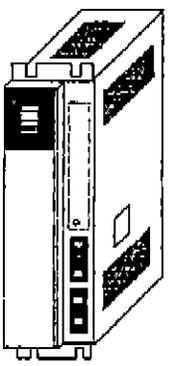
OMRON

TYPE R88D-E SERIES

TYPE R88D-EA06/EA12
TYPE R88D-EB13/EB15/EB16

DC SERVO DRIVER
(ANALOGUE INPUT TYPE)

INSTRUCTION MANUAL



1. GENERAL

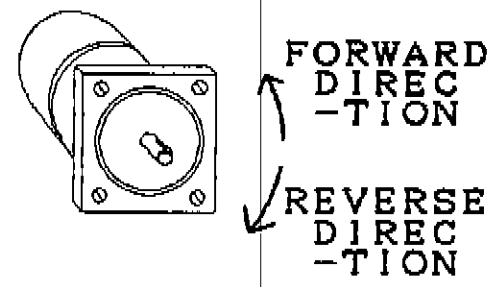
1.1 How to use this manual

This manual is compiled for users of the Servo Driver R88D-E Series to control a DC servo motor.
This manual consists of five chapters. Each chapter is independent so that you may refer to chapters in order of your preference.

Operators of machine using this equipment should read Chapter 2 "Adjustemnt and Operation", and Chapter 1.
Workers who install this equipment to control boxes or machines should read Chapter 3 "Initial setting" and and Chapter 1.
Designers who make plan or to make drawing should read Chapter 4, "Design" and Chapter 1.

1.2 Definition

(1) Motor rotation direction.
In this manual, rotation direction of a motor axis is defined as follows:
Forward rotation means anti-clock-wise direction when the motor is viewed from it's flange side.



Reverse rotation means clock-wise direction when the motor is viewed from the flange side.

(2) Nomination of types.
In this manual, □ is sometimes indicated at nomoination of types. For example, R88M-E□□□□□-5C, or so. This indication means that the description is applicable for any types with any number.

1.3 Features of this series.

A servo driver is a driving controller that rotates DC servo motor with command signals based on data from a programmable controller. It generates and supplies DC power source to a servo motor from commercial AC source, and perform highly accurate and wide ranging positioning.

In this DC servo driver E series, two analogue input types are available. One is R88D-EA Series, incorporating a power unit, for 50W to 200W motors. The other is R88B-EB Series, with a power unit separated, for 300W to 500W motors.

For the combination of these series and motors, see the following table:

Combination Table

Item	Types of Driver	R88D -EA06	R88D -EA12	R88D -EB13	R88D -EB15	R88D -EB16
Applicable Motor	Output Power(W)	50~80	120~200	300	400	500
	Rated Voltage(V)	75			85	90
Power Unit		Built-in power unit type		R88S-S serise		

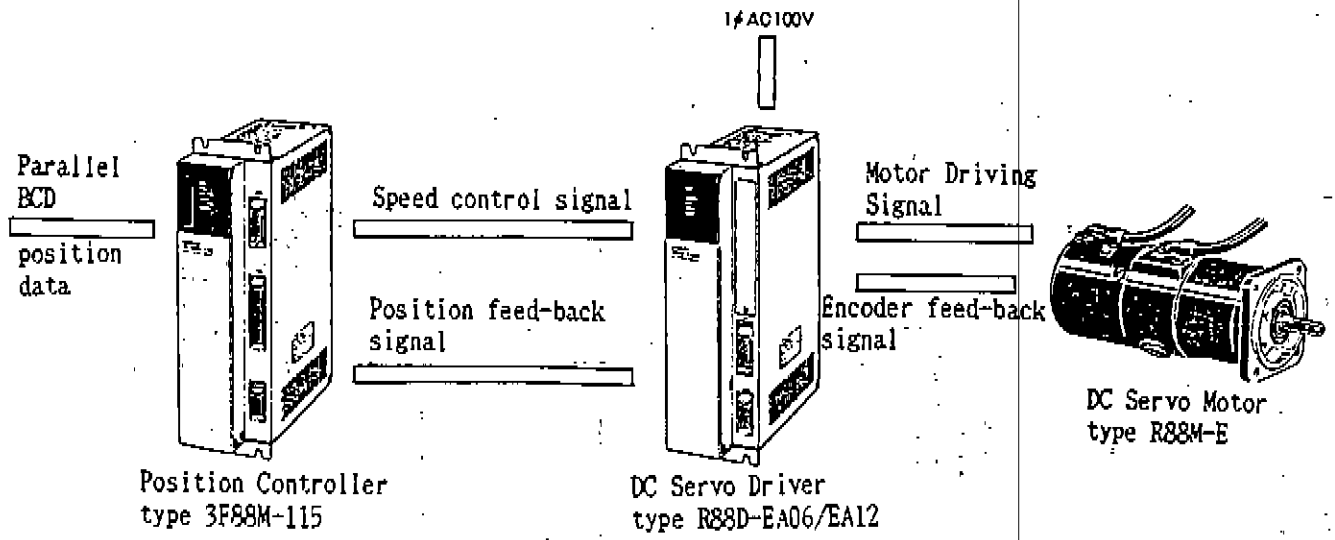
Servo motors (R88M-E series) controlled with this driver has the following features:

- Compact and light weight.
- Speed control range is 1000:1 (Control motor rotation from 100% to 0.1% of rated speed with required power.)
- Magnetic encoder is used as detector for positioning and speed control.
- Excellent durability against shock and ambient conditions.

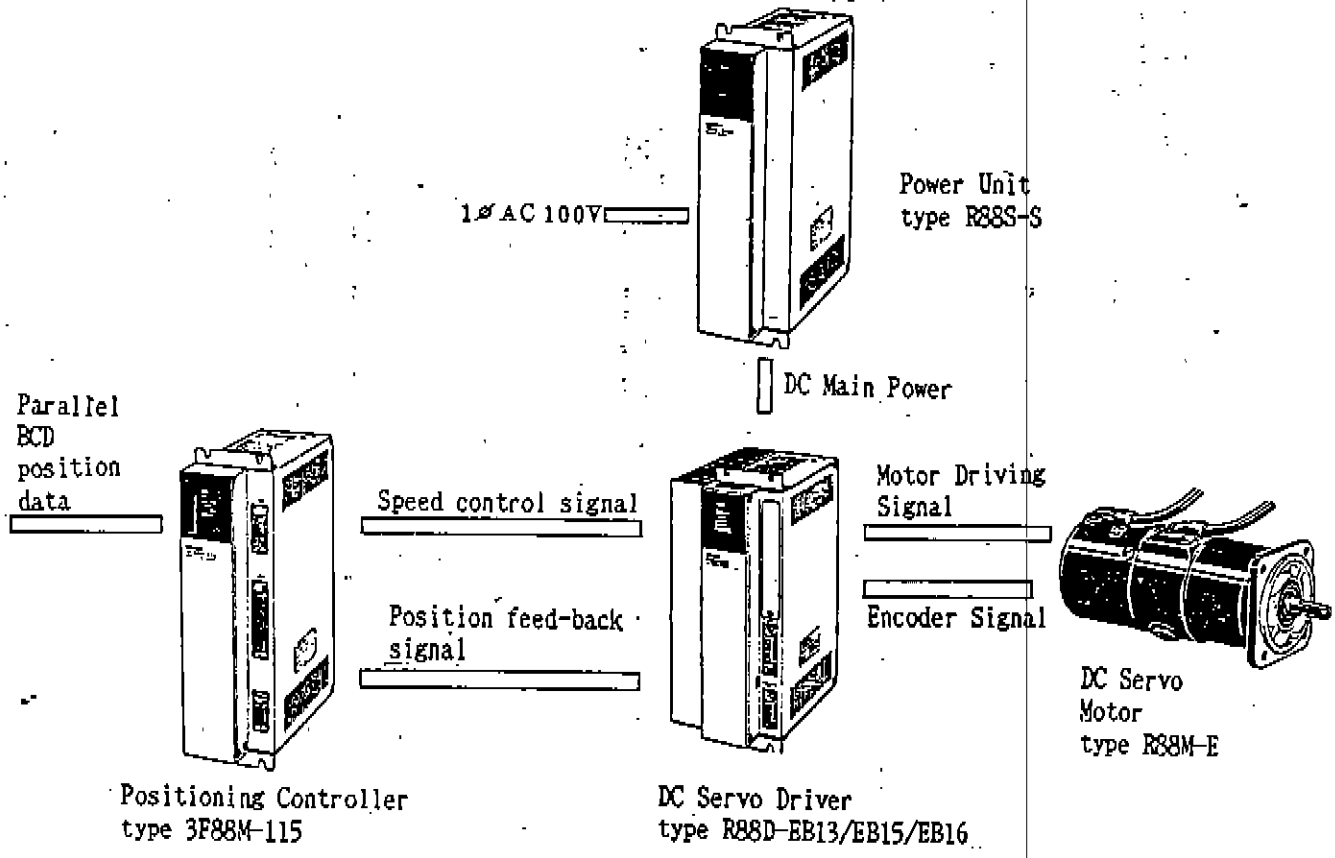
1.4 Servo motor control system.

