YASKAWA ELECTRIC

TSE-S800-8
BULLETIN

ANALOG CLAMP SYSTEM

AC Servo Drives

R SERIES FOR POSITIONING CONTROL

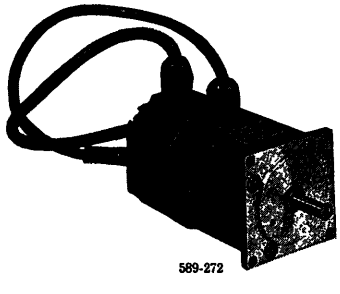
Servomotor TYPE USAREM- C 2 (for 200V) (With Optical
D 2 (for 100V) Encoder

Servopack™ TYPE CACR-PR AD3 R (for 200V)
CACR-PR AD4 R (for 100V)

Yaskawa AC Servo Drives have been developed as the basic mechatronics drives for the most advanced FA and FMA including robots and machine tools.

In addition to our AC Servo Drive R series, which has been favorably received, a commercial series of an AC servo with analog clamp system has been developed at this time with application of technology enhanced with our DC servo analog clamp system.

In addition to naturally achieving stable high accuracy and high speed response control, this is a product series of great variety in which emphasis has been placed on high power, compactness and high density mounting.



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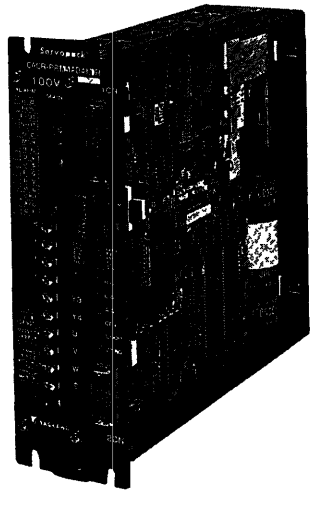

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(1) Ratings

Time Rating: Continuous
Insulation: Class B
Isolation Voltage: 1000 VAC, one minute
Insulation Resistance: 500 VDC, 10MΩ or more
Enclosure: Totally-enclosed, self-cooled
Ambient Temperature: 0 to +40°C
Storage Temperature: -20 to +60°C
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15 μm or below
Finish in Munsell Notation: N1.5
Excitation: Permanent magnet
Mounting: Flange mounted
Drive Method: Direct drive

Table 1 1 Ratings and Specifications of R Series AC Servomotors (For 200V)

Item \ Motor Type USAREM-		A5C ⬚2	01C ⬚2	02C ⬚2
Rated Output*	W (HP)	50 (0 07)	100 (0 13)	200 (0 27)
Rated Torque*	N-m (oz・in)	0 159 (22 5)	0 318 (45)	0 637 (90)
Continuous Max Torque*	N-m (oz・in)	0 19 (25 9)	0 382 (51 8)	0 765 (103 5)
Peak Torque*	N-m (oz・in)	0 476 (67 5)	0 955 (135)	1 91 (270)
Rated Current*	A	0 71	1 0	2 0
Rated Speed*	r/min	3000		
Max Speed*	r/min	4500		
Torque Constant	N-m/A (oz・in/A)	0 235 (33 3)	0 353 (50 0)	0 346 (49 0)
Moment of Motor Inertia $J_M(=GD^2/4)$	$kg \cdot m^2 \times 10^{-4}$ $(oz \cdot in \cdot s^2 \times 10^{-3})$	7 64 (1 08)	12 5 (1 78)	50 7 (7 18)
Power Rate*	kW/s	3 30	8 09	8 01
Inertia Time Constant	ms	4 4	3 4	2 9
Inductive Time Constant	ms	1 3	1.6	4 1

* Values when servomotor is combined with Servopack and the armature winding temperature is 75℃
Other values are for temperature of 20℃ Shown are normal (TYP) values above

Note
1 [---]in type designation is determined by output pulses (pulses/rev) of optical encoder as follows ·
- Standard N (1000 pulses/rev for analog clamp)
- Optional Q (2000 pulses/rev for analog clamp)

2 The power supply unit for brake
- Input 200 VAC, Output 90 VDC (DP8401002-1)

For details, see par 8 3 on page 40

1.1 RATINGS AND SPECIFICATIONS OF R SERIES AC SERVOMOTORS (FOR 200V) (Cont'd)

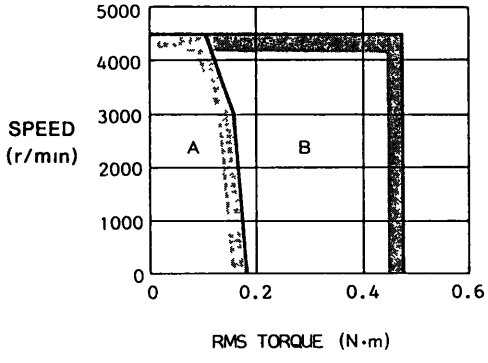
(2) Torque-Speed Characteristics

The values in intermittent duty zone are normal (TYP) values when the power voltage of Servopack is 200 VAC.

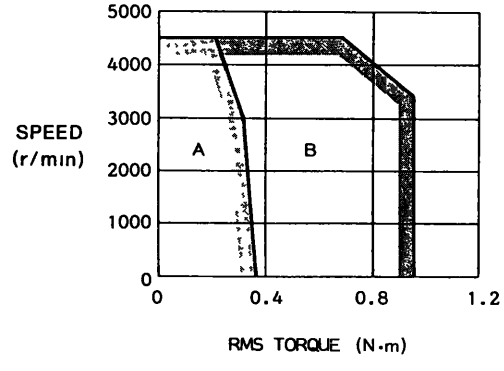
If 200 VAC or below, the output characteristics may be decreased even if the data is within allowable variation.

■ r/min-N•m

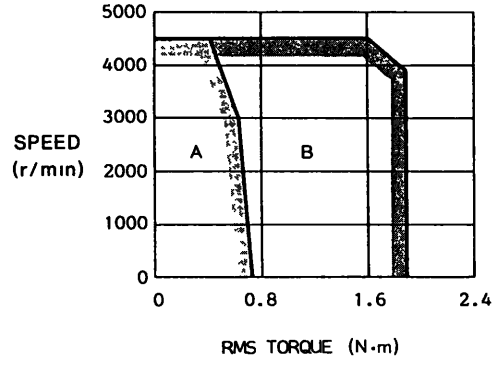
Type USAREM-A5C



Type USAREM-01C

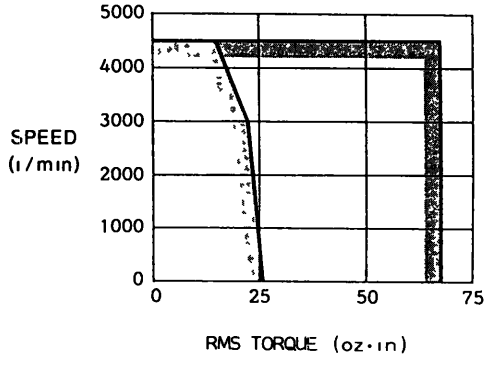


Type USAREM-02C

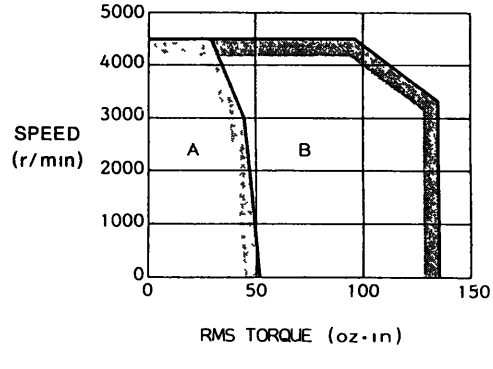


■ r/min-oz•in

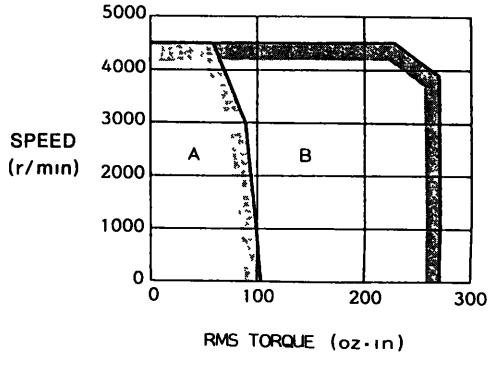
Type USAREM-A5C



Type USAREM-01C



Type USAREM-02C



A : Continuous Duty Zone

B : Intermittent Duty Zone

1.2 RATINGS AND SPECIFICATIONS OF R SERIES AC SERVOMOTORS (FOR 100V)

(1) Ratings

Time Rating: Continuous
Insulation: Class B
Isolation Voltage: 1000 VAC, one minute
Insulation Resistance: 500 VDC, 10MΩ or more
Enclosure: Totally-enclosed, self-cooled
Ambient Temperature: 0 to +40°C
Ambient Humidity: 20% to 80% (non-condensing)
Vibration: 15 μm or below
Finish in Munsell Notation: N1.5
Excitation: Permanent magnet
Mounting: Flange mounted
Drive Method: Direct drive

Table 1 2 Ratings and Specifications of R Series AC Servomotors (For 100V)

Item \ Motor Type USAREM-		A5D ⬚ 2	01D ⬚ 2	02D ⬚ 2
Rated Output*	W (HP)	50 (0 07)	100 (0 13)	200 (0 27)
Rated Torque*	N-m (oz • in)	0 159 (22 5)	0 318 (45)	0 637 (90)
Continuous Max Torque*	N-m (oz • in)	0 19 (25 9)	0 382 (51 8)	0 765 (103 5)
Peak Torque*	N-m (oz • in)	0 476 (67 5)	0 955 (135)	1 91 (270)
Rated Current*	A	1 2	1 7	2 9
Rated Speed*	r/min	3000		
Max Speed*	r/min	4000		
Torque Constant	N-m/A (oz • in/A)	0 136 (19 3)	0 198 (28 1)	0 235 (33 3)
Moment of Motor Inertia $J_M(=GD^2/4)$	$kg \cdot m^2 \times 10^{-4}$ $(oz \cdot in \cdot s^2 \times 10^{-3})$	7 64 (1 08)	12 5 (1 78)	50 7 (7 18)
Power Rate*	kW/s	3 30	8 09	8 01
Inertia Time Constant	ms	4 2	3 2	3 0
Inductive Time Constant	ms	1 4	1 7	4 0

* Values when servomotor is combined with Servopack and the armature winding temperature is 75℃
Other values are for temperature of 20℃. Shown are normal (TYP) values above.

Note
1 ⬚ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows
- Standard · N (1000 pulses/rev)
- Optional Q (2000 pulses/rev)

2 The power supply unit for brake
- Input 100 VAC, Output 90 VDC (DP8401002-2)

For details, see par 8 3 on page 40

1.2 RATINGS AND SPECIFICATIONS OF R SERIES AC SERVOMOTORS (FOR 100V) (Cont'd)

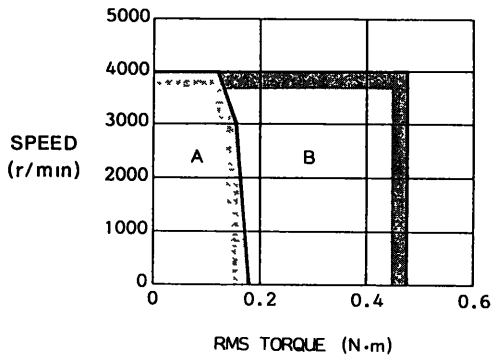
(2) Torque-Speed Characteristics

The values in intermittent duty zone are normal (TYP) values when the power voltage of Servopack is 100 VAC.

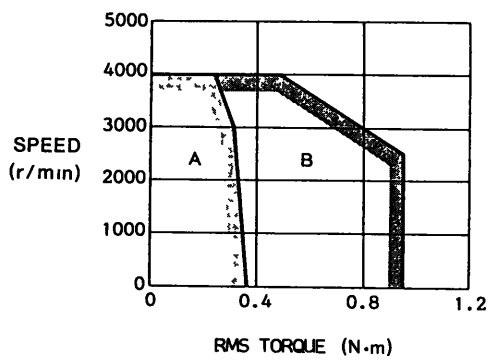
If 100 VAC or below, the output characteristics may be decreased even if the data is within allowable variation.

