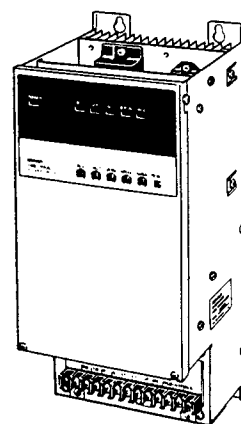Cat. No. I503-E1-1B

OMRON

USER'S MANUAL

OMNUC R SERIES

MODEL : R88D-RA05/RA10/RA15/RA20
(ANALOG INPUT TYPE)

AC SERVO DRIVER

Notes About Using This Manual

(1) This manual describes in as much detail as possible the functions of the unit and relations with other units. Items not described in this manual should be understood as "unavailable."

(2) Though we have tried to create the manual optimum, do not hesitate to contact our agent if you find anything difficult to understand.

(3) Inside the cover, there are potentially dangerous parts. If you open the cover, serious problems may arise. Never repair or disassemble the unit.

(4) We recommend adding the following precautions to your instruction manuals for unit-installed systems.
 • High voltage equipment is dangerous.
 • Do not touch terminals of the unit after power is switched OFF as voltage remains.

(5) Specifications and functions may change without notice in order to improve performance.

INDEX

1.1 Features and Configuration

This unit is an AC servo driver that performs fine positioning by controlling power to AC servo motor in compliance with analog input signal.

This series consists of power unit combined with AC servo drivers (R88D-RA series), operative 100W to 1,100W motors.

- Compactness, light weight, with a power unit combined (built-in type).
- Shockproof, durable in any environmental condition.
- Electromagnetic encoders are applied for detection.
- AC servo motors are able to rotate up to instant rate 4,000 rpm.
- Smooth and vibrationless rotation with minimized ripple by sinusoidal wave method.
- Easily applicable outside dynamic brake circuit as dynamic brake sequence is installed internally.
- Extendable distance between the motor and driver up to 30 m when the standard cable is used.

1. GENERAL

1.2 Outline of Configuration

System configuration example using a unit
is shown below.

R88D-RA series
AC servo driver

Encoder signal
(serial
transfer)

Three phase
200/220 VAC

Dynamic
brake unit

Motor drive signal

R88M-R
AC servo motor

Servo driver	Servo motor	Motor output
R88D-RA05	R88M-R10030	100W
R88D-RA10	R88M-R20030	200W
	R88M-R30030	300W
R88D-RA15	R88M-R45030	450W
	R88M-R60030	600W
R88D-RA20	R88M-R82030	820W
	R88M-R1K130	1,100W
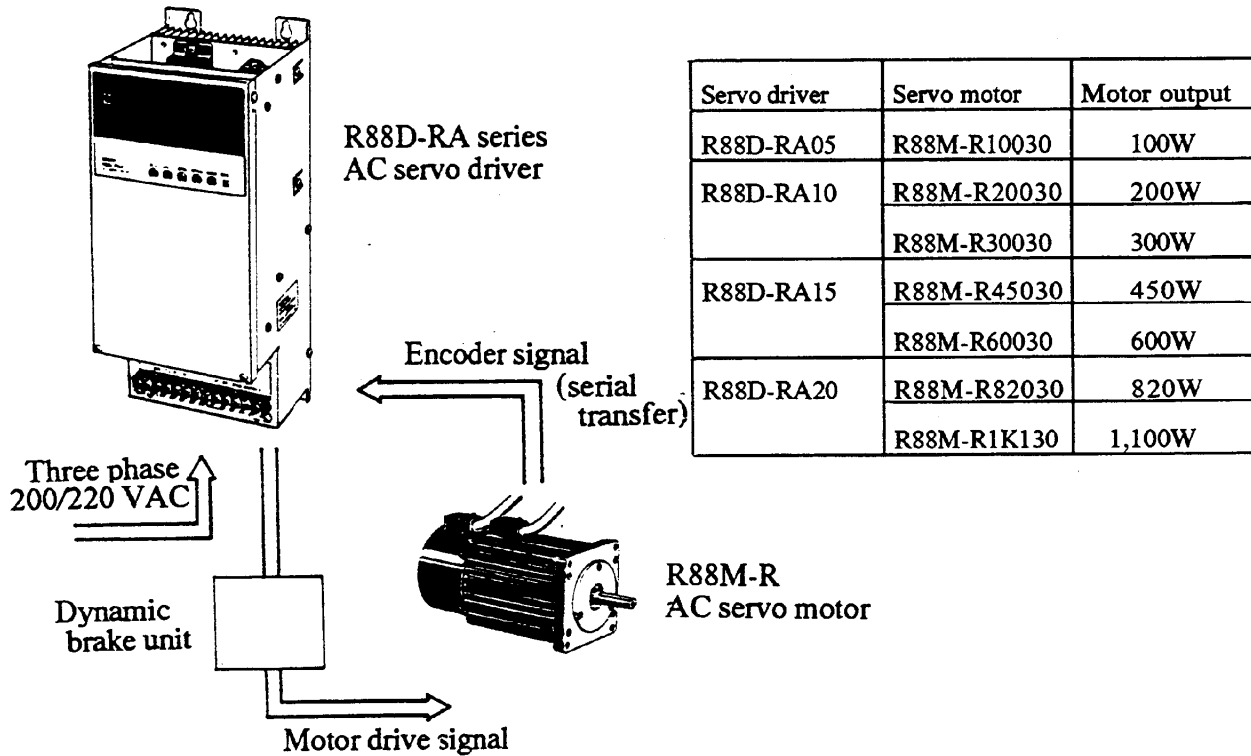
☐ **AC servo motor**

- AC servo motors are available in 7 models: 100 W, 200 W, 300 W, 450 W, 600 W, 820 W and 1,100 W. Be careful to choose proper servo motor suitable to the AC servo driver

☐ **AC servo driver**

- AC servo drivers of 4 models can control AC servo motors of 100 W to 1,100 W. Types of AC servo drivers must be in accordance with each AC servo motor.

☐ Exclusive cable

• Encoder cable for 100 to 450 W motors (R88A-CRR☐☐☐S)

This is a cable to connect R series AC servo motors (100 to 450 W) with R series AC servo drivers.
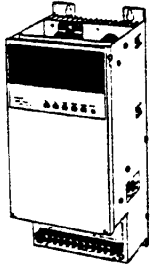
R88D-R
AC servo driver
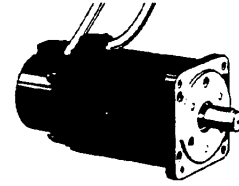
R88M-R
AC servo motor (100 to 450 W)

• Encoder cable for 600 to 1,100 W motor (R88A-CRR☐☐☐N)

This cable is to connect R series AC servo motors (600 to 1,100 W) and R series AC servo drivers.

R88D-R
AC servo driver
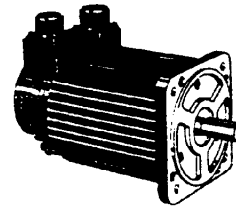
R88M-R
AC servo motor (600 to 1,100 W)

• Power cable for 600 to 1,100 W motor (R88A-CAS☐☐☐S)

This cable is to connect armature connectors of 600 to 1,100 W AC servo motors and R series AC servo drivers.

R88D-R
AC servo driver
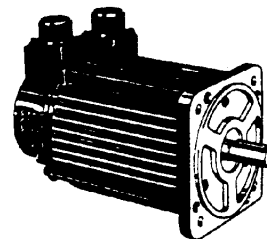
R88M-R
AC servo motor (600 to 1,100 W)

• Encoder cable

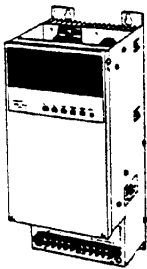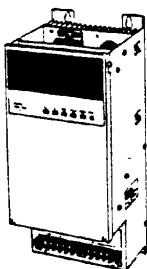| SPECIFICATIONS	Length	MODEL
Motor capacity:	3 m	R88A-CRR003S
100 W,200 W,	5 m	R88A-CRR005S
300 W,450 W	10 m	R88A-CRR010S
(single-side	15 m	R88A-CRR015S
connector)	20 m	R88A-CRR020S
	30 m	R88A-CRR030S
Motor capacity	3 m	R88A-CRR003N
600W,820W,	5 m	R88A-CRR005N
1100W	10 m	R88A-CRR010N
(dual-side	15 m	R88A-CRR015N
connector)	20 m	R88A-CRR020N
	30 m	R88A-CRR030N

• Power cable

SPECIFICATIONS		MODEL
Motor capacity	3 m	R88A-CAS003
600 W, 820 W,	5 m	R88A-CAS005
1,100 W	10 m	R88A-CAS010S
(single-side connector)	15 m	R88A-CAS015S
	20 m	R88A-CAS020S
	30 m	R88A-CAS030S

1.3 Before Reading This Manual

Read this manual carefully before using the unit. In this manual, AC servo motor rotation directions are defined as "Forward" and "Reverse." "Forward" rotation means to rotate motor shaft in an counter-clockwise (CCW) direction, "Reverse" rotation means clockwise (CW) direction looking at the motor from the shaft side.

Forward rotation
Reverse rotation

AC servo motor
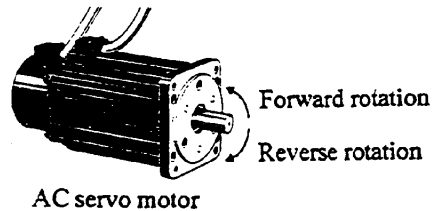
☐ Encoder output phase

The encoder output signal from the servo driver is as follows.

• At forward rotation

A phase output

B phase output
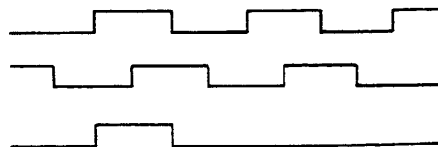
Z phase output

• At reverse rotation

A phase output

B phase output

Z phase output
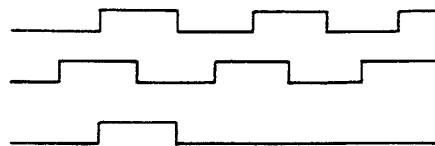
The system consists of an AC servo driver and an AC servo motor.

Specifications of AC servo driver and AC servo motor are shown below.

2.1 General Specifications of Servo Driver

Item	Contents	
Ambient operating temperature	0 to +55°C	
Ambient operating humidity	35 to 85% RH (without dew condensation)	
Storage temperature	-10 to +75°C	
Ambient condition	Without corrosive gases	
Vibration proof	Less than 2G or the acceleration of 10-150 Hz with half amplitude of 0.15 mm	
Shock proof	Less than 10G in peak acceleration (tested each 3 times in X, Y, Z directions)	
Insulating resistance	Between outside terminals and outside box, more than 5 MΩ at 1,000 VDC.	
Voltage proof capacity	Between outer terminals and outer box, 1 minute at 1,500 VAC 50/60 Hz	
Structure	Installation inside a box type	
Weight	R88D-RA05/RA10	Approx. 4.5 kg
	R88D-RA15/RA20	Approx. 4.9 kg

2. SPECIFICATION

2-2 Performance Specifications
2-2-1 AC servo driver

☐ **Specifications of the speed control section and control input/output signals**

	Item	Unit	Standard
	Speed control Control rigidity		1: 1,000 Rated torque at 7.5 mV
	Load characteristics	%	Less than 0.2% at 0 to 100% load.
	Voltage characteristics	%	Less than 0.5% at 170 to 253 VAC.
	Temperature characteristics	%	Less than 1% at 25°C ±25°C.
	Frequency characteristcis	Hz	Adjustable to more than 50 Hz with the same amount of motor roter inertia.
	Rated command voltage	V	±10 VDC, ± 3,000 rpm.
	Input impedance	kΩ	Approx. 22 kΩ.
	Time constant	μs	20 μs.
	Run command		24 V, 12 mA contact or open collector
	Gain minimization		24 V, 12 mA contact or open collector
	Torque limit		24 V, 12 mA contact or open collector
	Alarm reset		24 V, 12 mA contact or open collector
	Auxiliary command voltage		± 3V to ± 10 VDC, ± 3,000 rmp.
	Input impedance	kΩ	Approx. 10 to 30 kΩ.
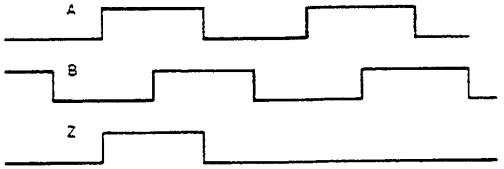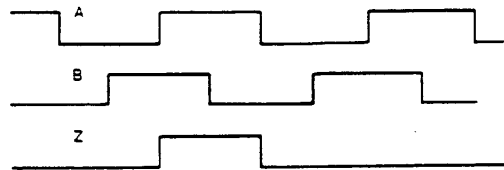
❑ Specifications of servo driver

Item		Unit	Standard			
Power source	Main circuit	V	170 - 253VAC, 50/60 Hz, 3-phase			
	Control circuit	V	170 - 264VAC, 50/60 Hz, single phase 80 VA.			
Output	Model		R88D-RA05	R88D-RA10	R88D-RA15	R88D-RA20
	Continuous	A0-P	1.7	3.3	5.0	7
	Maximum	AO-P	5.5	10	15	20
Speed feedback			Magnetic encoder 1000 ppr (Pluse Per Revolution)			
Protection functions			Overcurrent, overload ,overvoltage, and abnormal speed.			

Note 1: Prepare main power supply approx. 200% of used motor output capacity. For example, 1.2 kVA main power supply for 600W motor.

Note 2: No regenerative control circuit is installed in R88D-RA05, and R88D-RA10. Only condenser is installed as regenerative function.

❑ Encoder output

Item	Standard
Output pulse	A and B phase: 1000 PPR Z phase: 1 PPR
Output phase	At forward rotation At reverse rotation Serial transfer delay of Z phase is 5 to 20 µs.
Output system	EIA-RS-422A or equivalent
Insulation resistance	5 MΩ or up
Durability of sensor	1 minute at 50 VDC between the case and the ground.

Note: Do not practise insulation test on encoders. It may damage the encoder.

