driver Panel

3. PREPARATION FOR OPERATION

3.1 Initial Setting

(1) Setting of the Jumper Switches in the Driver Box

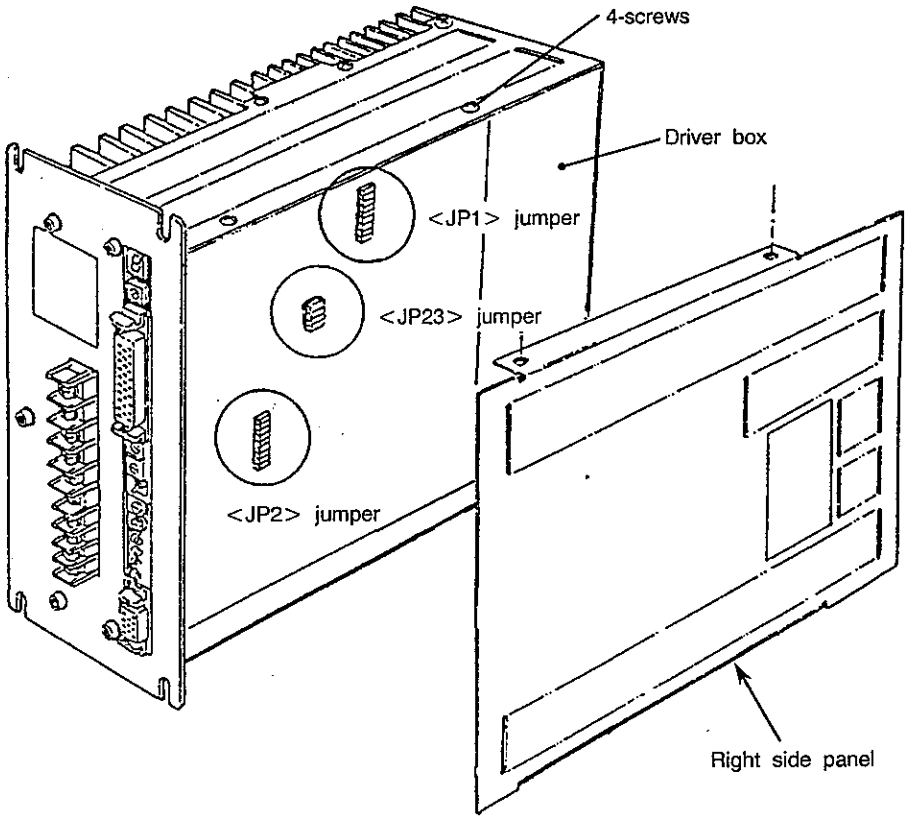


Figure 3.1 Setting of the Jumper Switches in the Driver Box

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 4-screws shown in the above figure.

CAUTION

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

<JP1> Jumper

- [••] MODE : See the next page
- [••] CALIB : See the next page
- [••] RATE#1 : Position command pulse multiplying factor setting
- [••] RATE#2 : Position command pulse multiplying factor setting
- [••] UD / AB : With jumper / A / B-phase, Without jumper / Up / Down pulse
- [••] VFFH : Velocity feed forward amount setting (Note 1)
- [••] VFFM : Velocity feed forward amount setting (Note 1)
- [••] VFFL : Velocity feed forward amount setting (Note 1)
- [••] GAIN H : DC gain magnification setting (Note 2)

<JP2> Jumper

- [••] I : Velocity I type control
- [••] P : Velocity P type control
- [••] 100 : Velocity detection filter (Hz) selection (Open when a mechanical resonance filter is installed)
- [••] 200 : Velocity detection filter (Hz) selection (Open when a mechanical resonance filter is installed)
- [••] PV : Mode selection
- [••] VEL : Velocity input
- [••] TORQ : Torque input
- [•••] TLIM : Open for standard models

Note : [••] indicates setting prior to shipment.

(Note 1)

VFFH	VFFM	VFFL	Velocity Feed Forward Amount (%)
Shorted	Shorted	Shorted	100
Shorted	Shorted	Open	95
Shorted	Open	Shorted	90
Shorted	Open	Open	85
Open	Shorted	Shorted	80
Open	Shorted	Open	75
Open	Open	Shorted	70
Open	Open	Open	65

(Note 2)

Type	Gain Magnification
With jumper	DC Gain×13
Without jumper	DC Gain×1

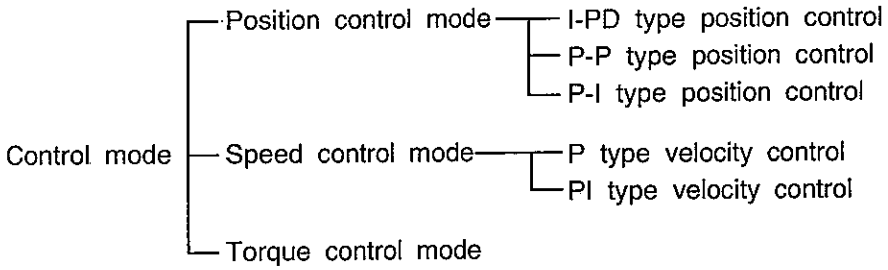
(3) Switch, Volume Settings Done Prior to Shipment

Switch Name / Volume Name	Setting Status
DC GAIN	Minimum position
AC GAIN	Minimum position
POSW	Set to "8"
fc	Set to "0"
I. LIM	Set to "0"
TEST	Set to "OFF"

3.2 Control Mode Setting

(1) Control Mode Types

The following 6 control modes are available for the LINEARSERV | LR/TR series.



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 3.1 List of Control Modes and Jumper Pin Switch Settings

Section	Jumper Name Switch Name	Position Control			Velocity Control		Torque Control Mode
		I-PD Mode	P-P Mode	P-I Mode	P Mode	PI Mode	
JP1	MODE	Shorted	Shorted	Shorted	Open	Open	Open
	CALIB	Open	Open	Open	Open	Open	Shorted
	RATE #1	○	○	○	○	○	○
	RATE #2	○	○	○	○	○	○
	UD/AB	○	○	○	○	○	○
	VFFH	○	○	○	×	×	×
	VFFM	○	○	○	×	×	×
	VFFL	○	○	○	×	×	×
	GAIN H	○	○	○	○	○	×
JP2	I	Open	Open	Shorted	Open	Shorted	Open
	P	Shorted	Shorted	Open	Shorted	Open	Open
	100	○	○	○	○	○	○
	200	○	○	○	○	○	○
	PV	Shorted	Shorted	Shorted	Shorted	Shorted	Open
	VEL	Open	Open	Open	Shorted	Shorted	Open
	TORQ	Open	Open	Open	Open	Open	Shorted
V1	DC GAIN	○	○	○	○	○	×
	AC GAIN	×	×	○	×	○	×
S1	POSW	○	○	○	×	×	×
S2	fc	○	○	○	×	×	×
	I. LIM	○	×	×	×	×	×
	TEST	○	○	○	○	○	×

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 / JP1

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 8 times. (See the table on the next page)

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.

Set Value		Multiplying Factor	Model (μm)		
RATE#1	RATE#2		LR106	LR115	LR130
Shorted	Shorted	1	0.5	1.0	1.0
Open	Shorted	1/2	1.0	2.0	2.0
Shorted	Open	1/4	2.0	4.0	4.0
Open	Open	1/8	4.0	8.0	8.0

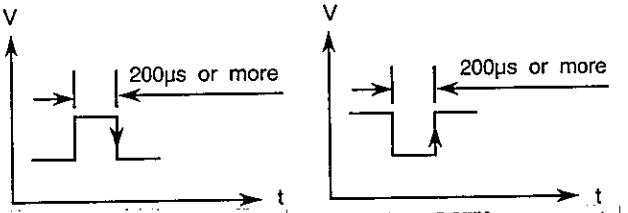
(3) Velocity Signal Filter Setting / JP2

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

(4) Origin Pulse Output Signal Setting

When the original position is detected by the original positions detection signal set to the positions obtained by dividing one motor stroke equally. When the original position is detected, the following pulse signal is output. The point at which H changes to L when the motor move to the UD direction, or L changes to H when the motor move to the DOWN direction, corresponds to the original position.
The UP and DOWN directions are show on the page 8.

Origin reproducibility accuracy depends on the number of motor strokes. The figure on the right shows the characteristics.



Origin Signal and Zero Position

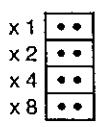
The number of origins per stroke can be selected with setting of jumper <JP23>.

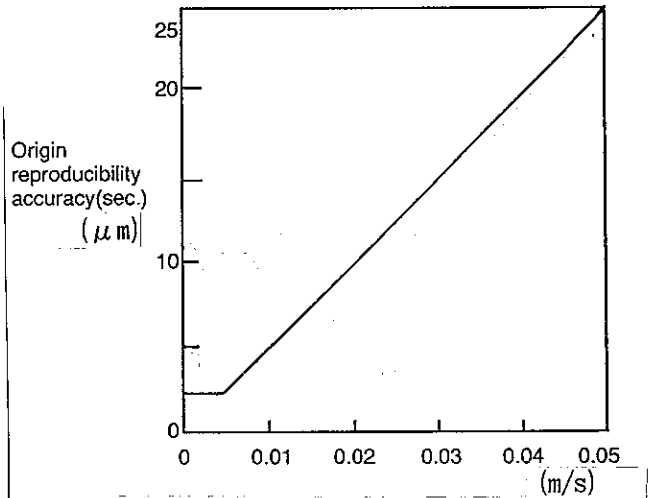
The following table shows the relationship between the set values and the number of origins.

(Unit : Pulse /mm)

	LR106	LR115	LR130
×1 Shorted with the others open	1/2.048	1/4.096	1/4.096
×2 Shorted with the others open	2/2.048	2/4.096	2/4.096
×4 Shorted with the others open	4/2.048	4/4.096	4/4.096
×8 Shorted with the others open	8/2.048	8/4.096	8/4.096

<JP23> Jumper





Relationship between the motor speed and origin reproducibility accuracy

(5) Positioning Completion Width Setting / S1

When positioning in the position control mode is completed, the CN1 connector COIN signal is set to ON. This positioning completion width can be selected by the [POSW] switch on the front panel.

The following table shows the relationship between [POSW] switches with <POSW 0, 1> signal of the CN1 connector set to H and positioning completion width.

At the same time, when setting the position completion width using <POSW 0, 1> signal, set the [POSW] switch in 4 steps as shown in the table. With a combination of H and L of the <POSW> signals, the same selection as the [POSW] switch can be carried out.

Table 3.2 Setting of the Positioning Completion Width

[POSW] Switch Setting	Positioning Completion Width (Unit : Pulse)	<POSW> Signal Setting		
		POSW 1	POSW 0	POSW Switch
0	1	H	H	0
1	5	H	L	
2	20	L	H	
3	100	L	L	
4	2	H	H	4
5	10	H	L	
6	40	L	H	
7	200	L	L	
8	4	H	H	8
9	20	H	L	
A	80	L	H	
B	400	L	L	
C	8	H	H	C
D	40	H	L	
E	160	L	H	
F	800	L	L	

(6) Mechanical Resonance Filter (Notch Type) Adjustment (Optional)

The following explains the adjustment procedure when the mechanical resonance filter (notch type) is installed as an option. The board of the filter is located as shown below just inside the square cut-out on the side panel. The controls <fn_1> and <fn_2> on the board are used to set the notch frequencies at the first stage and the second stage respectively. The frequencies can be set within the range from 150Hz to 1.5kHz (the frequencies are factory-set to 1.5kHz when shipped).

Use the controls <Q1> and <Q2> to change the setting of the Q values. The Q values can be set within a range from 0.5 to 2.5 (0 to 20kΩ) (the Q values are factory-set to 2.5 at the time of shipping). The offset voltage shall be readjusted when the Q value has been changed. This voltage is to be adjusted using adjustment controls so that the voltage difference between <TP1> and <TP3> becomes 50mV or less.

The first-order delay filter is also located on this board. The frequencies can be selected from 20 / 80Hz, 30 / 120Hz and 40 / 160Hz, using a jumper. In addition, using an appropriate pair of C and R, a desired filter frequency can be set. The frequencies of the first-order delay filter are factory-set to 20 / 80Hz at the time of shipping.