A system using this equipment consists of:

☐ Type R88D-EA06/EA12(Built-in power unit type)



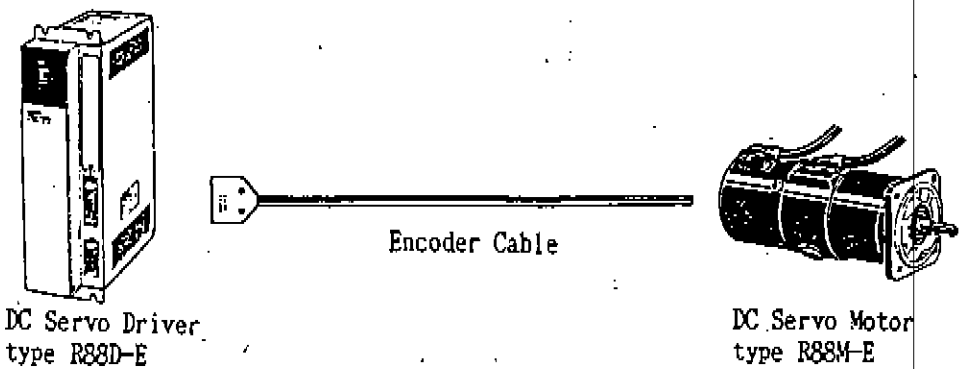
☐ R88D-EB13/EB15/EB16(power unit separated type)



(1) DC servo driver, type R88D-E
This is a circuit unit that controls the speed of a DC servo motor. Types of servo driver should be selected according to the voltage and current of each DC servo motor.

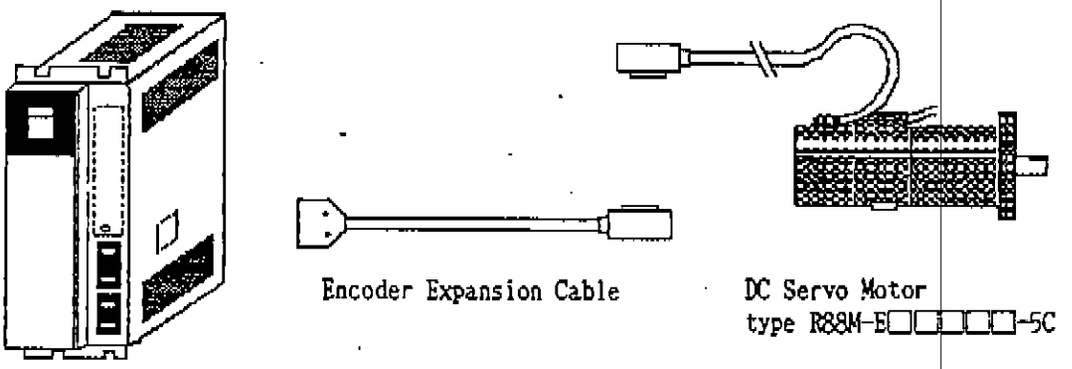
(2) DC Servo Motor, type R88M-E
This motor series includes seven types: 50W, 80W, 120W, 200W, 300W, 400W and 500W. Types of motor should be selected in accordance with load conditons.

(3) Exclusive cable between servo driver and servo motor.
· Encoder Cable (type R88A-CRE☐☐☐S)



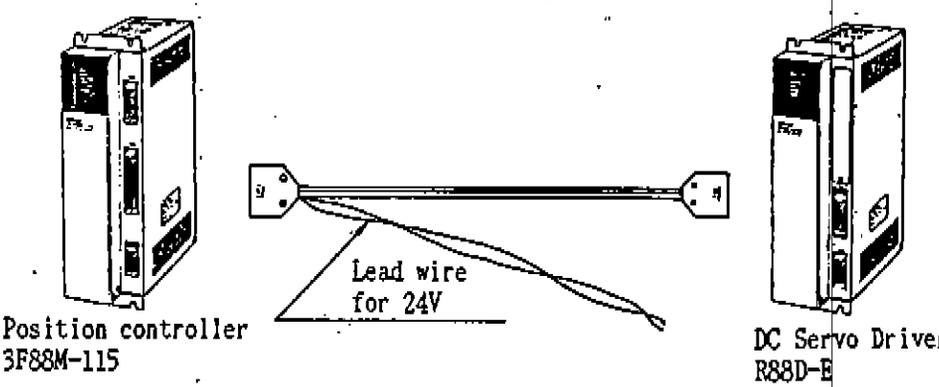
This cable should be used to connect a Connector CN2 of the E seris DC servo driver with an encoder of the DC servo motor.

· Encoder Expansion Cable (type R88A-CRE□□□C)



This cable is used to connect a Connector CN2 of E series DC Servo Driver with a connector of an encoder cable installed in the DC servo motor type R88M-E□□□□□-5C.

· Cable to connect position controller 3F88M-115 (R88A-CPS□□□N)



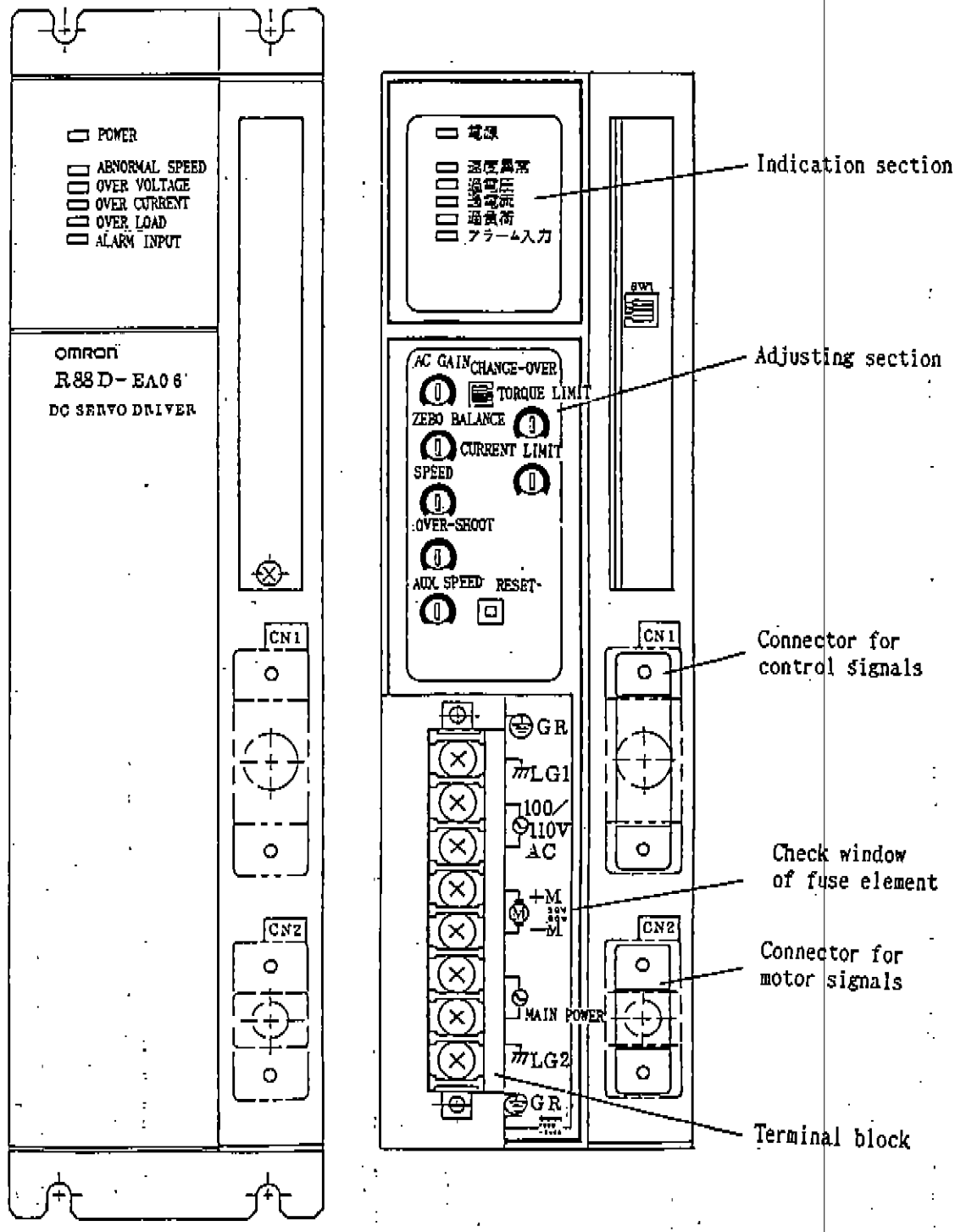
This is the cable to connect the connector CN1 of the DC servo driver with a position controller type 3F88M-115.

2. ADJUSTMENT AND OPERATION

2.1 Explanation of adjustment section

2.2.1 Front panel

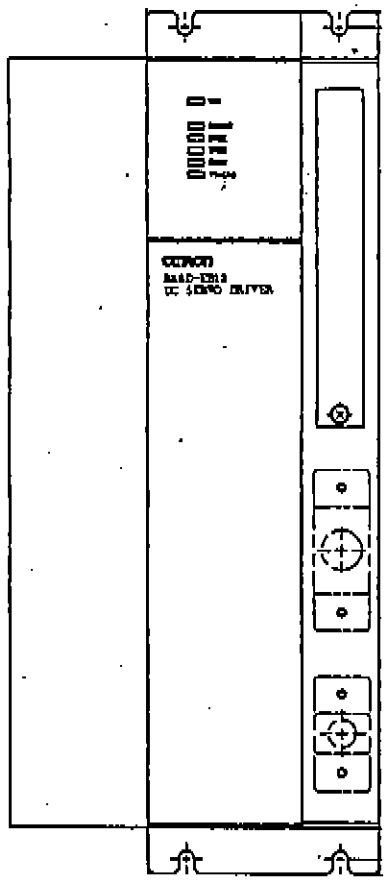
☐ Type R88D-EA06/EA12(built-in power unit type)