■ r/min-N•m

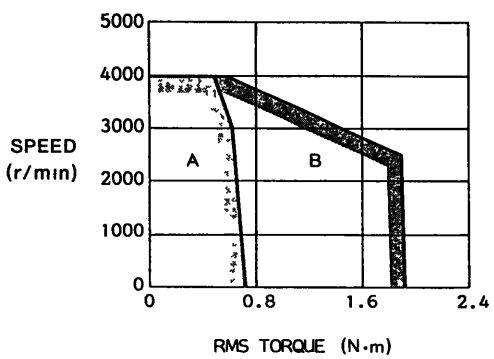
Type USAREM-A5D



Type USAREM-01D

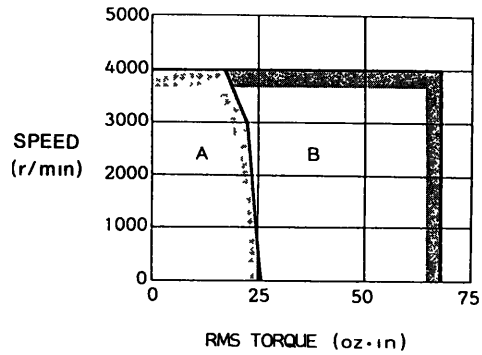


Type USAREM-02D

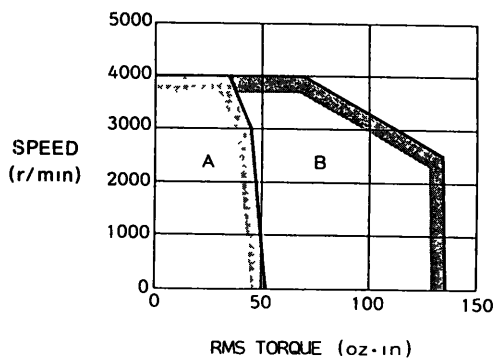


■ r/min-oz•in

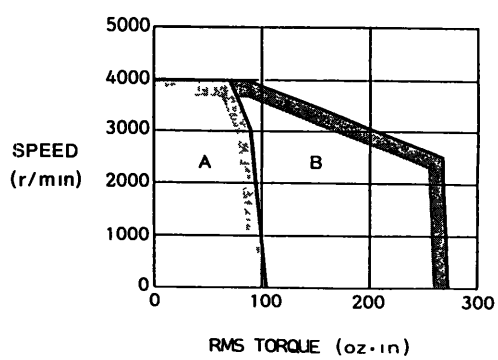
Type USAREM-A5D



Type USAREM-01D



Type USAREM-02D



A : Continuous Duty Zone

B : Intermittent Duty Zone

1.3 RATINGS AND SPECIFICATIONS OF *Servopack*

Table 1 3 Ratings and Specifications of Servopack

Voltage Class			200V		
Servopack Type CACR-			PRA5AD3 □R	PR01AD3 □R	PR02AD3 □R
Combined Specifications	Applicable AC Servomotor	Type USAREM-	A5C	01C	02C
		Output W (HP)	50 (0 07)	100 (0 13)	200 (0 27)
		Rated/Max Speed r/min	3000/4500		
	Continuous Output Current A (rms)		0 7	1 0	2 0
	Max Output Current A (rms)		2 1	2 8	5 7
	Allowable Load J*1 ($=GD^2/4$) kg·m²×10⁻⁴ (oz·in·s²×10⁻³)		0 76 (10 8)	1 25 (17 8)	5 07 (71 8)
Basic Specifications	Power Supply *2	Main	1-Phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60 Hz		
		Control			
	Control Method		1-Phase full-wave rectifying, transistorized PWM control		
	Feedback		Optical encoder (1000 or 2000 pulses/rev)		
	Environmental Conditions	Ambient Temp *3	0 to +55℃		
		Storage Temp	−20 to +85℃		
		Ambient and Storage Humidity	90% or less (non-condensing)		
		Vibration-/Shock-Resistance	0 5G/2G		
	Mounting Structure		Rack mounted		
	Approx Weight kg (lb)		2 7 (5 9)	2 8 (6 2)	2 8 (5 2)
Basic Functions	Kv Setting (SW4)		1 00 to 30 0 (×1, ×4)		
	Kp Setting (SW5)		5 0 to 200 0 S^{-1} (×1, ×0 5, ×0 25, ×0 125)		
	CUR Setting (SW6)*1		100 to 300%		
	Bias Setting (SW6)*4		0 to 450 r/min (10% of max motor speed)		
	Ki Setting (SW7)		2 ms to ∞		
I/O Signal	Reference Pulse	Input Type	Sign + pulse train (SIGN + PULSE signal), Two-phase pulse with 90° phase difference (phase A + B), CCW pulse + CW pulse		
		Input Pulse Form	+5 V level (TTL, line driver) or +12 V open collector		
		Pulse Frequency	0 to 200 kpps		
	Control Signal		Clear and gain changeover signals		
	PG Pulse Output	Output Form	Phases A, B Line driver or open collector Phase C Open collector		
	Sequence Input Signal		Servo ON, F run inhibit (P-OT), R run inhibit (N-OT), alarm reset		
	Sequence Output Signal		Servo alarm servo ready, excessive error, positioning completion, alarm code (3-bit)		
	Dynamic Brake		Operated at main power OFF, servo alarm, servo OFF, stop after deceleration at P/N-OT		
	Regeneration		• 50/100 W type Not provided • 200 W Provided (containing regenerative resistor)		
	Applicable Load Inertia		Up to 10 times motor inertia		
	Overtravel Prevention		Stop after deceleration at P/N-OT, free running stop*1		
	Protection Function		Overvoltage (OV), overcurrent (OC), overload (OL), overspeed (OS), MCCB trip (MCCB), PG trouble (PG), voltage drop (UV), CPU error (CPU), overflow (OF), regeneration trouble (RG)		
	Indication		Power supply (MAIN LED), alarm (7-segment LEDs), lag pulse indication bargraph LED		
	Monitor Output		Speed 2 V ± 5% at 1000 r/min, Torque 3 V ±10%/100% (or speed reference 2 V ±10% at 1000 r/min)		
	Positioning Control		Reference pulse multiplier ×1, ×2, ×4 (For two-phase pulse with 90° phase difference)*4 Feedback pulse multiplier ×1, ×2, ×4 (×4 without analog clamp)*4 Reference pulse logic reverse L active, H active*4		

*1 When load J exceeds applicable range, see par 6 6 2 Load Inertia (J)
*2 In main circuit power supply, voltage should not exceed 230 V, +10% (253 V) If the voltage should exceed this value, a step down transformer is required
*3 When housed in a panel, the inside temperature must not exceed ambient temperature range
*4 Use by selecting internal setting SW

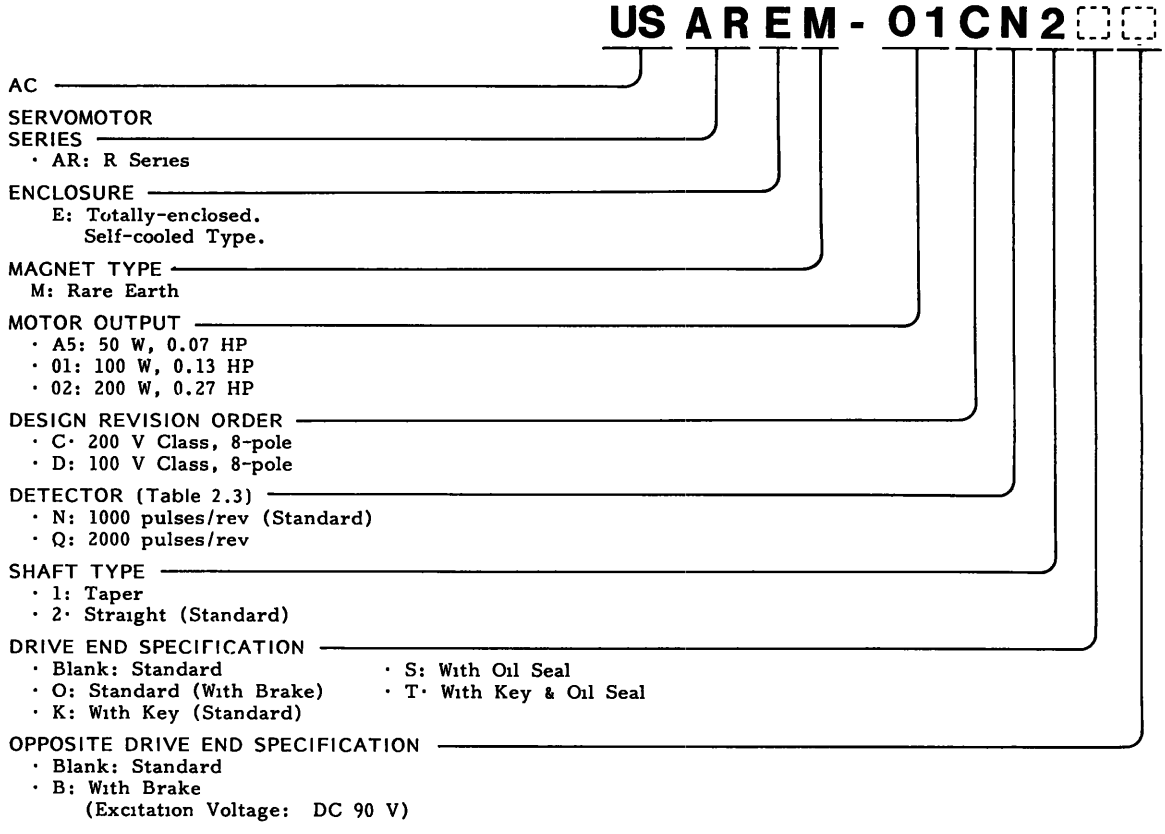
Table 1 3 Ratings and Specifications of Servopack (Cont'd)

Voltage Class			100V		
Servopack Type CACR-			PRA5AD4 ⬚R	PR01AD4 ⬚R	PR02AD4 ⬚R
Combined Specifications	Applicable AC Servomotor	Type USAREM-	A5D	01D	02D
		Output W (HP)	50 (0 07)	100 (0 13)	200 (0 27)
		Rated/Max Speed r/min	3000/4000		
	Continuous Output Current A (rms)		1 2	1 7	2 9
	Max Output Current A (rms)		3 6	5 0	8 5
	Allowable Load J*1 ($=GD^2/4$)	$kg \cdot m^2 \times 10^{-4}$ ($oz \cdot in \cdot s^2 \times 10^{-3}$)	0 76 (10 8)	1 25 (17 8)	5 07 (71 8)
Basic Specifications	Power*2 Supply	Main / Control	1-Phase 100 to 115 VAC $^{+10\%}_{-15\%}$ 50/60 Hz*2		
	Control Method		1-Phase full-wave rectifying, transistorized PWM control		
	Feedback		Optical encoder (1000 or 2000 pulses/rev)		
	Environmental Conditions	Ambient Temp *3	0 to +55℃		
		Storage Temp	−20 to +85℃		
		Ambient and Storage Humidity	90% or less (non-condensing)		
		Vibration-/Shock-Resistance	0 5G/2G		
	Mounting Structure		Rack mounted		
	Approx Weight kg (lb)		2 7 (10 1)	2 8 (12 5)	2 8 (14 1)
Basic Functions	Kv Setting (SW4)		1 00 to 30 0 (×1, ×4)		
	Kp Setting (SW5)		5 0 to 200 0 S^{-1} (×1, ×0 5, ×0 25, ×0 125)		
	CUR Setting (SW6)*4		100 to 300%		
	Bias Setting (SW6)*4		0 to 450 r/min (10% of max motor speed)		
	Ki Setting (SW7)		2 ms to ∞		
I/O Signal	Reference Pulse	Input Type	Sign + pulse train (SIGN + PULSE signal), Two-phase pulse with 90° phase difference (phase A + B), CCW pulse + CW pulse		
		Input Pulse Form	+5 V level (TTL, line driver) or +12 V open collector		
		Pulse Frequency	0 to 200 kpps		
	Control Signal		Clear and gain changeover signals		
	PG Pulse Output	Output Form	Phases A, B Line driver or open collector*4 Phase C Open collector		
	Sequence Input Signal		Servo ON, F run inhibit (P-OT), R run inhibit (N-OT), alarm reset		
	Sequence Output Signal		Servo alarm, servo ready, positioning completion, alarm code (3-bit)		
	Dynamic Brake		Operated at main power OFF, servo alarm, servo OFF, stop after deceleration at P/N-OT		
	Regeneration		• 50 W type Not provided • 100, 200 W Provided (containing regenerative resistor)		
	Applicable Load Inertia		Up to 10 times motor inertia		
	Overtravel Prevention		Stop after deceleration at P/N-OT, free running stop*4		
	Protection Function		Overvoltage (OV), overcurrent (OC), overload (OL), overspeed (OS), MCCB trip (MCCB), PG trouble (PG), voltage drop (UV), CPU error (CPU), overflow (OF), regeneration trouble (RG)		
	Indication		Power supply (MAIN LED), alarm (7-segment LEDs)		
	Monitor Output		Speed 2 V ± 5% at 1000 r/min, Torque 3 V ±10%/100%		
	Positioning Control		Reference pulse multiplier ×1, ×2, ×4 (For two-phase pulse with 90° phase difference)*4 Feedback pulse multiplier ×1, ×2, ×4 (×4 without analog clamp)*4 Reference pulse logic reverse L active, H active*4		

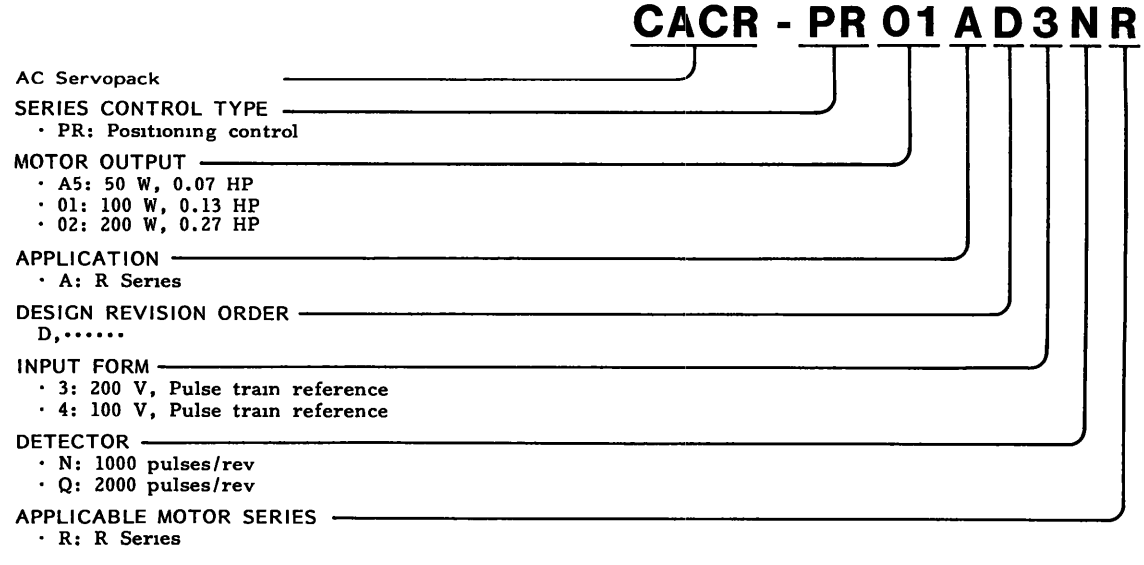
*1 When load J exceeds applicable range, see par 6 6.2 Load Inertia (J).
*2 In main circuit power supply, voltage should not exceed 230 V, +10% (253 V) If the voltage should exceed this value, a step down transformer is required
*3 When housed in a panel, the inside temperature must not exceed ambient temperature range
*4 Use by selecting internal setting SW

2. TYPE DESIGNATION

· AC Servomotor



· Servopack



3. LIST OF STANDARD COMBINATION

Table 3 1 List of Standard Combination

Class	Servopack Type CACR-		AC Servomotor Type USAREM-	AC Servomotor Optical Encoder pulses/rev	Power Capacity per Servopack* kVA	Current Capacity per MCCB of Fuse† A	Applicable Noise Filter	Recommended Noise Filter‡ Type	Recommended Noise Filter‡ Specification		Power ON/OFF Switch
200 V	50 W (0 07 HP)	PRA5AD3NR	A5CN2	1000	0 3	5	Good	LF-205A	Single-phase, 200 VAC class	5A	Yaskawa type HI-15E, rated 30 A or equivalent
		PRA5AD3QR	A5CQ2	2000							
	100 W (0 13 HP)	PR01AD3NR	01CN2	1000	0 5						
		PR01AD3QR	01CQ2	2000							
	200 W (0.27 HP)	PR02AD3NR	02CN2	1000	0 75						
		PR02AD3QR	02CQ2	2000							
100 V	50 W (0 07 HP)	PRA5AD4NR	A5DN2	1000	0 3	5	Poor	LF-205A	Single-phase, 200 VAC class	5A	
		PRA5AD4QR	A5DQ2	2000							
	100 W (0 13 HP)	PR01AD4NR	01DN2	1000	0 5						
		PR01AD4QR	01DQ2	2000							
	200 W (0 27 HP)	PR02AD4NR	02DN2	1000	0 75	8		LF-210		10A	
		PR02AD4QR	02DQ2	2000							

* Values at rated load
† Operating characteristic (25℃) 200% 2 s or more, 700% 0 01 s or more
‡ Made by Tokin Corp