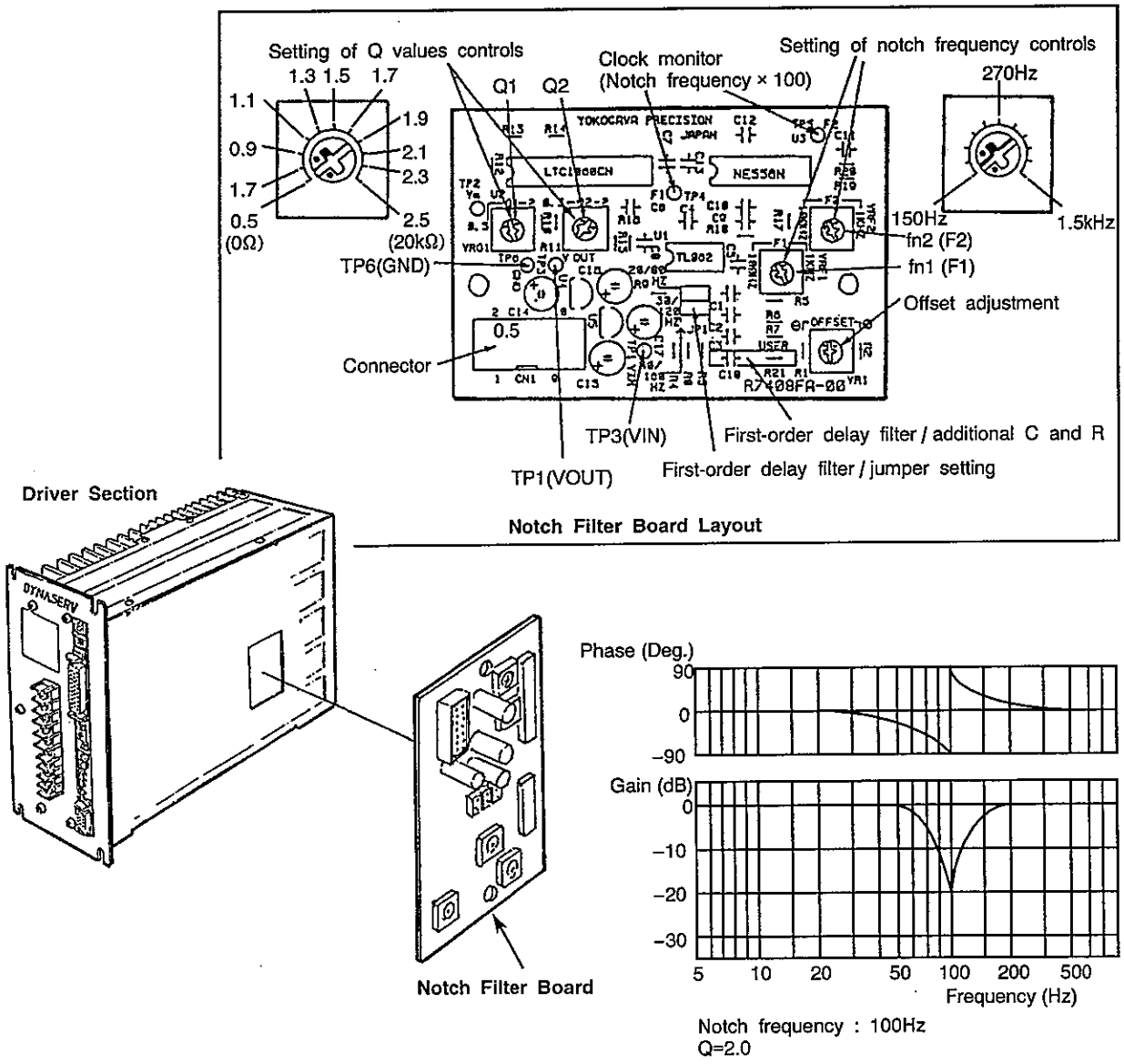
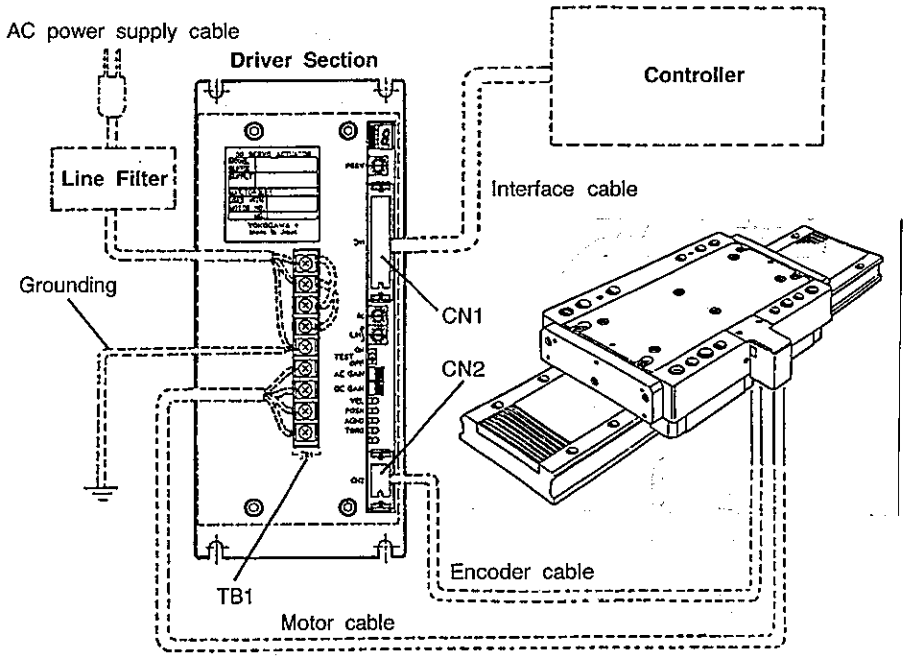


Figure 3.2 Mechanical Resonance Filter (Notch Type) Adjustment (Optional)

3.3 External Wiring

(1) External Connection Outline Diagram



Note : The items shown by the dotted lines should be prepared by the customer.

Figure 3.3 External Connection Outline Diagram

(2) Connection between the Motor and the Driver

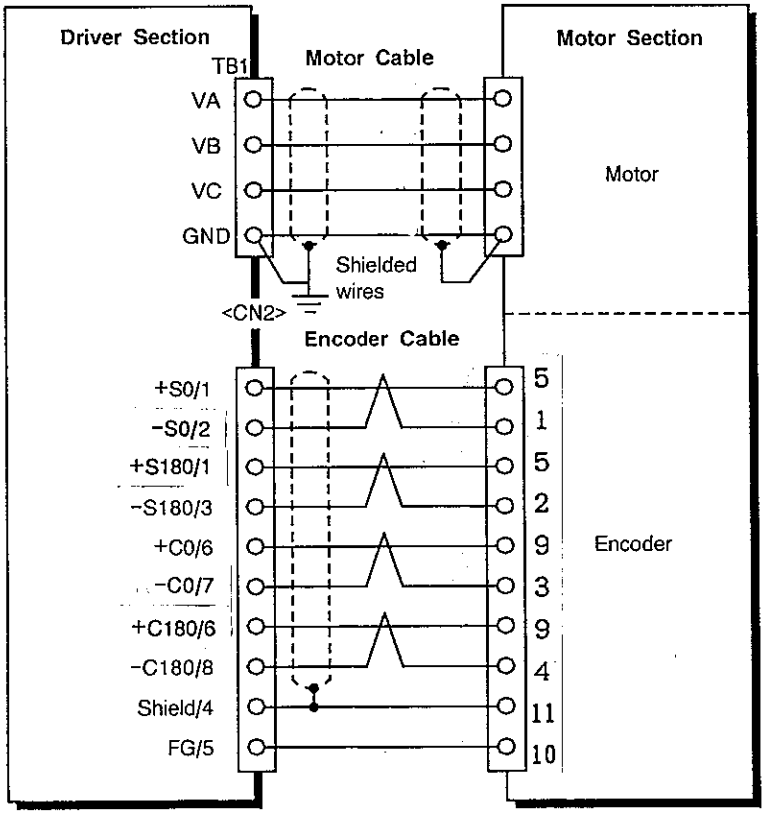


Figure 3.4 Connection between the Motor and the Driver

(3) Typical Wiring Example (In the Position Control Mode)

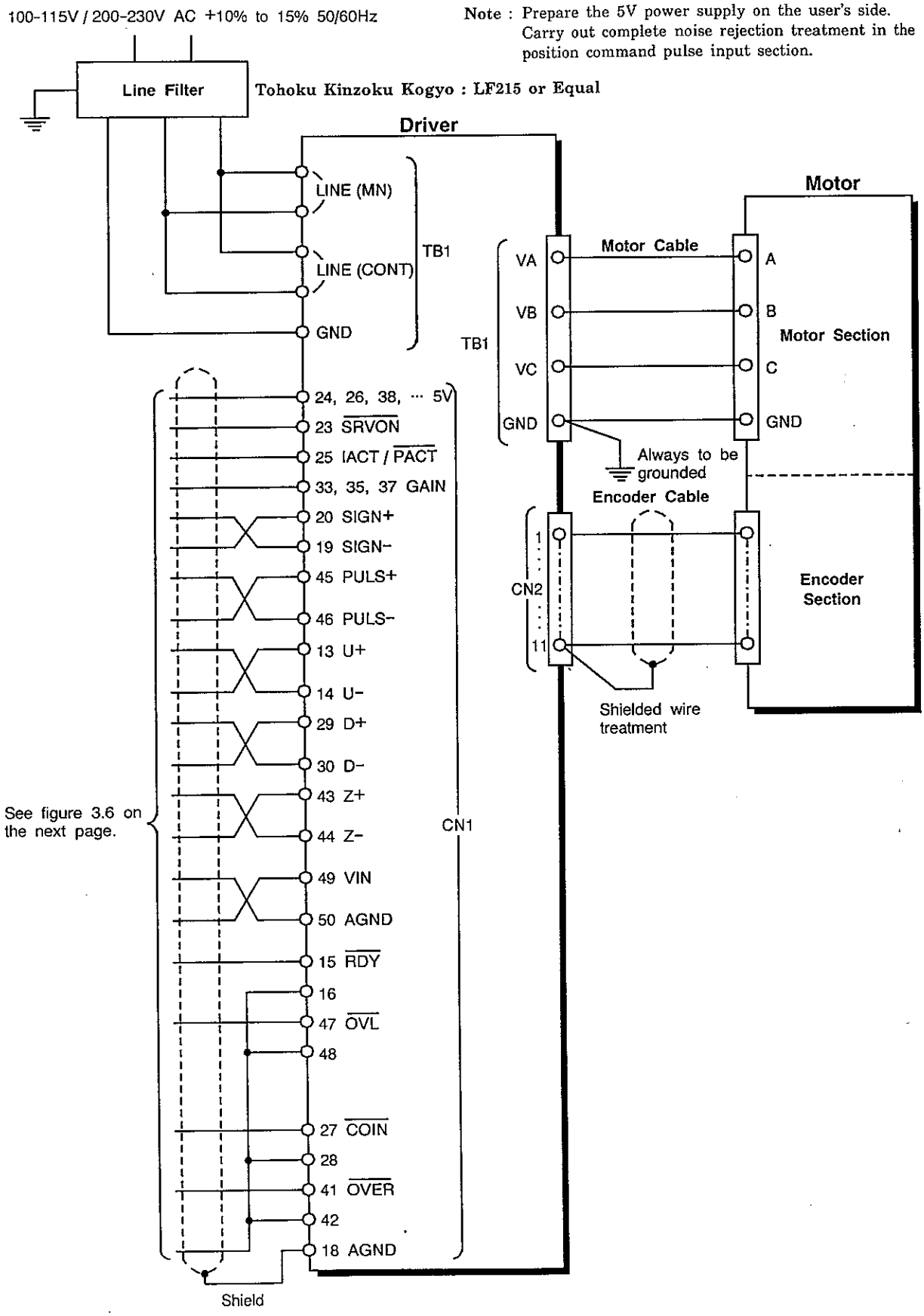
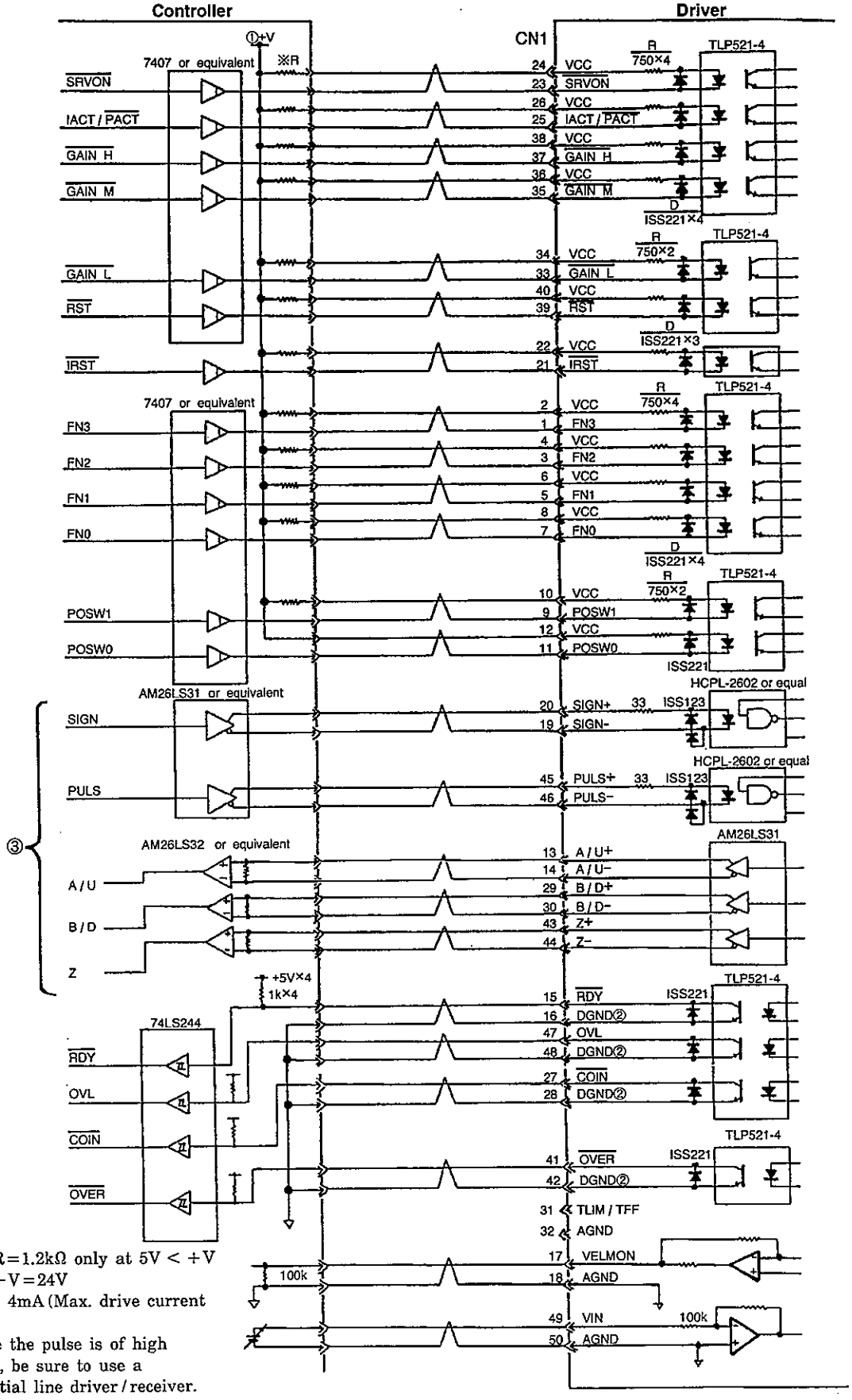


Figure 3.5 Typical Wiring Example

(4) Connection to External Controller

(CN1 terminal I/O signal connection and external signal processing)



① Insert R=1.2kΩ only at 5V < +V < 24V+V=24V

② Approx. 4mA (Max. drive current 15mA)

③ Because the pulse is of high velocity, be sure to use a differential line driver / receiver.