2. SPECIFICATION

2-2-2 AC servo motor

□ Specification of AC servo motor (1)

Item	Unit	R88M -R10030	R88M -R20030	R88M -R30030	R88M -R45030
Output power	W	100	200	300	450
Rated torque	kgf·cm	3.25	6.49	9.74	14.6
Rated speed	rpm	3,000	3,000	3,000	3,000
Instantaneous max. speed	rpm	4,000	4,000	4,000	4,000
Instantaneous max. torque	kgf·cm	9.7 or up	24 or up	28 or up	36 or up
Rotor inertia	kgf·cm·s^2	1.89×10^{-4}	5.31×10^{-4}	7.70×10^{-4}	1.60×10^{-3}
Torque constant.	kgf·cm/A	2.02	4.13	3.76	3.32
Induction voltage constant	V/rps	1.25	2.54	2.32	2.04
Power rate	kW/s.	5.48	7.62	11.9	12.8
Mechanical time constant	ms	1.98	1.98	1.6	1.9
Coil resistance	Ω	4.2	6.24	2.9	1.28
Coil inductance	mH	9	18.5	11.5	14.3
Electrical time constant	ms.	2.14	2.96	3.97	11.2
Weight	kg	1.3	2.0	2.6	4.5
Ambient operating conditions	°C, %RH	Temperature: 0 to +40°C, Humidity: 35 to 85 % (without dew condensation)			
Storage condition	°C, %RH	Temperature: -10 to +75°C, Humidity: 35 to 85% RH (without dew condensation)			
Operating atmosphere		Without corrosive gases			
Installation direction		Each direction			
Insulation class		Item B			
Structure		Full-close, self-cooling			
Dustproof structure		IP-52 (in the case of oil seal is applied as option, IP-54)			

Note : See Section 1-3 in Chapter 4 about oil seal.

☐ **Specification of AC servo motor (2)**

Item	Unit	R88M -R60030	R88M -R82030	R88M -R1K130
Output power	W	600	820	1100
Rated torque	kgf·cm	19.5	26.6	35.7
Rated speed	rpm	3,000	3,000	3,000
Instantaneous max. speed	rpm	4,000	4,000	4,000
Instantaneous max. torque	kgf·cm	50 or up	78 or up	88 or up
Rotor inertia	kgf·cm·s^2	2.03x10^{-3}	2.5x10^{-3}	3.66x10^{-3}
Torque constant	kgf·cm/A	5.12	5.34	5.43
Induction voltage constant	V/rps	3.15	3.29	3.34
Power rate	kW/s.	18.4	27.7	34.1
Mechanical time constant	ms	1.54	1.12	0.91
Coil resistance	Ω	1.95	1.25	0.72
Coil inductance	mH	20	16.2	11.1
Electrical time constant	ms	10.3	13	15.4
Weight	kg	5.5	7.1	8.5
Ambient operating conditions	°C, %RH	Temperature: 0 to +40°C, humidity: 35 to 85 % (without dew condensation)		
Storage condition	°C, %RH	Temperature: -10 to +75°C, Humidity: 35 to 85% RH (without dew condensation)		
Operating atmosphere		Without corrosive gases		
Installation direction		Each direction		
Insulation class		Item B		
Structure		Full-close, self-cooling		
Dust proof structure		IP-52 (in the case of oil seal, IP-54)		

Note 1: Servo motor model R88M-R60030 (600W) can be used with the servo driver model R88D-RA20. Is this case, max. torque becomes 60 kfg·cm or over.

Note 2 : See Section 1-3 in Chapter 4 about oil seal.

2. SPECIFICATION

☐ Specifications of built-in brake motor

Brake release voltage is 24VDC without polarity.

The brake releases when 24VDC is applied to the line.

The purpose for this brake is to hold axis at stop condition, not to stop the axis. Thus, release the brake with the release voltage ON while in operation of the motor. Be careful that the brake inertia should be added to the load inertia.

• Brake circuit

In order to protect the circuit from surge noise at brake excitation OFF, be sure to insert a surge killer. To select surge killer, see the table below:
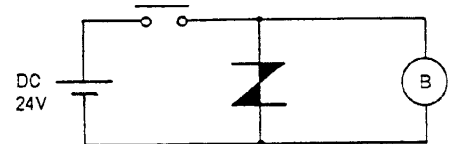
Type	Model	Mfg.	Application
Thyrister	C-5A3	ISHIZUKA ELECTRONICS COPR.	24VDC
Thyrister	V-3	ISHIZUKA ELECTRONICS CORP.	24VDC
Varistor	Z15L470	ISHIZUKA ELECTRONICS CORP.	24 VDC
Varistor	ERZ-C14DK470	MATSUSHITA ELECTRONICS COMPONENTS CO., LTD.	24 VDC
Spark killer	CR50500	OKAYA ELECTRIC INDUSTRIES. CO., LTD.	Compatible AC and DC

☐ Specifications of built-in brake motor (1)

• Brake specification

Item	Unit	R88M -R10030-B	R88M -R20030-B	R88M -R30030-B	R88M -R45030-B
Brake inertia	kgf·cm·s^2	7.7×10^{-5}	1.0×10^{-4}	1.0×10^{-4}	3.0×10^{-4}
Excitation voltage	V	24 vDC			
Power consumption	W	7.2	10	10	19.5
Static friction torque	kgf·cm	5 or up	10 or up	15 or up	25 or up
Braking time constant	ms	(30)	(40)	(50)	(50)
Release time constant	ms	(20)	(30)	(30)	(100)
Allowable work (1)	kgf·m/time	13	25	25	60
Allowable work (2)	kgf·m/life	1.3×10^4	2.5×10^4	2.5×10^4	5×10^4
Backlash	axis angle	(0.75°)	(0.63°)	(0.63°)	(0.61°)
Rated		Continuous rating			
Insulation class		Item F			

• Weighth

Item	Unit	R88M -R10030-B	R88M -R20030-B	R88M -R30030-B	R88M -R45030-B
Weight (motor + brake)	kg	1.8	2.7	3.4	5.8

Note: Values indicated in parentheses are not guaranteed.

☐ Specifications of built-in brake motor (2)

• Brake specification

Item	Unit	R88M -R60030-B	R88M -R82030-B	R88M -R1K130-B
Brake inertia	kgf•cm•s^2	3.0×10^{-4}	3.0×10^{-4}	5.0×10^{-4}
Excitation voltage	V	24 vDC		
Power consumption	W	19.5	19.5	18
Static friction torque	kgf•cm	25 or up	40 or up	55 or up
Braking time constant	ms	(50)	(50)	(50)
Release time constant	ms	(100)	(100)	(100)
Allowable work (1)	kgf•m/time	60	60	60
Allowable work (2)	kgf•m/life	5×10^4	5×10^4	5×10^4
Backlash	axis angle	(0.61°)		
Rated		Continuous rating		
Insulation class		Item F		

• Weight

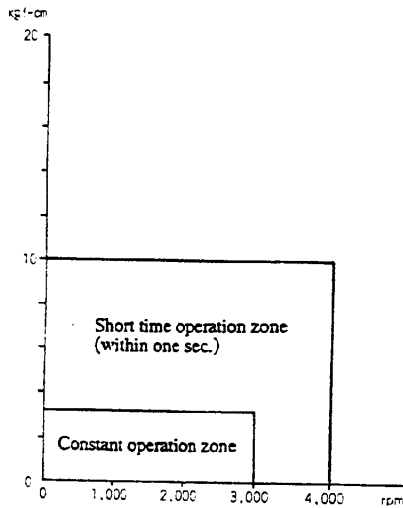| Item	Unit	R88M -R10030-B	R88M -R20030-B	R88M -R30030-B
Weight (motor + brake)	kg	6.8	8.4	10.5

Note: Values indicated in parentheses are not guaranteed.
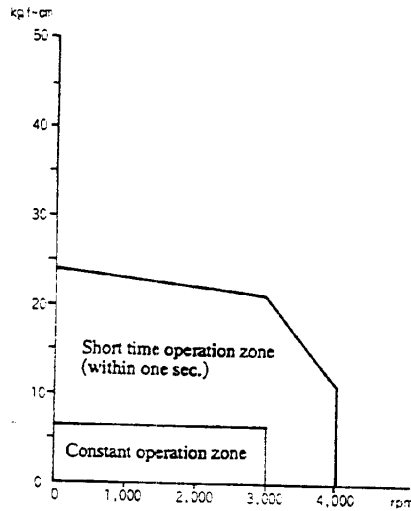
2. SPECIFICATION

□ **Characteristic curve (tested with the standard cable 3m)**

The characteristic curves below shows operation zones when 200VAC in 3-phase has been input.
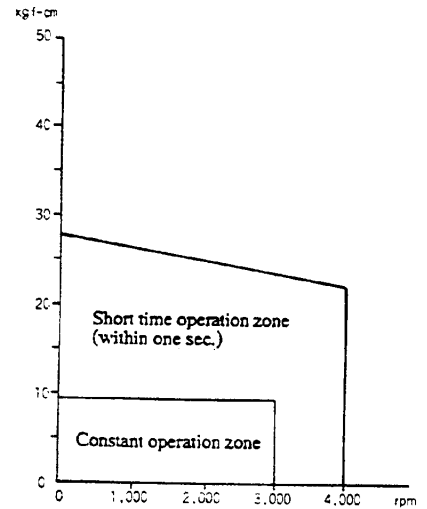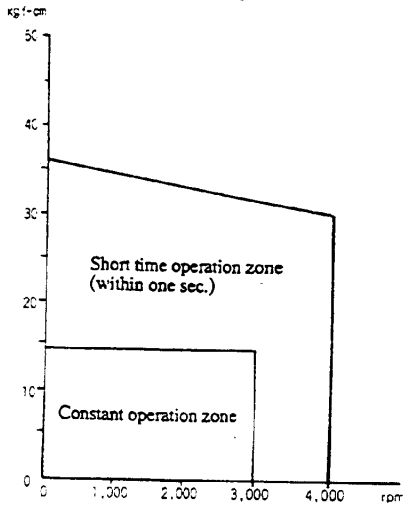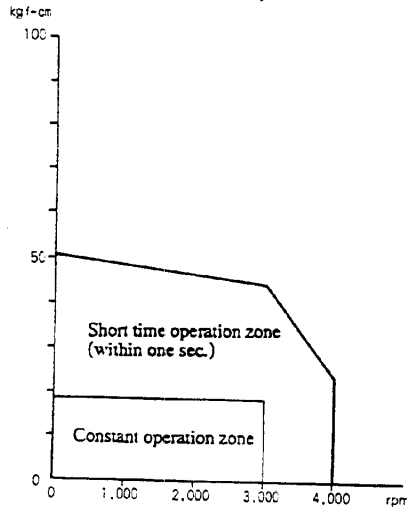
R88M-R10030 (100 W)

kg f-cm

Short time operation zone
(within one sec.)

Constant operation zone

R88M-R20030 (200 W)

kg f-cm

Short time operation zone
(within one sec.)

Constant operation zone

R88M-R30030 (300 W)

kg f-cm

Short time operation zone
(within one sec.)

Constant operation zone

R88M-R45030 (450 W)

kg f-cm

Short time operation zone
(within one sec.)

Constant operation zone

R88M-R60030 (600 W)

kg f-cm

Short time operation zone
(within one sec.)

Constant operation zone

R88M-R82030 (820 W)

kg f-cm

Short time operation zone
(within one sec.)

Constant operation zone

R88M-R1K130 (1,100 W)

kg f-cm

Short time operation zone
(within one sec.)

Constant operation zone

2-8

❏ Radiation condition of AC servo motors

In case of continuous operation at the rated torque, the following radiation fins are necessary on the motor flange.

R88M-R20030   Thickness: 6 mm, area: 200mm^2 metal board or equivalent.

R88M-R30030   Thickness: 6 mm, area: 250mm^2 metal board or equivalent.

R88M-R45030   Thickness: 12 mm   area: 200mm^2 metal board or equivalent.

R88M-R60030   Thickness: 12 mm   area: 250mm^2 metal board or equivalent.

R88M-R82030   Thickness: 12 mm   area: 250mm^2 metal board or equivalent.

R88M-R1K130   Thickness: 12 mm   area: 250mm^2 metal board or equivalent.

Note: Above recommendation are at condition of horizontal installation without blockage obstacles around the motor.

❏ Vibration proof characteristics

OMNUC R series AC servo motor allowable against 2G every directions installed in a horizontal axis positions.
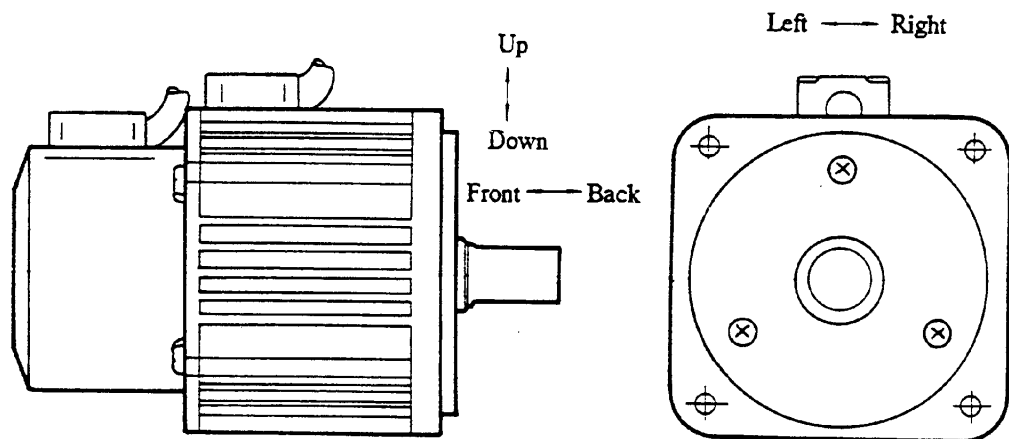
❏ Shockproof characteristics

OMNUC R series AC servo motor can withstand a 50G vertical shock three times when it is installed in a horizontal axis position.

Note : Do not remove the encoder cover nor disassemble the AC servo motor.

2. SPECIFICATION

- **Allowable load to motor axis**

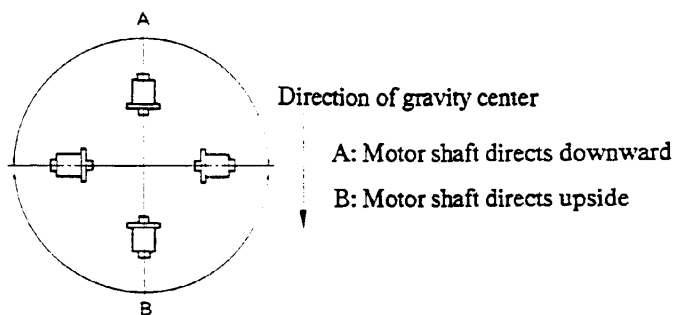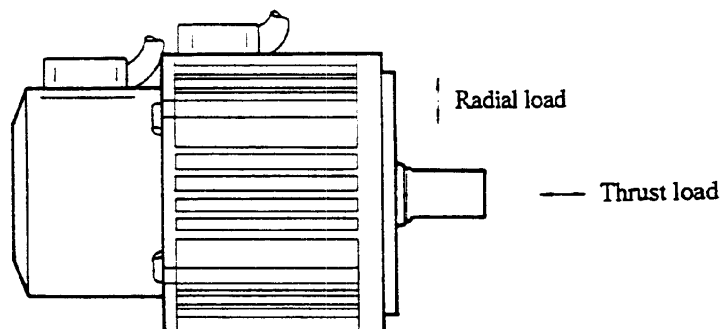   Allowable radial and thrust load to motor axis are as follows:

(unit : kgf)

Type	Output power	Allowable radial load	Allowable thrust load A	Allowable thrust load B
R88M-R10030	100 W	11.5	3	3
R88M-R20030	200 W	19	8	7.5
R88M-R30030	300 W	20	8	7.5
R88M-R45030	450 W	34	12	11
R88M-R60030	600 W	36	12	11
R88M-R82030	820 W	38	12	11
R88M-R1K130	1,100 W	45	15	13

Note 1: Above allowable radial load are values at the center of the axis (one second of shaft length).