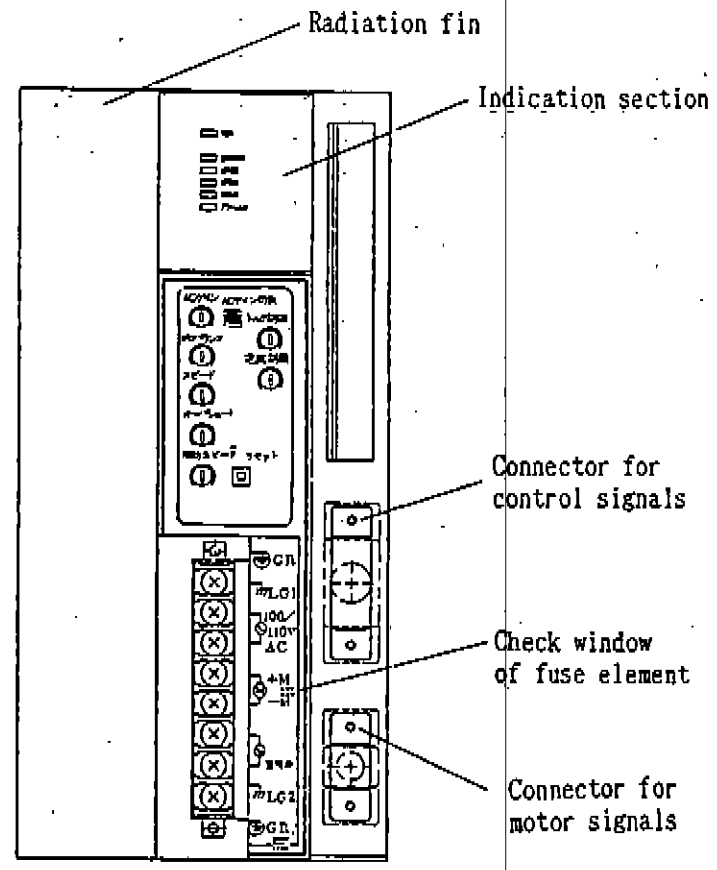
Front view with protection cover

Front view without protection cover

☐ Type R88D-EB13/EB15/EB16 (Power unit separated type)



Front view with protection cover



Front view without protection cover

2.1 Display and adjustment sections

☐ Display section

Display	Function	Conditions for illumination
Power	Indicates input of control power source	Supplied control power source (AC100V)
Abnormal speed	Indicates over-speed	Rotation speed is more than the limit. Motor axis is mechanically locked.
Over voltage	Indicates over voltage	DC voltage of main circuit is abnormally increased.
Over current	Indicates over current	Supply current to motor exceeds over 200% of "Peak current".
Over load	Indicates over load	Load to motor is too large. Radiation fin is overheated.
Alarm input	Indicates input from outer alarm	ALMI input signal opens.

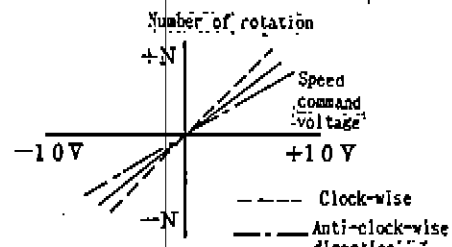
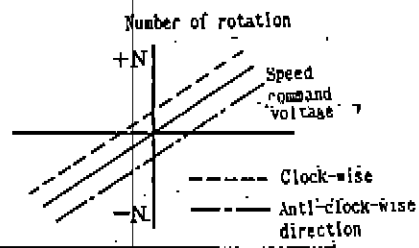
☐ Adjusting section

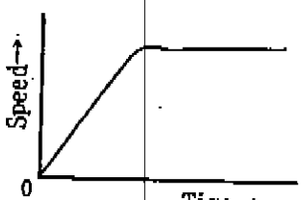
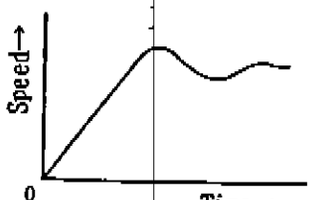
Volume	Function	Preset value at factory
Speed	Adjusts speed command input (REF) with this volume.	3000 rpm at ±10V
Auxiliary speed	Adjusts aux. speed command input (S.REF) with this volume.	3000 rpm at ±10V
Over-shoot	Adjusts overshoot and undershoot at start/stop of the motor rotation	Optimum
Torque limit	Adjusts current limit value. Adjustable between 0 and 240%.	150% of rated torque
AG gain	Adjusts response of speed loop gain.	Gain low (scale 1)
Change-over AC gain	For the support to delay response, switch No. 1 & 2., are useful . For large load conditions, switch No. 3 & 4 are useful.	Fixed to optimum with 3 time of the load inertier
Current limit	Adjusts maximum current rate to motor. Adjustable between 0 and 300%	3 time of motor rated current
Zero balance	Stops drift of the motor axis when the command input is 0V.	0 rpm
Reset	Release protection function condition. Same function of RESET input signal.	

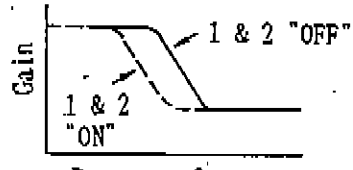
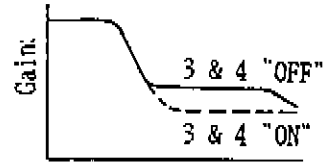
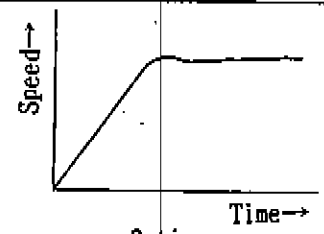
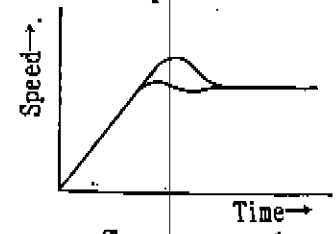
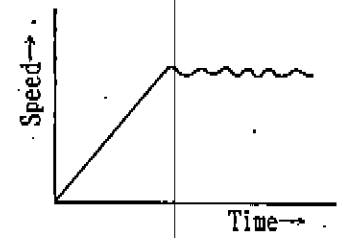
2.2 Adjustment of each volume

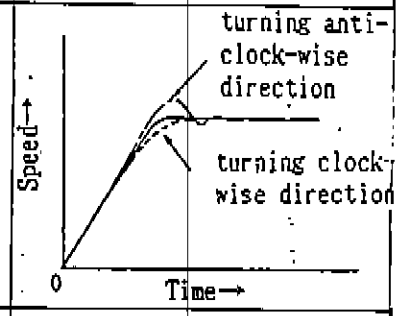
Each drivers is factory-adjusted together with E series motors. However, if it is required to re-adjust drivers because of the load conditions and the change of motor types, see the following table:

<Caution> If unable to obtain an optimum operation conditon through the adjustment measures below, recheck the initial settings of switches and/or wiring and combination equipment types.

Name of volume	Functions	The result with the adjustment
Speed and Aux. speed	Speed adjustment Adjusts to get the rated rotation speed with speed command voltage ±10V. Increase speed with turning this volume to clock-wise direction.	
Zero balance	Zero adjustment Adjusts to stop motor rotation at 0V speed command voltage.	

Name of volume	Functions	The changes with the adjustment
AC Gain Change-over of AC gain	Adjustment of AC gain At our factory, first, AC gain is adjusted to obtain an optimum condition throught three time of load inertier. But , after them, it is minimized. Therefore, each user may adjust AC gain with each load condition. Mis-adjustment will cause the following conditions: (1) With excessive gain, vibration or abnormal noise may occure. (2) With too little gain, the servo lock power may lessen and the positioning accuracy is recuded. 1. AC gain volume Inspect wave shape with oscilloscope through a speed monitor terminal of NM(pin No. 18 of CN1) and a ground AG(pin No. 5 of CN1). Turn the voluem, and conditions will appeare at the right side.	 Optimun  Turn to Notch 0 (Fluctuation)  Turn to Notch 10 (Vibration)

Name of volume	Functions	The changes with the adjustment
AC Gain Change-over of AC gain	2. AC gain change-over With put on/off No. 1 & 2, fluctuation is adjusted. With change-over of No. 3 & 4, the vibration is adjusted. Ex: With change No. 1 & 2 from "on" to "off", the fluctuation will occure. This is because of the expansion of the gain to the higher zone.  Next, with change No. 3 & 4 switchs from "on" to "off" position, the vibration will occure. This is becase of the increase of the higher zone gain.  In the above instructions, two switches are changed at once. With change-over of only one switch, the result may be smaller.	 Optimun  Change-over of No. 1 & 2 switches  Change-over of No. 3 & 4 switches

Name of volume	Functions	The changes with the adjustment
Overshoot	The adjustment of overshoot This volume is for the adjustment to mininize overshoot and under-shoot at acceleration and at dece-leration of a motor rotation. Carry out this adjustment after the optimum setting of AC gain.	
Current limit.	Current limit value adjustment. Adjust maximum current value with this volume.	Fixed to full value of 300%. With turning volume toward anti-clock-wise direction, the current limit value decreases.
Torque control	The max. current value for motor is altered among "current control" and "torque control" with CLIM signal. With CLIM signal input, torque control is useful as current limitation.	This value is fixed to 150%. Turning the volume to anti-clock-wise direction, the current limit value decreases.

2.3 Protection and self-checking function

The Light Emitting Diodes (LED) on the driver front panel indicate operational and abnormal conditions of the inside of the servo driver.