Figure 3.6 Connection to External Connector

(5) List of Interface

a) Input

Table 3.3 List of Input Interface

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) (See Note 1.)	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 16Hz (See Note 2.)
POSW 1 POSW 0	9 (10) 11 (12)	Positioning completion pulse width end (See Note 1.)	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	Movement direction command	The motor move to UP direction with this signal set to H and DOWN direction with this signal set to L. (UP & DOWN direction show on the page 8)
$\overline{\text{IRST}}$	21 (22)	Integral capacitor reset	The integral capacitor in the velocity loop is shorted.
$\overline{\text{SRVON}}$	23 (24)	Servo ON	The motor is set to the servo ON status 0.2 sec. after this signal is set to L to set the driver to the command wait status.
IACT/$\overline{\text{PACT}}$	25 (26)	Integral / Proportional action selection	Integral action is selected when this signal is set to H and proportional action is selected when this signal is set to L in the position control mode.
TLIM / TFF	31 (32)	Torque Limit Torque feed forward	For input of torque limit and torque feed forward (option)
$\overline{\text{GAIN H}}$ $\overline{\text{GAIN M}}$ $\overline{\text{GAIN L}}$	37 (38) 35 (36) 33 (34)	Gain selection	Signal to select the variable DC gain range. (See Note 3.)
$\overline{\text{RST}}$	39 (40)	CPU reset	The driver control section is initialized with this signal set to L for more than 50μ seconds.
PULS+ PULS−	45 46	Position command pulse	Driver position command pulse signal
VIN	49 50	Velocity command input Torque command input	Set to the max. speed at ±6V input. UP direction/ +6V, DOWN direction/ −6V, #50 pin: GND For torque command ±8V.
AGND	32	Analog input GND	Velocity / torque input analog GND

Note : ( ) indicates Vcc signal input's terminal.
(Note1) : FN0 to 3 and POSW 0, 1 are logically wired in the "OR" configuration with the rotary switch and jumper (JP1 / GAIN H)
When using external controller, set this rotary switch to the "0" position and GAIN H to open.

b) Output

Table 3.4 List of Output Interface (1/2)

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 moving position. Either A / B phase or UP / DOWN phase pulse can be selected by the jumper on the board.
$\overline{\text{RDY}}$	15 (16)	Servo ready	The motor is ready to operate with this signal set to L. This signal is set to the H level about 3 seconds after driver power-ON.
VELMON	17 (18)	Velocity monitoring	Signal for monitoring the motor speed to output positive voltage for UP direction and negative voltage for DOWN direction. Velocity detection sensitivity is as shown on the following table. (See Note 3.) Velocity detection sensitivity is not guaranteed for the motor speed in the range exceeding ±7.5V.

Note : ( ) indicates GND signal output.

Table 3.4 List of Output Interface (2/2)

Signal Name	Pin No.	Meaning	Details
$\overline{\text{COIN}}$	27 (28)	Positioning completion signal	This signal is set to L when the deviation counter value becomes less than the POSW switch set-value.
$\overline{\text{OVER}}$	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 3MHz. 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 1 stroke of the motor and changes from H to L during UP direction and from L to H during DOWN direction.
OVL	47 (48)	Overload	Set to H during overload, it simultaneously reduces motor current automatically to 1/3.

Note : ( ) indicates GND signal output.

(Note 2)

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 3)

GAIN H	GAIN M	GAIN L	Gain * Magnification
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 variable resistor position (0.5 to 5.5) becomes the total gain.

(Note 4)

Model	Velocity Detection Sensitivity (V/ m/s)	Velocity detection limit (m/s)
LR106	5 / 0.7	0.83
LR115	5 / 1.4	1.67
LR130	5 / 1.4	1.67

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°C
- Dust concentration is low, air ventilation is good and humidity is low.

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

b) **Mechanical Coupling**

- The flatness of the object-surface to be mounted on the slider must be maintained within a parallelism specification of less than 0.02mm.
- The gap between the scale and the slider of this system is about 0.1mm, which is extremely limited in terms of space. Hence, ensure that the scale surface is free from particle dust contamination (or accumulation).

(2) Driver Section Mounting

The standard driver is designed for rack mounting.

a) Installation Location

- When there is a heat generating source near the installated location, ensure that temperature does not exceed 50°C in the aproximity of the driver by providing an appropriate heat shield or cover, etc.
- When there is a vibration generating source close to the driver then mount the driver on the rack with appropriate vibration insulators.
- Further, the installation must be at locations where the humidity is low, and where the surrounding environment is free from high temperature, dust, metal powders and corrosive gases.

b) Mounting Procedure

- Normally, the driver is rack mounted (L-shaped angle brackets) with its driver panel facing forward and its top and bottom surfaces horizontal. However, it may be mounted with its driver panel facing upward. Always avoid mounting it with its panel surface facing sideways or upside down. (See the figure(b) below.)
- Mount the driver using 4-screw holes at the top and bottom of the driver panel.

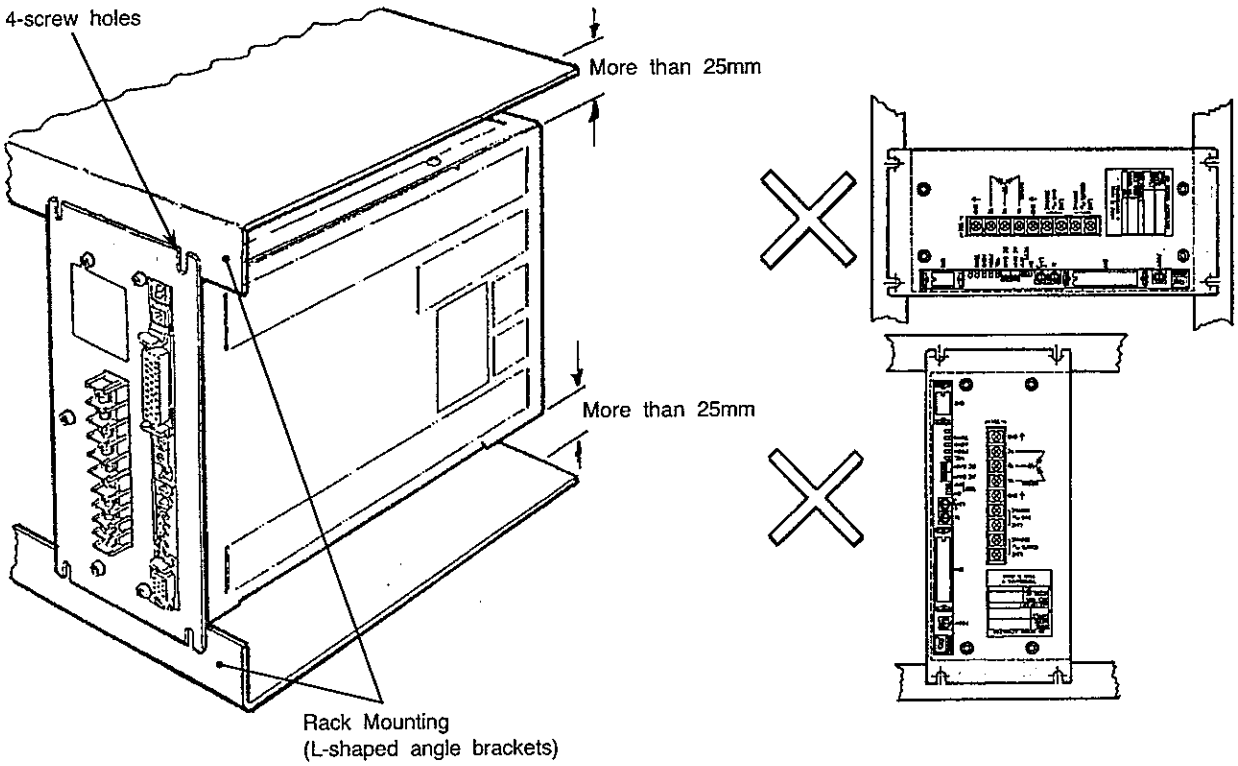


Figure 3.8 Driver Section Mounting

(3) Electro-magnetic clamp fixing procedure:-

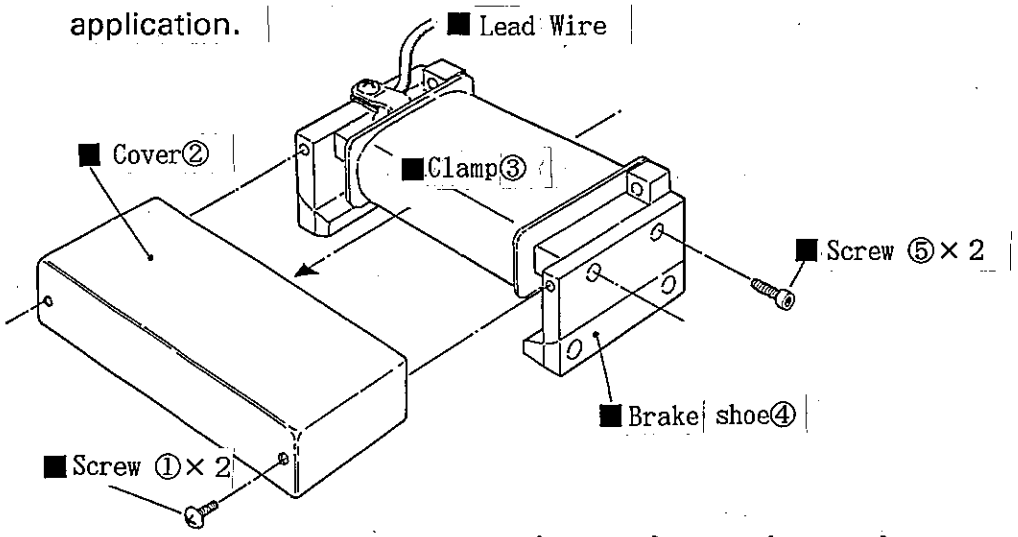
The following steps describe the procedure to connect the Electro-magnetic clamp to the motor :

1. Unscrew the {No. 1 } bolts (x2), and then remove the cover {No. 2 }.
2. Unscrew the {No. 5 } bolts (x2) in the electro-magnetic clamp {NO. 3 } and so unfasten the brake shoe {No. 4 } and remove it.

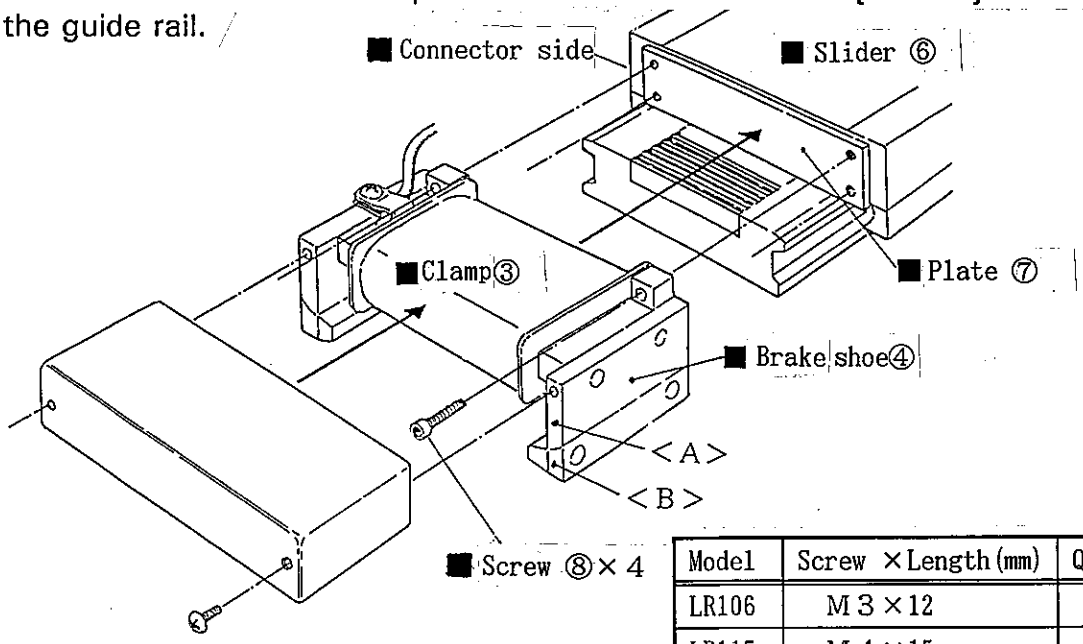
Note:

a. The brake shoes need not be removed, if it is possible to insert the electro-magnetic clamp from the extremity of the guide rails.

b. Fixing the electro-magnetic clamp on to the motor is possible only if the motor has not been inserted or assembled into the intended application.