Note 2: Thrust load value differs from load directions.

Note 3: The above load values are defined according to the target life of 30,000 hours.
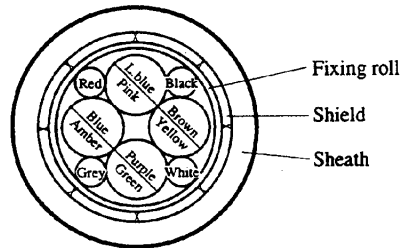

Radial load

—— Thrust load

Direction of gravity center

A: Motor shaft directs downward

B: Motor shaft directs upside

☐ Motor lead wire

• Signal wire (signal and power lines of encoder)

UL2589(105°C,30V) 24AWG x 3P + 22AWG x 3C or equivalent.

Sectional view

Note:Purple, green, and white electric wires are housed inside the sheath.

Item		Specification	
		24AWG	22AWG
Outside diameter	mm	Ø 8 ± 0.2	
Conductor resistance	Ω/km	58.7 or less	42.5 or less
Voltage proof	V/s.	500	
Insulation resistance	MΩ/km	1.0	
Min. bending radial	mm	30	

• Armature wire (wires to supply power to stator winding of motor and to grounding.)

UL2517 (105°C,300V) 18AWG x 4C or equivalent.

Sectional view
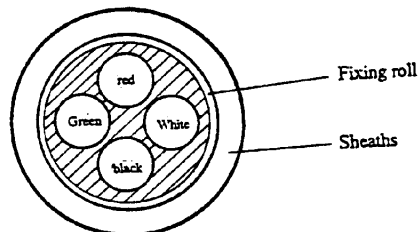
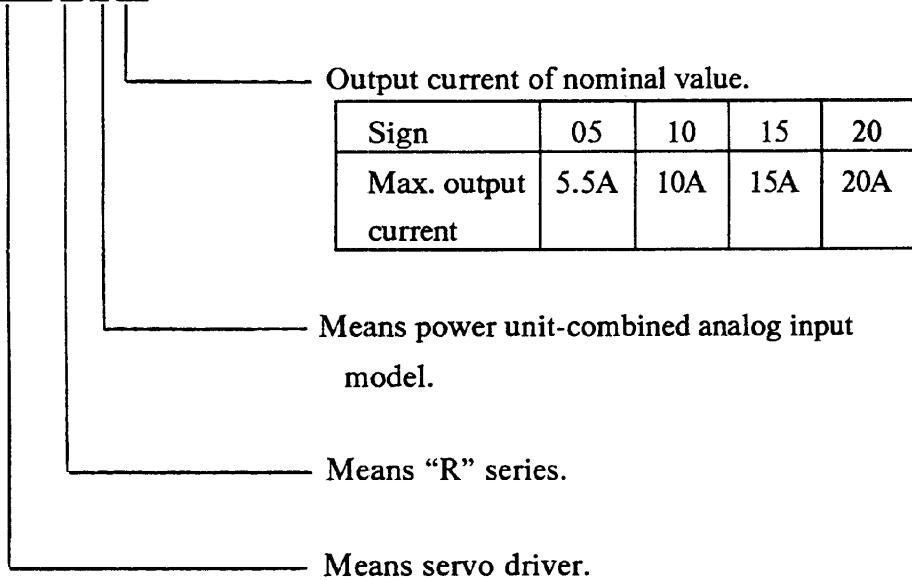

Item		Specification
Outside diameter	mm	Ø 8 ± 0.2
Conductor resistance	Ω/km	24.2 or less
Voltage proof	V/s.	2,000
Insulation resistance	MΩ/km	3.5
Min. bending radial	mm	40

3. MODEL DENOMINATION

☐ AC servo driver

Model <u>R88D</u>-<u>R</u><u>A</u> <u>05</u>

— Output current of nominal value.

Sign	05	10	15	20
Max. output current	5.5A	10A	15A	20A

— Means power unit-combined analog input model.

— Means "R" series.

— Means servo driver.

☐ AC servo motor

Model <u>R88M</u>-<u>R</u> <u>100</u> <u>30</u> - ☐☐☐☐

— Special specification

— Rated rotation speed is 3,000 rpm

— Output

  100 : 100W
  200 : 200W
  300 : 300W
  450 : 450W
  600 : 600W
  820 : 820W
  1K1 : 1100W

— Means "R" series.

— Means servo motor.
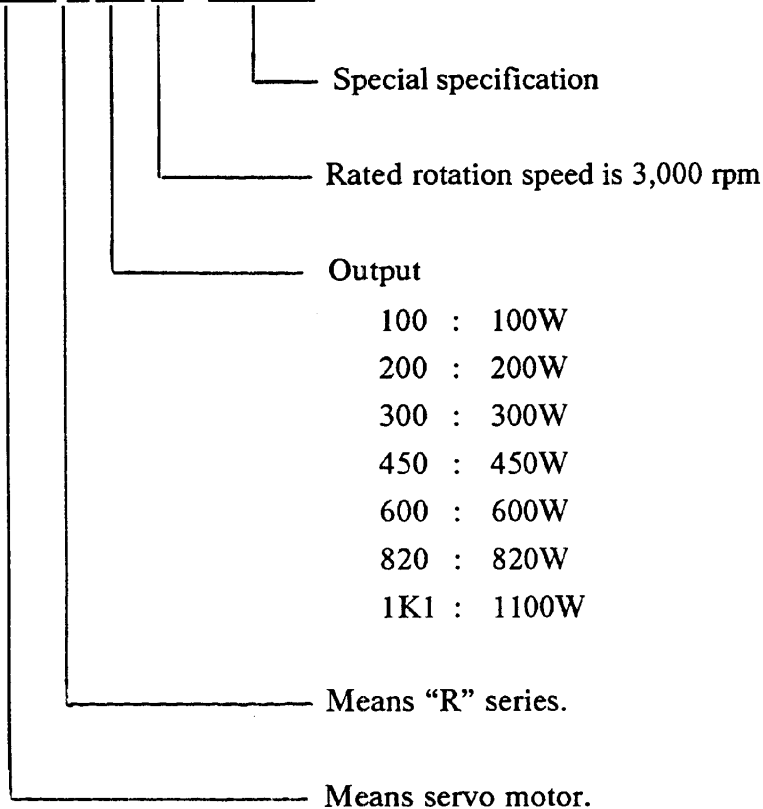
4.1 Installation and Mounting

4.1.1 Outside and installation dimensions of AC servo driver
□ **R88D-RA**
• **Outside dimensions**

4-M5 or M4 screw retention hole

4-M5 or M4

Rear side installation dimensions

4-1

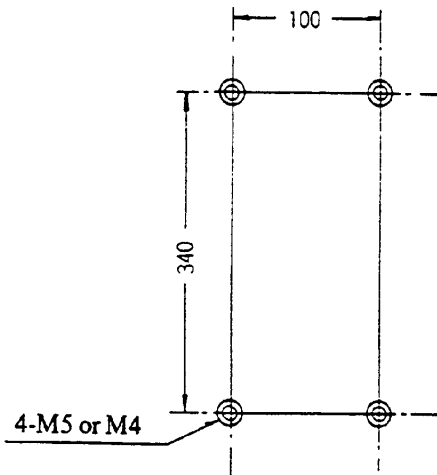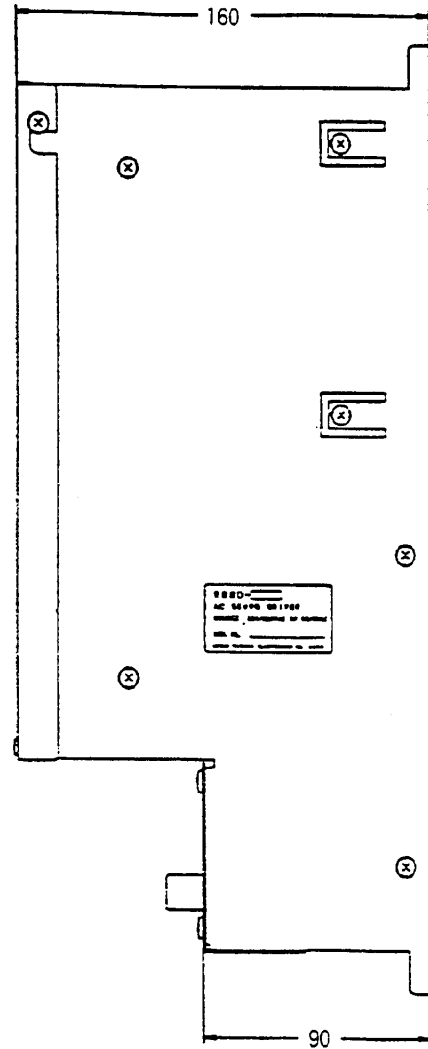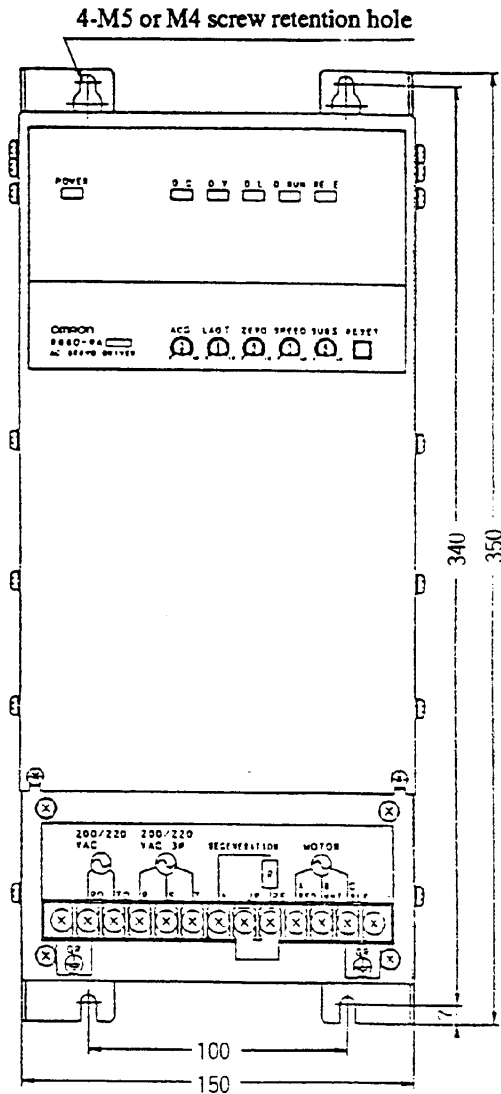# 4. DESIGN

4.1.2 Outside dimensions of AC servo motor

□ Standard model

• Models R88M-R10030, R88M-R20030, R88M-R30030, and R88M-R45030,
  (100 to 450W)

Type \ Dim. (mm)	LL	LR	L	LF	LI	LT	LM	DB	DG	A	B
R88M-R10030	151.7	122.7	81.5	8	$3.5^{+0.3}$	$29^{+0.5}$	$66^{+0.4}$	80	$50^{0}_{-0.025}$	5	4
R88M-R20030	160.7	131.7	90.5	9	$3.5^{+0.3}$	$29^{+0.5}$	$80^{+0.4}$	90	$70^{0}_{-0.03}$	6	10
R88M-R30030	182.7	153.7	112.5	9	$3.5^{+0.3}$	$29^{+0.5}$	$80^{+0.4}$	90	$70^{0}_{-0.03}$	6	10
R88M-R45030	201.2	161.2	120.0	12	$4.0^{+0.1}$	$40^{+0.5}$	$120^{+1.5}$	130	$110^{0}_{-0.035}$	9	15

Note: Lengths of armature wire and signal wire of standard motor are 500 mm.
Connectors are not installed at the ends of each cable.

Shaft shape

• Models R88M-R60030, R88M-R82030, R88M-R1K130,
  (600 to 1,100W)

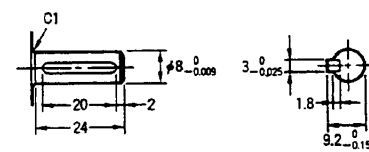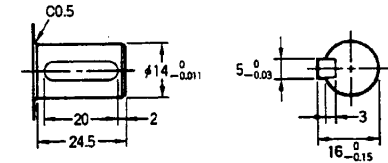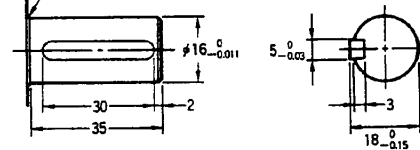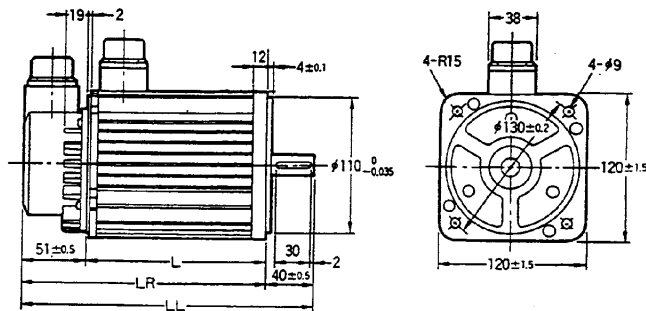| Type \ Dim. (mm)	LL	LR	L
R88M-R60030	242	202	151
R88M-R82030	277	237	186
R88M-R1K130	309	269	218

Shaft shape

□ Built-in brake model

- Models R88M-R10030-B, R88M-R20030-B, R88M-R30030-B, and R88M-R45030-B
  (100 to 450W)

Type Dim. (mm)	LL	LR	L	LF	LI	LT	LM	DB	DG	A	B
R88M-R10030-B	187.7	158.7	117.5	8	$3.5^{+0.3}$	$29^{+0.5}$	$66^{+0.4}$	80	$50^{0}_{-0.025}$	5	4
R88M-R20030-B	192.7	163.7	122.5	9	$3.5^{+0.3}$	$29^{+0.5}$	$80^{+0.4}$	90	$70^{0}_{-0.03}$	6	10
R88M-R30030-B	219.7	190.2	149.0	9	$3.5^{+0.3}$	$29^{+0.5}$	$80^{+0.4}$	90	$70^{0}_{-0.03}$	6	10
R88M-R45030-B	227.2	187.7	146.5	12	$4.0^{+0.1}$	$40^{+0.5}$	$120^{+1.5}$	130	$110^{0}_{-0.035}$	9	15