Table 3 2 Characteristics of AC Servomotor Detector and Holding Brake for Standard Combination

Class	Servopack Type CACR-	AC Servomotor Type USAREM-	AC Servomotor Receptacle Type	AC Servomotor L-type Plug	AC Servomotor Cable Clamp	Detector Receptacle Type	Detector L-type Plug	Detector Cable Clamp	Holding Brake Receptacle Type	Holding Brake L-type Plug	Holding Brake Cable Clamp
200 V	PRA5AD3NR	A5CN2KB	MS3101A 14S-2P	MS3106B* 14S-2S	MS3057 -6A	—	—	—	MS3101A 14S-6P	MS3106B 14-6S*	MS3057 -6A
	PRA5AD3QR	A5CQ2KB									
	PR01AD3NR	01CN2KB									
	PR01AD3QR	01CQ2KB									
	PR02AD3NR	02CN2KB	MS3102A 18-10P	MS3108B 18-10S	MS3057 -10A	MS3102A 20-29A	MS3108B 20-29S	MS3057 -12A	MS3102A 18-12P	MS3108B 18-12S	MS3057 -10A
	PR02AD3QR	02CQ2KB									
100 V	PRA5AD4NR	A5DN2KB	MS3101A 14S-2P	MS3106B 14S-2S*	MS3057 -6A	—	—	—	MS3101A 14S-6P	MS3106B 14-6S*	MS3057 -6A
	PRA5AD4QR	A5DQ2KB									
	PR01AD4NR	01DN2KB									
	PR01AD4QR	01DQ2KB									
	PR02AD4NR	02DN2KB	MS3102A 18-10P	MS3108B 18-10S	MS3057 -10A	MS3102A 20-29P	MS3108B 20-29S	MS3057 -12A	MS3102A 18-12P	MS3108B 18-12S	MS3057 -10A
	PR02AD4QR	02DQ2KB									

* Straight plug.
Note Connector types for detector (50 W and 100 W) are as follows ,

Made by Honda Tushin Co , Ltd

Connector Type for Detector	For Coupling Cable	
	Connector Type	Case Type
MR-20LF	MR-20RM	MR-20LK2

4. CHARACTERISTICS

4.1 OVERLOAD CHARACTERISTICS

The overload protective circuit built in Servopack prevents the motor and Servopack from overload and restricts the allowable conduction time of Servopack. (See Fig. 4.1.)

If the allowable power-on time during motor locking is maximum, the higher the motor speed is, the quicker the motor responce to the same overload.

The overload detection level is set precisely by the hot start conditions at an ambient temperature of 55°C and cannot be changed.

NOTE

Hot start is the overload characteristics when the Servopack is running at the rated load and thermally saturated.

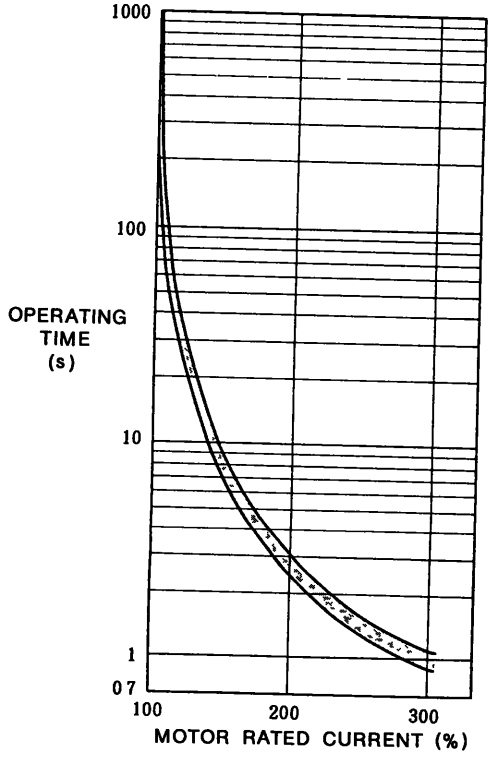


Fig. 4.1 Overload Characteristics

4.2 STARTING AND STOPPING TIME

The starting time (tr) and stopping time (tf) of servomotor under a constant load is shown by the formula below. Viscous or friction torque of the motor is neglected.

Starting Time:

$$tr = 104.7 \times \frac{N_R (J_M + J_L)}{Kt \cdot I_R(\alpha - \beta)} \quad (ms)$$

Stopping Time:

$$tf = 104.7 \times \frac{N_R (J_M + J_L)}{Kt \cdot I_R(\alpha + \beta)} \quad (ms)$$

Where,

N_R : Rated motor speed (r/min)

J_M : Moment of motor inertia J ($kg \cdot m^2 \times 10^{-4}$= $oz \cdot in \cdot s^2$) ($=GD^2_M/4$)

J_L : Moment of load inertia ($kg \cdot m^2 \times 10^{-4}$= $oz \cdot in \cdot s^2$) ($=GD^2_L/4$)

K_t : Torque constant of motor (N·m/A, oz·in/A)

I_R : Motor rated current (A)

$\alpha = I_P/I_R$: Accel/decel current constant

I_P : Accel/decel current (Accel/decel current α times the motor rated current) (A)

$\beta = I_L/I_R$: Load current constant

I_L : Current equivalent to load torque (Load current β times the motor rated current) (A)

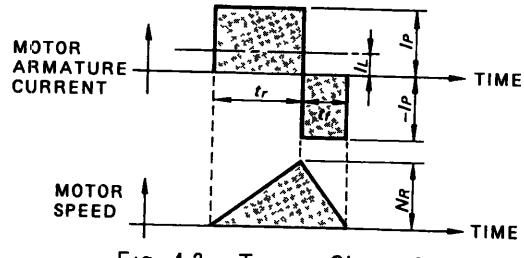


Fig 4.2 Timing Chart of Motor Armature Current and Speed

4.3 ALLOWABLE FREQUENCY OF OPERATION

The allowable frequency of operation is restricted by the servomotor and Servopack, and both the conditions must be considered for satisfactory operation.

(1) Allowable frequency of operation restricted by the ***Servopack***

The allowable frequency of operation is restricted by the heat generated in the regenerative resistor in the Servopack, and varies depending on the motor types, capacity, load inertia, acceleration/deceleration current values, and motor speed. If the frequency of operation exceeds 60 times/min when load inertia = 0 before the motor becomes rated speed, or if it exceeds $\frac{60}{m+1}$ cycles/min when load J = motor J × m, contact Yaskawa representative.

4.3 ALLOWABLE FREQUENCY OF OPERATION (Cont'd)

(2) Allowable frequency of operation restricted by the Servomotor

The allowable frequency of operation varies depending on the load conditions, motor running time and the operating conditions. Typical examples are shown below. See par.4.2 Starting and Stopping Time for symbols.

- When the motor repeats rated-speed operation and being at standstill (Fig.4.3).

  Cycle time(T) should be determined so that RMS value of motor armature current is lower than the motor rated current:

$$T \geqq \frac{Ip^2\ (tr+tf)+I_L^2 ts}{I_R^2}\ (s)$$

Where cycle time(T) is determined, values *Ip*, *tr*, *tf* satisfying the formula above, should be specified.

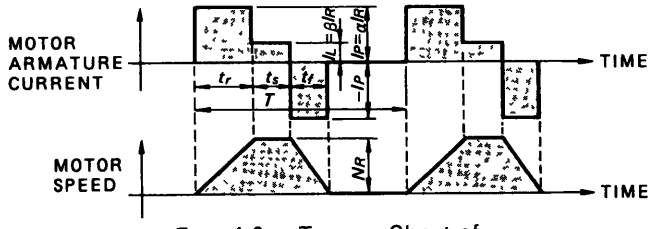


Fig 4 3 Timing Chart of Motor Armature Current and Speed

- When the motor remains at standstill between cycles of acceleration and deceleration without continuous rated speed running (Fig.4.4).

  The timing chart of the motor armature current and speed is as shown in Fig.4.4. The allowable frequency of operation "n" can be calculated as follows:

$$n = 286\ 5 \times \frac{K_t \cdot I_R}{N_R\ (J_M+J_L)} \left(\frac{1}{\alpha} - \frac{\beta^2}{\alpha^3}\right)$$

(times/min)

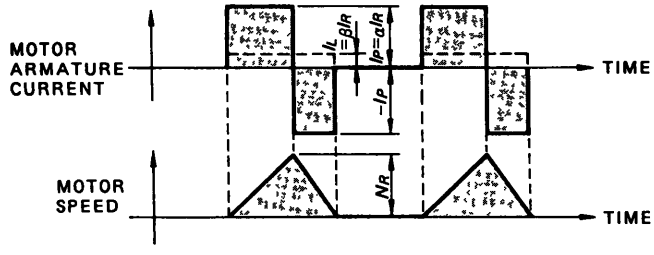


Fig 4 4 Timing Chart of Motor Armature Current and Speed

- When the motor accelerates, runs at constant speed, and decelerates in a continuing cycle without being at standstill (Fig. 4.5).

  The timing chart of the motor armature current and speed is as shown in Fig.4.5. The allowable frequency of operation "n" can be calculated as follows.

$$n = 286\ 5 \times \frac{K_t \cdot I_R}{N_R\ (J_M+J_L)} \left(\frac{1}{\alpha} - \frac{\beta^2}{\alpha}\right)$$

(times/min)

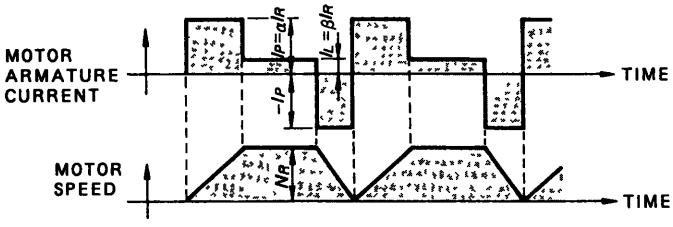


Fig 4 5 Timing Chart of Motor Armature Current and Speed

4.4 MOTOR MECHANICAL CHARACTERISTICS

4 4 1 Mechanical Strength

AC servomotors can carry up to 300% of the rated momentary maximum torque at output shaft.

4 4. 2 Allowable Radial Load and Thrust Load

Table 4.1 shows allowable loads according to AC servomotor types.

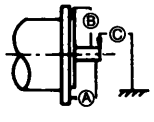
Table 4 1 R Series Allowable Radial Load and Thrust Load

Motor Type USAREM—	Allowable Radial Load* kg (lb)	Allowable Thrust Load kg (lb)
A5 □□ 2K	8 (18)	4 (9)
01 □□ 2K		
02 □□ 2K	25 (55)	10 (22)

* Maximum values of the load applying to the shaft extension

4 4 3 Mechanical Specifications

Table 4.2 Mechanical Specifications in mm

Accuracy (T I R)†		Reference Diagram
Flange surface perpendicular to shaft Ⓐ	0 04	
Flange diameter concentric to shaft Ⓑ	0 04	
Shaft run out Ⓒ	0 02	

†T I R (Total Indicator Reading)

4 4 4 Direction of Rotation

AC servomotors rotate counterclockwise viewed from drive end when motor and detector leads are connected as shown below.

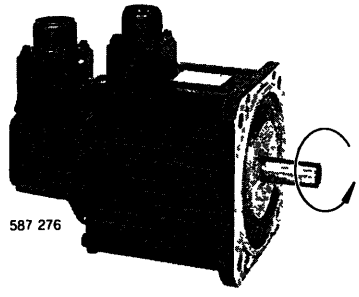
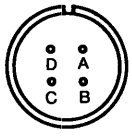


Fig 4 6 AC Servomotor

(1) Connector Specifications

(a) Motor receptacle

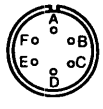
· Standard



A	Phase U
B	Phase V
C	Phase W
D	Ground

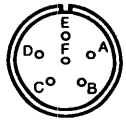
· With brake

(50W, 0 07 HP
100W, 0 13 HP)



A	Phase U
B	Phase V
C	Phase W
D	Brake terminal
E	
F	Ground

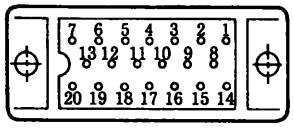
(200W, 0 27 HP
or more)



4 4 4 Direction of Rotation (Cont'd)

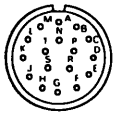
(b) Detector receptacle

(50W, 0 07 HP
100W, 0 13 HP)



Connector No	Application	Color
1	0 V	Black
2	—	—
3	—	—
4	+5 VDC	Red
5	—	—
6	Channel SIN B output	Brown
7	Channel SIN $\overline{B}$ output	White (Brown)
8	Channel U output	Orange
9	Channel $\overline{U}$ output	White (Orange)
10	Channel V output	Purple
11	Channel $\overline{V}$ output	White (Purple)
12	Channel W output	Gray
13	Channel $\overline{W}$ output	White (Gray)
14	Channel Z output	Green
15	Channel $\overline{Z}$ output	White (Green)
16	Channel A output	Blue
17	Channel $\overline{A}$ output	White (Blue)
18	Channel B output	Yellow
19	Channel $\overline{B}$ output	White (Yellow)
20	FG (Frame ground)	Green (Yellow)

(200W)



A	Channel A output	K	Channel U output
B	Channel $\overline{A}$ output	L	Channel $\overline{U}$ output
C	Channel B output	M	Channel V output
D	Channel $\overline{B}$ output	N	Channel $\overline{V}$ output
E	Channel Z output	P	Channel W output
F	Channel $\overline{Z}$ output	R	Channel $\overline{W}$ output
G	0V	S	Channel SIN B output
H	+5VDC	T	Channel SIN $\overline{B}$ output
J	Frame ground	—	—

4 4. 5 Impact Resistance

When mounted horizontally and exposed to vertical shock impulses, the motor can withstand up to two impacts with impact acceleration of 10G (Fig. 4.7).

NOTE

A precision detector is mounted on the opposite-drive end of AC servomotor. Care should be taken to protect the shaft from impacts that could damage the detector.

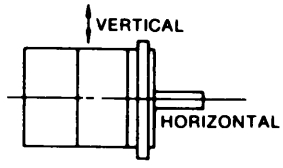


Fig 4 7 Impact Resistance

4 4 6 Vibration Resistance

When mounted horizontally, the motor can withstand vibration (vertical, lateral, axial) of 2.5G (Fig. 4.8).

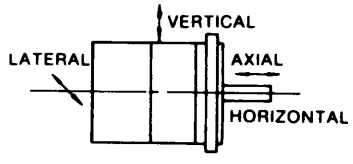


Fig 4 8 Vibration Resistance

4 4 7 Vibration Class

Vibration of the motor running at rated speed is 15 μm or below (Fig. 4.9).