3. Fasten the electro-magnetic clamp {No. 3 }, with {No. 8 } bolts (x4) to the fixing plate {No. 7 } onto the slider. At the time of fastening, the direction of the wire leads from the clamp must face the connector on the slider.
4. The procedure described above may be used even when the brake shoe {No. 4 } has been removed. However, upon re-assembly of the brake shoe, ensure zero clearance between parts A & B of the brake shoe and also maintain the parallelism of the brake shoe {No. 4 } with the guide rail.



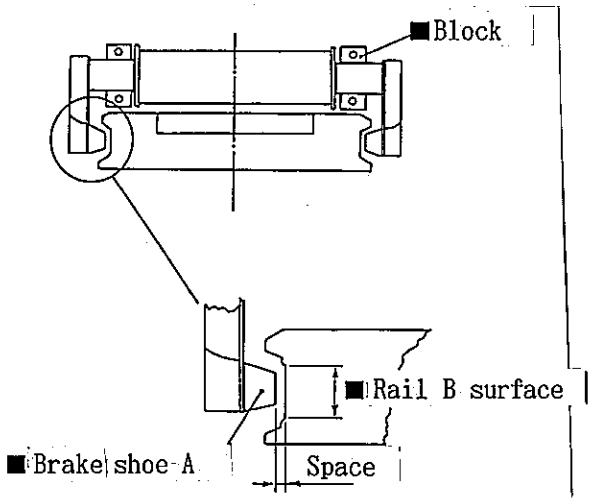
Model	Screw ×Length (mm)	Qt'y
LR106	M3×12	4
LR115	M4×15	4
LR130	M5×20	4

5. Maintain a proper and even clearance between the brake shoe the machine surface on the guide rail { B } to be traversed. Further, ensure that the clearance between the shoes on either side is kept equally even.

Note:
a. Taking advantage of the hole clearances on the clamp, move the clamp either upwards, downwards or sideways and thus ensure the identical and even gaps on either side of the brake shoe.
b. If the gap between the left and right sides of the brake shoe differs even marginally, the clamping force will decrease substantially thus reducing the effectiveness of the brake.

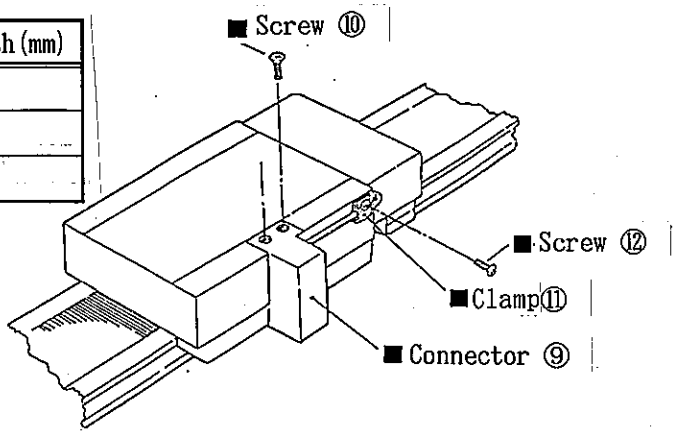
6. After completion of the necessary adjustements as required, fasten all bolts with appropriate force and thus lock the clamp in place.

Note: Use LOCK TITE (Medium strength) to lock the bolts in position.



7. Cut the wire leads from the clamp such that it reaches the slider connector without any slack and solder these leads onto the connector.
In order to connect the leads first unscrew the plate {No. 10 } bolts (x2) on the slider, and, remove the connector {No. 9 }. Solder the clamp leads to the connector pins using the following configuration:
Pin #7: Red lead (+) from the clamp.
Pin #8: Black lead (-) from the clamp.
Replace the connector back onto the slider. Using the wire clamper {No. 11 } and the fixing bolts { No. 12 }, clamp the wire leads tightly onto the slider.

Model	Lead wire Length (mm)
LR106	130
LR115	170
LR130	210

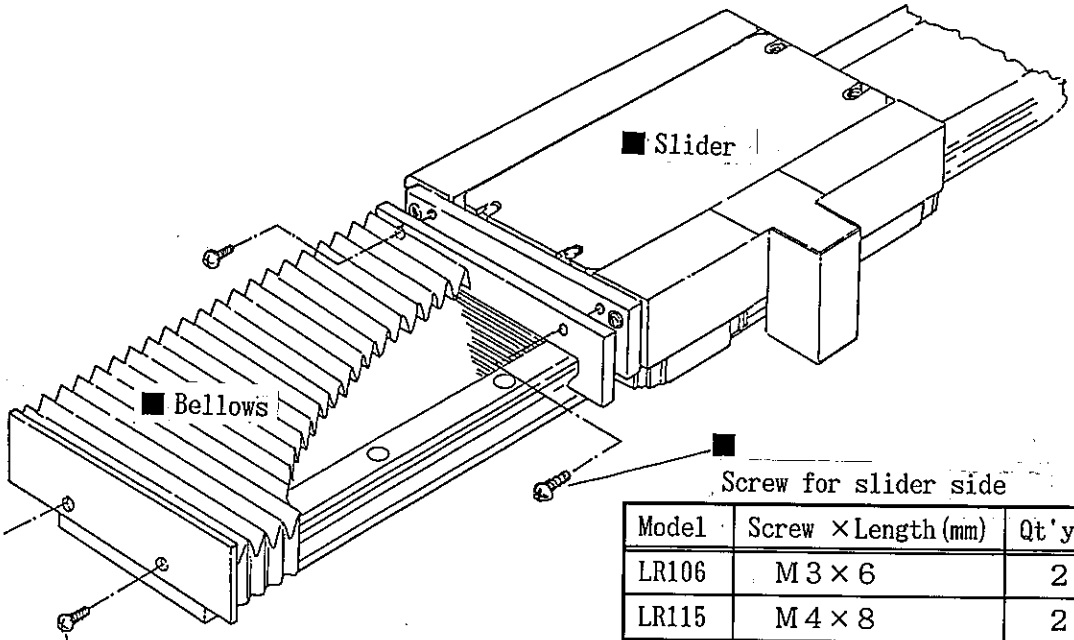


8. After completion of the assembly, replace the cover and connect the power line and then repeatedly turn on and turn off the power supply to test the clamp's ability to function properly.
9. Ensure that the clamp's holding force meets the specifications as listed in the table below:

Model	Cramp force (kg)
LR106	5.0
LR115	12.5
LR130	20.0

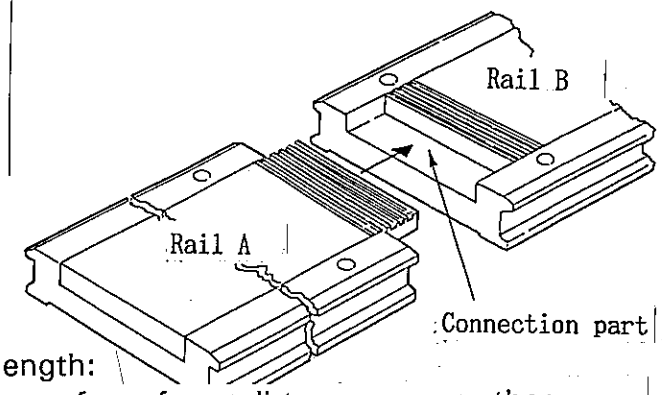
(4) Procedure to connect the retractable bellows to the stator surface

1. With the plate to be affixed to the slider, facing the slider, insert the bellows from the end of the guide rail and proceed with the assembly of the same.
2. The bolts required for fixing the bellows to the slider are categorized in tabular form below corresponding to motor type.



Model	Screw ×Length (mm)	Qt'y
LR106	M3×6	2
LR115	M4×8	2
LR130	M4×10	2

Model	Screw ×Length (mm)	Qt'y
LR106	M3×6	2
LR115	M4×8	2
LR130	M4×8	2



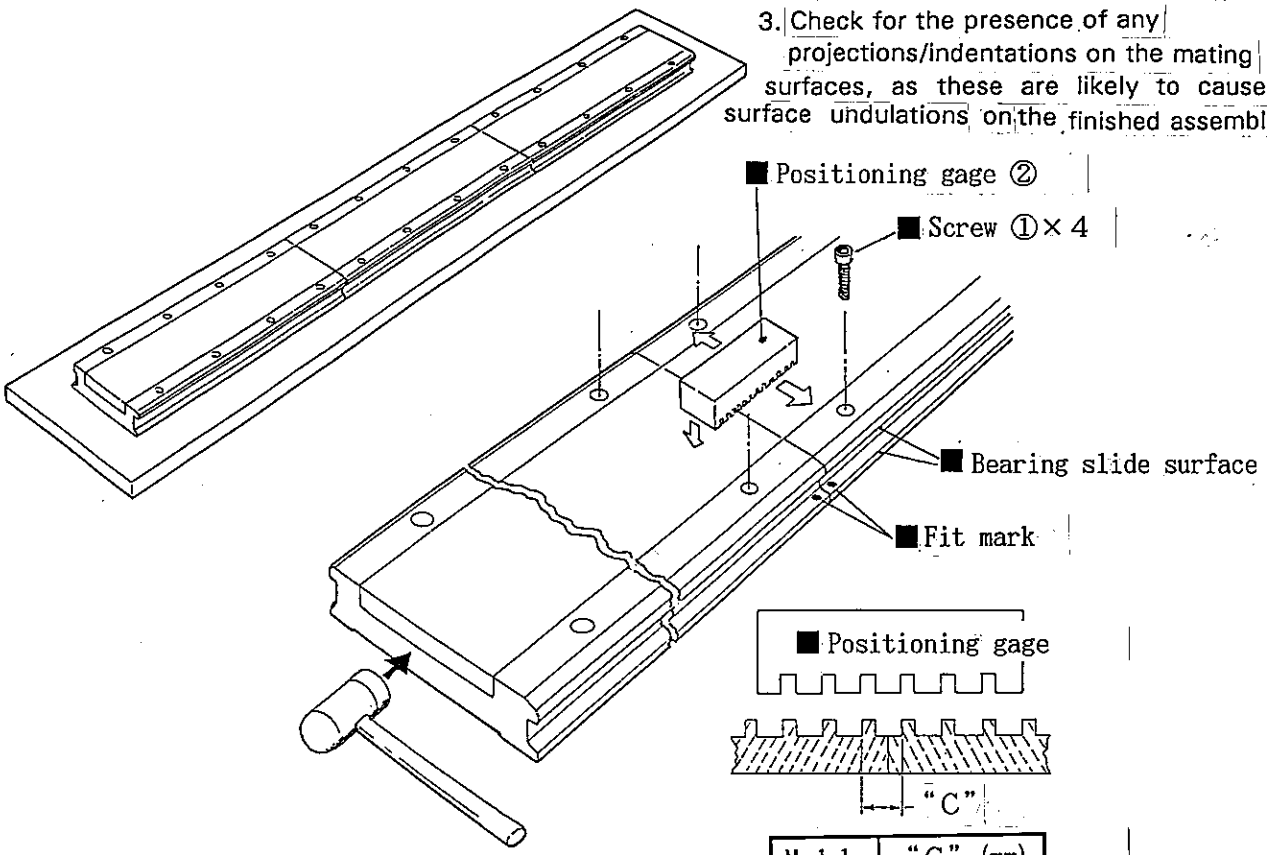
(5) Procedure for extending the stator length:

1. Ensure that the rail extenders are free from dirt, grease or other foriegn matter, especially at the interface for fastening the rails. Use alcohol based cleansers to remove the dirt or grease if any.
2. Inspect for scratches or cracks at the mounting surfaces. Use an appropriate File or a Fine Grade Sander to remove the scratches before mounting.

3. After the completion of alignment and ensuring the proper mating of the surfaces, use the bolts {No. 1 } (x4) to fasten the rails together.
4. Use the positioning jig {No. 2 } such that the teeth at the bottom of the positioning jig mesh with the teeth on both the stators, yet sliding freely once inserted. Tighten the bolts {No. 1 } (x4) with appropriate force and lock the stators together. After the bolts are tightened, ensure that the jig slides freely within the grooves of the stator.
5. Observe the mated joint carefully using the aid of a magnifying glass and ensure that no significant variations are visible at the mating surfaces.

Note:

1. When the stator extensions exceed more than three (3) units, then use the reference marks as a basis for matching these units.
2. Tap the mating surfaces gently using either a wooden or plastic headed hammer to align the rails.
3. Check for the presence of any projections/indentations on the mating surfaces, as these are likely to cause surface undulations on the finished assembly.



Model	"C" (mm)
LR106	2.048
LR115	4.096
LR130	4.096

6. Gently moving the slider over the extension/s, check and confirm that the motion at the joint and over the extension/s remains smooth.

Note:

1. If the slide movements are rough, uneven or noisy, inspect the extension and joint once again and, if necessary, adjust and correct the joint.

7. With the completion of above procedures connect the power supply lines and cycle power and using the proper electrical interface, check to confirm the smooth and repeatable motion especially, over the extension/s.