Note) Lengths of armature wire and brake wire of built-in brake AC servo motors are 500 mm.
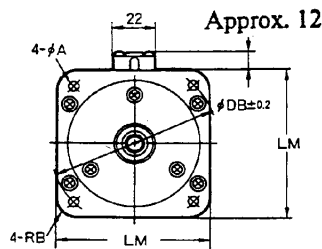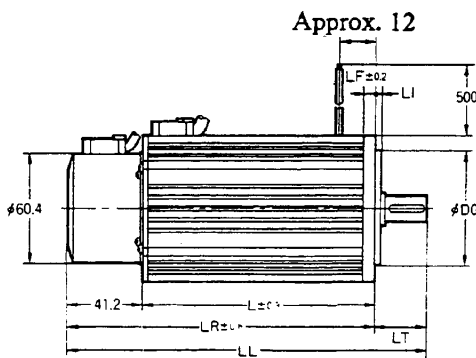
Shaft shape
R88M-R10030-B
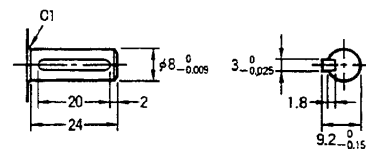
R88M-R20030-B
R88M-R30030-B
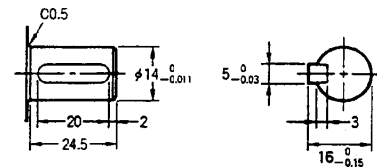
R88M-R45030-B
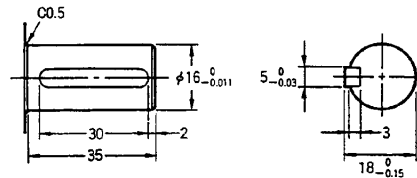
- Models R88M-R60030-B, R88M-R82030-B, R88M-R1K130-B,
  (600 to 1,100 W)

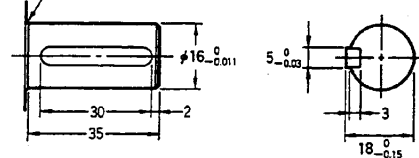| Type Dim. (mm)	LL	LR	L
R88M-R60030-B	268.5	228.5	177.5
R88M-R82030-B	306.5	265.5	214.5
R88M-R1K130-B	350.5	310.5	259.5
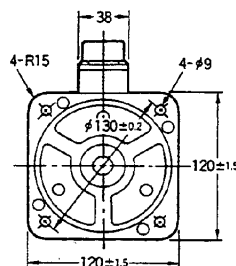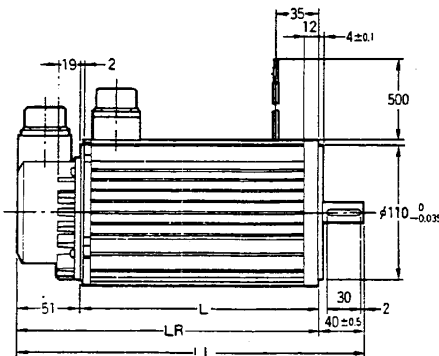
Shaft shape
R88M-R60030-B
R88M-R82030-B
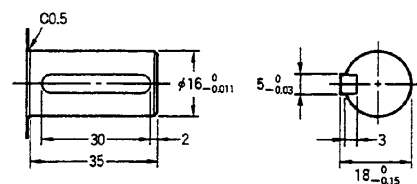
R88M-R1K130-B
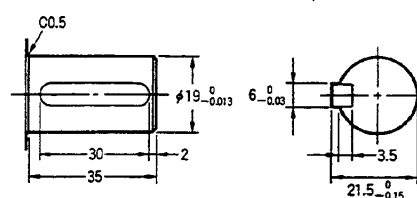
4. DESIGN

4.1.3 Installation conditions
☐ AC servo driver
(1) Follow the installation diagram below while installing the unit.
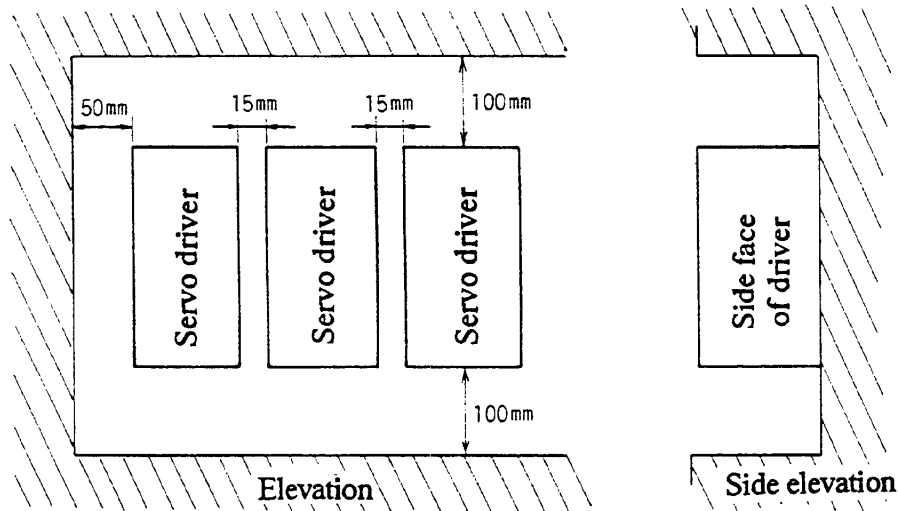
(2) Install the AC servo driver in a vertical direction.

(3) The inside temperature of the unit may increase by approx. 30°C. Therefore, keep away from other equipment and wirings which are thermally affecting.

(4) While installing the servo driver in a box, take measures such as installing forced-cooling fan or air conditioner in order not to increase environmental temperature by more than +55°C.

(5) If noise-producing equipment such as an electro-magnetic contactor, a relay, or a solenoid is placed near the AC servo driver, take measures to protect the unit from these noise.

(6) Operating environmental conditions

    Operating environmental temperature : 0 to 55°C

    Operating environmental humidity   : 35 to 85% RH (without dew condensation)

    Storage environmental temperature   : -10 to +75°C

    Storage environmental humidity   : 35 to 85% RH (without dew condensation)

(7) Be careful to install the AC servo driver in the environment without increasing temperature.

(8) Be careful not to let metal powder, oil mist, nor water enter the unit.

(9) Be careful not to let metal powder enter the unit, while installing.

(10)When using model R88D-RA20, be careful that temperature rise of right side should not be more than 20°C by regenerative energy.

    Reconfirm the amount of regenerative energy.

□ AC servo motor

(1) Do not give any excessive shock to the servo motor while transportation, installation, and removing.

Also, do not hold the encoder section, cable section, and connector sections for loading and unloading the AC servo motor.

(2) When installing a coupling on the motor shaft, do not give shock to the shaft by a hammer. This shock may damage plated part of the shaft and result in problems with the encoder. To remove couplings, be sure to use a special tool, such as pulley remover.

(3) Operating environmental conditions

Operating environmental temperature : 0 to 55°C

Operating environmental humidity : 35 to 85% RH (without dew condensation)

Storage environmental temperature : -10 to +75°C

Storage environmental humidity : 35 to 85% RH (without dew condensation)

(4) Do not cover the servo motor with any materials as the motor temperature rise and a sensor inside the encoder detect "encoder error" (REE).

When this error occurs, decrease load torque and cool the servo motor using a forced cooling fan.

Be sure not to exceed the motor center part temperature by more than 45°C with the rated operation cycle (see Chapter 2: Radiation of AC servo motor).

Do not use the servo motor where much dust, corrosive gas, flammable gas are evident, outside, in vacuum condition, place higher than 1,000 m.

(5) Conjunction with mechanism

• Be sure to use a flexible coupling to connect the motor shaft and mechanical parts such as ball screws. Plan and process mechanism to keep both shaft center precisely match in the same line. When the motor shaft is connected with high rigidity parts, slight difference of shaft center may give excessive radial load to the motor shaft and damage the motor shaft or the ball bearing.

In case of straight shaft, use "clamp type coupling" Oldam Coupling made by Myty Co., Ltd., "ETP bush" made by Miki Pulley Co., Ltd., Shupan Ring made by Shoda Shoji Co., Ltd.

• Deviation, pitch difference, gear shape differences etc. should be as small as possible to adjust backlash amount to proper level. Make a mechanism to adjust backlash amount. When bevel gear is used, it may give thrust load to the motor shaft. Check this thrust load together with backlash amount.

• When a timing belt is used, the motor shaft receives excessive radial load due to tension strength of the timing belt, temperature variation, and aging. This will cause damage to the motor shaft and the ball bearing.

Use the timing belt below the value shown in Chapter 2, Specification, "allowable load of AC servo motor output."

Install the pulley so that it makes the timing belt straight. When the difference arises, a great thrust load may occur. Prior to using the timing belt, see the instruction manual provided by the timing belt manufacturer for proper use.

In some cases, use of the timing belt makes vibration of mechanical part and damage of the shaft duet mechanical resonance point of the belt length and tension.

(6) Drip-proof

As the servo motor is not provide water-proof feature, cutting oil, especially coolant oil, may enter and cause malfunction due to insulation error and short circuit. Thus, prepare measures so as not to drop cutting oil on the servo motor body. Cables of the servo motor are another case of oil entry. Direct the lead wire downward and slacken. When intrusion of oil through the shaft is possible, fix the optional oil seal.

This motor, including its connectors, cannot be used in a location where dripping water and/or oil conditions exist, or in a misty atmosphere.

(7) Oil seal

Our servo motors are designed to connect mechanism by coupling as a whole so that oil seal is not installed. The following oil seals are available instillation. Replace interval of oil seals are approx. 5,000 hours with lubrication.

Model of servo motor	Model no. of oil seal	Mfg.
R88M-R10030	OS10173	
R88M-R20030/R30030	OS15223	IKO Tomson
R88M-R45030/R60030 R88M-R82030	AC0760AO	NOK
R88M-R1K130	AC1013AO	

(8) OMNIC AC servo motors are synchronous type motors using permanent magnets. They do not rotate even impressed commercial 3-phase power. But it will immediate burn out motor coil.

(9) Though the motor is painted corrosive-preventing oil, put oil or grease on the shaft after installing a coupling.

4.1.4 Wiring

Noiseproof characteristics of the total system are influenced by how it is wired.
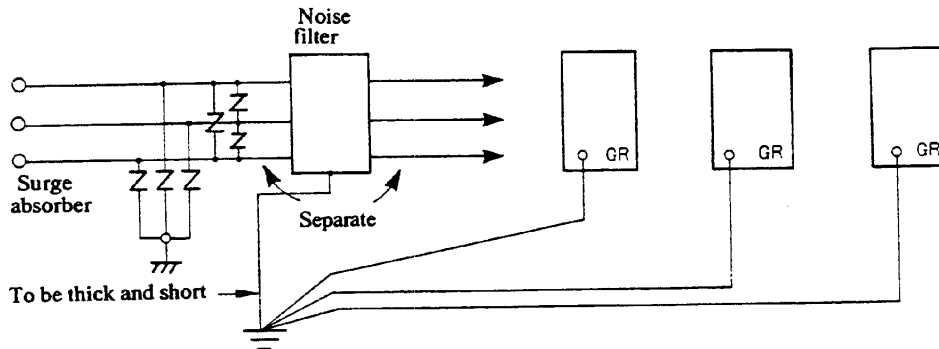
- Apply one-point earthing. Do not insert earthing line into the some ducts of filter output lines, motor power lines, and signal lines.
- In case of wiring in metal conduits and ducts, connect metal body with one point earthing as on the figure above.
- Insert surge absorber and noise filter on the AC lines.

❑ Terminal block for power and motor

Terminal block	Contents	Wire diameter	
		R88D-RA05/RA10	R88D-RA15/RA20
R_o, T_o	Input for servo driver power	0.75 mm^2	0.75 mm^2
R, S, T	Input for input power	1.25 mm^2	1.25 mm^2
A, B, C	Output terminal for motor	0.75 mm^2	1.25 mm^2
GR	Earthing terminal	2 mm^2	2 mm^2

Note : Above values are examples using HIV thermal proof vinyl wire (75°C) at an ambient temperature of 55°C.

❑ Connector terminal for control

Use MR series connectors by HONDA TSUSHIN for each connector. Plugs and cases for connectors are supplied together with the unit.

Use shielded twisted-pair cable for control line connector.

Shield wire should be connected to the designated terminal.

4. DESIGN

4.2 Details of Each Section

4.2.1 Front panel, inside the panel

Display panel

Inside the panel

Display section

Adjustment section

Connector for motor signals

Connector for control

Terminal block

Frame ground Screw

Load inertia response changeover switch

Short pin for changing motor rotation direct

Torque limit volume

Pin for NM, AM monitor

Connector for motor signal

Pin for optional sequence terminal input changeover

Connector for motor signal

Optional sequence terminal

4.2.2 Display, adjustment, and setting sections

☐ **Display section**

Indication	Function	Lighting conditions
POWER	supplied.	Indicate that control power is Control power is (200VAC) is input.
O.RUN	Indicate over speed	Motor speed exceeds 4,000 rpm.
O.V	Indicate overvoltage.	Abnormal increase of main circuit DC voltage.
O.C	Indicate overcurrent.	Motor current value exceeds current limit value.
O.L	Indicate overload.	Load to motor is too heavy.
RE.E	Indicate encoder error.	Disconnection of encoder signal lines, or power lines. Misconnection. Abnormal temperature rise inside the encoder.

☐ **Adjustment section**

Position	Symbol	Volume SW	Function	Set value at factory
Surface	SPEED	Speed	Volume for speed adjustment. Applied to speed command input. Forward rotation with + input.	Set to 3,000 rpm at ± 10 V.
Surface	SUB.S	Auxiliary speed	Volume to adjust auxiliary speed. Applied to aux. speed input (S.REF). Forward rotation with + input.	Set to 3,000 rpm at ± 10 V.
Surface	LAG.T	Start correction	Volume to adjust start characteristics.	"0"
Surface	AC.G	AC gain	Volume to adjust response characteristics.Adjust in compliance with load inertia.	"0"
Surface	ZERO	Zero balance	Volume to adjust motor rotation at 0 V speed command voltage.	Already adjusted to 0 rpm at 0 V.
Surface	RESET	Reset	Pushbutton switch to release from alarm condition. Same function as RESET input signal.	

Note 1: LAG.T and AC.G are adjusted so as not to vibrate at no load adjustment.