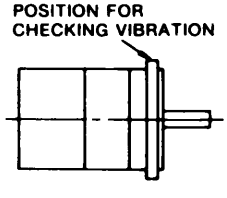


Fig 4 9 Vibration Checking

5. CONFIGURATION

5.1 CONNECTION DIAGRAM

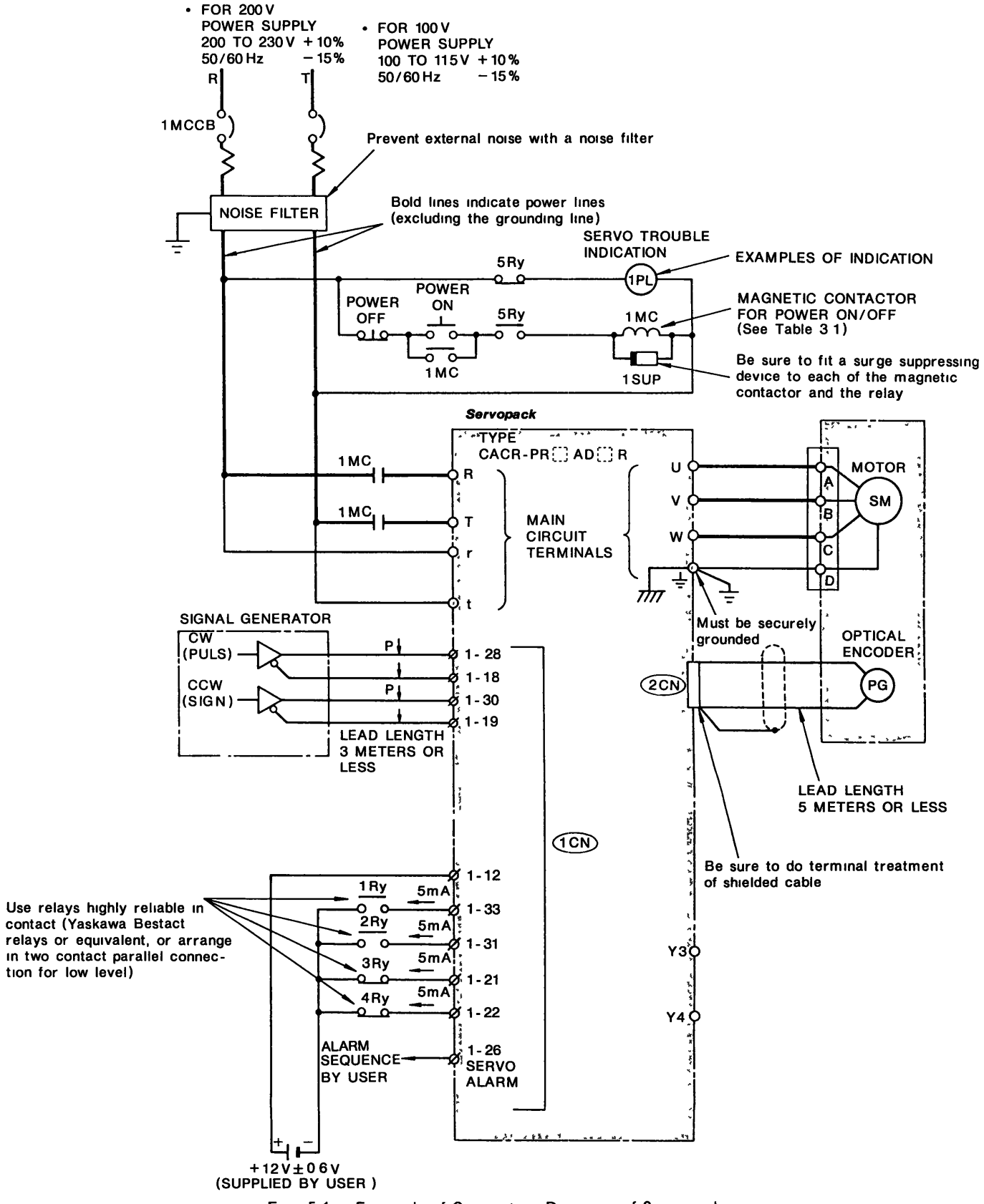


Fig. 5 1 Example of Connection Diagram of Servopack
(Type CACR-PR□AD□R) with a Servomotor and Peripherals

5.2 INTERNAL BLOCK DIAGRAM

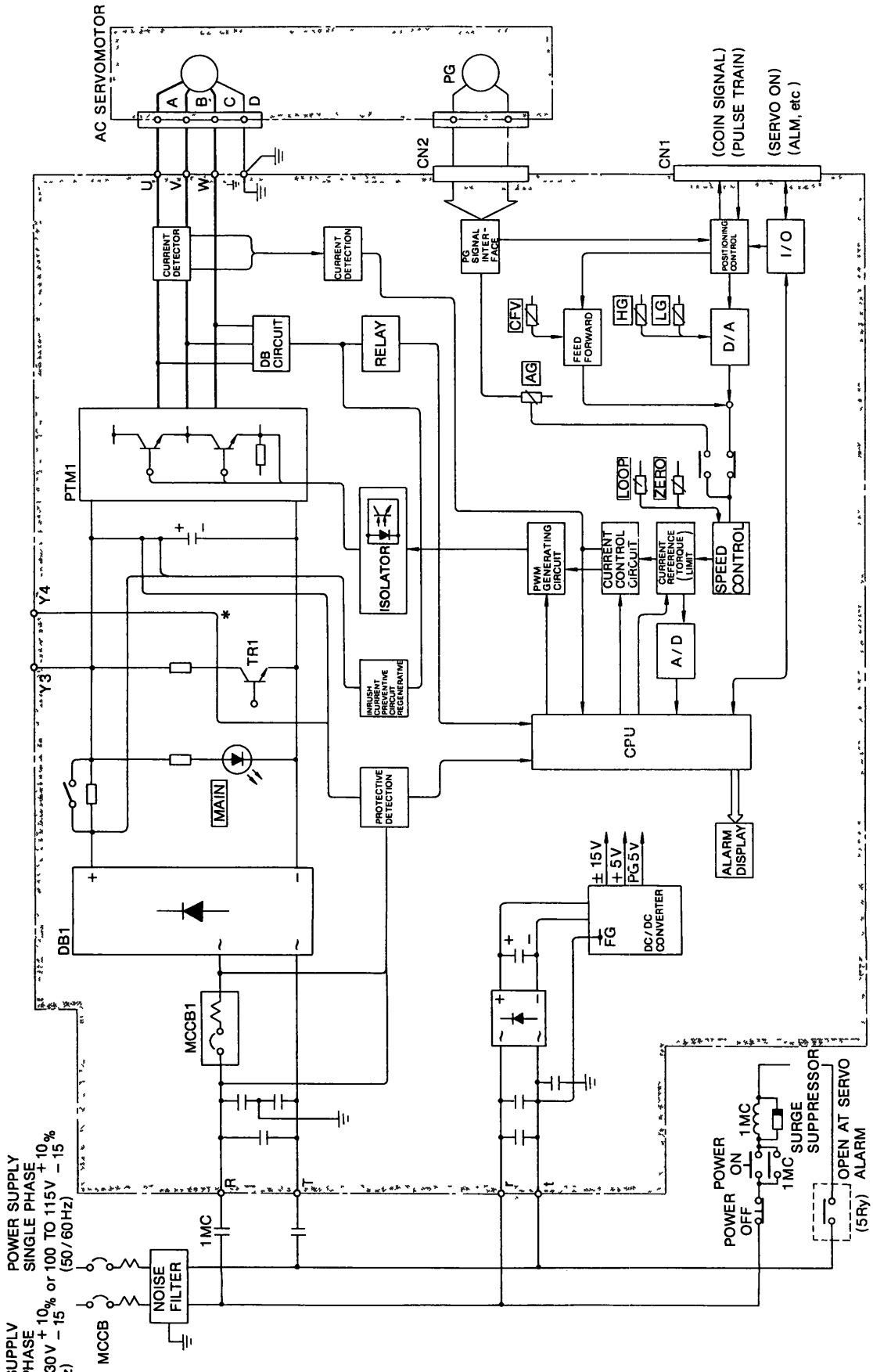


Fig. 5.2 Internal Block Diagram of Servopack Type CACR-PR [illegible]ADF[illegible]R

5.3 MAIN-CIRCUIT TERMINALS

Table 5 1 Main-Circuit Terminals for Servopack

Terminal Symbol	Name	Description
Ⓡ Ⓣ	Main-circuit AC input	• For 200V Single-phase 200 to 230V $^{+10\%}_{-15\%}$ 50/60Hz • For 100V Single-phase 100 to 115V $^{+10\%}_{-15\%}$ 50/60Hz
ⓊⓋⓌ	Motor connection	Connects terminal Ⓤ to motor terminal A, Ⓥ to B and Ⓦ to C
ⓡ ⓣ	Control power input	• For 200V Single-phase 200 to 230V $^{+10\%}_{-15\%}$ 50/60Hz • For 100V Single-phase 100 to 115V $^{+10\%}_{-15\%}$ 50/60Hz
⏚	Ground	Connects to motor terminal D Must be securely grounded
Ⓨ3 Ⓨ4	Regenerative register	External connection not usually required

5.4 CONNECTOR TERMINAL (1CN) FOR I/O SIGNAL

5 4 1 Specifications of Applicable Receptacles

Table 5 2 Specifications of Applicable Receptacles for Servopack I/O Signal

Connector Type* used in Servopack	Applicable Receptacle Type			
	Manufacturer	Soldered Type	Caulking Type	Case
MR-34RMA (Right angle 34P)	Honda Tsushin Co, Ltd	MR-34F†	MRP-34F01	MR-34L†

*The connectors for I/O signals used are type MR-50RMA made by Honda Tsushin Co Ltd
†Attached to *Servopack* when shipping

5 4 2 Connector 1CN Layout and Connection of *Servopack*

The terminal layout of the Servopack I/O signal connectors (1CN) is shown in Table 5.3. The external connection and external signal processing are shown in Fig. 5.3.

Table 5 3 Connectorl 1CN Layout of Servopack

1	2	3	4	5	6	7	8	9	10	11	12
FG	0 V	0 V	0 V	0 V	0 V	0 V	0 V	0 V	EXT1	EXT2	+12 V IN
Frame Ground	0 V for PCOT	0 V for AL01	0 V for AL02	0 V for AL03	0 V for ALM	0 V for COIN	0 V for SRDY	0 V for Input Pulse	Open Collector Reference External Power Supply Input		External Input Power Supply
	13	14	15	16	17	18	19	20	21	22	
	$\overline{\text{R-PULS}}$	$\overline{\text{F-PULS}}$	AL01	AL02	AL03	$\overline{\text{CW}}$ (PULSE)	$\overline{\text{CCW}}$ (SIGN)	$\overline{\text{ALMRST}}$	P-OT	N-OT	
	PG Output Signal (Phase A + Phase B)		Alarm Code Output			Reference Pulse Input		Alarm Reset Input	Forward Prohibit Input	Reverse Prohibit Input	
23	24	25	26	27	28	29	30	31	32	33	34
PCOT	R-PULS	F-PULS	ALM	$\overline{\text{COIN}}$	$\overline{\text{SRDY}}$	CW (PULSE)	CCW (SIGN)	$\overline{\text{CL}}$	$\overline{\text{GAIN}}$	$\overline{\text{S-ON}}$	+12 V
PG-C Open Collector	PG Output Signal (Phase A + Phase B)		Servo Alarm Output	Position-ing Comple-tion Signal	Servo Ready Output	Reference Pulse Input (line driver)		Clear Input	Gain Change-over Input	Servo ON Input	+12 V Output

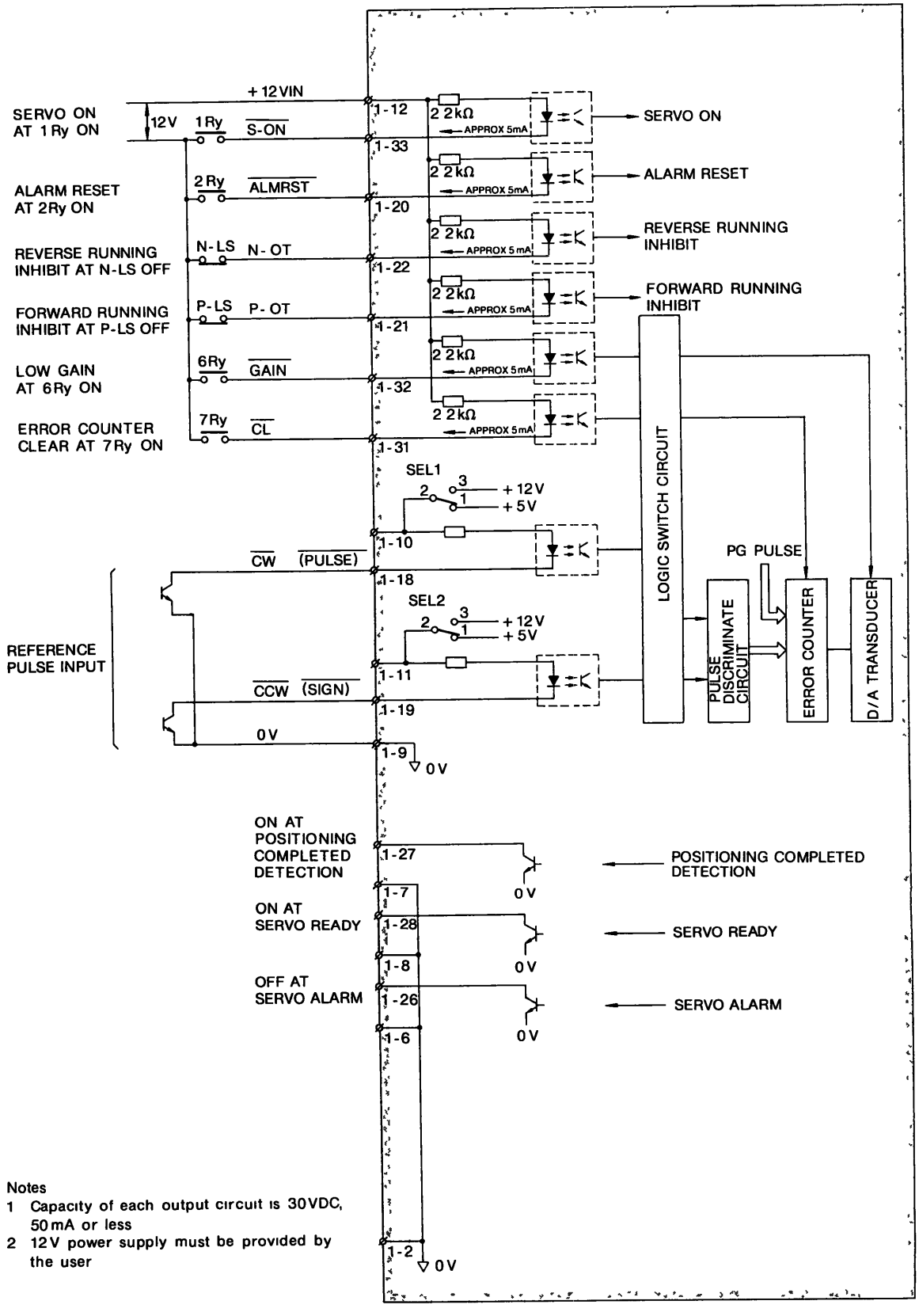


Fig 5 3 1CN I/O Signal Connection and External Signal Processing

5 4 3 I/O Signals of Connector 1CN

Table 5 4 Input Signals of Connector 1CN

Signal Name	Connector 1CN No.	Function		Description
$\overline{\text{S-ON}}$	33	Servo ON		Inputting this signal makes the Servopack ready to receive pulse reference input. Base block is cleared.
$\overline{\text{ALM-RST}}$	20	Alarm reset		This signal resets the alarm.
N-OT	22	Reverse running inhibit		In the case of linear drive, etc., connect limit switch signal according to the run direction. It is "closed" during normal run. When limit switch is tripped, it becomes "open".
P-OT	21	Forward running inhibit		
+12 VIN	12	+12 V		External power supply to 1CN-20, 21, 22, 31, 32 and 33. Prepare a 12 VDC (30 mA min.) power supply.
PULS	29	Reference pulse input	Main ref. input	Pulse train frequency = $\frac{\text{Motor speed (r/min)}}{60}$ × Dividing ratio × No. of PG pulses (pulse/rev) × M ≦ 200 kpps. (M:PG multiplication factor ... 1, 2, 4) Pulse width = Duty must be 50% at the maximum frequency used ≧ 2.5 μs.
SIGN	30	Reference sign input		(For positive logic) Forward rotation command: H-level Reverse rotation command: L-level
*PULS	18	(Reference pulse input)		When reference pulse signal is line driver output, use PULS signal in pairs.
*SIGN	19	(Reference sign input)		When reference sign signal is line driver output, use SIGN signal in pairs.
$\overline{\text{CL}}$	31	Error counter signal		Blocks reference and feedback pulses. Clears the error counter at L-level.
$\overline{\text{GAIN}}$	32	Gain Switch Signal		Switches the positioning loop gain.