□ Red color LED

Name of indication	Condition and function
Power source	Indicates when the power source of the gate drive functions at main power circuit. Motors do not rotate when this indication is not illuminating.
Abnormal speed	Indicates when: (1) Tacho-generator or F/V speed feedback is out of order. (2) A speed condition exceeds more than ±10V speed command. (3) The encoder is out of order.
Over current	Indicates when current more than "peak current value" is supplied, or shorts output terminals.
Over voltage	Indicates when the main power DC voltage increases abnormally with the re-generationg functions.
Over load	Indicates when: (1) Current value exceeds the rated output current and this condition continues more than 5 sec. (Limited time characte-ristic) (2) The radiation fin temperature is more than 85℃.
Alarm input	Indicates when outer abnormal signal or alarm stop signal is "ON".

In order to protect the servo driver and the servo motor, the following protection circuits are equipped inside of the driver. When these circuits function, the operation stops at inside of the servo driver and output servo abnormal signals.
<Caution> In this case, the motor axis comes in a free condition. When a mechanical lock is required for this condition, direct mechanical brake should be assembled outside of motor.

Protection function	LED indication	Motion	causes
Main circuit fuse element	none	When over current is supplied to DC main circuit, the fuse blow and this circuit shuts off.	·broken FET ·short between driver-motor ·broken condensor
Detect over current	Over current LED	When over current is supplied to the DC main circuit, the FET gate shuts off with a detector.	·short between driver-motor ·broken FET ·broken condensor
Protection against over voltage	Over voltage LED	When main circuit power voltage is over the rated value with re-generation function, the FET gate shuts off.	·load inertier too large ·supplied AC power is more than 100V
Protection against over load	Over load LED	When over load condition at motor continues more than rated interval, FET gate shuts off.	·load torque too large ·motor axis is locked mechanically
Radiation fin temp. rise	Over load LED	When the temp. of the radiation fin for the FET rises more than the rated temp., the FET gate shuts off.	·load torque too large ·motor axis is locked mechanically
Detect signal dis-connectin	speed abnormal LED	With disconnection of the encoder or the tacho generator signal wire, FET gate shuts off.	·encoder or TG signal disconnected

Protection function	LED indication	Motion	causes
Abnormal power source	Put off power source indication LED	When the power voltage is less than the rated value, FET gate shuts off.	·voltage drop of supply power source ·short of source capacity
Over speed	abnormal speed LED	When the motor speed is more than the rated value, the FET gate shuts off.	·Motor is rotated with over speed
Instan-taneous power failure	put off power source indication LED	When the power source does not feed more than 40msec., the FET gate shuts off and reset after 800 msec.	·AC supply power source failure at once.
Control fuse	put off power source indication LED	Fuse blows with high voltage to the control circuit side.	·shorted or broken control circuit.

2.4 Caution at alarm output signal.

1. Make circuit that an alarm out put signal applies as relay actuator when it comes from the circuit (when LED indicates).- This signal opens at abnormal conditions and closes at normal conditions.
   Also, make sure that the circuit output an alarm signal when the control source is not applied.
   About 800msec. later of the control source applied, above relay contactor will close.

2. With an abnormal alarm function, a driving signal to the motor opens and an electrical brake of the motor (re-generating brake) is released at once, due control circuit itself will stop operation. Therefore, when braking is required for the motor axis at this alarm conditions, a mechanical brake unit should be equipped so that it makes sequence to work this mechanical brake at alarm condition.

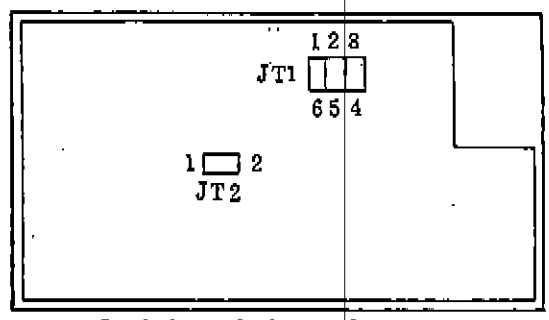
3. Abnormal alarm conditon is released with reset signal input at reset button or resupply of the power source. If RUN signal is input at re set condition, the motor may run at this time. Therefore, check this signal before reset.

4. With abnormal alarm output, put off main circuit power source (AC100V) and operation signal.
   Control source may stay in this condition, and detect causes of abnormal alarm. After removing these causes, restart the operation.

3. INITIAL SETTING

3.1 Setting of short pins

In order to adjust output current of the driver in accordance with the type of motor, set short pins as below.
The location of short pis is illustrated here.



Position of short pins at the driver circuit board

☐ R88D-EA06/EA12
(Built-in power unit type)

·Setting of JT1

Output current of the driver alters with the setting of short pins as the Chart 1. In case of the setting with our DC servo motor type R88M-E Series, set pins with the Chart 2.

CHART 1

JT1	DC servo driver	
Pin Nbr	R88D-EA06	R88D-EA12
1-6	6A	12A
2-5	5A	10A
3-4	4A	4A

CHART 2

JT1	DC servo driver	
Pin Nbr	R88D-EA06	R88D-EA12
1-6	———————	R88M-E20030
2-5	R88M-E08030	————
3-4	R88M-E05030	R88M-E12030

·Setting of JT2

Short JT2 in case of the tacho-generator is used as speed feedback.

☐ R88D-EB13/EB15/EB16(Power unit separated type)

·Setting of JT1(factory-adjusted)

JT1 is already factory-adjusted, and output current of driver is as the Chart 3.

CHART 3

Pin nbr of JT1	DC servo driver		
	R88D-EB13	R88D-EB15	R88D-EB16
1-6	———	———	16(A)
2-5	———	15(A)	———
3-4	12.5A		———

3.2 Setting of each switches

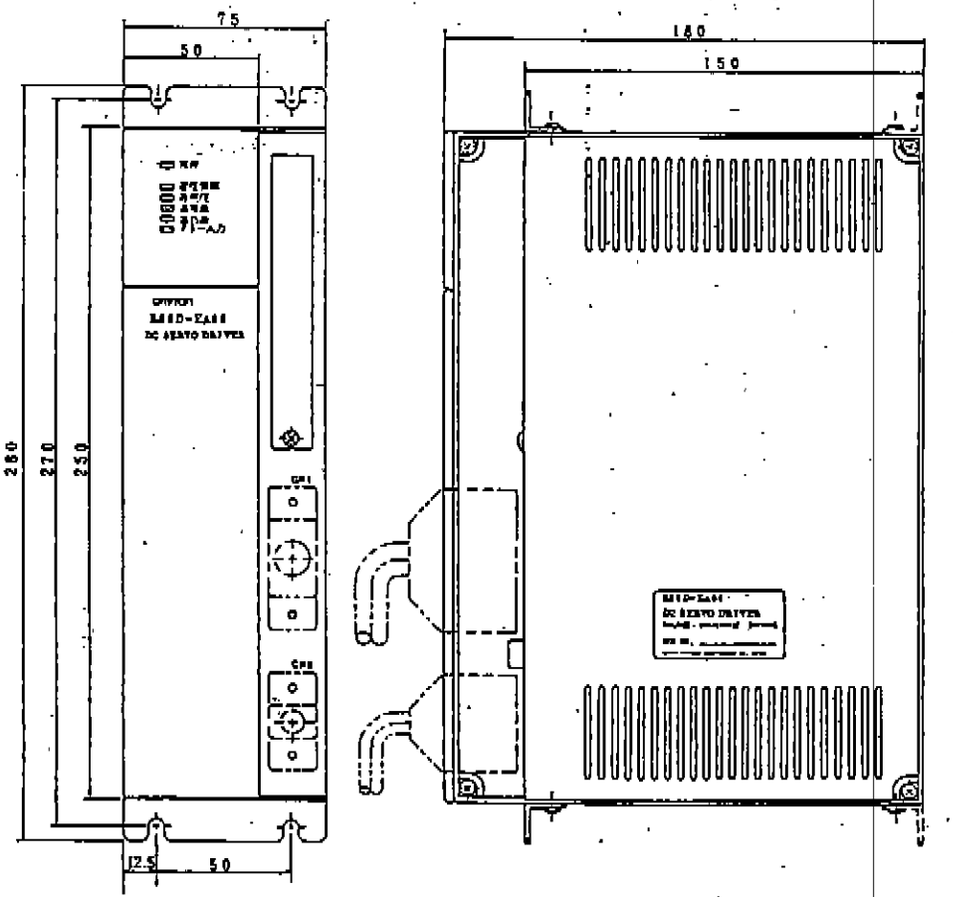
<table>
<tr><th colspan="2">Switch number</th><th>Function</th><th>Preset value at factory</th></tr>
<tr><td>SW1</td><td>No. 1
ƒ
No. 2</td><td>·Change-over of encoder pulse number
Fix this switch in accordance with the number of built-in encoder of the servo motor. Set the F/V voltage with this switch.
<table>
<tr><th>No. 1</th><th>No. 2</th><th>Number of encoder encoder pulse</th></tr>
<tr><td>OFF</td><td>OFF</td><td>2000 P/R</td></tr>
<tr><td>ON</td><td>OFF</td><td>1000 P/R</td></tr>
<tr><td>OFF</td><td>ON</td><td>500 P/R</td></tr>
</table></td><td>No. 1 "ON"
No. 2 "OFF"
(Number of encoder pulse = 1000 P/R)</td></tr>
<tr><td></td><td>No. 3</td><td>·Change-over of the speed feedback signal
In case of a tacho-generator use, set this to "OFF".
·In case of encoder use, set this to "ON".</td><td>"ON"</td></tr>
<tr><td></td><td>No. 4</td><td>·Change-over of speed command input (REF) input voltage.
3000rpm at 5V with "ON"
3000rpm at 10V with "OFF"</td><td>"OFF"
3000 rpm with 10V input voltage</td></tr>
</table>