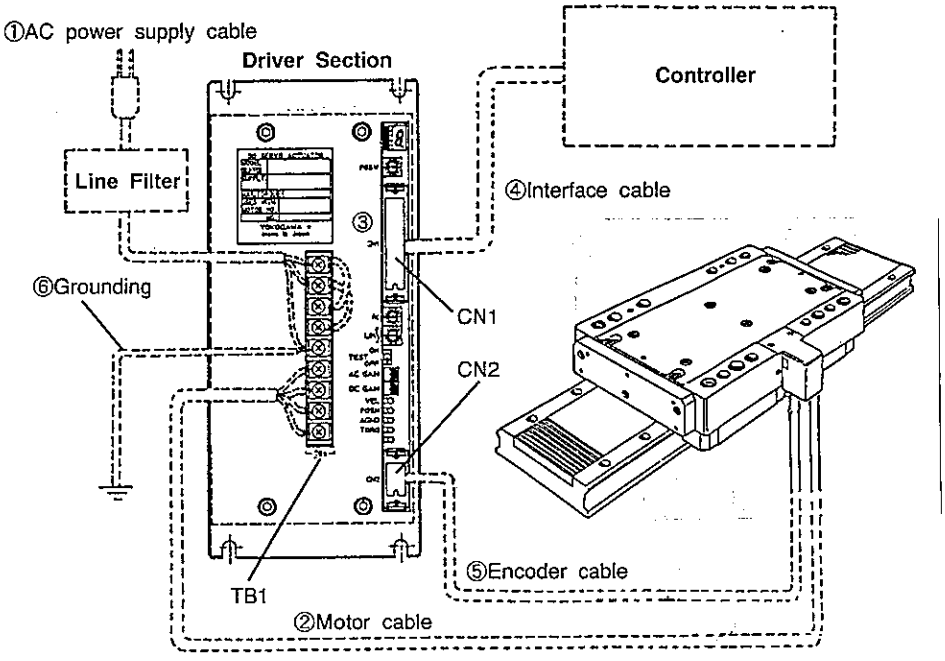
3.5 Wiring Cables

(1) Cable Sizes and Rated Currents

Table 3.5 Cable Sizes and Rated Currents

			Cable spcification
Input	①AC power supply cable	Current (A)	7
		Cable size	AWG 20 or over, Length : Within 30m
	②Motor cable	Current (A)	7
		Cable size	AWG 20 or over, Length : Within 30m
	③Jumper wire	Current (A)	7
		Cable size	AWG 20 or over
Output	④Interface cable	Current (A)	DC100mA·Max.
		Cable size	※Twisted pair collectively shielded wire, Length : Within 3m
	⑤Encoder cable	Current (A)	DC150mA·Max.
		Cable size	※Twisted pair collectively shielded wire, Length : Within 30m
	⑥Grounding	Cable size	AWG 20 or over

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 $0.2mm^2$ tin-plated twisted wire
4. Outer sizes of the cables used for CN1 and CN2 : Less than dia. 14mm or dia. 9mm, respectively
5. Cable size is obtained under the condition that ambient temperature is 40°C and the rated current flows through 3 bundled leadwires.
6. Cable rated must be AWG 18 or over when used for LR130



Note : The items shown by the dotted lines should be prepared by the customer.

Figure 3.9 Wiring Cables

(2) Wiring Cautions

- Use the specified multi-core twisted pair cables with collective shielding for the interface and the encoder cables. Ensure proper end shield connections.
- Use thick conductors as grounding cables as much as possible. Ground the LINEARSERV through a resistance of less than 100Ω
- Since high voltage, large current flows through the motor and the AC power cables, ensure proper wiring connections.

4. OPERATION CAUTIONS

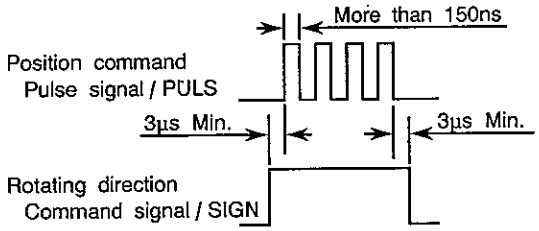
4.1 Input and Output Signal Cautions

(1) Position Command Pulse Input Signal (PULSE±)

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

(2) Motor Moving Direction Command Input Signal (SIGN±)

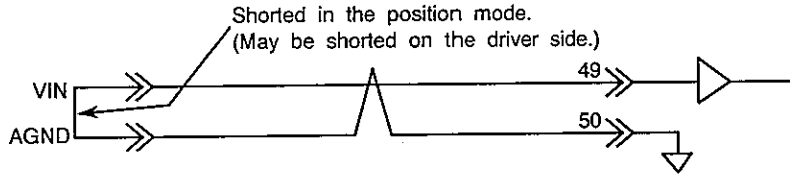
A signal to indicate the motor moving. The motor move in the UP direction with this signal set to H and DOWN direction with this signal set to L. Timing of this signal to the positioning command pulse signal at the output is as shown below.



Note : The pulse should be set to active H. This means that current does not flow through the driver photo-coupler when the pulse is not output.

(3) Velocity Command Input (VIN)

An analog input signal which gives the motor rotating velocity command value. The maximum velocity in the UP direction at +6V, and the maximum velocity in the DOWN direction at −6V. (In the −6V to +6V, input range, input impedance is 100kΩ.)

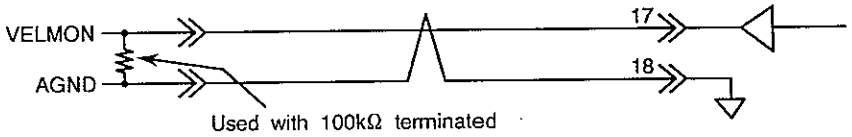


(4) Velocity Monitoring Output (VELMON)

Motor analog velocity monitoring output

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

At maximum velocity −6V (DOWN) (output impedance is 1kΩ.)



(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 status 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.

	DOWN direction	UP direction
A-phase pulse	750kHz Max.	750kHz Max.
B-phase pulse	90°	90°

b) **UP / DOWN Output Pulse**

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

	DOWN direction	UP direction
UP-pulse signal		3MHz Max.
DOWN-pulse signal	3MHz Max.	

Note : Because PULS±, SIGN±, A / U±, and Z± are signals of high speed pulses, a differential I/O interface is required.

4.2 Power ON / OFF

Pay attention to the following when the power is turned ON.

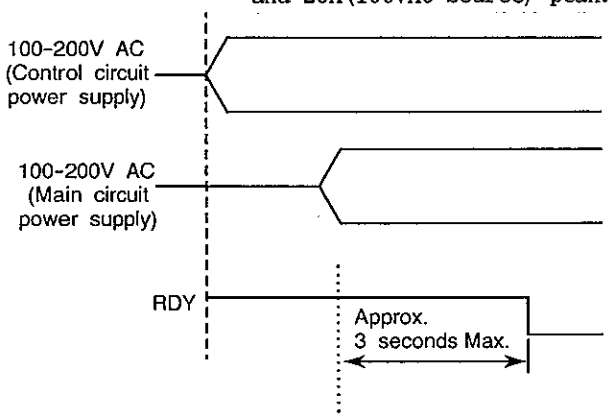
1) When turning ON the main and control circuit power supplies, turn them ON simultaneously or turn ON the control circuit power first.

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

(3) Inrush current in both the main and control power circuits is about 35A (200VAC Source) peak and 20A (100VAC Source) peak.

4) The motor is set to the servo status about 200ms 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 seconds. Therefore, hold the power-ON signal for more than 3 seconds.



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.

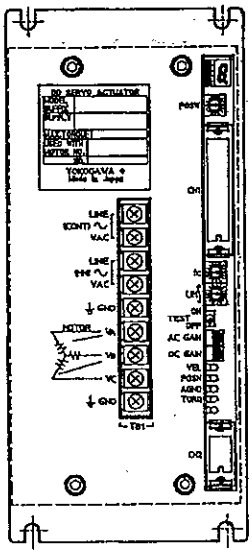
(1) I-PD Type Position Control

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>, <I. LIM switch> and <DC gain adjustment control> becomes necessary.

a) **<fc Switch>**
The 1 to 16Hz 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) **<I. LIM Switch>**
This prevents the wind-up phenomenon by limiting the output of the digital integrator during software servo computation. The larger the switch No., the larger the limited value. The smaller the limited value, the smaller the wind-up and the shorter the setting time. However, if the limited value becomes too small, the motor output torque is limited. Therefore, it can be said that it is better to make the switch value large within the no wind-up range. The fine adjustment is performed during the acceleration / deceleration operation.

c) **<DC Gain Adjustment Control>**
The combination of driver CN1 connector GAIN H to L signals results in an adjustment range of from 0.5 to 120 times. The DC gain should be as large as possible. When there is load change, adjust the gain so that it becomes optimum at the maximum load.



(2) P Type Position Control

Positioning accuracy is not high because proportional control is used for positioning feedback. The speed controls which can be set for simultaneous selection are P and I types, and they can be set with a jumper.

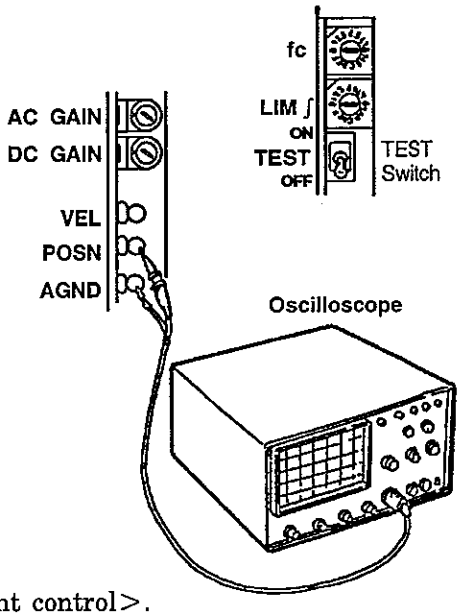
With P type speed control (P-P type), a force output which is proportional to the positioning error is obtained, and compliance control is possible. In this control mode, only <fc switch> and <DC gain control> are to be adjusted.

With I type speed control, a high tact positioning can be achieved. In this control mode, amount of speed feed forward is to be adjusted with a jumper in addition to <fc switch>, <DC gain control> and <AC gain control>.

(3) Position Control System Adjustment Procedure (See the Following Figure.)

The position control system can be adjusted in the test mode. Turning ON the test switch at the front of the driver generates a 2.5Hz square-wave position command signal inside the driver to output the motor position to the POSN signal terminals. At this time, ensure that the motor exhibits reciprocal action at very small displacements.

① The adjustment procedure for I-PD type position control in the test mode is as follows.



Step 1 : Connect an oscilloscope to the <POSN> signal terminals.

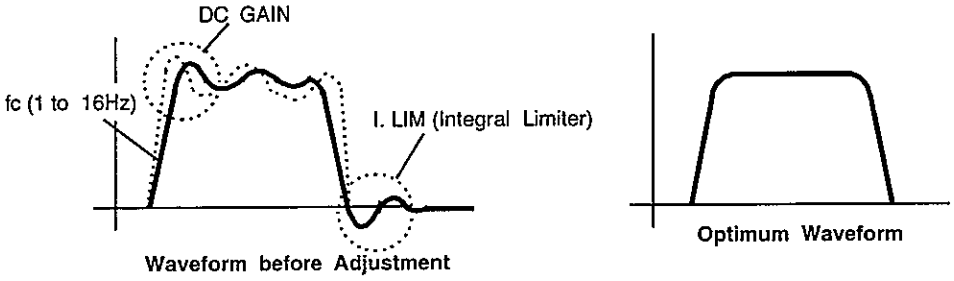
Step 2 : Set the CN1 connector <SERVO> signal to L. At this time, set the TEST switch to <OFF>.

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

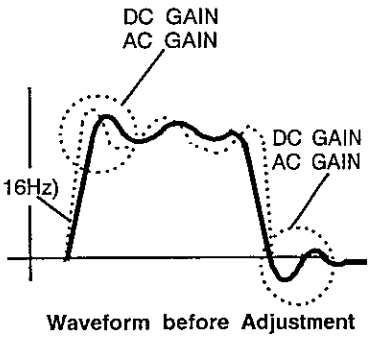
Step 4 : Adjust the <fc switch>. Its variable range is from 1 to 16Hz and it should be set to about 10Hz (scale graduation : 9) under normal load conditions.
Set the <I. LIM switch> to a large value within the range where there is no hunting.
Select the GAIN H to L signal so that they match the load condition.
Fine adjustment is done by the <DC gain adjustment control>.
Perform the above adjustments such that the POSN signal becomes a square wave.

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

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



② The adjustment procedure for P-I type position control in the test mode is as follows.



Step 1 : Connect an oscilloscope to the <POSN> signal terminals.

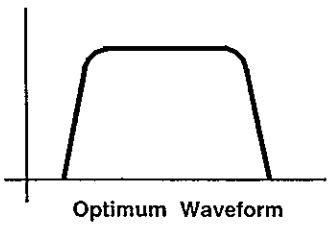
Step 2 : Set the CN1 connector <SERVO> signal to L. At this time, set the TEST switch to <OFF>.

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 16Hz and it should be set around the center position under normal load conditions.
Set the <AC gain control> to a large value within the range in which there is no hunting. Fine adjustment is done by the <DC gain control>.
Perform the above adjustments such that the POSN signal becomes a square wave.

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

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



(4) Procedure for Adjustment without Measuring Instruments

The preceding demonstrated procedures for performing adjustments while monitoring the waveform ; this section demonstrates an adjustment procedure that does not use any measuring instruments. These adjustment methods are valid only in the case of the position control mode (I-PD type, the setting when shipped).