Table 5 5 Output Signals of Connector 1CN

Signal Name	Connector 1CN No.	Function		Description
ALM	26	Servo alarm		Turns OFF if malfunction is detected. For details, refer to table 6.11.
$\overline{\text{S-RDY}}$	28	Servo ready		Turns ON when main power supply ON, and no servo alarm.
$\overline{\text{COIN}}$	27	Positioning completion signal		Output when No. of lag pulses of the error counter reaches the range of the set value (±1 to ±7) × 1 or × 5.
+12 V	34	+12 V output power supply		+12 V ±5% Max. output current 30 mA
F-PULS	24	Positioning signal output	Phase A	Positioning Output pulse
*F-PULS	13		Phase $\overline{\text{A}}$	
R-PULS	25		Phase B	
*R-PULS	14		Phase $\overline{\text{B}}$	
PCOT	23	Positioning signal output-2 Phase C		Open collector output Max. operating voltage: 30 VDC Max. input current: 20 mADC
AL01 AL02 AL03	15 16 17	Alarm output code (BCD code)		Open collector output Max. operating voltage; 30 VDC Max. input current: 20 mADC

5.5 CONNECTOR TERMINAL (2CN) FOR OPTICAL ENCODER (PG) CONNECTION

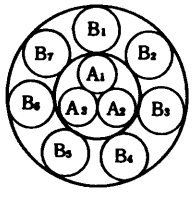
5 5 1 Specifications of Applicable Receptacles and Cables (Table 5 6)

Table 5 6 Specifications of Applicable Receptacles and Cables

Connector Type* used in Servopack	Applicable Receptacle Type				Connection Cable#
	Manufacturer	Soldered Type	Caulking Type	Case†	
MR-20RMA, right angle 20P	Honda Tsushin Co, Ltd	MR-20F	MRP-20F01	MR-20L	B8400403

*Made by Honda Tsushin Co, Ltd
†Attached to each applicable receptacle (soldered and caulking types)
#The cables listed in Table 5 7 are available on request If required, purchase in units of standard length as shown in Table 5 7

Table 5 7 Details of Specifications of Applicable Cables

Connection	Soldered Type		
Yaskawa Drawing No	B8400403		
Manufacturer	Fujikura Cable Co		
General Specifications	Double, KQVV-SW AWG 22 x 3C AWG 26 x 7P		
Internal Composition and Lead Color	For Soldered Type 		
	A_1	Red	Twisted cable
	A_2	Black	
	A_3	Green yellow	
	B_1	Blue - White/blue	
	B_2	Yellow - White/yellow	
	B_3	Green - White/green	
	B_4	Orange - White/orange	
	B_5	Purple - White/purple	
	B_6	Grey - White/grey	
	B_7	Brown White/brown	
Yaskawa Standard Specifications	Standard length 5m Terminal ends are not provided (without connectors)		

5 5 2 *Servopack* Connector (2CN) Terminal Layout and Connection

The terminal layout for the Servopack connectors (2CN) for connecting the optical encoder is shown in Table 5.7, and the connection method of 2CN and the optical encoder, in Fig. 5.4.

Table 5 8 Connector 2CN Layout of Servopack

1	2	3	4	5	6	7
PG0V	PG0V	PG0V	PG5V	PG5V	SIN-B	*SIN-B
8	9	10	11	12	13	
PU	*PU	PV	*PV	PW	*PW	
14	15	16	17	18	19	20
PC	*PC	PA	*PA	PB	*PB	FG

Note : For DIR, see par. 6 9.1

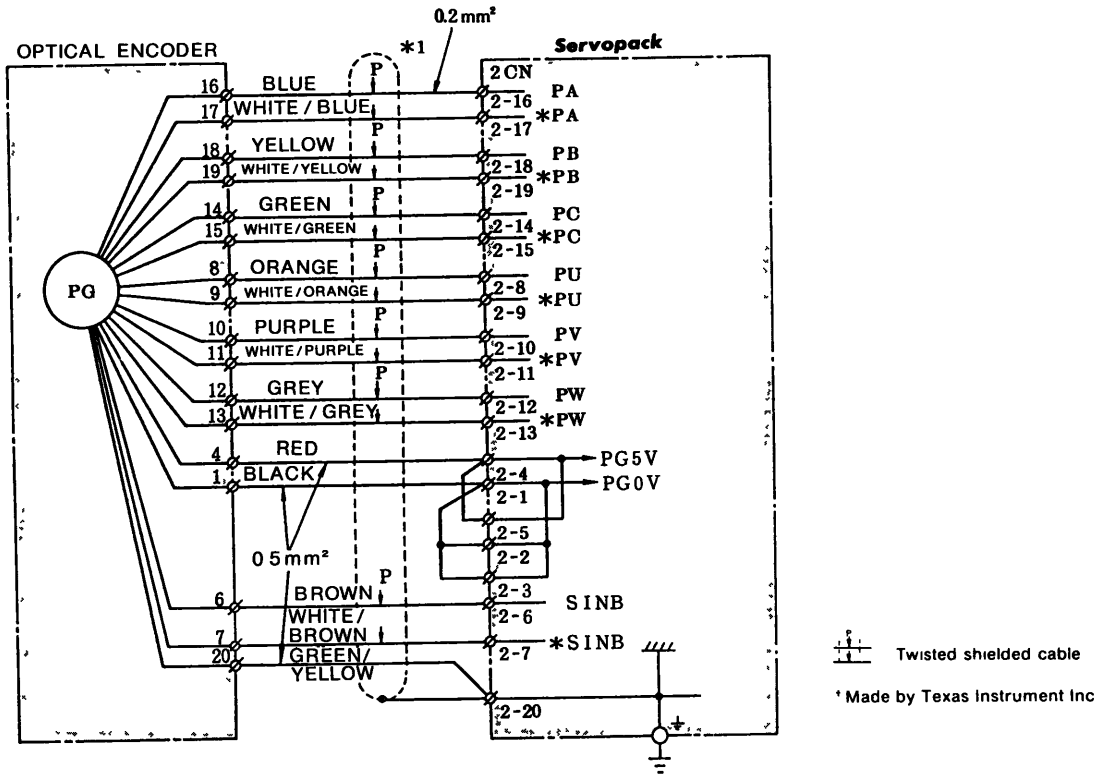


Fig 5 4 Soldered Type Connector 2CN Connection and
1CN Output Processing (50 W, 100 W)
(When using Connection Cable B8400403)

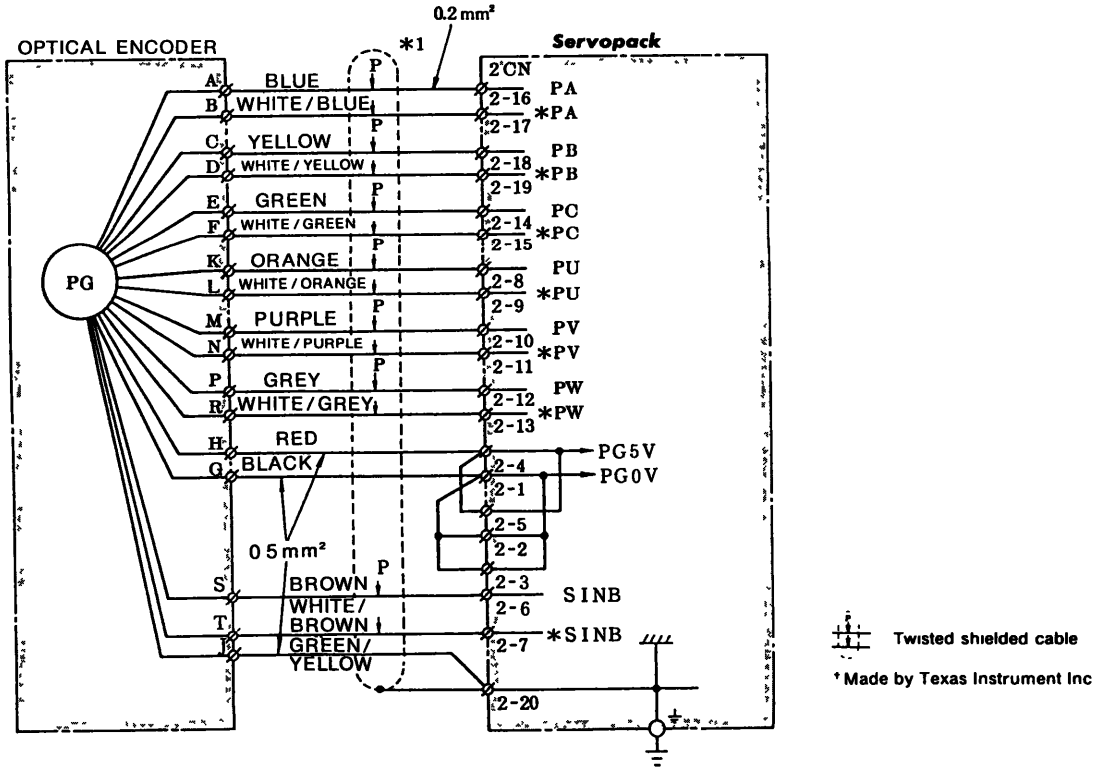


Fig 5.5 Caulking Type Connector 2CN Connection and
1CN Output Prosessing (200 W)
(When using Connection Cable B8400403)

6. OPERATION

6.1 POWER ON AND OFF

Arrange the sequence so that the powee is simultaneously supplied to the main circuit (R, T) and the control circuit (r, t), or supplied to the control circuit first, then the main circuit (Figs. 6.1 and 6.2).

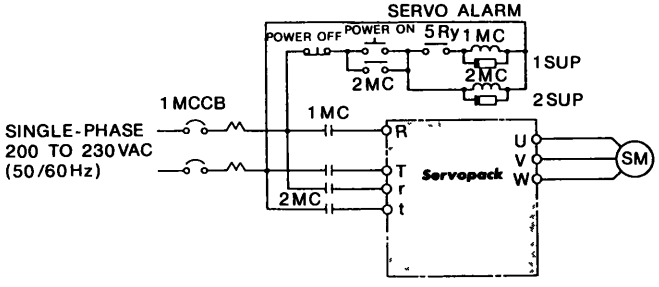
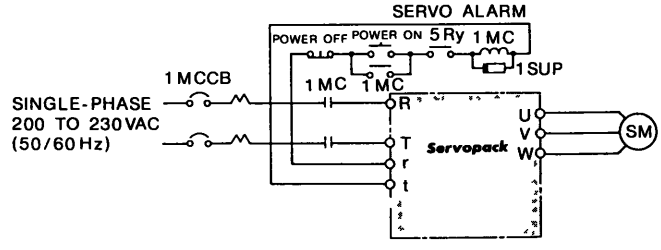


Fig 6 1 Connection Example for Simultaneous Control Power ON/OFF (When using AC Servomotor for 200 V)



1SUP, 2SUP Surge suppressor CR50500BA or equivalent (made by Okaya Electric Industries Co, Ltd)

Fig 6 2 Connection Example for Main-circuit Power ON/OFF (When using AC Servomotor for 200 V)

Arrange the sequence so that the power is simultaneously cut (including momentary power failure) (Fig. 6.1), or the power to the main circuit is cut first, then the control circuit (Fig. 6.2). The order is the reverse of the power ON sequence.

Precautions for connections (in Figs. 6.1 and 6.2)

- Make sequence to assure that the main-circuit power will be cut off by a servo alarm signal.

  If the control circuit is turned off, the LED indicating the kind of servo alarm also goes off.

- Since Servopack is of a capacitor input type, large recharging current flows when the main-circuit power is turned on (recharging time: 0.2s). If the power is turned on and off frequently, the recharging-current limit resistor may be degraded and a malfunction may occur. When the motor starts, turn ON the reference pulse train and turn it OFF when the motor stops. Do not turn the power ON or OFF.

- In Fig. 6.11, keep the power ON signal for a minute.

Before power on or off, turn off the "Servo ON" switch to avoid troubles at transient stage.

6.2 POSITIONING REFERENCE

6.2.1 Input Reference Pulse

"H" level is effective for input $\overline{CL}$ ($\overline{CLEAR}$) signal.

(1) Logic level of input reference pulse

For input reference pulse, positive logic (active H) or negative logic (active L) can be selected by switch [SW4]. See Table 6.1.

(2) Reference pulse mode

Three types of signals can be input as reference pulses. Set switches SW4-①, -②, and ③ according to the reference pulse modes and multipliers (only for 2-phase signals), as shown in Table 6.2.