4. DESIGN

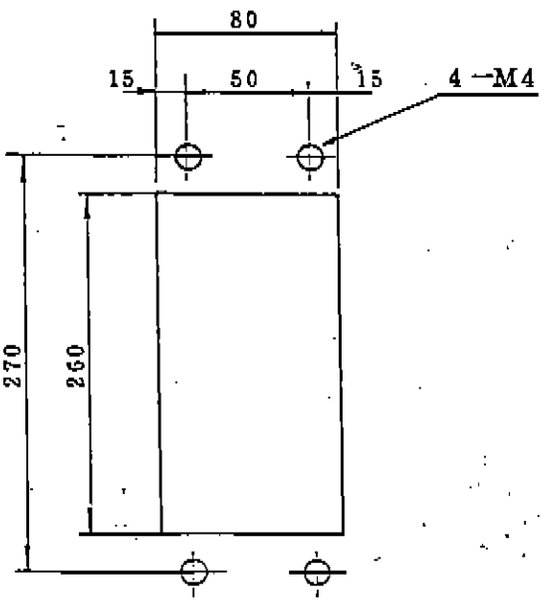
4.1 Design for installations

☐ Type R88D-EA06/EA12(Built-in power unit type)

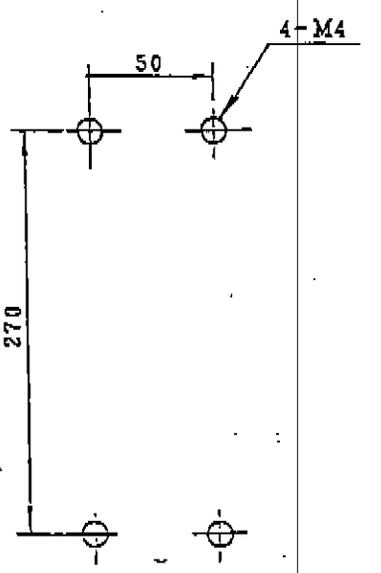
·Outside dimensions



·Installation dimensions



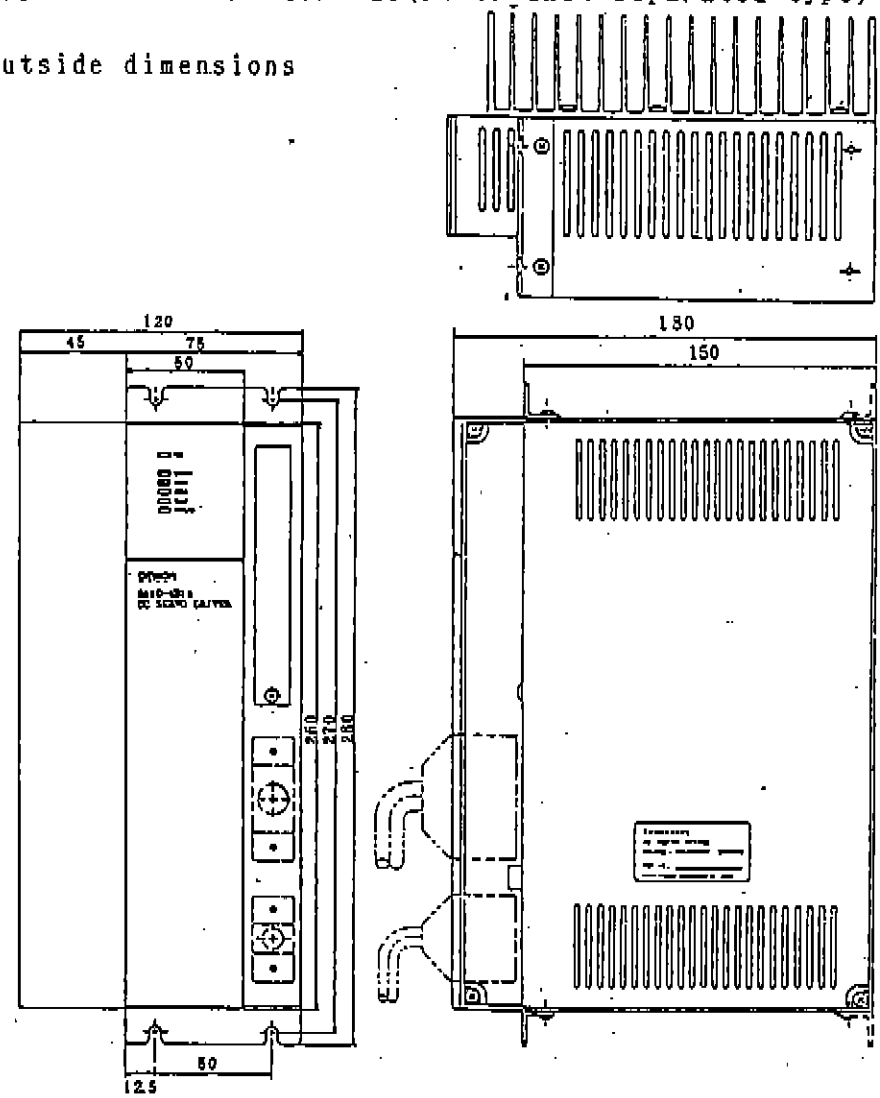
Installation Dimention
for rack mount fixing



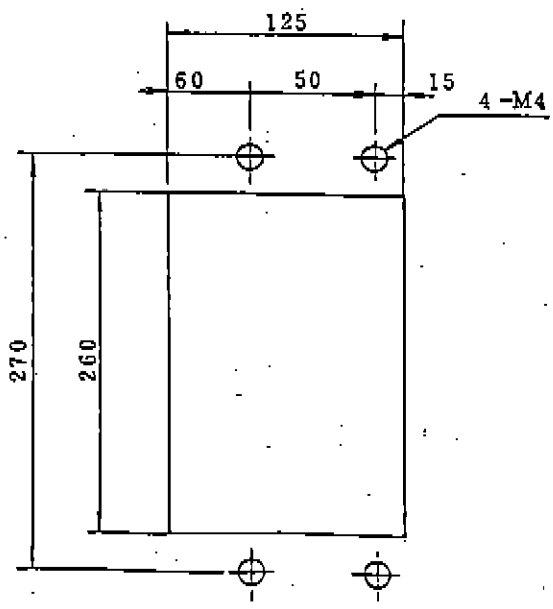
Installation Dimention
for back side fixing

☐ Type R88D-EB13/EB15/EB16(Power unit separated type)

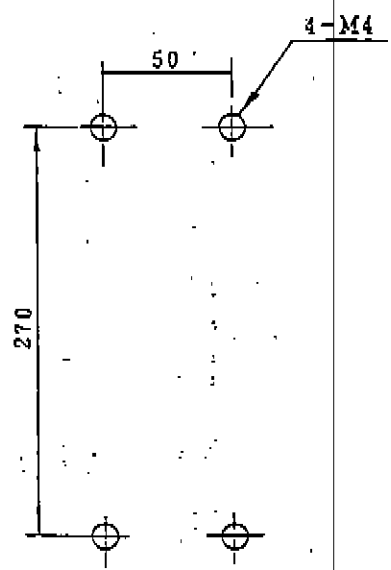
·Outside dimensions



·Installation dimensions



Installation Dimention
for rack mount fixing



Installation Dimention
for back side fixing

4.2 Connector and terminal block

4.2.1 The power source and the terminal block

· R88D-EA06/EA12(Built-in power unit type)

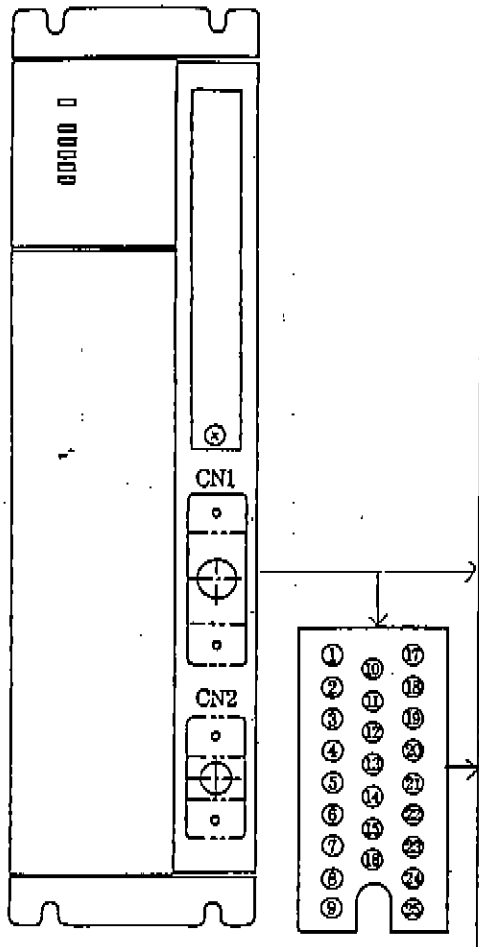
Sign	Name	Contents	
AC AC	Control Power input	Input terminal for control circuit. Supply commercial source between AC85 and 132V	
+M -M	Output for motor	Single phase output terminal for the DC servo motor	+M white -M black
┐ ⊖ ┘	Power source for main circuit	Supply commercial source between AC85 and 132V.	
GR FG)	Frame ground	This terminal is connected to the body. Connect low impedance earth.	
LG	Logic ground	This terminal is connected to AC100V. +M, -M at 4700pF. Short FG and this terminal with a bar.	