1) Calculate or otherwise verify the load.

2) Set the <TEST> switch on the driver front panel to [ON].
3) Take the computed load multiple and refer to the table of adjustment settings. For example, suppose that load is [15kg] for a LR130, thus the <3> range applies for this case. Next, follow this row to the right for the setting values.
4) First, look at the value in <DC gain> "Column 1". Because the value is [25], turn the <DC gain> control to [25].
5) Similarly, take the "Column 1" values for <fc> and <LIM ∫> in the same row, and set their respective controls to those values.
6) When the above settings have been completed, set the <TEST> switch to [OFF] to end the adjustments.

Note : The GAIN value for signal selection shown below is multiplied by the DC GAIN level value for containing a total gain.

GAIN H	H	H	H	H	L	L	L	L
GAIN M	H	H	L	L	H	H	L	L
GAIN L	H	L	H	L	H	L	H	L
GAIN	1	4	7	10	13	16	19	22

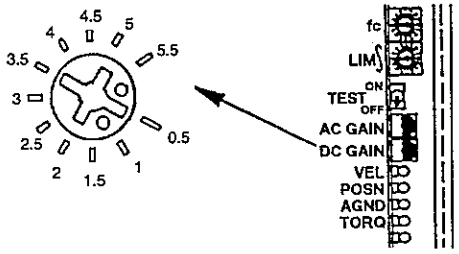


Table 5.1 Setting of the LINEARSERV controls

Range	Load [kg]			setting Value		
	LR106	LR106	LR106	<DC GAIN>	<f_c>	<LIM ∫ >
1	~4.0			8	C	4
2	4.0~8.0	~5.0	~9.9	13	B	3
3	8.0~16	5.0~10	9.9~19	25	A	3
4	16~40	10~25	19~50	50	9	1
5	40~56	25~35	50~71	65	8	2
6	56~80	35~50	71~99	80	7	1
7	80~120	50~75	99~144	100	5	2
8	120~242	75~152	144~297	110	2	4

5.2 Velocity Control Mode Adjustment

In the velocity control mode, the motor movement 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 speed.

Model	Speed/Input voltage (m/s/V)
LR106	0.7/5
LR115	1.4/5
LR130	1.4/5

(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> adjustment controls are adjusted.

a) **<DC Gain>**
The combination of the driver CN1 connector GAIN 0 to 2 signals results in an adjustment range of from 0.5 to 120 times.

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

(2) P Type Velocity Control

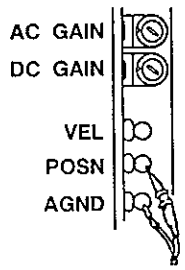
Since velocity control is effective only in proportional action, response is fast but is strongly influenced by disturbances in the controlled result. In this control mode, only the <DC gain> variable resistor at the front of the driver is adjusted.

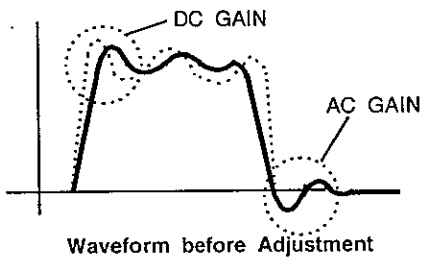
(3) Adjustment of Speed Control System

Adjustment of speed control system can be carried out in the test mode.

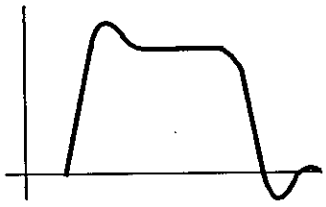
By turning the test switch on the front of the driver to ON applies a 2.5Hz square waveform signal to the speed input in the driver, and the motor starts back and force movements repeatedly at a small movement. Under this condition, observe the <VEL signal> at the front panel on an oscilloscope, and adjust <DC gain> and <AC gain> so that <VEL signal> becomes an optimum waveform as shown in the figure below.

An approximate setting position of the <AC GAIN> control for obtaining an appropriate gain is the mechanical center position of the control.





Waveform before Adjustment



Optimum Waveform

5.3 Force Control Mode Adjustment

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

Note : When using the force control mode, carefully design the velocity & position control loop and the interlock system to suit the exact specifications for your application.

6. Maintenance / Inspection:

6.1 Motor:

The maintenance and inspection procedure is described herein. With the exception of the routine as described in the box, the daily inspections are rather straightforward.

During the daily inspections, check the noise and vibration levels for any abnormality when compared to the standard values.

Do not dissemble the motor under any circumstances.

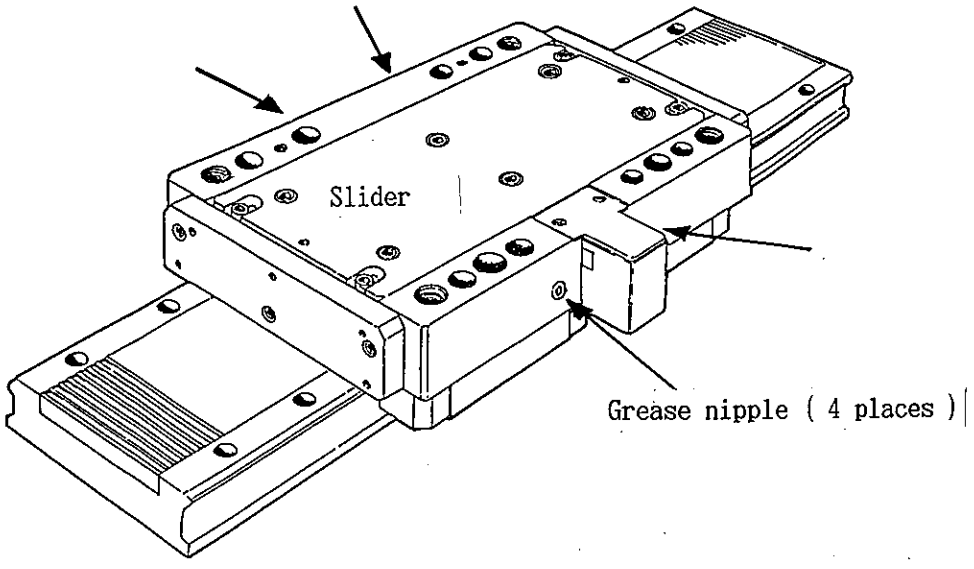
Depending upon the environment and the operating conditions, in general, faults emanating from the motor-driver combination system beyond approximately 20000 hours or a period of 5 years (whichever comes first) of usage would necessitate replacement of the motor-driver system.

CAUTIONS

When the slider of the motor traverses an accumulated distance of approximately 100 Km, lubricate the slider with the recommended lubricating grease. The four grease nipples located on the slider may be used for the purpose of lubrication.

N.B. Use the following recommendations:

Grease:	THK AFC-70 (Contents 70g)
	THK AFC-400 (Contents 400g)
Grease gun:	THK MG70



6.2 Servo drivers:

The servo driver does not require any daily maintenance or inspection. However, as dust and air borne particles could cause damage to the electrical circuitry, it is recommended that occasional cleaning be undertaken as a precaution.

7. TROUBLESHOOTING AND MEASURES

7.1 Motor Trouble and Measures

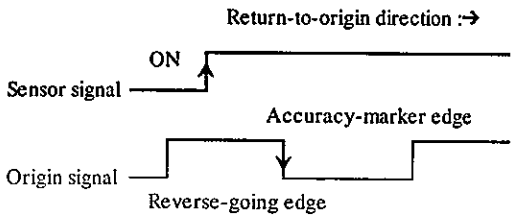
Whenever any abnormal condition occurs while operating the motor, check the LED display on the front panel of the driver. Take appropriate countermeasures as shown below if the cause of the abnormal condition is determinable by the indication of the LED display.

When the motor does not function normally, even after the following measures have been taken, immediately cease operation and contact the Yokogawa Precision Corp. or it's authorized agent.

Table 7.1 Motor Trouble and Measures (1/2)

Trouble	Estimated Cause	Inspected Item	Measures	Page for Reference
The motor is not servo locked.	◆No AC power is fed.	Wiring inspection	Apply the specified AC power	Pages 16, 17
	◆The servo ON (SRVON) terminal is set to H.	Inspection	Set to L.	Page 18
	◆The CPU reset (RST) terminal is set to L.	Inspection	Set to H.	Page 18
	◆The integral capacitor reset (IRST) terminal is set to L.	Inspection	Set to H.	Page 18
	◆fc, I. LIM, DC gain is small.	Inspection	To be adjusted to an appropriate value.	Pages 31 to 34
The motor does not start.	◆Under over load	Operate the motor under no load.	When starting the motor, lighten the load or replace the motor with a large output motor.	
	◆Incorrect external wiring	Inspect wiring.	Re-wire correctly by referring to the connection diagram.	Pages 16, 17
	◆fc, I. LIM, DC gain is small.	Inspection	To be adjusted to an appropriate value.	Pages 31 to 34
Motor rotation is unstable.	◆Imperfect connection	Check the connection of each phase of A, B, C and GND.	Re-wire correctly by referring to the connection diagram.	Pages 16, 17
	◆The motor and driver combination is wrong.	Check the combination Nos. on the nameplate.	If the combination is wrong, return it to the corrct combination.	Page 7
The motor overheats.	◆Ambient temperature is high.	Check to see if ambient temperature is more than 45°C	Lower the ambient temperature to below 45°C	
	◆The motor is overloaded.	Operate the motor under no load.	When starting the motor, lighten the load, or replace the motor with a larger output motor.	
Abnormal sound is produced.	◆Incorrect mounting	Loosen set screws.	Tighten the screws.	
	◆Mounting base vibration	Check the mounting base.	Reinforce the mounting base.	
Abnormally small motor torque	◆Incorrect motor / driver combination	Check the combination Nos. on the nameplate.	If the combination is wrong, return it to the correct combination.	Page 7
	◆Motor is overloaded.	Check the OVL signal.	Recheck the operation. Lighten the load.	Pages 19, 20
	◆fc, I. LIM, DC gain is small.	Inspection	Adjust to appropriate value.	Pages 31 to 34

Table 7.1 Motor Trouble and Measures (2/2)

Trouble	Estimated Cause	Inspected Item	Measures	Page for Reference
Motor runs out of control.	◆Incorrect motor / driver combination	Check the combination Nos. on the nameplate.	If the combination is wrong, return it to the correct combination.	Page 7
	◆Inappropriate jumper setting	Inspection	Perform correct jumper setting.	Pages 10 to 15
	◆Imperfect connection	Check motor / encoder connection.	Re-wire correctly by referring to the connection diagram.	Pages 16, 17
Position is dislocated.	◆Incorrect A/B-phase and U/D-pulse jumper, selection	To be inspected.		Pages 10 to 15
	◆Command pulse rate and width are not as specified.	Check the command pulse width.		Pages 29, 30
	◆Feedback pulse rate and receive circuit response speed are not as specified.	Check the feedback pulse rate (3MHz Max.) and receive circuit response speed.		Pages 29, 30
	◆Both ends of the feedback pulse transmission cable shield are not connected to the earth.	To be inspected. If so, connect the driver to AGND and the controller to SG.		
The motor does not return to its origin accurately.	■ Connection with unmatched controller	Check the method for returnig the motor to its origin and reconfigure the settings.		
	■ Improper positioning of the "around-the-origin" sensor	Observe the positional relationship of the accuracy-marker edge of the "around-the-origin" sensor signal with the one for the origin signal using an oscilloscope to ensure that these two edges do not overlap.		
	■ Chattering in origin signal	Check for any chattering in the origin signal. Increasing the speed of the return-to-origin signal helps prevent chattering from occurring. If chattering still persists, adjust the position of the "around-the-origin" sensor. (If the reverse-going edge appears first, you may confuse it with the accuracy-marker edge.) 		

7.2 List of LED Display

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 tables.