Table 6.1 Logic Level of Reference Pulse

[SW4] Setting	④ [o o] Short pin ON ⑤ [o o]	④ o o Short pin OFF ⑤ o o
Effective Logic	negative (active L)	positive (active H)

Table 6.2 Reference Pulse Mode

	Reference Pulse Mode	Input Pin No.	Forward Running Reference of Motor (CCW)	Reverse Running Reference of Motor (CW)	Input Multiplier*	SW2† ①	②	③
Positive Logic Setting	Sign + Pulse Train	1CN-⑱ 1CN-⑲	"H"	"L"	—	○	○	
	Two-Phase Pulse Train with 90° Phase Difference (1, 2 or 4 Times)	1CN-⑱ 1CN-⑲	90°	90°	× 1	○	○	○
					× 2		○	○
					× 4	○		○
	CW Pulse Train + CCW Pulse Train	1CN-⑱ 1CN-⑲	"L"	L"	—		○	
Negative Logic Setting	Sign + Pulse Train	1CN-⑱ 1CN-⑲	"L"	H'	—	○	○	
	Two-Phase Pulse Train with 90° Phase Difference (1, 2 or 4 Times)	1CN-⑱ 1CN-⑲	90°	90°	× 1	○	○	○
					× 2		○	○
					× 4	○		○
	CW Pulse Train + CCW Pulse Train	1CN-⑱ 1CN-⑲	"H"	H	—		○	

* The input multiplier can be set for two-phase pulse train with 90° phase difference. This defines the method of counting the input pulse waves in Servopack. Table 6.3 shows the forward running reference (positive logic) for 90° phase difference 2-phase pulses when phase A = phase B = f(pps).

† Circles in SW2 show the positions for installing the setting plugs on the pins.

Table 6 3 Counting Method of Reference Pulse
(For positive logic, forward run command)

Multiplier	Content of Pulse Counting of Servopack	Reference Pulse Frequency of Servopack
× 1	Counts only the leading edge of phase-A pulse input (1CN- ⑱). PHASE A (1-18) PHASE B (1-19) Servopack COUNTING PULSE TRAIN	f(pps) [Nr/min*]
× 2	Counts the leading and trailing edges of phase-A pulse input (1CN- ⑱). PHASE A (1-18) PHASE B (1-19) Servopack COUNTING PULSE TRAIN	2 × f(pps) [2 × Nr/min]
× 4	Counts the leading and trailing edges of phase-A pulse input (1CN- ⑱) and phase-B pulse input (1CN- ⑲). PHASE A (1-18) PHASE B (1-19) Servopack COUNTING PULSE TRAIN	4 × f(pps) [4 × Nr/min]

* Motor speed

(3) Interface of reference pulse

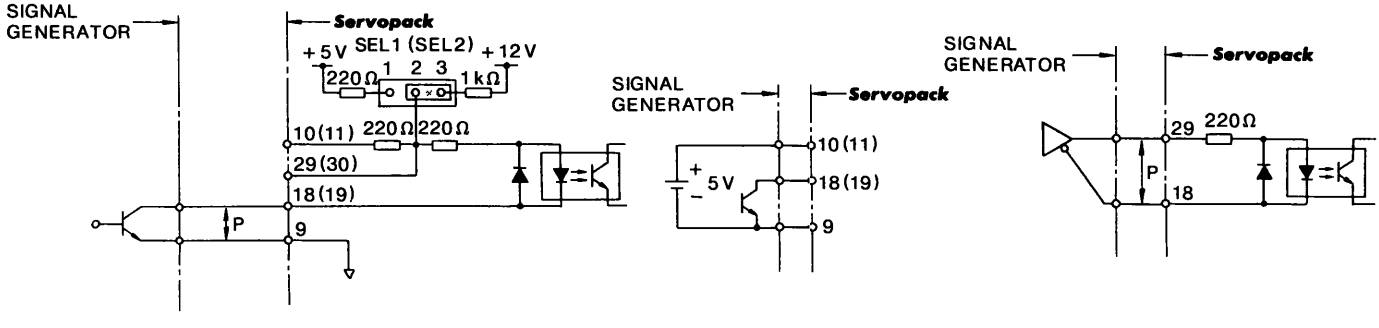
Three types; +12 V/+5 V open collector or line driver output is applicable to interface of reference pulse. Set it by internal switch [SEL1] [SEL2]. See Table 6.4.

Table 6 4 Voltage Level Setting of Reference Pulse

[SEL1] [SEL2] Setting	② – ③ Short 1 2 3 +12 V	① – ② Short 1 2 3 +5 V	①②③ Open 1 2 3
Voltage Level of Reference Pulse	+12 V Open collector	+5 V Open collector	+5 V external power supply (Line driver is set the setting plugs to this position)

(4) Input circuit

Figs. 6.3 (a) and (b) show input part of reference pulse and reference sign signals.



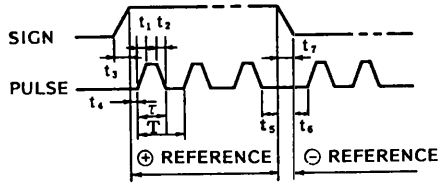
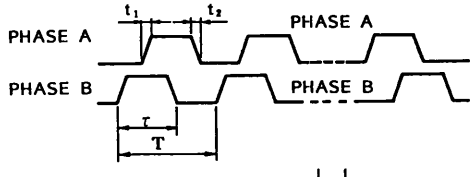
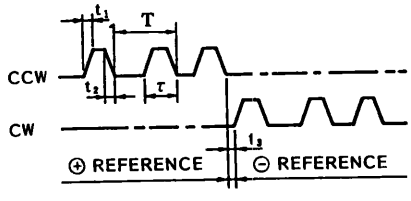
(a–1) For internal power supply (a–2) For external power supply (b) For line driver

Fig 6 3 Reference Pulse Input Circuit

(5) Reference pulse voltage and timing

The pulse waveforms shown in Table 6.5 are for positive logic. For negative logic, ⊕ and ⊖ references are only switched, and the other conditions are the same.

Table 6 5 Applicable Voltage Level and Timing

Item		Electrical Specifications		Remarks
Voltage Level of Signal	+12 V Level	H Level	+10.8 V to +12 V	+5 V level or +12 V level is set by internal switch SEL1 and SEL2.
		L Level	0 V to +1.2 V	
	+5 V Level	H Level	+4.2 V to +5 V	
		L Level	0 V to +0.8 V	
		Line driver	(H level-L level) > 2.0 V	
Reference Pulse Signal Mode	Sign + Pulse Train Input (SIGN + PULSE Signal)	 $t_1, t_2 \leq 0.1\ \mu s$ $t_3, t_7 \leq 0.1\ \mu s$ $t_4, t_5, t_6 > 3\ \mu s$ $\tau \geq 2.5\ \mu s$ $\frac{\tau}{T} \times 100 \leq 50\%$	SIGN. H - ⊕ Reference L - ⊖ Reference
	2-phase Pulse with 90° Phase Difference (Phase A + Phase B)	 ⊕ REFERENCE: PHASE B 90° AHEAD OF PHASE A ⊖ REFERENCE: PHASE B 90° BEHIND FROM PHASE A $t_1, t_2 \leq 0.1\ \mu s$ $\frac{\tau}{T} \times 100 = 50\%$	Multiplier mode is set by the internal switch SW4-① to -③.
	CCW Pulses + CW Pulses	 $t_1, t_2 \leq 0.1\ \mu s$ $t_3 > 3\ \mu s$ $\tau \geq 2.5\ \mu s$ $\frac{\tau}{T} \times 100 \leq 50\%$	—

Note Maximum reference frequency is 200 kpps.

6.3 CONFIGURATION OF I/O CIRCUIT

6 3 1 Input Circuit

There are six input signals: Servo ON, forward/reverse overtravel protection, alarm reset, clear, gain changeover. Construct the input circuit using 12 V power supply (Fig. 6.4). Typical circuits are shown in Fig. 5.3.

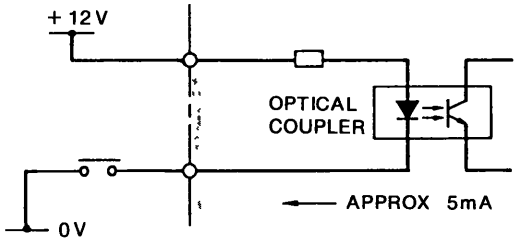


Fig 6 4 Configuration of I/O Circuit

(1) Forward and reverse running prohibit (P-OT, N-OT)

These circuits prohibit motor drive in forward rotation (counterclockwise rotation viewed from the load coupling side) and in reverse rotation.

By inputting the P-OT or N-OT signal, the circuit stops drive of the rotating motor and energizes the built-in dynamic brake to stop the motor. After stopping, the motor can be operated only in a resetting direction. However, drive is not possible on the reference to operate to the overtravel side.

The P-OT and N-OT operation specification is as follows:

	Side P Power-ON TR	Side N Power-ON TR	Operable Direction	Display
During P-OT	Base cut off	Power on	Side N	P
During N-OT	Power on	Base cut off	Side P	n

Note Operation in a reverse direction is possible for both sides P and N after cutting off the base and releasing DB during DB operation after P/N-OT

NOTE

When the overtravel prevention circuit is not used, connect 1CN- ㉑ and ㉒ to the 0 V terminal of the external 12 V power supply.

(2) Servo ON ($\overline{\text{S-ON}}$)

This circuit is used to turn on the main-circuit power-drive circuit of the Servopack. When the signal of the circuit is not input (Servo OFF state), the motor cannot be driven. If this signal is applied during motor running, the motor will coast to stop.

NOTE

Before turning power on or off, turn off the "Servo-ON" switch to avoid troubles resulting from transient current. Allow at least 40 ms for the reference pulse to be accepted after servo-on.

(3) Alarm reset ($\overline{\text{ALM-RST}}$)

This is the input to reset a servo alarm state other than the overcurrent alarm (Display [1.]).

If an overcurrent alarm ([1.]) occurs, turn off control power temporarily to reset the servo alarm.

(4) Deviation counter clear signal (CL)

The deviation counter resets at "L" level. Apply the reset signal for a period of only 50-50 ms. (If applied for longer periods, the motor will turn continuously in one direction because of zero drift.)

(5) Gain switching signal (GAIN)

The motor will not operate smoothly and vibration will occur on the motor shaft at low speeds since the motor complies with the command pulse. The motor will operate smoothly at low speed feed for a short period of time as in the MANUAL mode with this signal at "L" level and gain switched to L.

However, there will be a shock if gain is switched during operation. Also, always leave it in H gain when stopped.

6.3 2 Output Circuit

There are three output signals: positioning completion, Servo alarm, Servo ready.

These output circuits are non-contact, employing transistors. Voltage and current specifications are as follows:

Applied Voltage (Vmax) ≤ 30 V
Conduction Current (Ip) ≤ 20 mA

NOTE

The output circuit requires a separate power supply. It is recommended to use the same 12 V power supply used for the input circuit (Fig. 6.5).

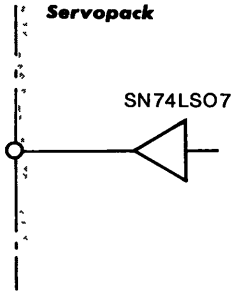


Fig 6 5 Output Circuit

6 3 3 Optical Encoder (PG) Output Circuit

Phase A and B signals can select open collector or line driver output mode by setting of internal SW SEL4 to SEL7 of Servopack.

However, phase C (original point) signal has only open collector output.

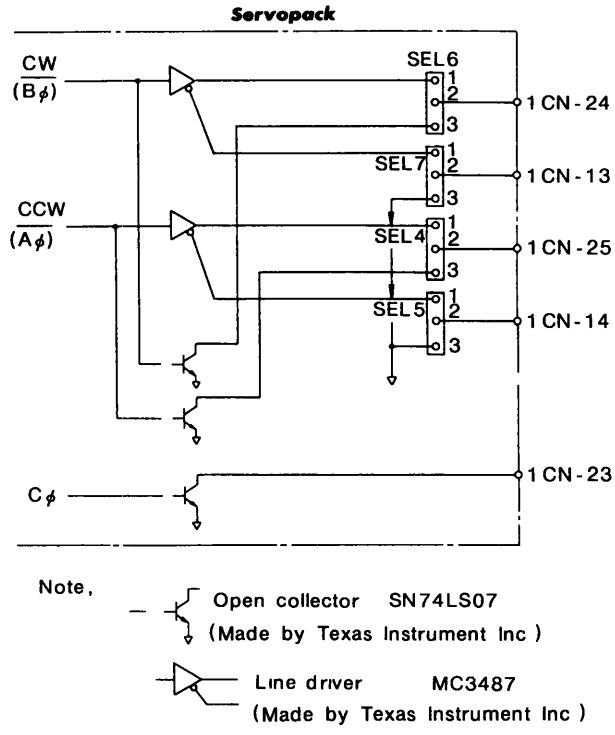


Fig 6 6 Output Circuit of Optical Encoder (PG)

(1) For open collector (factory-setting before user)

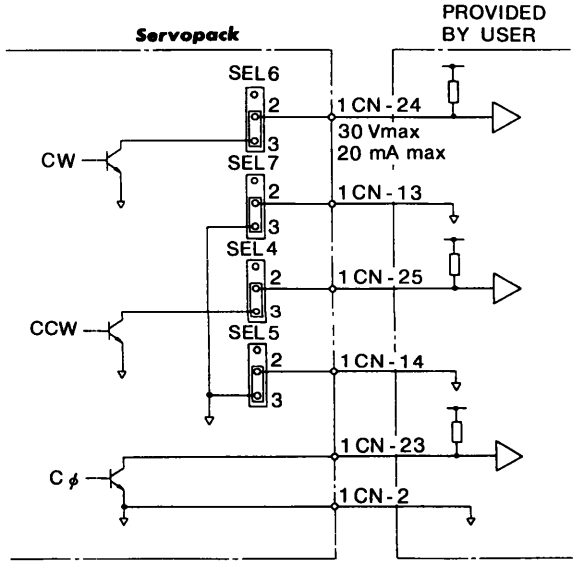


Fig 6 7 Setting for Open Collector

(2) For line driver

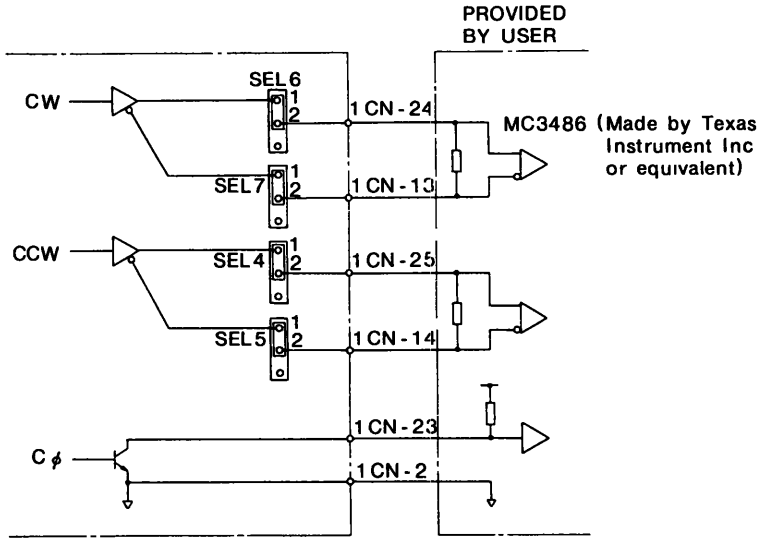


Fig 6 8 Setting for Line Driver

Optical encoder (PG) output can select output mode by setting of internal switch (SW3-①, ②) of Servopack.