· R88D-EB13/EB15/EB16 (Power unit separated type)

Sign	Name	Contents
AC AC	Control Power input	Input terminal for control circuit. Supply commercial source between AC85 and 132V
+M -M	Output for motor	Single phase output terminal for the DC servo motor +M white -M black
P N	DC power input terminal for main circuit	Connect these terminals to P and N terminals of the power unit respectively. P as positive (+), N as negative (-) polarity.
GR FG)	Frame ground	This terminal is connected to the body. Connect low impedance earth.
LG	Logic ground	This terminal is connected to AC100V, +M, -M at 4700pF. Short FG and this terminal with a bar.

4.2.2 Connector terminal for control and motor signal.

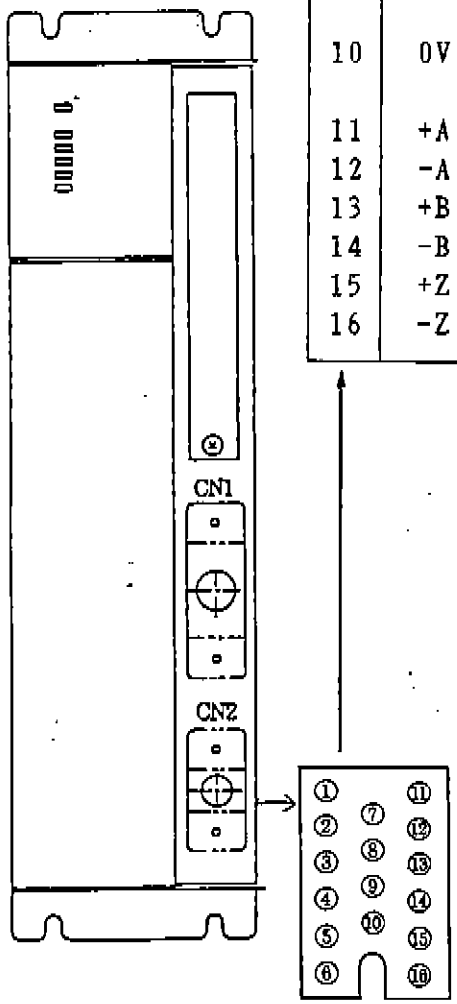
☐ Connector terminal for control CN1
This connector CN1 consists of the speed command, ON/OFF, monitor, and output lines of encoder signal.



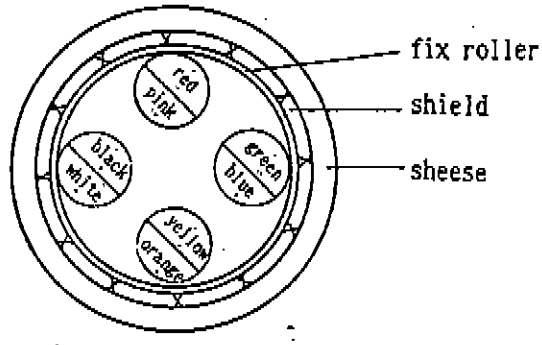
No	Sign	Function
1	REF	Speed command input
2		
3	S.REF	Aux. speed command input
4	AG	Analogue ground
5	AG	Analogue ground
6	GND	Encoder signal ground
7	ALM1	Alarm output (contactor output)
8	ALM2	-ditto-
9	FG	Frame ground
10	AM	Current monitor
11	AG	Analogue ground
12	RUN	Run command input
13	RESET	Reset of alarm condition
14	+A	Encoder A phase + output
15	-B	Encoder B phase - output
16	+Z	Encoder Z phase + output
17	NM	Speed voltage monitor output
18	P15	+15V power output(2KΩ) for speed setting
19	N15	-15V power output(2KΩ) for speed setting
20	+COM	Positive common terminal
21	CLIM	Current limit input
22	MING	Gain minimizing input
23	-A	Encoder A phase - output
24	+B	Encoder B phase + output
25	-Z	Encoder Z phase - output

☐ Connector terminal for motor signal
This is a terminal to input encoder signal from the built-in encoder of the motor.

No	Sign	Function	Color	Wire size
1	-TG	Tacho-generator -input		
2	+TG	Tacho-generator +input		
3	SG	Shield ground		
4	+5V	Encoder supply power +5V	white	AWG24
5	+5V	Encoder supply power +5V		
6	SG	Shield ground	shield	
Remark 1→ 7	ALMI1	Outer abnormal input		
Remark 1→ 8	ALMI2	Outer abnormal input		
9	0V	Encoder GND supply terminal	black	AWG24
10	0V	Encoder GND supply terminal		
11	+A	Encoder +A phase input	red	AWG24
12	-A	Encoder -A phase input	pink	AWG24
13	+B	Encoder +B phase input	green	AWG24
14	-B	Encoder -B phase input	blue	AWG24
15	+Z	Encoder +Z phase input	yellow	AWG24
16	-Z	Encoder -Z phase input	orange	AWG24



MR-16RFA
Honda Tsushin



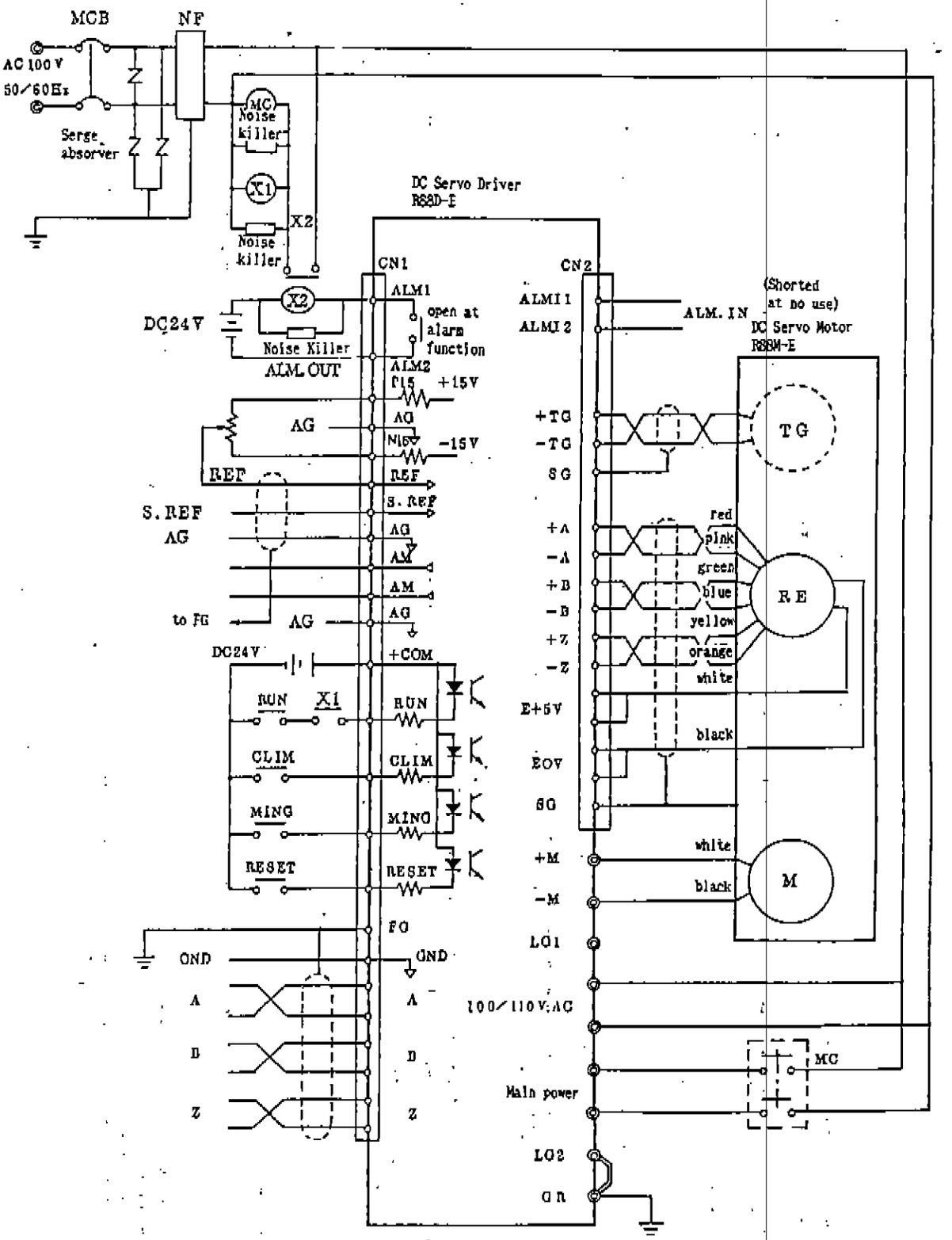
Cross section for
motor signal lead wire

Remark 1: In case outer abnormal input is not used, short ALMI1 and ALMI2 terminals. When an optional cable (type R88A-CRE series) is used, these terminals connected inside of this plug.