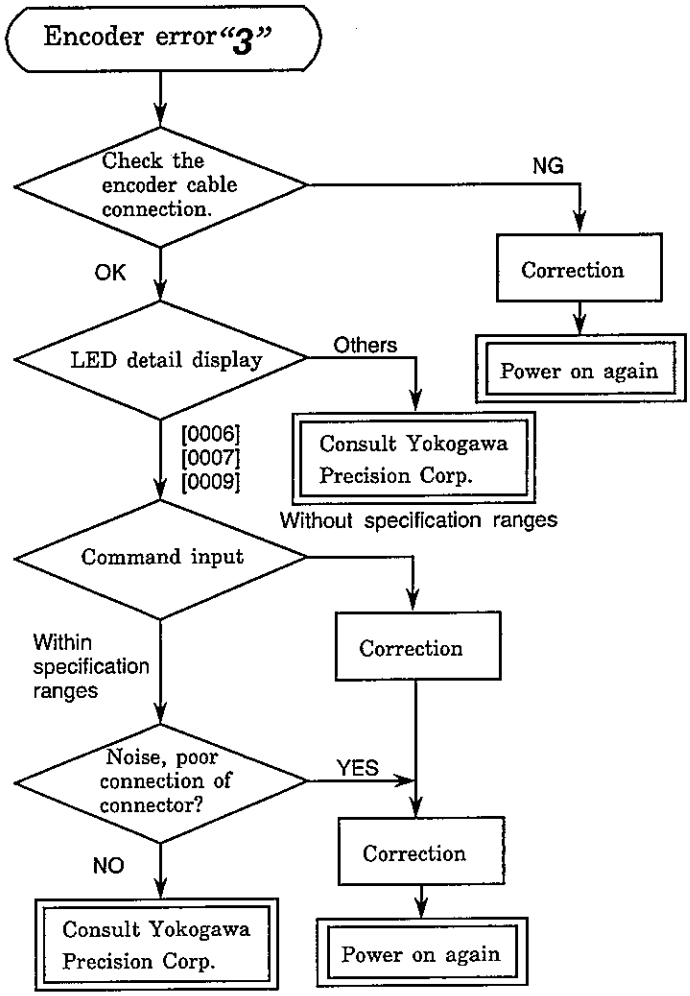
Table 7.2 List of LED Display

LED Display		Status	Display Details with TEST Switch ON (Serial display of 4-digit hexadecimal notation)	Measures / Page for Reference
Servo OFF	Servo ON			
0	0.	Normal status	No detail display	
1	1.	Speed over	No detail display	See pages 31 to 33
2		RAM error	Indiscriminate	Reparation required
3		Encoder error	0000 : Open circuit (SIG Ø, SIG 1 stop) 0001 : Open circuit (SIG 1 stop) 0002 : Open circuit (SIG Ø stop) 0006 : Abnormal frequency (Smoother error) 0007 : Abnormal frequency (Incorrect interruption, detected) 0009 : Abnormal frequency (Divided error)	See pages 31 to 33
6		Over count shut down	Indiscriminate	See pages 31 to 33
	6.	Counter overflow	No detail display	See pages 31 to 33
7		ROM error	ROM checksum code 4 digits	Reparation required
8		Abnormal main power supply	No detail display	See pages 31 to 33
8.		Reset status of driver Power supply error	No detail display	Release reset Reparation required
9		CPU error	0000 : Watch dog timer (WDT) error	Reparation required
R		Amplifier error	0001 : Over voltage (OVV) signal ON 0003 : Over current (FAULT) signal ON	See pages 31 to 33
C	C.	Overload error	No detail display	See pages 31 to 33

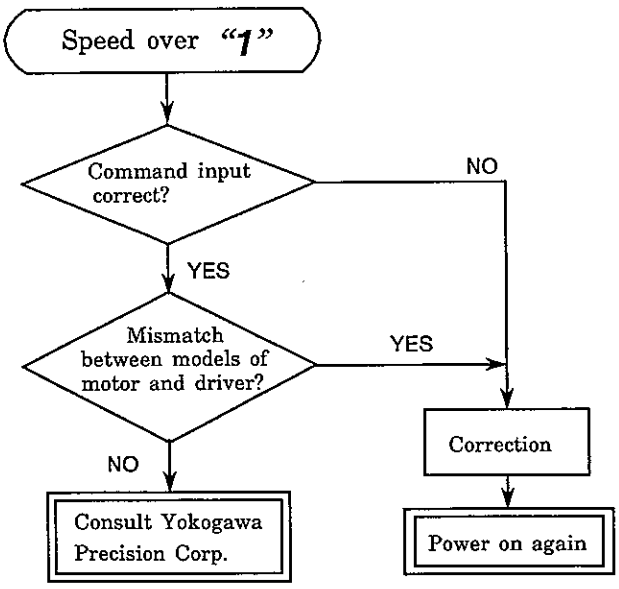
Note : Consult Yokogawa Precision Corp. or it's authorized agency when reparation is required.

7.3 Procedure for Error Correction

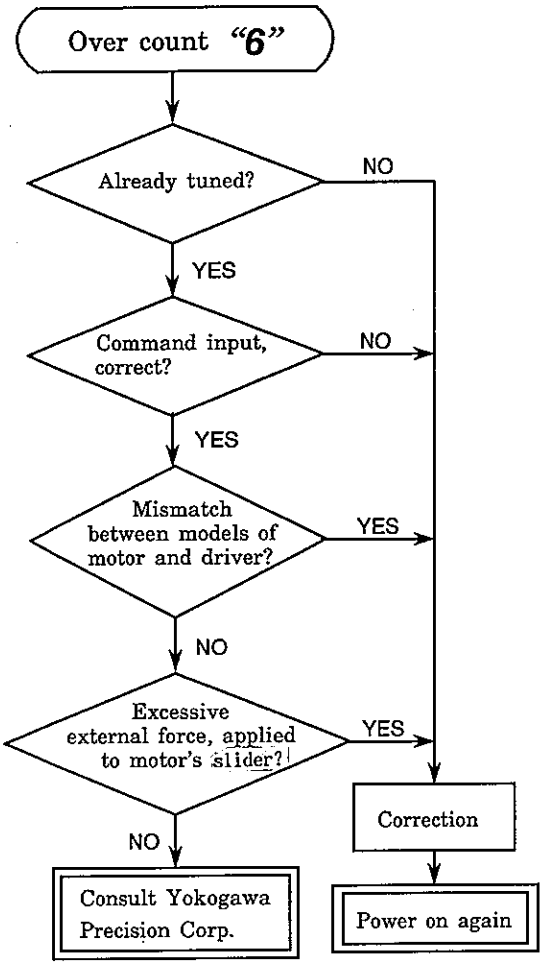
(1) Encoder Error



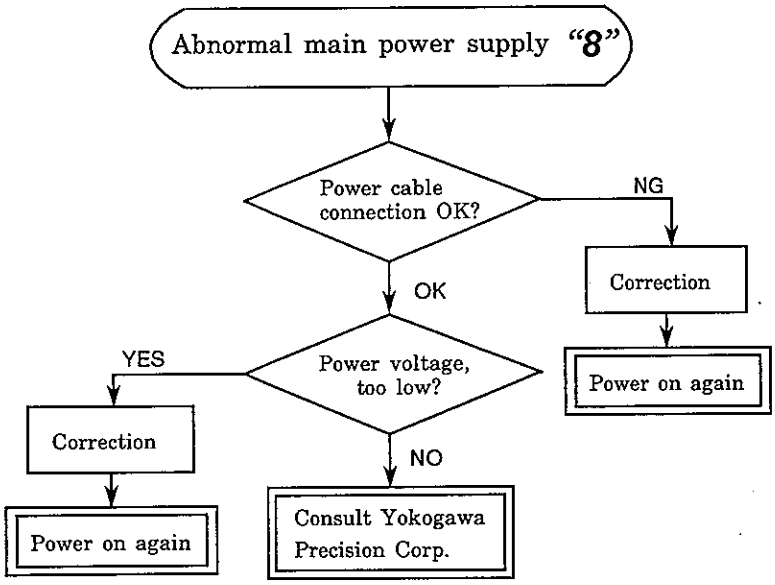
(2) Over Speed



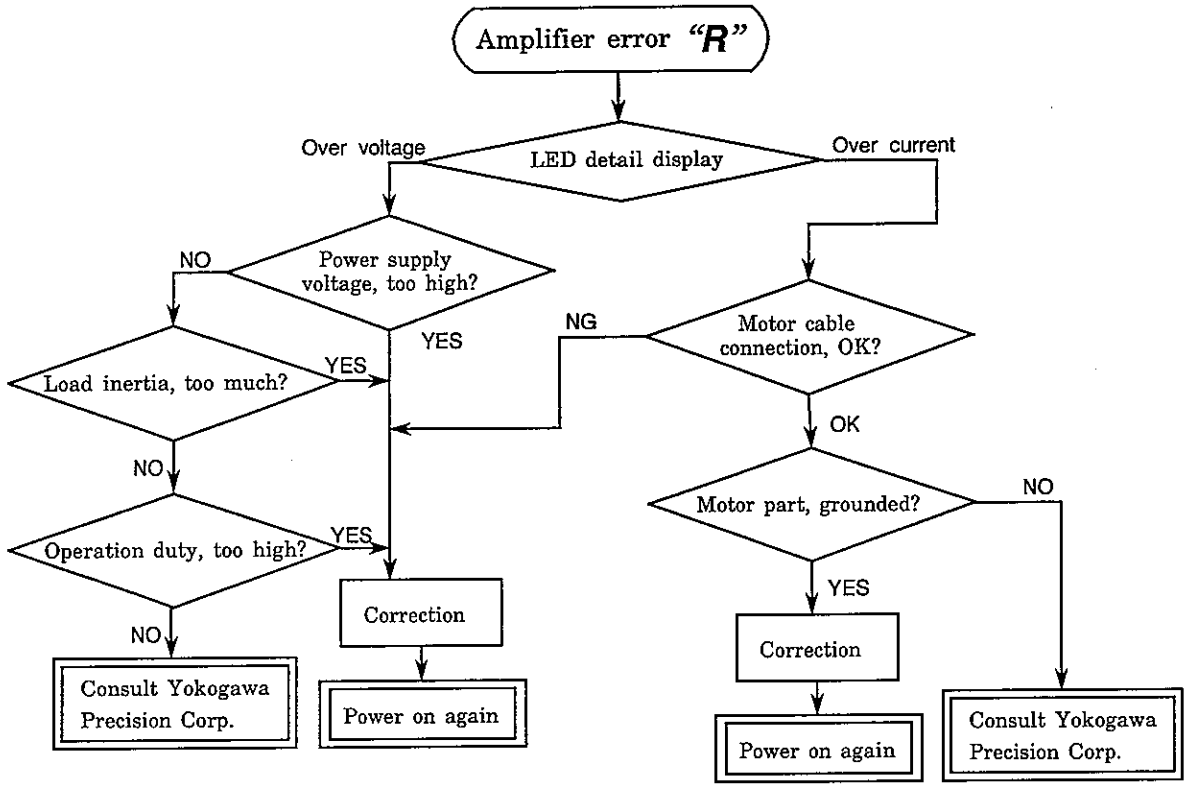
(3) Over Count



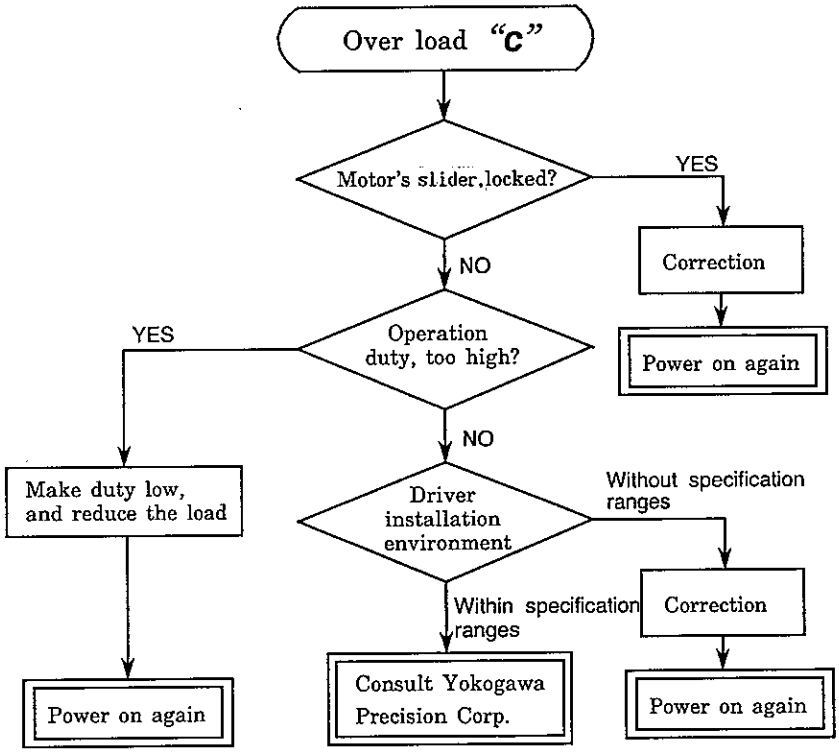
(4) Abnormal Main Power Supply



(5) Amplifier Error



(6) Over Load



8. OTHERS

8.1 Standard Specification

(1) Motor section

Model		LR106		LR115		LR130	
		Without Clamp	With Clamp	Without Clamp	With Clamp	Without Clamp	With Clamp
Max. force (N)		60		150		300	
Max. speed (m/s)		0.83		1.67		1.67	
Encoder resolution (μm/p)		0.5		1.0		1.0	
Tooth pitch (mm)		2.048		4.096		4.096	
Repeatability (μm)		±0.5		±1.0		±1.0	
Position accuracy (μm)		50Ls/1000±10		50Ls/1000±20		50Ls/1000±20	
Max. load (kg/N)		40/400		100/1000		180/1800	
※ Overhung load (N·m)	M_A	50		200		200	
	M_B	50		200		200	
	M_C	50		200		200	
Slider weight (kg)		2.0	2.5	5.0	6.3	9.0	12.0
Rail weight (kg/m)		8.0		14.5		21.6	
Oregin signal (Pulse/mm)		1/2.048		1/4.096		1/4.096	
Clamp force (N)			49		123		196
Rail length(L) /Max. stroke length (L_s) (mm)		480/320 660/500 840/680 1020/860	480/280 660/460 840/640 1020/820	480/260 660/440 840/620 1020/800 1560/1340 2040/1820	480/210 660/390 840/570 1020/750 1560/1290 2040/1770	660/390 840/570 1020/750 1560/1290 2040/1770	660/310 840/490 1020/670 1560/1210 2040/1690

※ For customized requirements exceedind the maximum listed here, kindly contact the manufacturer.