The pulse logic is "L" effective and pulse width is 0.7μs.

Table 6 6 Output Pulse Mode

Output Pulse		Input Pin No	Forward Running Reference of Motor	Reverse Running Reference of Motor	SW3* ①	SW3* ②	
Reference Pulse	Sign + Pulses	1CN-㉔ 1CN-㉕	L	H	○	○	
Feedback Pulse	CW Pulses + CCW Pulses	1CN-㉔ 1CN-㉕	H	H	○		
	Sign + Pulses	1CN-㉔ 1CN-㉕	L	H		○	
	90° Phase Difference 2-Phase Pulses	1CN-㉔ 1CN-㉕	INVERSION OF PHASE B INVERSION OF PHASE A 90°				Factory setting before shipment

* Circles in SW3 show the positions for installing the setting plugs on the pins

6 3 3 Optical Encodcr (PG) Output Circuit (Cont'd)

Phase C signal outputs optical encoder Cφ (original point) signal. The output logic can be selected by setting of internal switch SW5-②.

Table 6 7 Phase C Output

SW5-②	Output Logic	
○		
×		Factory setting before shipment

6 3 4 Input and Output Pulse

When the Code + Pulse output mode and CW/CCW output mode are selected, the output pulse will be the pulse after multiplying.

If the 90° phase difference, 2-phase pulse output mode is selected, the inverted signal of the optical encoder (PG) A phase and B phase pulse will be output.

6 3 5 Setting Number of Optical Encoder Pulses

The optical encoder issues numbers of pulses, 1000 or 1500 pulses/rev. These pulses are set by the short switch (SW1- ③, ④, ⑤) in the Servopack.

Note that if wrong number of pulses is set for the servomotor and Servopack, the motor cannot run.

- The number of pulses of the optical encoder is indicated with the type of the servomotor.
- The number of pulses of the Servopack's optical encoder set at the factory is indicated with the type of the Servopack. (The factory setting is E: 1000 pulses/rev.)

If the number of pulses of the Servopack's optical encoder set at the factory is different from the number of motor pulses, change the setting switches in the Servopack according to Table 10.3.

6.4 PROTECTIVE CIRCUIT

Servopack provides functions to protect the body and motor from malfunctions.

(1) Dynamic brake function

Servopack incorporates a dynamic brake for emergency stop. This brake operates when:

- Alarm (fault detection) occurs.
- Servo ON command is opened.
- Main power supply is turned off.
- During deceleration at P/N overtravel

(2) Trouble detecting functions

Table 6 8 Trouble Detecting Functions

Trouble	Detection
Overcurrent (OC)	Overcurrent flow in the main circuit
Circuit Protector Trip (MCCB)	Circuit protector tripped
Regeneration Trouble (RG)	Regenerative circuit not activated in Servopack • For 200 V only 200 W • For 100 V only 100, 200 W
Overflow (OF)	Excessively large number of lag pulses of error counter
Overvoltage (OV)	Excessively high DC voltage in the main circuit • For 200 V approx 420 V • For 100 V approx 220 V
Overspeed (OS)	Excessively large speed reference input (detected at approx 4900 r/min)
Overrun Prevention (PG)	Wrong wiring of motor circuit or PG signal line
Voltage Drop (UV)	Low DC voltage in the main circuit after power ON • For 200 V approx 150 V or less • For 100 V approx 75 V or less
Overload (OL)	Overload condition of motor and Servopack
CPU Error (CPU)	Any error of CPU

(3) Overload (OL) detection level

Fig. 6.9 shows the setting of overload detection level at 100% rated motor current. If the allowable power-on time during motor locking is maximum, the higher the motor speed is, the quicker the motor response to the same overload.

(4) Servo alarm output (ALM+, ALM-)

If any trouble detection circuits in Table 6.8 functions, the power drive circuit in the Servopack goes off, 7-segment LEDs indicate the operation condition and a servo alarm signal is output.

The alarm codes are also output to the external through open collector output circuits of AL01 to AL03. See Table 6.9.

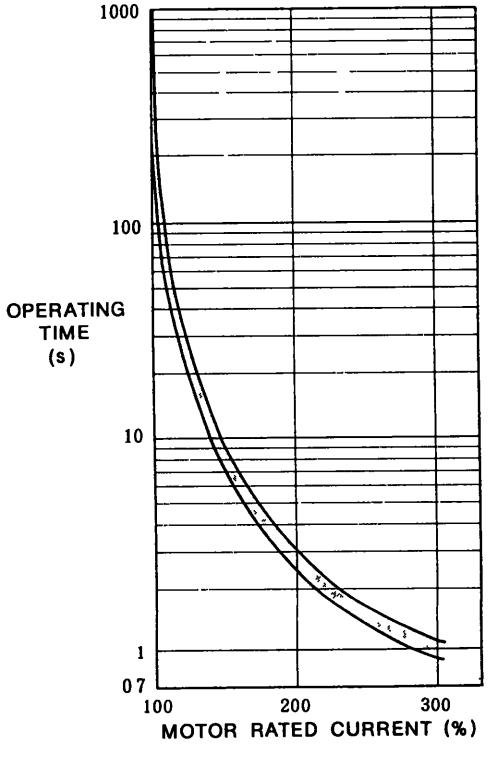


Fig 6 9 Overload Characteristics

Table 6 9 Alarm Display and Alarm Output Code (SVALM and 3-bit Output)

Specifications	Display (LED)	Code No	Output 1	Output 2	Output 3	SVALM
Normal	0	8	×	×	×	○
OC	1	1	○	×	×	×
MCCB	2	2	×	○	×	×
RG	3	3	○	○	×	×
OF	J					
OV	4	4	×	×	○	×
OS	5	5	○	×	○	×
PG	C					
UV	6	6	×	○	○	×
OL	7	7	○	○	○	×
CPU	-	0	×	×	×	×
A/D	b					

○ Output transistor is turned ON
× Output transistor is turned OFF

(5) Protective circuit operation

An alarm signal indicates some trouble. Check the cause and correct the trouble, and restart the operation. Before checking the cause, turn off the power to the main circuit to avoid danger. Apply the sequence so that the alarm signal turns off only the main circuit(Ⓡ , Ⓣ), as shown in Figs. 6.1 and 6.2. This allows rapid reaction in the event of a malfunction.

If the power to the control circuit (Ⓡ , Ⓣ) is simultaneously turned off, this also turns off the LED in the Servopack indicating the cause of the alarm signal.

CAUTION

When an alarm signal cuts off only the main circuit, stop the reference pulse before supplying power to the main circuit to resume the operation.

(6) Resetting servo alarm

To reset the servo alarm, turn ON the alarm reset ($\overline{\text{ALM-RST}}$) signal of input signal, or turn OFF the control power supply once.

If 7. or 1. is on (Servopack is over loaded), the reset alarm is not immediate and occurs a few minutes later.

6.5 LED INDICATION

Table 6 10 LED Status Indications (Red)

Status of Servopack	Indication	
Control Power Applied	Any indications of 7-segment LED is lit	
Main Power Applied	[MAIN] LED inside MCCB is lit	
Base Current Interrupted	7-segment LED	[-] is lit
Current Conducting (Normal Operation)		[ ] is lit
P Side Overtravel		[P] is lit
N Side Overtravel		[n] is lit

6.6 PRECAUTIONS FOR APPLICATION

6.6 1 Minus Load

The motor is rotated by the load; it is impossible to apply brake (regenerative brake) against this rotation and achieve continuous running.

Example: Driving a motor to lower objects (with no counterweight)

Since Servopack has the regenerative brake capability of short time (corresponding to the motor stopping time), application to a minus load is not allowed.

6.6 2 Load Inertia (J)

The allowable load inertia J converted to the motor shaft must be within ten times the inertia of the applicable AC servomotor. If the allowable inertia is exceeded, and overvoltage alarm may be given during deceleration.

The lower load inertia J brings out the higher features (frequency, positioning, etc.) of Servopack.

6.6.3 High Voltage Line

If the supply voltage is 400/440 V, the voltage must be dropped, three-phase 400/440 V to single-phase 200 V or 100 V by using a power transformer. Table 6.12 shows the transformer selection. Connection should be made so that the power is supplied and cut through the primary (on secondary) side of the transformer.

6 6 4 Processing Use

This analog clamp type AC servo drive is not suited for processing use, but the most suitable for positioning (point to point) use.

6.7 PRECAUTIONS OF OPERATION

6 7.1 Noise Treatment

Servopack uses is a power transistor in the main circuit. When these transistors are switched, the effect of $\frac{di}{dt}$ or $\frac{dv}{dt}$ (switching noise) may sometimes occur depending on the wiring or grounding method.

The Servopack incorporates CPU. This requires wiring and treatment to prevent noise interference. To reduce switching noise as much as possible, the recommended method of wiring and grounding is shown in Fig. 6.10.

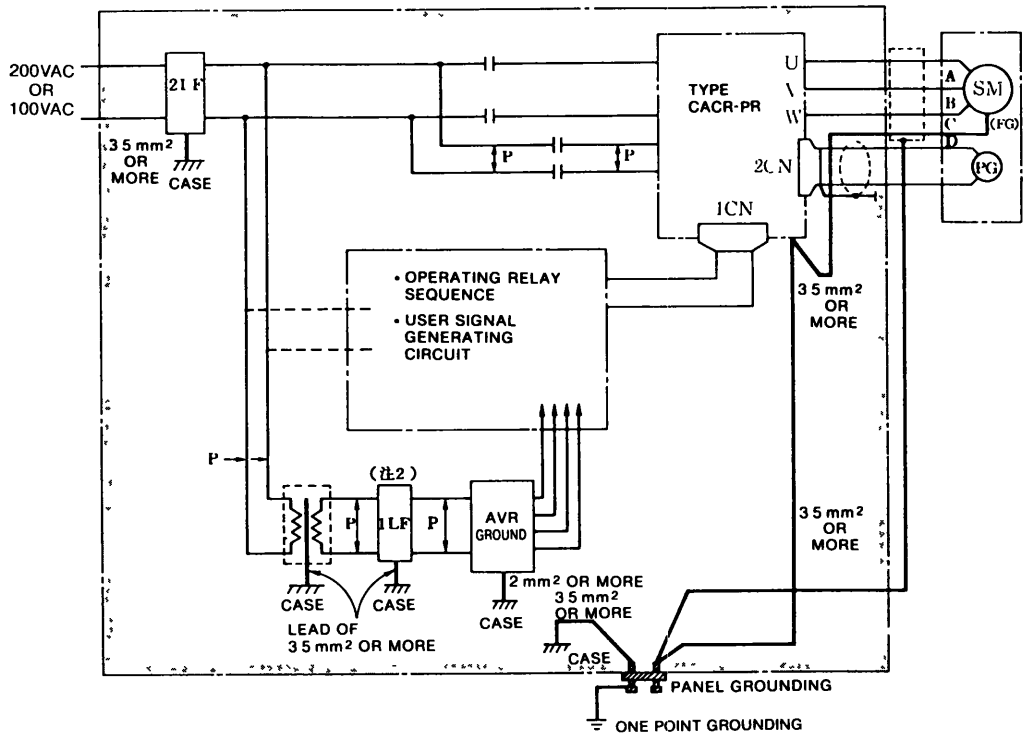
(1) Grounding method (Fig. 6.10)

- Motor frame grounding

  When the motor is at the machine side and grounded through the frame, Cf $\frac{dv}{dt}$ current flows from the PWM power through the floating capacity of the motor. To prevent this effect of current, motor ground terminal Ⓓ (motor frame) should be connected to terminal ⏚ of Servopack. (Terminal ⏚ of Servopack should be directly grounded.)

- Servopack SG 0 V

  Noise may remain in the input signal line, so make sure to ground SG 0 V. When motor wiring is contained in metal conduits, the conduits and boxes must be grounded. The above grounding uses one-point grounding.



P — Twisted cable

Note
1 Use wires of 3.5mm² or more for grounding to the case (preferably flat-woven copper wire)
2 Connect line filters observing the precautions as shown in (2) Noise filter installation

Fig 6.10 Grounding Method

(2) Noise filter installation

When noise filters are installed to prevent noise from the power line, the block type must be used. The recommended noise filter is shown in Table 6.11. The power supply to peripherals also needs noise filter.

NOTE

If the noise filter connection is wrong, the effect decreases greatly. Observing the precautions, carefully connect them as shown in Figs. 6.11 to 6.14.

Table 6.11 Recommended Noise Filter

Class	Servopack Type CACR-		Applicable Noise Filter	Recommended Noise Filter*	
				Type	Specifications
200V	50W (0.07HP)	PRA5AD3[ ]R	CORRECT	LF-205A	Single-phase 200VAC class, 5A
	100W (0.13HP)	PR01AD3[ ]R			
	200W (0.27HP)	PR02AD3[ ]R			
100V	50W (0.07HP)	PRA5AD4[ ]R	WRONG	LF-205A	Single-phase 200VAC class, 5A
	100W (0.13HP)	PR01AD4[ ]R			
	200W (0.27HP)	PR02AD4[ ]R		LF-210	Single-phase 200VAC class, 10A

* Made by Tokin Corp.
If noise filter is required, request your Yaskawa representative.

6.7 1 Noise Treatment (Cont'd)

(a) Separate the input and output leads. Do not bundle or run them in the same duct.

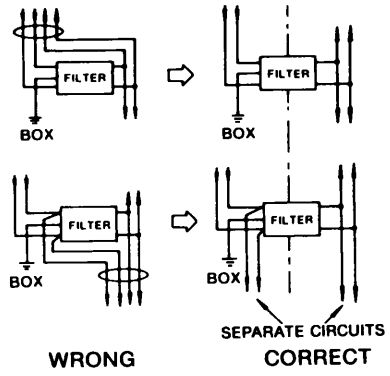


Fig 6 11

(b) Do not bundle the ground lead with the filter output line or other signal lines or run them in the same duct.

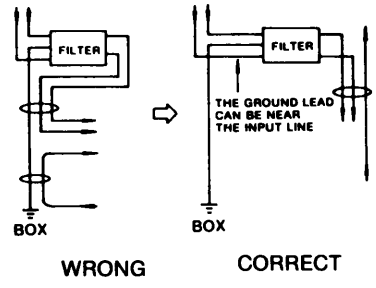


Fig 6 12

(c) Connect the ground lead singly to the box or the ground panel.