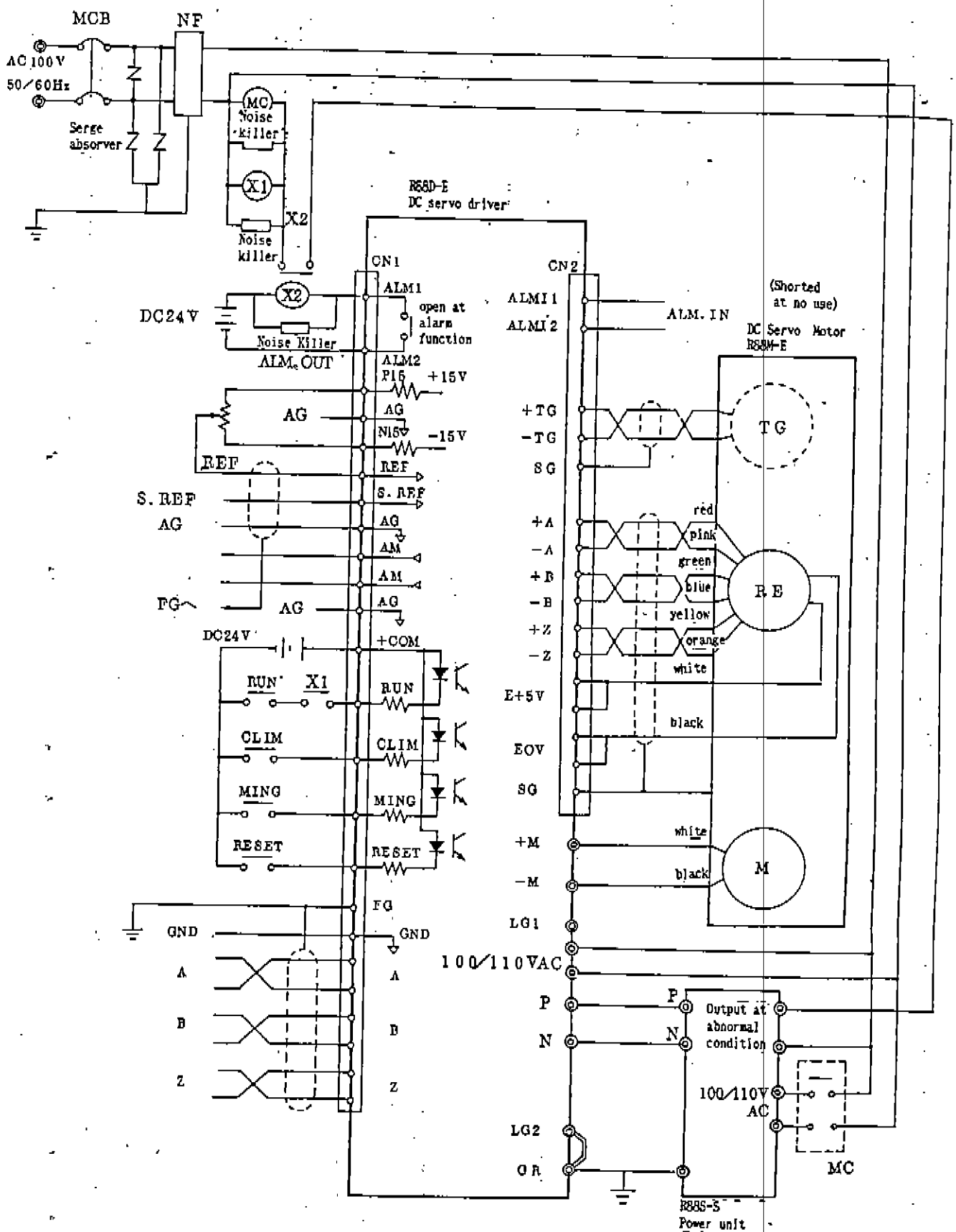
4.3 Connection diagram

4.3.1 Example of connection

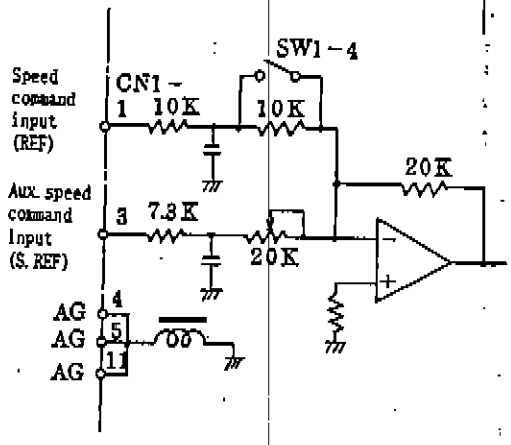
☐ Type R88D-EA06/EA12(Built-in power unit type)

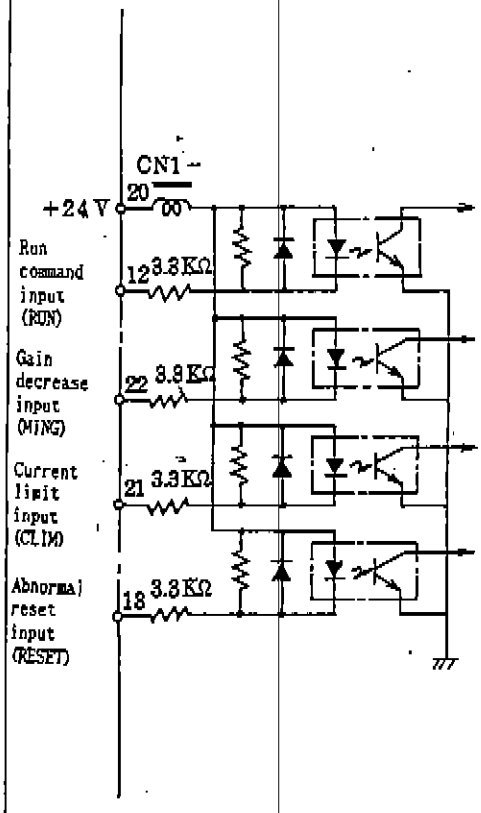


☐ Type R88D-EB13/EB15/EB16 (Power unit separated type)

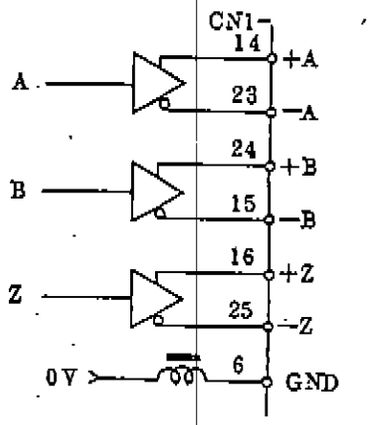
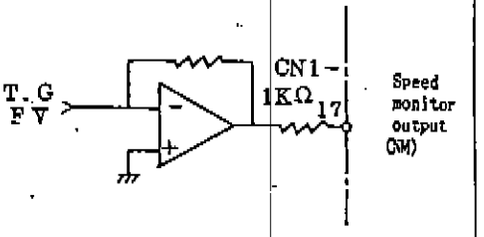
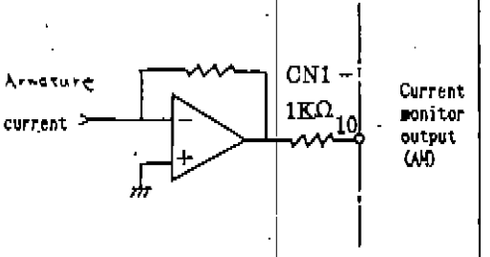


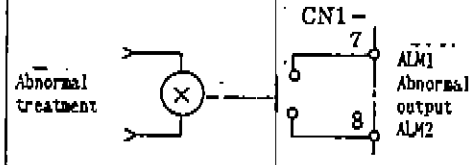
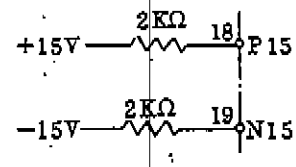
4.3.2 Control input interface

Signal	Function	Specification	Input interface
Speed command input (REF)	Voltage input to control speed of servo driver. Valiation of speed is altered with speed feed-back.	·Input voltage 0～±5V with "ON" of SW1-4 0～±10V with "OFF" of SW1-4	
Aux. speed command input (S.REF) reverse change-over	Auxiliary input to operate syncronous control or feed-forward control. This is used after adjusting add/subtruct value.	·Input voltage 0～±10V	

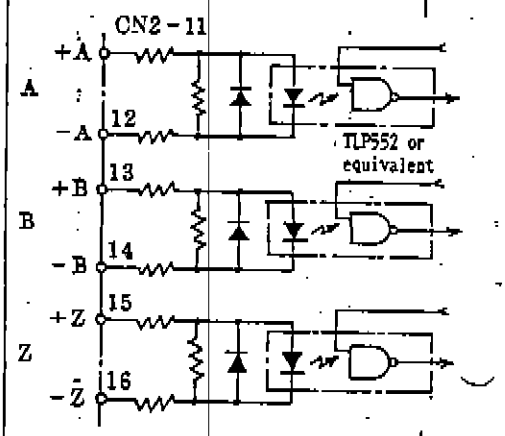
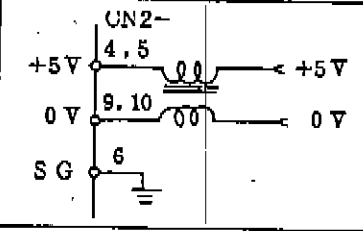
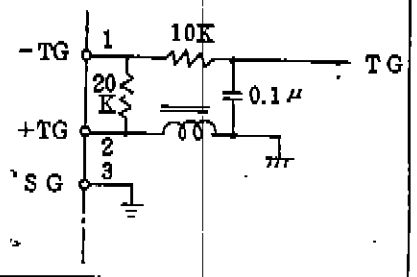
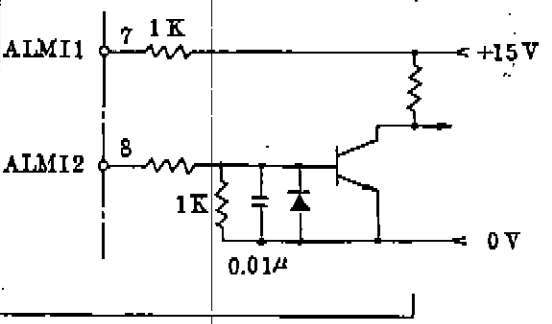
Name of signals	Function	Specification	Input interface
Run command input (RUN)	If this signal is applied, armature current is feeded to the motor.	+24V -7mA	
Gain minimize input (MING)	Stop the motor rotation completely. However, the servo lock power decreases with lack of gain.		
Current limit input	Function current limit with the set value of torque limit value.		
Reset input from abnormal protection condition (RESET)	The protection function reset to normal operation. Same function available with inner reset switch.		