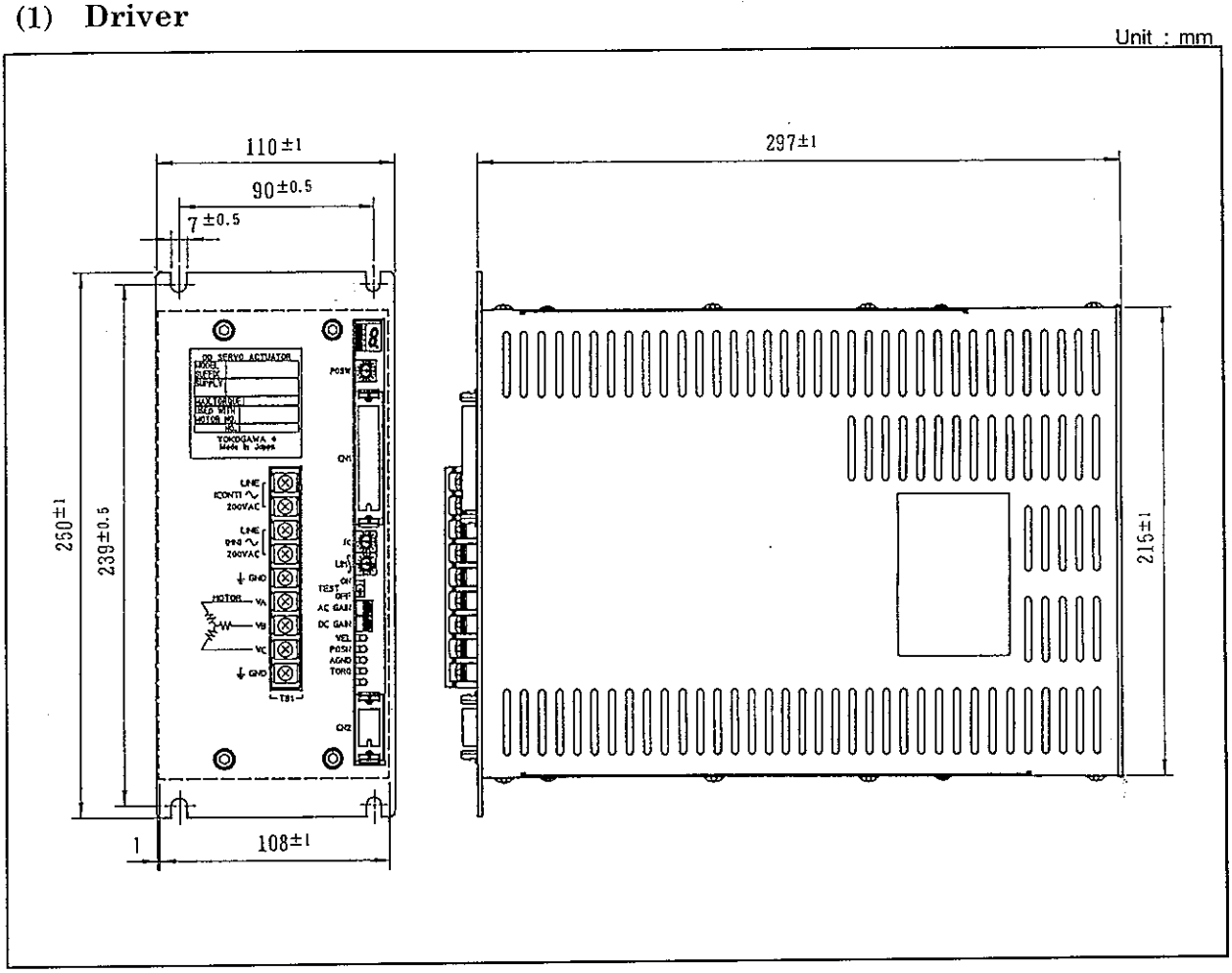
(2) Driver section

Model		TR106	TR115	TR130
Input signal	Speed	Analog voltage : DC±6VMax.		
	Positioning	Serial pulse : 1. 6MHz Max.		
	Torque	Analog voltage : DC 8V Max.		
	Movement direction	HIG : R／LOW : L		
Output signal	Speed	+6V (R) ～−6V (L)		
	Encoder	Track A/B (400KHzMax.), Oregin signal		
	Alarm	Over-current, Over-voltage, Heat sink over temperture, Under-voltage, Encoder abnormal, CPU abnormal		
	Monitor	2.5Hz Step response output (Test mode)		
Power source		100~115VAC/200~230VAC +10%-15% · 50/60Hz		
Weight		6Kg		
During operation temparat.		0～50℃		
During operation humidity		20～90%R. H (No condensing)		

8.2 Dimensional Outline Drawing

(1) Driver

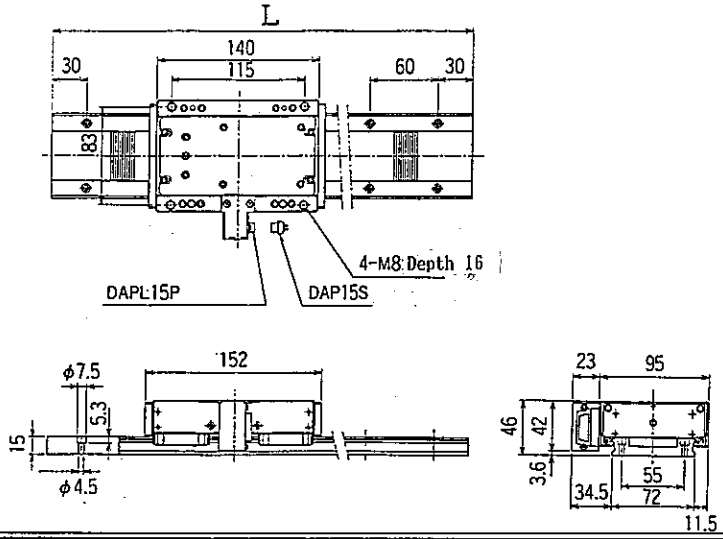
Unit : mm



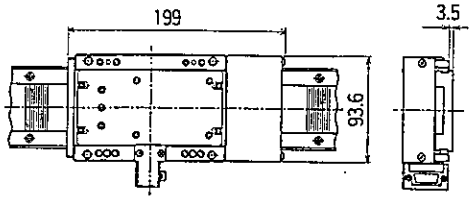
(2) Motor

Unit : mm

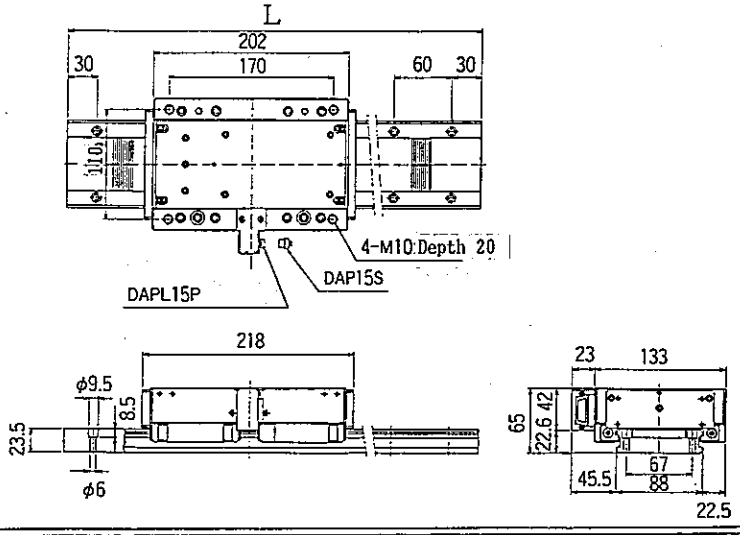
LR106 (St'd)



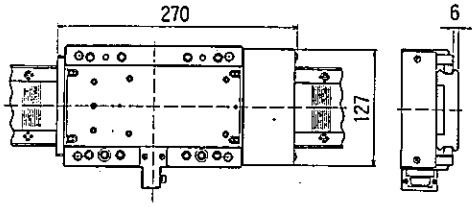
LR106 (With clamp)



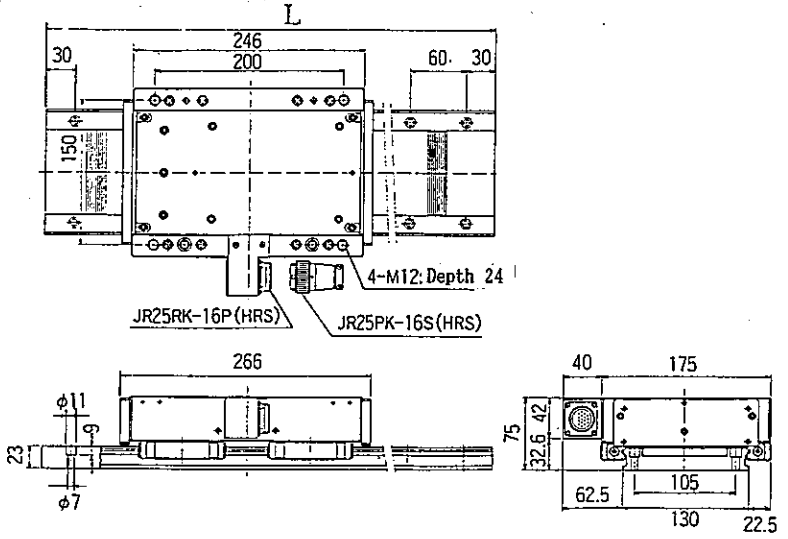
LR115 (St'd)



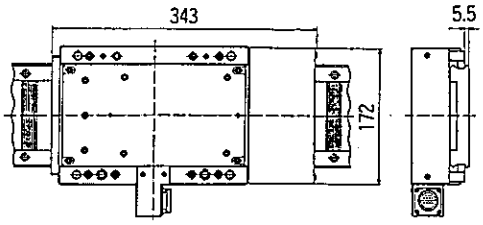
LR115 (With clamp)



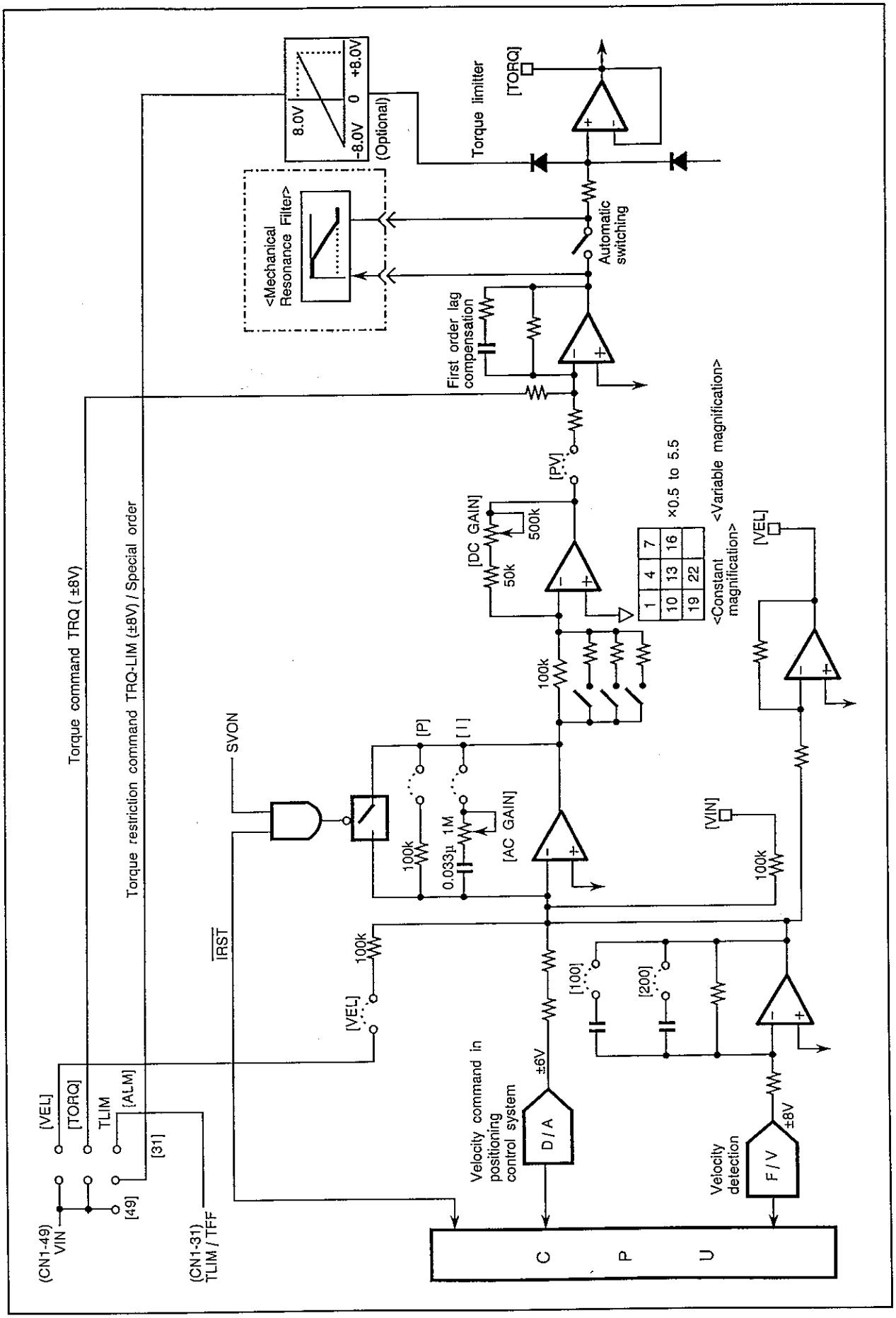
LR130 (St'd)



LR130 (With clamp)



8.3 Driver Block Diagram



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