Note 2: Readjustments are required to get optimum value together with AC gain changeover (SW101).

4. DESIGN

☐ Setting section

Position	Symbol	Volume Switch	Function	Preset value at factory
Inside	T.LIM	Torque limit.	Volume to adjust current limit value at using torque limit input (CLIM).	"5" Set to approx. 150% of the rated torque.
Inside	SW101	AC gain change-over	Changeover switch to adjust response characteristics. Set as the below in compliance with load inertia. | Load inertia	Bit 1	Bit 2
Up to 3 times of motor inertia	OFF	OFF
2 to 5 times of motor inertia	ON	OFF
4 to 7 times of motor inertia	OFF	ON
6 to 10 times of motor inertia	ON	ON	 To get optimum gain, adjust by AC gain volume.	Bit 1 / Bit 2 : OFF / OFF
Inside	SW101	Proportional control change	Changeover switch to adjust response characteristics. Turning bit 3 ON changes PI control to P control and P control gain is changeable.	Bit 3 : OFF
Inside	SP101	Rotation direction change	Switch to reverse rotation direction change by impressed voltage to Vref. (Normally, forward at + and backward at -.)	Shorted "+" and "C" at CN101.

☐ Terminal blocks for power source and motor

Sign	Name	Contents
Ro To	Control power input	Power input terminal for control circuit. Supply commercial source between 170 and 264 VAC.
R S T	Main power input	Input terminal for motor power. Supply power between 170 and 253 VAC, 3-phase.
+	Positive line of main circuit	A terminal for the inverter main circuit. Note 2
JP	Built-in regenerative resistance	A terminal for inside regenerative resistance. Note 1
RE	Regenerative control terminal	A terminal for controlling outside and inside regenerative resistance. Note 1, Note 2
A B C	Output for the motor	Three-phase output terminal to AC servo motor. If three phases are misconnected, the motor cannot rotate. A-red, B-white, C-black

Note 1: • This function does not come with R88D-RA05 and R88D-RA10.

     • "JP" and "RE" is shorted for R88D-RA15 and R88D-RA20.

Note 2: • When installing outside resistance on R88D-RA15 and R88D-RA20, insert this resistance between "+" and "RE".

Note 3: • Connect "GR" to ground with class 3 or up.

4. DESIGN

4.2.3 Connectors and terminals

☐ Connector terminal for control

• Connector terminal for control circuit (CN1)

Connector CN1 has terminals for motor control signals and encoder signals.
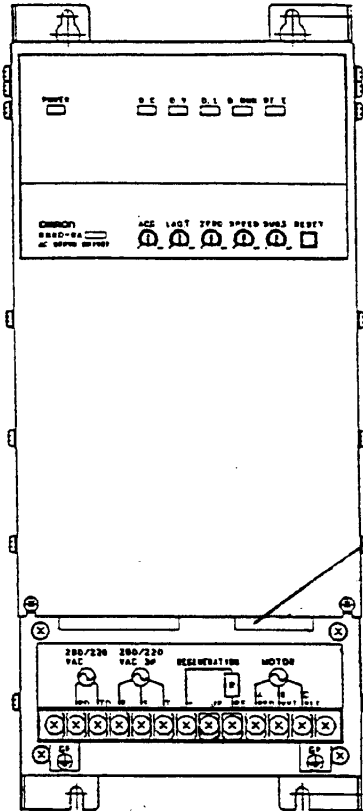
No	Signal	Function
1	REF	Speed command input
2	AG	Analog ground
3	SREF	Aux. speed command
4	AG	
5	AG	Analog ground
6	EGND	Encoder signal ground
7	ALM1	
8	ALM2	Alarm output
9	SG	Shield ground
10	AM	Current monitor output
11	AG	Analog ground
12	RUN	Operation ready command input
13	RESET	Alarm reset input
14	+A	Encoder A phase + output
15	-B	Encoder B phase - output
16	+Z	Encoder Z phase + output
17	NM	Speed monitor output
18	P15	+15 V output for speed setting
19	N15	-15 V output for speed setting
20	COM	+24 V common terminal for sequence
21	CLIM	Torque 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
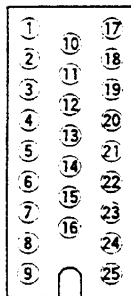
made by HONDA TSUSHIN KOGYO CO., LTD.

MR-25M (cable side)

MR-25L (cover)

4-12

☐ Connector for motor signal

• Connector for motor signal (CN2)

Connector CN2 has terminals to input encoder and pole sensor signals.
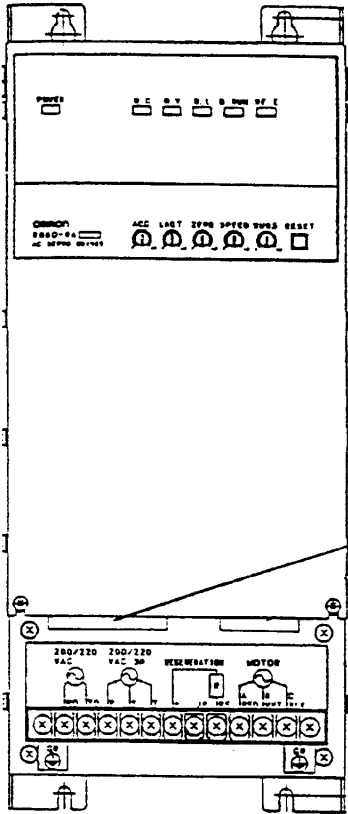
Connector for driver			Cable for motor		
No	Sign	Function	No.	Wire dia.	Wire color
1	+5V	Encoder supply power +5VDC	H	AWG22	Red
2	+5V				
3	0V	GND terminal of encoder power	G	AWG22	Black
4	0V				
5	RG	Encoder return ground	A	AWG22	Gray
6	SG	Shield ground		Shield	
7	-	Note 1			
8	-	Note 1			
9	-	Not used			
10	-	Not used			
11	A+	Encoder A phase +	D	AWG24	Blue
12	A-	Encoder A phase -	N	AWG24	Orange
13	B+	Encoder B phase +	M	AWG24	Pink
14	B-	Encoder B phase -	B	AWG24	Light blue
15	S+	Encoder S phase +	L	AWG24	Yellow
16	S-	Encoder S phase -	C	AWG24	Brown

Note 1: Do not connect any line to pin No.7 and 8.
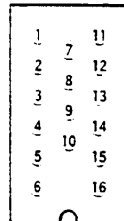
made by HONDA TSUSHIN KOGYO CO., LTD.

MR-16M (cable side)

MR-16L (cover)
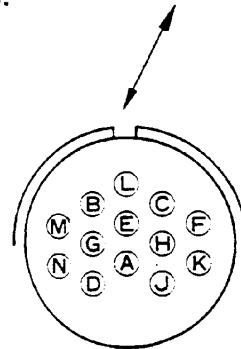
made by AMPHENOL

MS3106A20-11S (cable side)

MS3057A-12A (clamp)

4. DESIGN

4.2.4 Connector of motor
☐ **Connector for 600 - 1,100W motors**

Connector for motor signal	Connector for amateur
Made by AMPHENOL	Made by AMPHENOL
MS3106A20-11S	MS3106A20-4S
(Cable side)	(Cable side)
MS3057A-12A	MS3057A-12A
(Cable cramp)	(Cable cramp)
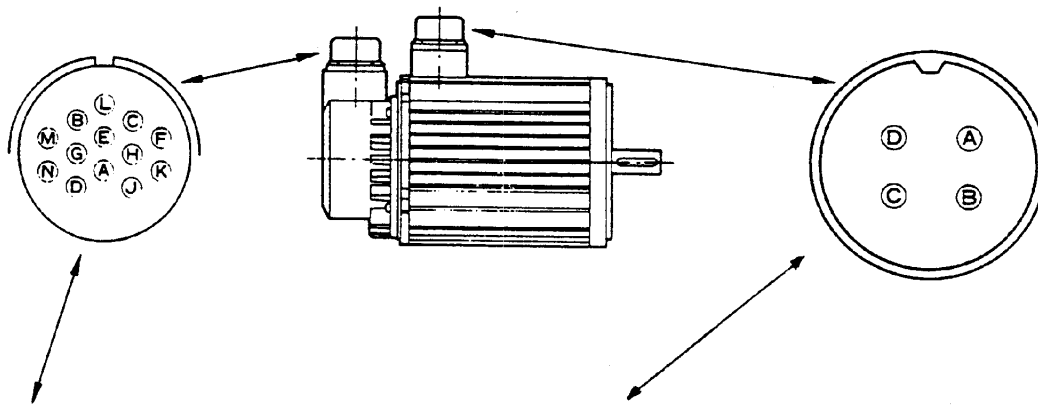
Connec-tor No.	Sign	Function	Cable Wire side	Wire color
A	RG	Encoder return ground	AWG22	Gray
B	B-	Encoder B phase -	AWG24	Light blue
C	S-	Encoder S phase -	AWG24	Brown
D	A+	Encoder A phase +	AWG24	Blue
E				
F				
G	0V	Terminal GND of encoder power.	AWG22	Black
H	+5V	Encoder supply power +5VDC	AWG22	Red
J				
K				
L	S+	Encoder S phase +	AWG24	Yellow
M	B+	Encoder B phase +	AWG24	Pink
N	A-	Encoder A phase -	AWG24	Orange

Connec-tor No.	Sign	Function	Cable Wire dia.	Wire color
A	A	Armature A phase input	AWG16 or up	Red
B	B	Armature B phase input	AWG16 or up	White
C	C	Armature C phase input	AWG16 or up	Black
D	GR	Motor frame ground	AWG16 or up	Green

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4.3 Connection with Support Devices and External Devices

4.3.1 Input/output interface

Note 1: The figure below is for reference. Follow designated time chart of upper master controller. (See section 6-3.)

Note 2: Wait 2 seconds or more after control power and main power being ON, to input RUN operation ready command input.(RUN)

Note 3: Signs in ( ) mean connector signs on R88M-R60030, R82030 and R1K130.

Note 4: Use insulation soldering iron or soldering.

Note 5: Use thermal proof vinyl covered wire (HIV, 75°C or up) for DC power and motor power lines.

Note 6: After switching power OFF, residual voltage remains in a terminal block. Do not touch terminals within 1 minute after power OFF.
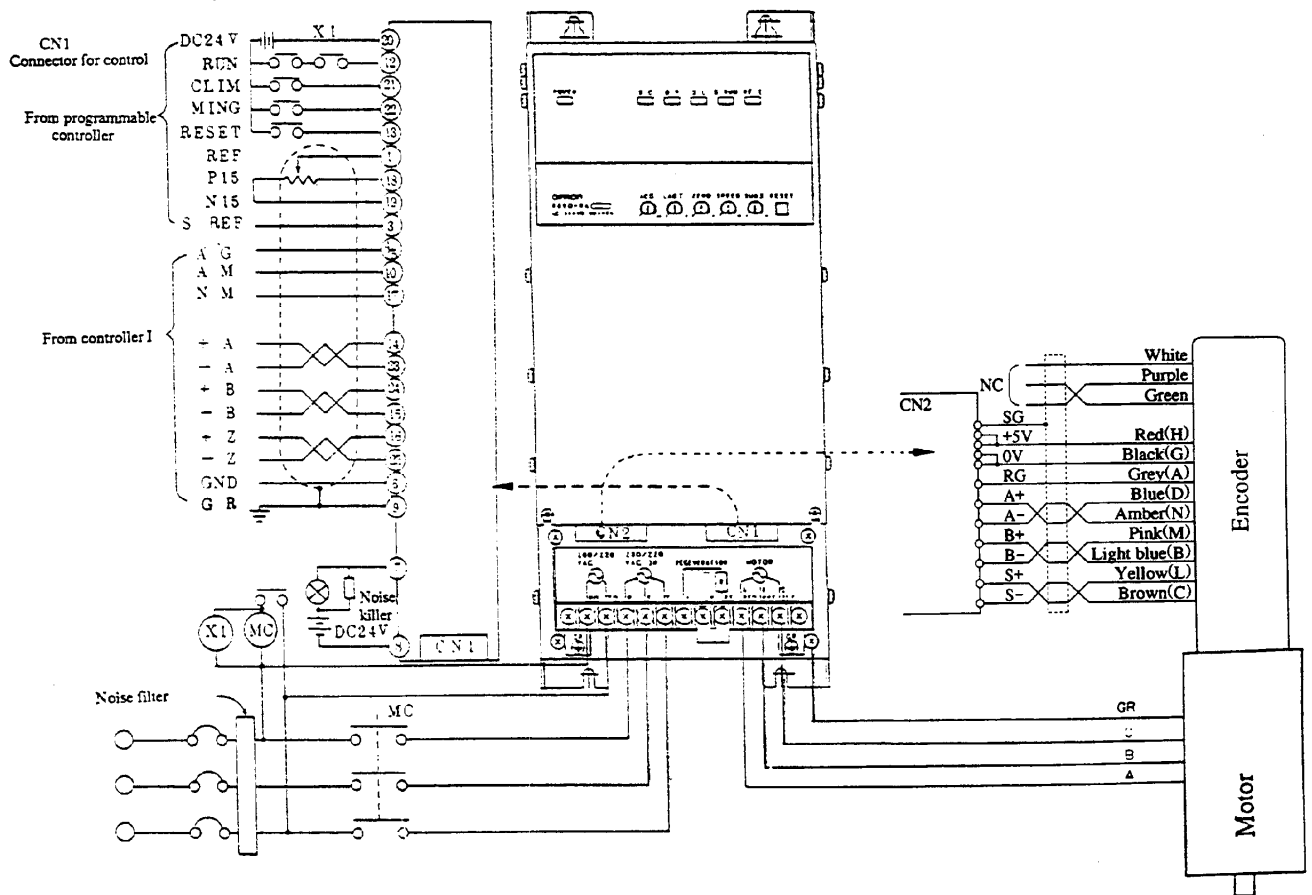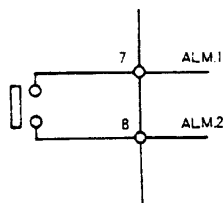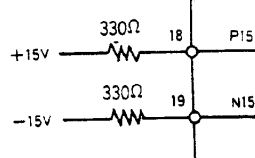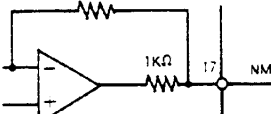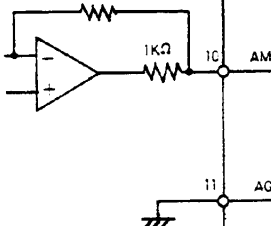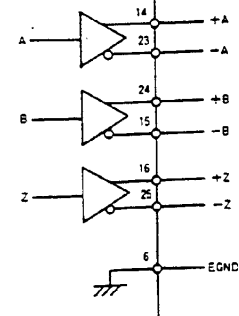
4. DESIGN