4.3.3 Control output interface

Signals	Function	Specification	Input interface
Encoder feed-back output (A, B, Z)	The encoder signals are converted to line driver signal with a high speed photocoupler. If you need TTL level signal, use one phase of this line driver and GND with required polarity.	Line driver output for AM26LS31 or equivalent. Load inpedance is more than 100Ω	
Speed monitor output (NM)	This is a output to monitor output voltage of tacho-generator or F/V feed-back At forward rota -tion, positive output. At reverse rotation, negative output.	0～±10V	
Current monitor output (AM)	This is a transfered voltage of the supply ampere to the motor. At forward rotation, positive output. At reverse rotation, negative output	0～10V For voltage amount of each driver type, see item 6.2	

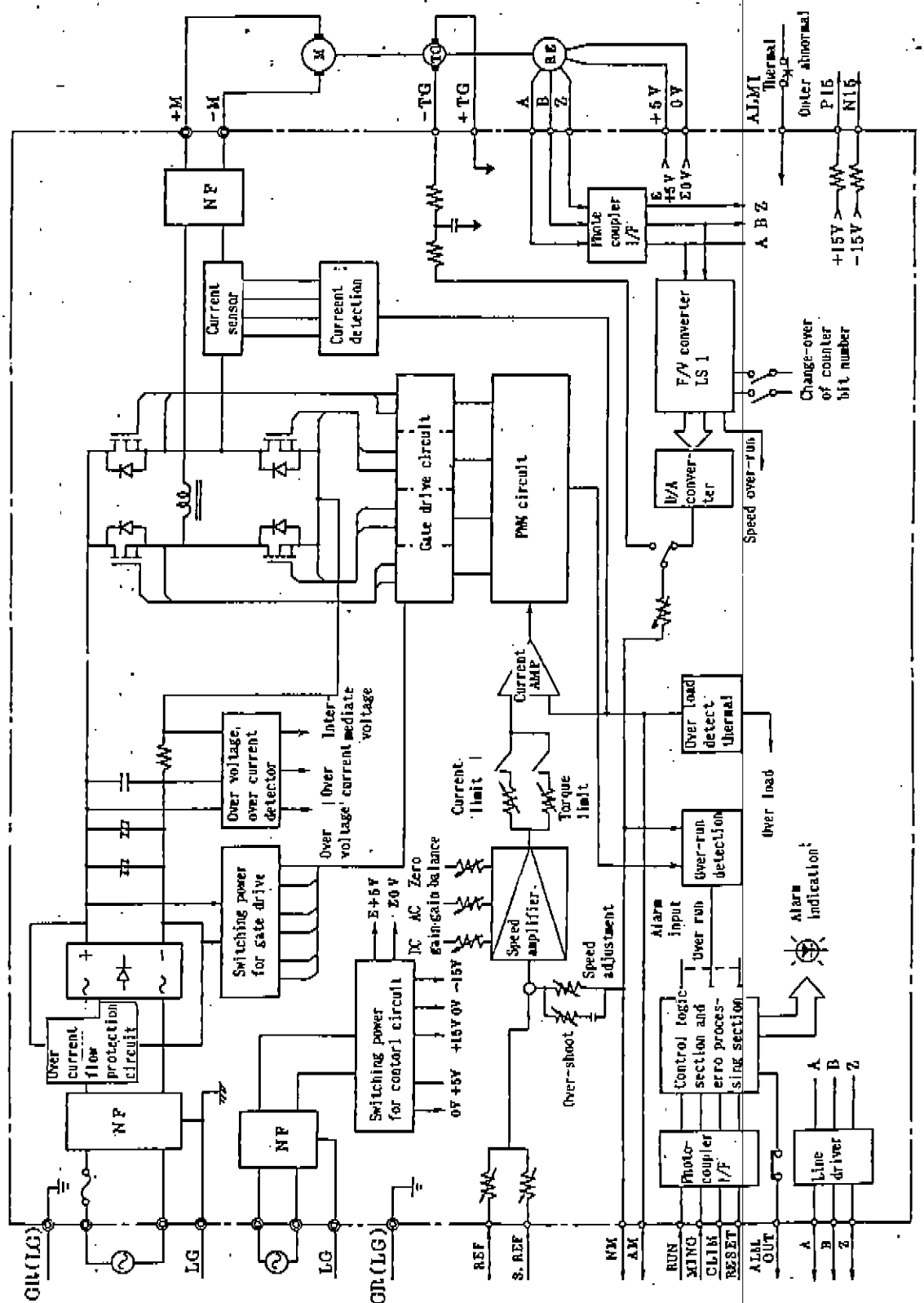
Name of signals	Function	Specification	Input interface
Abnormal output (ALM.OUT	Shut off the connection when outer or inner abnormal condition occures. For reset, input abnormal reset input or push reset button.	DC48V -0.5A	
Command voltage (P15, N15)	Applicable speed command voltage. When wiring outer volume, motor speed is controlled manually.	±15V ±5%	

4.3.4 Serovo motor interface

Name of signals	Function	Specification	Interface
Encoder input (A, B, Z)	Input terminal for the built-in encoder of the servo motor.	+5V-13mA +3V-5.5mA ·Line driver ·Open collector ·TTL applicable	
Power output to encoder	+5V power source for the rotary encoder. This line is isolated from inner logic	+5V±5% max 200mA	
Tacho -gene -rator input	Input terminal for speed feed-back from tacho-generator. This line is not isolated from inner logic.	7V/1000rpm	
Outer abnormal input (ALMI1, ALMI2)	Input terminal of thermal switch for the motor or a thermal relay. Abnormal output without this signal.	Sink +15V-7mA	

4.4. Inner block diagram of the servo driver

☐ R88D-EA06/EA12(Built-in power unit type)



5 SPECIFICATION

5.1 General specification

type	Built-in power unit type		Power unit separated type		
Item	R88D -EA06	R88D -EA12	R88D -EB13	R88D -EB15	R88D -EB16
Main power source voltage allowance	1φ AC85～132V		DC120～187V		
Control power source voltage allowance	1φ AC85～132V 50Hz/60Hz				
Insulating resistence	Between outer terminal and outer box more than 20MΩ (at DC 500V Mega)				
Voltage proof capacity	Between outer teminal and outer box (excluded control input/output section) AC1500V 50/60Hz with 1 minite				
Noise proof capacity	Equivalent to NEMA ICS3-304 (1200V P-P with pulse width 1μs) (up time = 1 ns)				
Vibration proof capacity	JIS C 0911 ⅡB 3 item (16.7Hz Vibration range 3mm, 30 times for each X, Y, Z direction)				
Shock proof capacity	Equivalent to JIS C 0912 (10G, 3 time for each X, Y, Z direction)				
Ambient temperature	0℃～+55℃				
Ambient humidity	35 ～ 90% RH (without duew condensation)				
Stock temperature	-10 ～+70℃				
Ambient condition	Without corrosive gases				
Structure	Rack mount or hanging up installation type				
Painting color	5Y7/1				
Weight	2.4 kg		3.7 kg		

5.2 Performance specification

		Power unit combined type		Power unit separated type		
Type of servo driver		R88D -EA06	88D -EA12	R88D -EB13	R88D -EB15	R88D -EB16
Capacity of applicable servo motor		50～80W	120～200W	300W	400W	500W
Control system		MOS-FET, PWM system				
Main circuit DC voltage		100～160V		---	---	---
Capacity of control power		17VA		20VA		
Peak output current		6A	12A	13A	15A	16A
Continuous output current		3A	5A	5.5A	6A	6.6A
Range of current limit		0～100% of maximum output current				
Servo rigidity		2A/mV	3A/mV			
Range of speed control		3000:1 with tacho-generator detection. In case of F/V feed-back, this value is depends on the number of encoder pulse.				
SPEED RATE	Load variation	0.1%(at load 0～100%)				
	Voltage variation	0.1%(at main power variation ±10%)				
	Temp. variation	0.5%(at 25℃ ±25℃)				

		Built-in power unit type		Power unit separated type		
Type of servo driver		R88D -EA06	88D -EA12	R88D -EB13	R88D -EB15	R88D -EB16
Aux. speed input	Command voltage	0～±10V				
	Input impe-dance	10～20kΩ				
Speed input	Command voltage	0～±10V				
	Input impe-dance	5～20kΩ				
Outer cur-rent limit	Control system	One point command with inner variable resistence, 0～80% of max. output current.				
	Control input	+24V-7mA, isolated with photocoupler.				
Speed monitor output		0～±10V				
Current monitor output		0～±10V	0～±10V	0～±5V	0～±5.8V	0～±6.2V
Speed feedback		·Tacho-generator input, 7V/1000rpm (adjustable amoung 3～7V) or encoder F/V input (change-over with encoder)				

		Built-in power unit type		Power unit separated type		
Type of servo driver		R88D -EA06	88D -EA12	R88D -EB13	R88D -EB15	R88D -EB16
PROTECTION FUNCTION	Electoronics thermal	Functions when the exceeded ampere of the continuous value applies with a certain interval.				
	Over-heat radiation fins	The temperature of radiation fins is exceeded more than 85℃ ± 5℃				
	Over voltage at main circuit	Functions at 220V				
	Over current	Functions at 200% of peak current				
	Over-run detection	Functions when speed feedback exceeds the rated value or does not delivered. (Tacho-generator or encoder is out of order)				
	Intermediate voltage detection	Functions when the FET gate drive voltage is in the main power circuit.				