☐ Control input interface

Name of signal	Function	Specification	Interface
Speed command voltage (REF)	Motor rotates in accordance with speed command voltage. Forward rotation by +. Reverse rotation by -. To change rotation direction without changing polarity, set short pin SP101 between "C" and "-". Inside command voltage P15 and N15 is usable as speed command voltage.	$\pm 3,000$ rpm at command voltage ± 10V.	Input impedance
Aux. speed command voltage (SREF)	Add or reduce speed command voltage and to be used as synchronous control with multiple motors. When speed command voltage is relatively low, use this terminal. Motor get $\pm$ 3,000 rpm between $\pm$ 3 to $\pm$ 10 V.	$\pm 3,000$ rpm at command voltage ± 10V.	
Run command (RUN)	Inputting run command, the driver turns to operation condition.		
Alarm reset (RESET)	The driver shut off operation signal by actuation of error detection circuit. To release this condition, the reset signal is used. Before reset, check indication LED.	Input voltage: 24 VDC, 12 mA.	
Torque limit (CLIM)	ON: This signal limits supply current to motor to preset value by "TLIM" volume.		
Minimizing gain (MING)	ON: This signal is used for minimizing the vibration of servo motor. However, this signal decreases servo lock power.		
Positive common input for sequence (COM)	24 V sequence + common input		

❏ Control output interface

Name of signal	Function	Specification	Interface
Alarm output (ALM1) (ALM2)	Contactor output. Open at abnormal condition. It also opens while the reset signal is input.	Rated contact load: 24 VDC, 0.5 A At inductance load: 24 VDC, 0.3A cosø = 0.4 L/R = 7 ms.	
Built-in command voltage (P15, N15)	Volume for speed command setting. By connecting an external volume, this voltage is useful as speed command voltage. Output current should be less than 5 mA.		
Speed monitor output (NM)	This is an output to monitor the speed of servo motor. The voltage allowance is about ± 10%	CCW +7.5 V CW - 7.5 V at 3,000 rpm	
Current monitor terminal (AM)	An output to monitor supplied current to servo motor. This is output as voltage converting from supply current of servo motor armature line.	±12 V at the instant max.	
GND for monitor (AG)	Ground for monitor signal		
Encoder feedback output (A, B, Z)	Line driver output after receiving encoder signal from servo motor. For TTL level use, connect EGND and one of the lines according to its polarity.	EIA-RS-422 or equivalent	

4. DESIGN

◻ Connection with single axis positioner OMNUC N115 series/N116

DC Stable power supply

T/B	
24 VDC	
0 V	

DC24V

0V

CN3	
+V	1
Servo alarm	2
+0 V	3
+0 V	4
Run output 1	5
〃 2	6
	7
GND	8
Speed command voltage	9
GND	10
A phase	11
A̅ ̅p̅h̅a̅s̅e̅	12
B phase	13
B̅ ̅p̅h̅a̅s̅e̅	14
Z phase	15
Z̅ ̅p̅h̅a̅s̅e̅	16

R88D-RA series

CN1	
1	REF
2	AG
3	SREF
4	AG
5	AG
6	EGND
7	ALM1
8	ALM2
9	SG
10	AM
11	AG
12	RUN
13	RESET
14	+A
15	-B
16	+Z
17	NM
18	P15
19	N15
20	COM
21	CLIM
22	MING
23	-A
24	+B
25	-Z

Note: Use R88A-CPS series cables for connection.

4.3.2 Dynamic brake circuit

Dynamic brake circuit can be provided using optional sequence terminal T1.
The figure below shows connection diagram of the dynamic brake. Be sure to take off short pin SP1 on the control circuit board prior to using the dynamic brake.
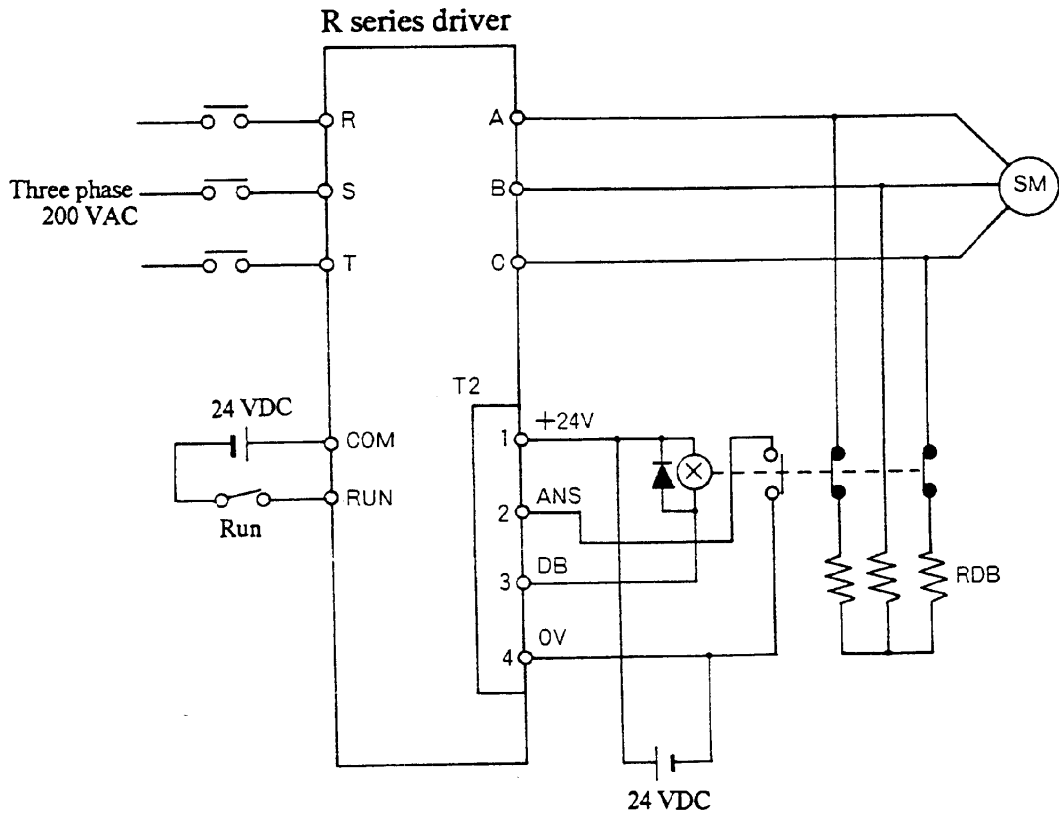
4. DESIGN

(1) Dynamic brake resistance

Motor model	Armature resistance (Ω)	Brake resistance RDB(Ω) should be greater than below	Counterelectromotive force voltage at 3,000 rpm
R88M-R10030	4.2	0	62.5 Vo-p
R88M-R20030	6.24	0	125 V
R88M-R30030	2.90	0	116 V
R88M-R45030	1.28	6.8 Ω - 20 W	102 V
R88M-R60030	1.95	6.8 Ω - 20 W	157.5 V
R88M-R82030	1.25	5.6 Ω - 20 W	164.5 V
R88M-R1K130	0.75	5.6 Ω - 20 W	167 V

(2) Relay

LY3(OMRON), 24 VDC or LY3-D, 24 VDC.

Or inside resistance 400 Ω or up, actuation current less than 60 mA, 24 VDC

(3) Diode

S5688G (TOSHIBA) or equivalent (400 V withstand voltage)

(4) Dynamic brake unit

A dynamic brake unit, integrated above circuit, is available.

(Model R88A-DB20 for 450 W or up)

4.3.3 Selection example of outer connecting parts

(1) No fuse breaker (NFB)

Use a breaker having applicable current value for your system. Never use one for semiconductor and one having characteristics for immediate response.

Use one with delay characteristics 62 (2.2 to 20 s. at 200% load).

(2) Noise filter (NF)

Phase	Model	Rated	Mfg.
Single phase	GT-205U	5A	TOKIN
	GT-210U	10A	
	ZAC2206-11	6A	TDK
	ZAC2210-11	10A	
	SUP-E3H-EP	3A	OKAYA ELECTRIC IND
	SUP-E5H-EP	5A	
Three phase	LF-315K	15A	TOKIN
	LF-325K	25A	
	LF-305	5A	
	LF-310	10A	
	LF-315	15A	
	LF-320	20A	
	ZCW2205-01	5A	TDK
	ZCW2210-01	10A	
	ZCW2220-01	15A	
	3SUP-A5J-E	5A	OKAYA ELECTRIC IND
	3SUP-A10J-E	10A	
	3SUP-A15J-E	20A	

(3) Magnet relay (MC)

Model	Current	Mfg.
MA415A	15A	
LC1-D173A60	18A	OMRON
LC1-D253A60	26A	

4. DESIGN

(4) Surge absorber (ZNR)

Model	Current	Mfg.
ERZC20EK471	5 kA	MATSUSHITA ELECTRIC
ERZC25EK471	10 kA	
ERZC32EK471	20 kA	

(5) Surge killer

Model	Current	Mfg.
CR-50500	50 Ω - 0.5 μF	OKAYA ELECTRIC IND
S2-A-0	200 Ω - 0.1 μF	
CRE-50500	50 Ω - 0.5 μF	

4.3.4 Calculation of regenerative energy

(1) In case of horizontal axis
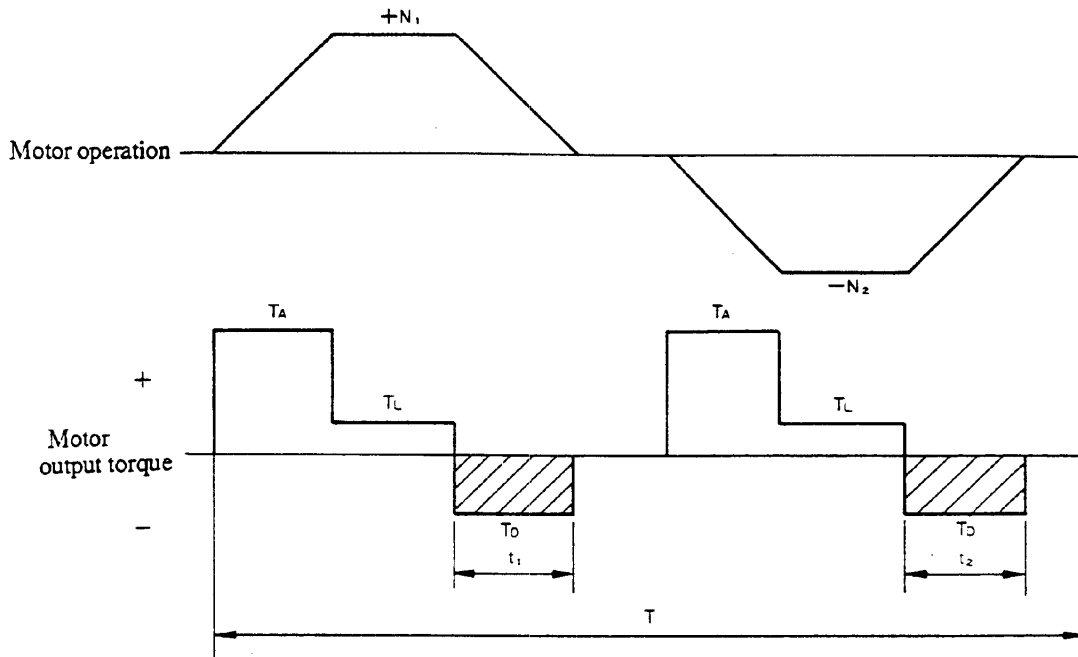
As shown above, regenerative energy occurs when motor output torque becomes negative.
Regenerative energy in each section is given in the formula below:

$$Eg_1 = \frac{1}{2} \times N_1 \times T_D \times t_1 \times 1.027 \times 10^{-2} \ [J]$$

$$Eg_2 = \frac{1}{2} \times N_2 \times T_D \times t_2 \times 1.027 \times 10^{-2} \ [J]$$

N   : Number of motor revolutions at triggering deceleration (rpm)

T_D : Required deceleration torque (kgf·cm)

t_1, t_2 : Deceleration interval (s)

Average regenerative power is given in the formula below:

$$Eg = \frac{(Eg1 + Eg2)}{T} \ (W) \qquad\qquad T: \text{operation cycle (s)}$$

Generally, there is energy loss by motor coiling resistance and actual value is approx. 90%
of above figure.

4. DESIGN

(2) In case of vertical axis
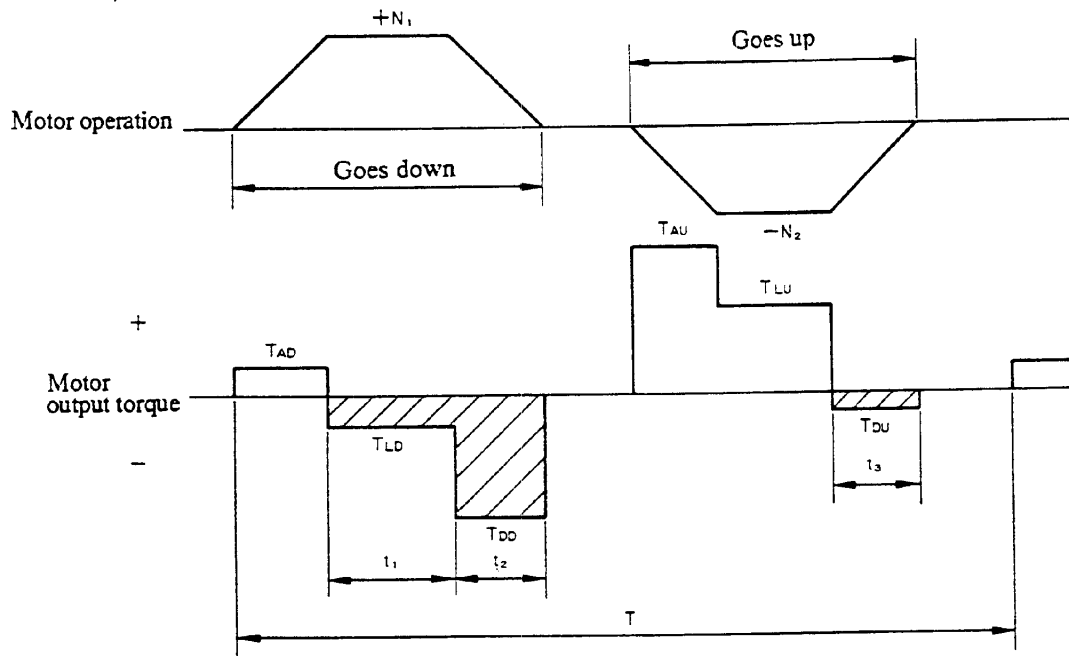
In the above movement, regenerative energy occurs while motor output torque becomes negative. Regenerative energies in each section is given by the formula below:

$$Eg_1 = N_1 \times T_{LD} \times t_1 \times 1.027 \times 10^{-2} \ [J]$$

$$Eg_2 = \frac{1}{2} \times N_1 \times T_{DD} \times t_2 \times 1.027 \times 10^{-2} \ [J]$$

$$Eg_3 = \frac{1}{2} \times N_2 \times T_{DU} \times t_3 \times 1.027 \times 10^{-2} \ [J]$$

N   : Number of motor revolutions at triggering deceleration (rpm)

T_D : Required deceleration torque (kgf·cm)

t_2, t_3 : Deceleration interval (s)

Average regenerative power is given in the formula below:

$$Eg = \frac{(Eg1 + Eg2 + Eg3)}{T} \ (W) \qquad T: \text{operation cycle (s)}$$

Generally, there is energy loss by motor coiling resistance and actual value is approx. 90% of above figure.

4.3.5 Absorption of regenerative energy

The regenerative energy circuit is installed only in R88D-RA15 and R88D-RA20. R88D-RA05 and R88D-RA10 are installed condensers for absorbing energy.

When regenerative energy exceeds the limited values below, install an outer regenerative resistance. For R88D-RA05 and R88D-RA10, use driver model 1 or 2 class up, lower operation speed, or set longer deceleration time to reduce regenerative energy.

Model	Allowable regenerative energy (J) at one regenerative operation	Average regenerative power (W)
R88D-RA05	45J	-
R88D-RA10	45J	-
R88D-RA15	200J	25W
R88D-RA20	200J	25W

Note 1: 1W = 1 J/S   1 cal = 4.2J

Note 2: Thermal produced by regenerative energy increases on right side of the driver. Design not to exceed 20°C at surface temperature of the driver.

For absorption of regenerative energy other than above method, prepare resistance parts at the outside of the driver. For fixing the outer regenerative resistance, take out contact metal from between JP and RE and connect the resistance in chain of "+" and "RE" referring to the figure below:
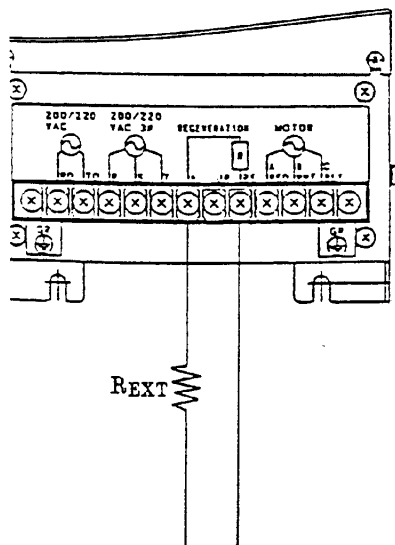
Use 47 Ω coiling resistance for R_{ext} and twist cables.
The following resistance are available. Select and order in accordance with regenerative capacity while checking delivery terms.

Model	Mfg.	Nominal capacity	Power at 120°C	Radiation condition
CF220N47ΩK	CHIBA OHM CO., LTD.	220W	60W	T1.0 SPCC 350 X 350
CAS200N47ΩK	CHIBA OHM CO., LTD.	200W	75W	T1.0 SPCC 350 X 350
CAS300N47ΩK	CHIBA OHM CO., LTD.	300W	90W	T1.0 SPCC 350 X 350
CAS400N47ΩK	CHIBA OHM CO., LTD.	400W	120W	T1.0 SPCC 350 X 350
MRS22N470K	MICRON INSTRUMENTS INC.	220W	60W	T1.0 SPCC 350 X 350
MLS20L470K	MICRON INSTRUMENTS INC.	200W	80W	T1.0 SPCC 350 X 350
MLC30L470K	MICRON INSTRUMENTS INC.	300W	110W	T1.0 SPCC 350 X 350
SMR220W47Ω	JAPAN REGISTOR MFG. CO., LTD.	220W	60W	T1.0 SPCC 350 X 350

In order to prevent smoke and fire due to thermal produced by resistance, we recommend to use thermal switch or temperature fuse installed types. Installation of a thermal switch near by the resistance has same function.
Set actuating temperature considering surrounding condition.

5.1 Unpacking

☐ **AC servo driver**

• Check the following items soon after opening the package.

Whether the delivered goods are different from the ordered ones.

Check whether the combination of servo motors and servo drivers are correct by referring to Item 1, 1-1.

Check for possible transportation damage, and check that screws have not been loosened.

Accessories

CN1	connector plug	MR-25M	1 pc.
CN1	connector case	MR-25L	1 pc.
CN2	connector plug	MR-16M	1 pc.
CN2	connector case	MR-16L	1 pc.
Fixing metal			2 pcs.
Fixing screw		M4x6	4 pcs.
Instruction Manual			1 set

☐ **AC servo motor**

Installation Manual	1 set

5. USAGE

5.2 Trial Operation

☐ Check items before operation.

Confirm the following before start operations

1	Supplied power should be 170 to 242 VAC, 50/60 Hz
2	Has a circuit to turn OFF 200 VAC of the power unit automatically when the servo driver supplies servo abnormal alarm signals.
3	Remove the motor from machine during the trial operation. When it is installed, be ready to stop the motor anytime. Confirm that no one is near the machine.

• Changing rotation direction.

Changing rotation direction is done by switching SP101 on the inside control board

(1) Check that the run signal (RUN) is not input and speed command voltage (REF) is 0 V.

Otherwise, the motor rotates too soon after power is supplied.

(2) Put ON control power

(3) Confirm the power indication LED (POWER) is ON. When the LED does not light, check the voltage (170 to 264 VAC) on control power input terminal (Ro.To).

(4) Confirmation of abnormal circuits

Confirm that the system has a circuit to switch OFF main power automatically when abnormal signals are supplied.

(5) Supply main circuit power.

(6) Input RUN (ready for operation) signal two seconds after turning ON main circuit power.

With inputting RUN signal, the motor has holding torque.

If command pulse is supplied, be sure that motor rotates soon after inputting RUN signal.Even if speed command voltage is 0 V, the motor may rotate quite slowly by drift inside the servo driver. In this case, adjust zero balance volume to eliminate drift.

(7) Input command voltage

Gradually raise speed command voltage starting at 0 V, and check whether the motor is rotationg smoothly in proportion to voltage raise.The motor rotates forward with positive voltage and in reverse with negative voltage. To change rotation direction without changing voltage polarity, short "C" and "-" by SP101.

(8) When there are problems such as no rotation and rotation without control of the motor, check red LED and see item 6-3, "Troubleshooting.".

(9) Confirm other functions below...

- Gain minimizing (MING) Decrease vibration of the servo motor. Servo lock power is weakened.

- Torque limit (CLIM) Turn the torque limit volume (TLIM) toward CCW direction and check that motor torque is decreased.

- Alarm reset (RESET) Check that after protection circuit - such as emergency input etc.- works, alarm condition is released by RESET input.

After confirmation of above, operate the motor with the rated operation cycle.

Check heat condition of the motor and driver after 2 to 3 hours of operation.

5. USAGE

5.3 Adjustment

The servo driver is adjusted with no load at delivery. Adjust and get the optimum condition by referring to the following chart.

Name of volume SW	Functions	Vibration by adjustment
Speed (SPEED) Aux. speed (SUB. S)	Adjust motor rotation speed Adjusted to get the rated rpm at speed command ± 10 V. To increase speed, turn volumes CW direction.	Speed command Voltage --- CW direction ... CCW direction rpm
Zero balance (ZERO)	Zero adjustment Adjust the motor rotation to almost zero at speed command 0 V.	Speed command Voltage ----- CW direction —·—·— CCW direction rpm
AC gain (ACG)	AC gain adjustment This is used to adjust response characteristics. Adjust in accordance with load inertia. To monitor response characteristics, use speed monitor signal. Gain → Volume 0 Volume 10 Response frequency	AC gain increase and improves frequency characteristics by turning the volume in a clockwise direction. In case of a small load inertia, decrease the AC gain and vice-versa to minimize overshoot and undershoot. Too much AC gain causes vibration and an unstable condition for the motor. When AC gain is low Speed → When AC gain is high Time →

Name of volume SW	Functions	Vibration by adjustment
Acceleration correction (LAG.T)	Acceleration correction Together with AC gain, adjust acceleration characteristics. It adjust phase and gain at high range.	This volume improves response characteristics by increasing this value when the load rigidity is high enough. However, this is not effective when the load rigidity is low. Adjust within a range that does not cause vibration during rotation.
Torque control (TOL.L)	This torque control is engaged by CLIM signal, and the maximum current value is limited by this setting value. (Switching ON bit 3 of the changeover switch makes variable proportionalcontrol gain by a variable resistance.)	Increase the setting value by turning the volume in the CW direction. Maximum setting is instantaneous maximum torque.
Rotation direction changeover SP101	When "C" and "–" are shorted: Forward rotation is engaged by positive voltage. Reverse rotation is engaged by negative voltage. When "C" and "+" are shorted: Reverse rotation is engaged by positive voltage.Forward rotation is engaged by negative voltage.	When both switches are shorted, or not shorted, the motor cannot rotate.
AC gain changeover SW-101	This is a switch to adjust response characteristics. Adjust with load inertia. See the table right for reference.	Load inertia / No.1 / No.2 table and note below
Proportional control changeover SW101	Switching ON bit 3 makes variable proportional control gain by the TLIM volume. This is useful at proportional control.	

For the AC gain changeover row, right column:

Load inertia	No.1	No.2
0-3 times of motor inertia	OFF	OFF
2-5 times of motor inertia	ON	OFF
4-7 times of motor inertia	OFF	ON
6-10 times of motor inertia	ON	ON

For finer adjustment, use the AC gain volume.

6.1 Protective and Check Functions

LED on the display section indicate operation and abnormal conditions of the servo driver.

□ Green LED

Display	Function	Condition
POWER	Indicate pilot lamp	Control power (200 VAC) is input.

□ Red LED

Display	Function	Condition
O.V	Overvoltage indication	• When the main power DC voltage abnormally increases.
O.L	Overload indication	• When the motor load is too heavy.
O.RUN	Abnormal speed counter over	• When the motor exceeds the instantaneous max. speed. • When encoder signals are abnormal condition.
O.C	Overcurrent indication	• Supply current to the motor exceeds limited value. • Main circuit power is disconnected. • The fuse element is blown.
RE.E	Encoder error	• When encoder signals are abnormal condition. • Abnormal temperature rise of encoder inside.

6. MAINTENANCE

In order to protect the servo driver and servo motor, the following protective circuits are integrated.
When a protective circuit works, the driver stops operation and supplies servo abnormal signal. At this time, the motor axis turns to free condition. If you need to lock the axis, mechanical brake is required.

☐ Servo driver

Protective function	Indicating LED	Function	Causes
Main circuit fuse	O.C lights	When an overcurrent is supplied to the main circuit, fuse blows and opens circuit connection.	• Short circuit between driver and motor.
Overcurrent detection	O.C lights	The driver detects when the DC main circuit receives overcurrent and shut off the base.	• Short circuit between driver and motor.
Overvoltage protection	O.V lights	The driver opens the base when the main circuit power voltage exceeds the rated value due to regenerative resistance.	• Too much load inertia. • Supplied power exceeds the rated value.
Overload protection	O.L lights	The driver opens the base when the motor exceeds coil thermal time constant.	• Too much load torque. • Miswiring between A, B, and C phase. • Mechanical lock of motor axis.
Temp. rise of radiation fin	O.L lights	The driver opens the base when the radiation fin of the inverter exceeds the rated value.	• Too much load torque. • Miswiring between A, B, and C phase. • Mechanical lock of motor axis.
Detection of signal disconnection	RE.E lights	The driver opens the base when RE or PS signal is disconnected.	• RE or PS is disconnected.
Abnormal power	POWER flickers	The driver opens the base when the power is lower it voltage than the rated value.	• Voltage down of supplied power. • Lack of the power capacity.
Overspeed	O.RUN lights	The driver opens the base when the motor exceeds the rated speed.	• The motor rotates with more than the rated speed. Disconnection of encoder signal cables
Instantaneous stoppage of the power supply		The driver opens the base at the power failure for more than 40 msec.	• Instantaneous power failure of AC commercial line.
Control power fuse	POWER lights OFF	The fuse is brown with high current to the control circuit.	• Shorted, malfunction in the control circuit.
Lack of phase	O.C lights	One phase of main circuit is failure.	Supplied power is abnormal condition.

☐ Alarm contactor output (OMRON G2E-184P-H-M or equivalent)

Contactor section

Load	Resistance load (cosφ = 1)	Induction cosφ = 0.4 Load L/R = 7 mS
Rated load	24 VDC, 0.5 A	24 VDC, 0.3 A

Note: Never connect 100 VAC line to the alarm contactor output.

• Protections and alarm timing when the power ON, OFF and down.

In order to protect a built-in power transistor from misoperation of the servo driver, the following measures are provided:

1) At power ON, the inside the driver goes into the alarm condition. It is released after approx. 800 ms. after putting ON alarm control power.

2) At power OFF, shut off operation signal inside the unit while the control power in the unit is within the normal range.

If the stopping time is less than 40 ms., servo abnormal alarm is not supplied.

3) Timing chart

• Overcurrent detection   • Overspeed   • Radiation fin temp. rise   • Control circuit fuse
• Overvoltage protection   • Overload protection   • Instantaneous power failure • Lack of phase
• Main circuit fuse   • Signal line disconnection • Abnormal power etc.
                                     detection
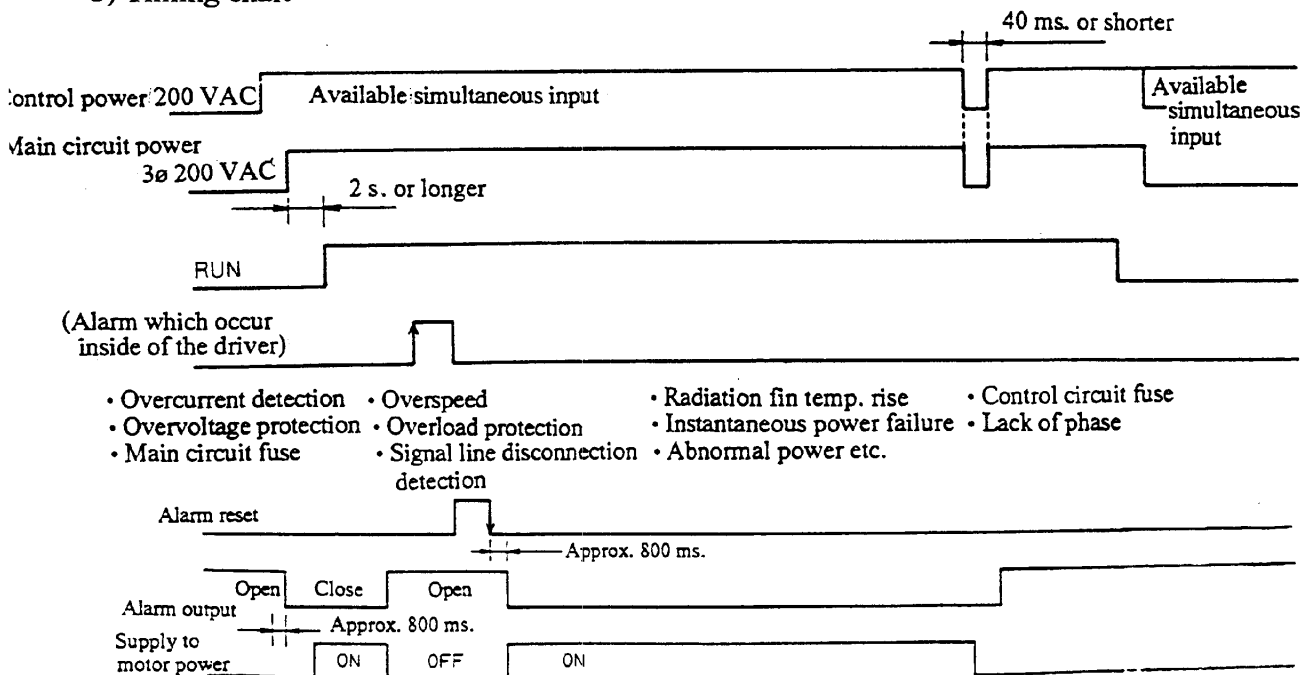
Alarm signals output through relay contacts. It takes approx. 10 ms. to supply alarm output as relay output after the alarm occurs inside of the unit.

Be sure to secure 2 s. interval to put ON RUN signal after turning ON main circuit power. Simultaneous input of both may blown protective fuse due to surge in current.

Turn off the main circuit power and control power simultaneously or turn off the main circuit power before turning off the control power.

6. MAINTENANCE

☐ Cautions at alarm output

1. The unit outputs abnormal alarm as relay contact simultaneously at abnormal indication on LED.

    This output is available even if the power of the servo driver is OFF.

    The contactor closes after approx. 800 ms. of control power OFF.

2. The unit shuts off RUN signal together with alarm output. Thus, the electrical brake of the motor (regenerative control) does not work.

    In order to stop the axis in this condition, make a circuit to trigger the mechanical brake with this alarm contact signal.

3. Abnormal condition of control power automatically is released after ± 15V being returned to normal condition. Other abnormal alarms are released by reset button, reset signal input, and the re-input of power.

    When the unit receives reset signal or power ON while inputting a RUN signal, make sure it has been in operation for approx. 800 ms.

4. When an abnormal signal outputs, turn OFF the driving power input and operation command input.

    Keep power to the servo driver ON, and check the abnormal condition with LED.

    Remove causes of the abnormal condition and restart operation.

> When an overload (O.L) occurrs, an abnormality in the mechanical section may be the cause. Check the mechanical section. Do not supply power more than 10 minutes after this alarm condition. Repeated overload may burnout the motor coil.

5. The driver becomes operational condition after approx. 800 ms. of inputting control power 200 VAC, single phase. Supply main circuit power 100 ms. before inputting the run command. Otherwise, the driver stops operation, flickering O.C as it detects a fuse blown or the lack of a phase. To restart operation, put OFF main circuit power, and input reset signal.

6. When an alarm signal is output, check wiring and the installation of the system.

6.2 Maintenance

☐ **Daily check**

Confirm whether there are abnormal noise, loose screws, or abnormal heat in the motor, and operating ambient temperature while in operation.

There is no daily check item for the servo driver. Check ambient temperature, dust on the forced cooling fan.

☐ **Periodical check**

● Servo motor

  · Abnormal noise from the motor.

  · Looseness of retention screws.

  · Outside look.

● Servo driver

  · Looseness of terminals, connectors, and retention screws.

  · Dust in ventilation holes of the servo driver.

6. MAINTENANCE

☐ **Periodical Maintenance for Parts**

The servo motor and driver are comprised of many mechanical and electronic parts. To ensure that the motor remains in peak condition throughout its expected service life, some parts require periodical maintenance or replacement according to the specified service life of each.

(Taken from "Periodical Maintenance Recommended for General-Purpose Inverters" compiled by JEMA).

The maintenance interval depends on the environment and operating condition in which the servo motor or driver is used. The following shows the recommended maintenance intervals for major parts:

● **Servo Motor**

Recommended maintenance interval:

        Oil seal: 2,000 hours

        Bearing: 30,000 hours

The above maintenance intervals are based on the assumption that the ambient temperature, shaft load, torque, and rotation rate are within the specified range, and that the unit was installed according to the Instruction Manual.

When the timing pulley or other belt- loaded pulleys are operating (rotating), they sustain a radial load twice as high as the stationary load. Design the belt system so that the motor's maximum shaft load is not exceeded when the belt system is operating. The motor shaft may sustain damage or the bearing may seize if this is not done.

● **Servo Driver**

Recommended maintenance interval:

        Electrolytic capacitors: 30,000 hours

The above maintenance interval is based on the assumption that the ambient temperature is a maximum of 40 °C, torque is within the specified range, and the unit was installed according to the Instruction Manual. The maintenance interval can be exteneded by keeping the ambient temperature and operating time as low as possible.

*For detailed maintenance methods, consult our sales engineer.

6.3 Troubleshooting

Use this chart to locate the cause of malfunctions.

☐ **Diagnosis Based on LED Information**

LED on	Theory	Possible cause	Items to check	Action
O.C.	Main circuit overcurrent: A current exceeding the maximum allowable output current passed though the main circuit.	Motor's power supply cables are shorted across two phases.	Measure power cables' inter-phase insulation resistances with a 500 V (or 250 V) megger (must be 5M or higher).	Replace the motor power cable.
		Motor cable sustain burn damage.	Check motor cable's DC resistance against the rated value.	Replace the motor.
		One of the three phase wirings is connected to FG.	Check motor power cable connections.	Replace the motor power cable.
		Main circuit's supply terminals are shorted to each other or to FG.	Check main circuit supply terminal connections.	Correct main circuit terminal connections.
		Servo driver is damaged.		Replace the driver.
	Open-phase: No voltage is applied across any pair of three-phase supply inputs.	At least one of the 3-phase wirings is open.	Check main circuit supply terminal connections.	Correct main circuit terminal connections.
		Three-phase supply voltage is less than 170 V.	Check main circuit supply voltage.	Increase main circuit supply voltage to 170 V or above (not exceeding 253 V).

6. MAINTENANCE

LED on	Theory	Possible cause	Items to check	Action
O.V.	Main circuit overvoltage: A DC voltage exceeding 380 V was applied to the main circuit.	Main circuit's supply voltage exceeds 253 V.	Check main circuit supply voltage.	Lower main circuit supply voltage to 253 V or below(not less than 170 V).
		Regeneration exceeds the allowable level.	Calculate regeneration.	Use a regenerative resistor (for the R88D-RA15/20).
				Extend deceleration time.
		One of the three-phase wirings is connected to FG.	Check motor power cable connections.	Correct power cable connections.
		Servo driver is damaged.		Replace the driver.

LED on	Theory	Possible cause	Items to check	Action
O.L.	Motor overload: Motor overload is detected from reverse time if the effective motor current exceeds the rated motor current. Motor overload is also detected if the maximum motor current is surpassed for 3 seconds, or a current which is 130% to 150% of the rated current lasts for 20 sec.	Load torque or acceleration/ deceleration torque is too high.	Calculate effective torque (with an NM/AM monitor).	Extend acceleration/ deceleration time.
				Choose a motor with the correct rating.
		Motor is vibrating.	Observe the NM/AM monitor output with an oscilloscope.	Adjust gain.
		Motor's power cables are cross- connected.	Check motor power cable connections.	Correct power cable connections.
		Motor bearings are damaged.	With all motor cabling disconnected, check to see if the motor shaft can be manually rotated with relative ease (do not short power cables).	Replace the motor.
		Servo driver is damaged.		Replace the driver.
	Driver overheat: Driver overheat is detected if the driver heat sink temperature exceeds 65°C.	Servo driver's ambient temperature is too high.	Check to see if the driver's ambient temperature does not exceed 55 °C.	Lower driver's ambient temperature.
		Servo driver is damaged.		Replace the driver.

6. MAINTENANCE

LED on	Theory	Possible cause	Items to check	Action
O.RUN	Overspeed: Overspeed is detected if the on/off period of encoder's magnetic pole sensor exceeds the rated maximum at 4000 rpm.	Motor speed exceeded 4000 rpm.	Observe the NM monitor output with an oscilloscope.	Lower the maximum speed.
				Adjust gain (4000 rpm is exceeded due to overshoot).
		Noise is created in the encoder cable.	Check the encoder cable.	Use a shielded twist- pair cable (encoder cable by OMRON).
		Encoder cable is cross-connected.	Check encoder cable connections.	Correct encoder cable connections.
		Servo driver is damaged.		Replace the driver.
RE.E	Encoder failure: Encoder failure is detected if the line driver signals at the encoder output are simultaneously set to high.	Encoder cable is cut off.	Check encoder cable's continuity.	Replace the encoder cable.
		Encoder signal wirings are cross- connected.	Check encoder cable connections.	Correct encoder cable connections.
		Encoder's internal temperature exceeds 85°C.	Encoder cover temperature exceeds 70°C.	Improve heat dissipation.
				Lower the ambient temperature.
		Encoder is damaged.		Replace the motor.
		Servo driver is damaged.		Replace the driver.

For other symptoms, consult us.

☐ Check motor conditions

Check abnormal condition due to mismatch of coupling center.

Noise: Confirm that AC gain is not excessive.

Confirm that the motor rotor is rotating smoothly.

Confirm that there is no abnormal sound by wear of ball bearings.

Thermal: Check that load actual torque is within the motor rated torque.

<u>When OL lights, wait at least 10 minutes to cool. Repeated alarm condition without cooling may damage the motor.</u>

Vibration: Vibration occurs at following conditions:

        (1) When AC gain increases too much.

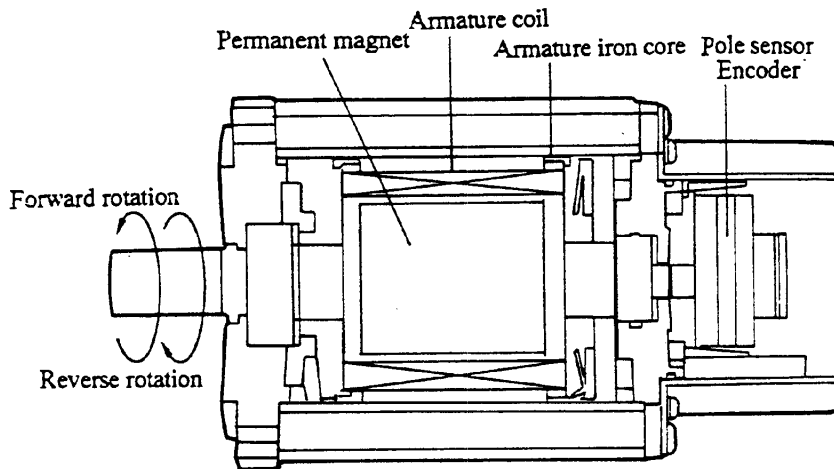   (2) When LAG gain increases too much.

        (3) When resonance point of mechanical section is within servo loop response range.

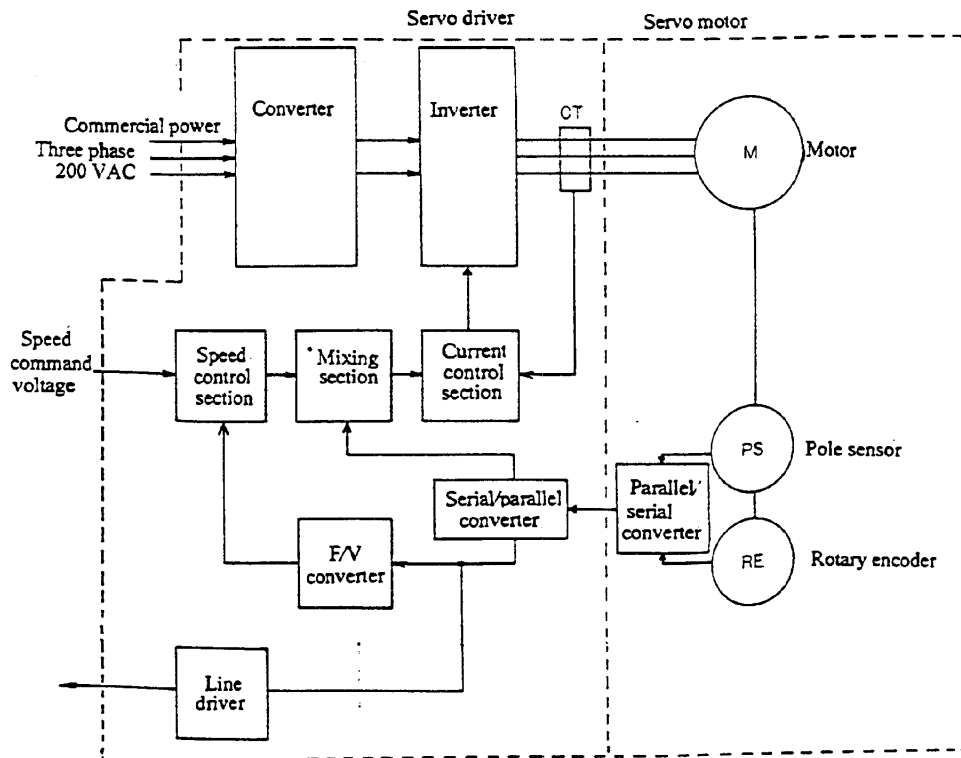# 7. CONFIGURATION, CONSTRUCTION AND OPERATION PRINCIPLE

7.1 Structure of Motor and Driver

❏ Structure of motor

AC servo motor is a synchronous motor having rotating core of permanent magnet.

Fields consist of 3-phase coiling wires on iron core. Pole change in accordance with the position of a rotor is required for coiling wires which is not required for DC servo motors. Therefore, a pole sensor is installed together with an encoder.

❏ Structure of servo driver

- **Converter**

  Changer commercial electric 200VAC to DC, and supply to main circuit of the servo driver.

- **Inverter**

  This section controls current supplied to field coil from DC power by PWM system.

- **Pole sensor**

  This is a sensor to control supply timing of the inverter AC current with detection of the motor rotor position.

- **Rotary encoder**

  Incremental encoder having precision of 1,000 P/R for control motor speed and positioning.

□ Inner configuration