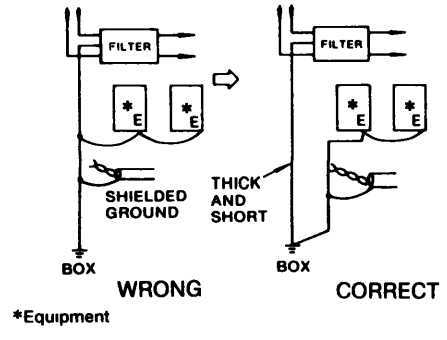


Fig 6 13

(d) If the control panel contains the filter, connect the filter ground and the equipment ground to the base of the control unit.

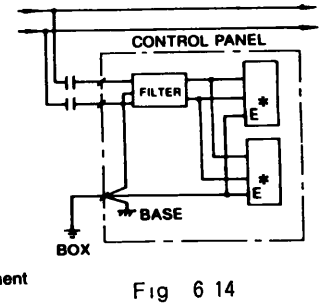


Fig 6 14

6 7 2 Power Line Protection

The Servopack is operated through the commercial power line (200 V or 100 V). To prevent the power line accidents due to grounding error, contact error, or to protect the system from a fire, circuit breakers (MCCB) or fuses must be installed according to the number of Servopacks used (Table 6.12).

A quick-melting fuse cannot be used, because the Servopack uses the capacitor-input power supply and the charging current might melt such a fuse.

Table 6 12 Power Supply Capacity and MCCB or Fuse Capacity

Class	Rated Output W (HP)	Servopack Type CACR-	Power Capacity* per Servopack kVA	Current Capacity† per Servopack A
200 V	50 (0 07)	PRA5AD3[ ]R	0 3	5
	100 (0 13)	PR01AD3[ ]R	0 5	5
	200 (0 27)	PR02AD3[ ]R	0 75	5
100 V	50 (0 07)	PRA5AD4[ ]R	0 3	5
	100 (0 13)	PR01AD4[ ]R	0 5	5
	200 (0 27)	PR02AD4[ ]R	0 75	8

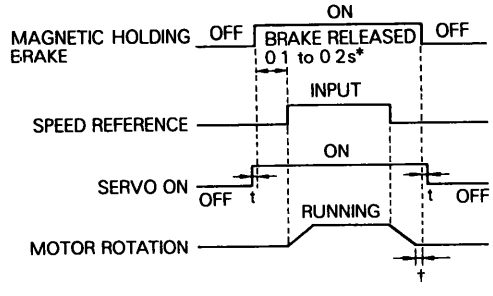
* Values at rated load

† Interruption characteristics at 25℃ 200 % 2 s or more
700 % 0 01 s or more

6.8 APPLICATION

6 8 1 Use of Servomotor with Holding Magnetic Brake

When Servomotor with magnetic holding brake is used, execute the following timing for signals ON and OFF. The magnetic holding brake is released by current conduction.



*Input speed reference after waiting 0 1 to 0 2 second after the brake release reference has been input
† Apply brake after the motor has stopped completely (Do not use the brake to declerate the motor)
Note t shows a delay time greater than the operating time (10ms) of one relay After Servo ON signal is turned on the motor will enter servo lock status after approx 30 ms

Fig 6 15 Magnetic Holding Brake ON-OFF Timing

7. INSTALLATION AND WIRING

7.1 RECEIVING

This motor has been put through severe tests at the factory before shipped. After unpacking, however, check and see the following.

- Its nameplate ratings meet your requirements.
- It has sustained no damage while in transit.
- The output shaft should be hand-rotated freely. However, the brake-mounted motor does not rotate as it is shipped with the shaft locked.
- Fastening bolts and screws are not loose.

If any part of the motor is damaged or lost, immediately notify us giving full details and nameplate data.

7.2 INSTALLATION

7 2 1 Servomotor

AC Servomotor can be installed either horizontally or vertically.

(1) Before mounting

Wash out anticorrosive paint on shaft extension and flange surface with thinner before connecting the motor to the driven machine. See Fig. 7.1.

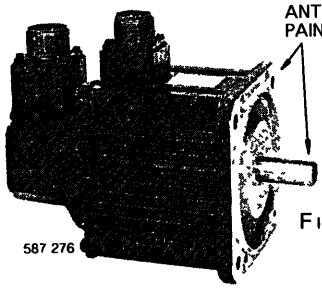


Fig 7 1 Anticorrosive Paint to be Removed

(2) Location

Use the motor under the following conditions.

- Indoors
- Free from corrosive and/or explosive gases or liquids
- Ambient temperature: 0 to +40° C
- Clean and dry
- Accessible for inspection and cleaning

If the AC servomotor is subject to excessive water or oil droplets, protect the motor with a cover. The motor can withstand a small amount of splashed water or oil.

(3) Environmental conditions

Ambient Temperature: 0° to +40°C

Storage Temperature: -20°C to +60°C

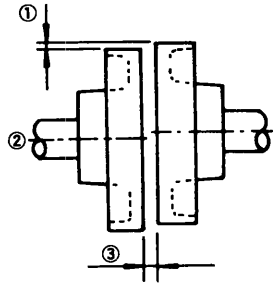
Humidity: 20% to 80% RH (non-condensing)

(4) Load coupling

True alignment of motor and driven machine is essential to prevent vibration, reduced bearing and coupling life, or shaft and bearing failures.

Use flexible coupling with direct drive. The alignment should be made in accordance with Fig. 7.2.

When mounting coupling, ease the impact on the shaft and avoid the excessive force on the bearing.



①Measure the gap between the straight edge and coupling halves at four equi distant points of the coupling The each reading should not exceed 0 03 mm
②Align the shafts
③Measure the gap between the coupling faces at four equidistant points around the coupling rim with thickness gage The maximum variation between any two readings should not exceed 0 03mm

Fig 7 2 Alignment of Coupling

(5) Allowable bearing load

Avoid both excessive thrust and radial loads to the motor shaft. If unavoidable, never exceed the values in Table 4.1.

When mounting the gear, coupling and pulley, ease the impact on the shaft and avoid excessive force on the bearing. (10G max.)

7 2 2 *Servopack*

(1) Installation

The Servopack type CACR-PR□□AD is rack-mounted type.

(2) Location

- When installed in a panel:

  Keep the temperature around Servopack at 55°C or below.

- When installed near a heat source:

  Keep the temperature around Servopack below 55°C.

- If subjected to vibration:

  Mount the unit on shock absorbing material.

- If corrosive gases are present:

  Avoid locations where corrosive gases exist as it may cause extensive damage over long use. Especially vulnerable are switching operation of contactors and relays.

7 2 2 ***Servopack*** (Cont'd)

- Unfavorable atmospheric conditions:

  Select a location with minimum exposure to oil, water, hot air, high humidity, excessive dust or metallic particles.

(3) Mounting Direction

Mount the Servopack unit vertically on the wall with main terminals being at the bottom to take advantage of natural air convection (Fig. 7.5). Install it with setscrews tightened at four mounting holes in the unit base.

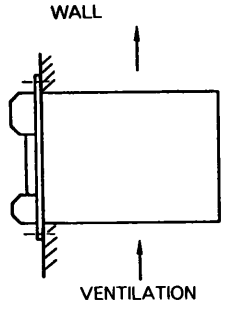


Fig 7 5 Mounting Direction

7.3 WIRING

7 3 1 Rated Current and Cable Size

Tables 7.1 and 7.2 show external terminals, rated current, and cable sizes of the power unit and Servopack, respectively. Select the type and size of cables to meet ambient conditions and current capacity. The cable size is calculated so that a bundle of three cables can bear the rated current at an ambient temperature of 40°C. Table 7.3 lists the type of cables.

Table 7 1 Rated Current

External Terminal		Type CACR- / Symbol	Rated Current (Effective Current)					
			200 V Class			100 V Class		
			PRA5AD3	PR01AD3	PR02AD3	PRA5AD4	PR01AD4	PR02AD4
On Line	Main Circuit Power Input	Ⓡ Ⓣ	1 3	2 5	4 4	2 6	4 5	8 0
	Motor Connection	Ⓤ Ⓥ Ⓦ	0 7	1 0	2 0	1 2	1 7	2 9
	Control Power Input	ⓡ ⓣ	0 5					
Off Line	Control I/O Signal Connector	1CN	100 mA DC max					
	PG Signal Connector	2CN	100 mA DC max (500 mA DC for power line only)					
	Ground	⏚	—					

Table 7 2 Recommended Cable Size of Servopack

External Terminal		Type CACR- / Symbol	Cable Size* mm²					
			200 V Class			100 V Class		
			PRA5AD3	PR01AD3	PR02AD3	PRA5AD4	PR01AD4	PR02AD4
On Line	Main Circuit Power Input	Ⓡ Ⓣ	HIV 1 25 or more			HIV 1 25		HIV 2 0 or more
	Motor Connection	Ⓤ Ⓥ Ⓦ	HIV 1 25 or more					
	Control Power Input	ⓡ ⓣ	HIV 1 25 or more					
Off Line	Control I/O Signal Connector	1CN	Two-core twisted shielded cable Core must be 0 2 mm² or more Tin-plated soft-copper twisted cable Finished cable dimension 16 dia or less for 1CN, 11 dia or less for 2CN					
	PG Signal Connector	2CN						
	Ground	⏚	HIV 1 25 or more					

Note These cable size are measured when the rated current are sent into a group of three leads at environmental temperature 40°C

Table 7 3 Cable

Type of Cable	Allowable Conductor Temperature °C
Vinyl Cable (PVC)	—
600 V Vinyl Cable (IV)	60
Special Heat-Resistant Cable (HIV)	75

Note
1 For main circuits use cables of 600 V or more
2 Where cables are bundled or run through a duct (unplasticized polyvinyl chloride conduit or metalic conduit) select the larger cable size than listed considering the current drop rate of the cables
3 Where the ambient (panel inside) temperature is high (40°C to 60°C) use heat-resistant cables

7 3 2 Wiring Precautions

The following precautions should be taken for wiring.

(1) For signal lines an PG feedback lines, use twisted cables or multi-core shielded twisted-pair cables (Yaskawa Drawing No. DB8400403).

Cable length is a maximum of 3 m for reference input lines and a maximum of 5 m for PG feedback lines. Use the shortest possible length.

(2) For ground line, cable should be as heavy as possible to provide class 3 ground (ground resistance 100Ω or less). Make sure to ground at one point. If the motor and machine are insulated, ground the motor.

(3) To prevent malfunction due to noise, take the following precautions:

- Place the noise filter, Servopack and I/O reference as near as possible to each other.
- Make sure to mount a surge absorbing circuit into the relay, electromagnetic contact, and solenoid coils.
- Run the power line and signal line, holding the distance to 30 cm or more; do not run them in the same duct or in a bundle.
- When the same power is used for Servopack, as for an electric welder or electrical discharge machine or when a high-frequency noise source is present in the vicinity, use filters in the power and input circuits.
- The Servopack uses a switching amplifier, and spurious noise may be present in the signal line. Never leave the termination of the analog input wiring open.

(4) Remedy for Radio Frequency Interference (R.F.I)

Servopack is not provided with protected from radio frequency interference. If the controller is adversely affected by radio waves, connect a noise filter to power supply.

(5) The signal line uses cables whose core is extremely fine (0.2 to 0.3 mm^2). Avoid using excessive force which may damage these cables.

7 3 3 Power Loss

The power loss of Servopack is shown in Table 7.4.

Table 7 4 Power Loss at Rated Output

Class	Rated Output W (HP)	Servopack Type CACR-PR	Output Current ±ADC	Power Loss			
				Main Circuit W	Regenerative Resistance* W	Control Circuit W	Total W
200 V	50 (0 07)	A5AD3□R	0 7	20	—	30	50
	100 (0 13)	01AD3□R	1 0	25	—		55
	200 (0 27)	02AD3□R	2 0	30	6		66
100 V	50 (0 07)	A5AD4□R	1 2	20	—		50
	100 (0 13)	01AD4□R	1 7	25	6		61
	200 (0 27)	02AD4□R	2 9	40	6		76

* The regenerative resistor causes power loss when the motor is decelerated These values show allowable maximum value of mean power loss Where the motor is run at duty cycle exceeding these values,the regenerative resistor should be installed separately from Servopack

8. DIMENSIONS

8.1 SERVOMOTOR DIMENSIONS in mm (inches)

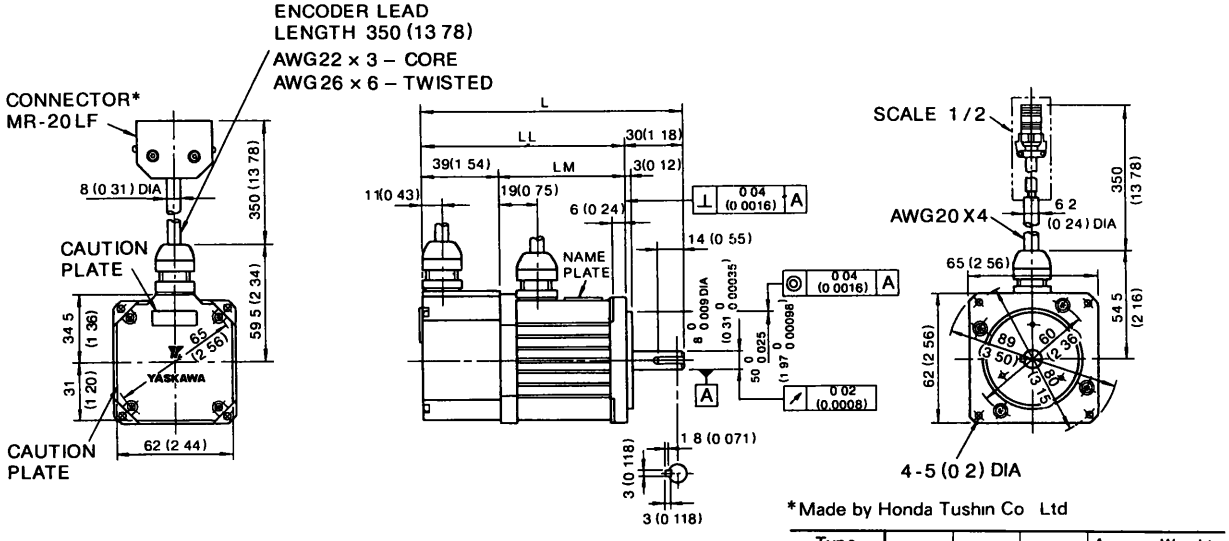
If the capacity is the same, the dimensions are the same even if the voltage or pulse specifications differ (100 V, 200 V, 1000 pulses or 2000 pulses).

The dimension diagrams show two types: without brake (with key) and with brake (with key). The shaft end dimensions that are non-standard are shown for applied models. The Servomotor proper is the same as shown in each diagram.

(1) Standard (with key, straight shaft)

Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1301 "Sunk keys and their corresponding keyways)." Parallel key has been attached.

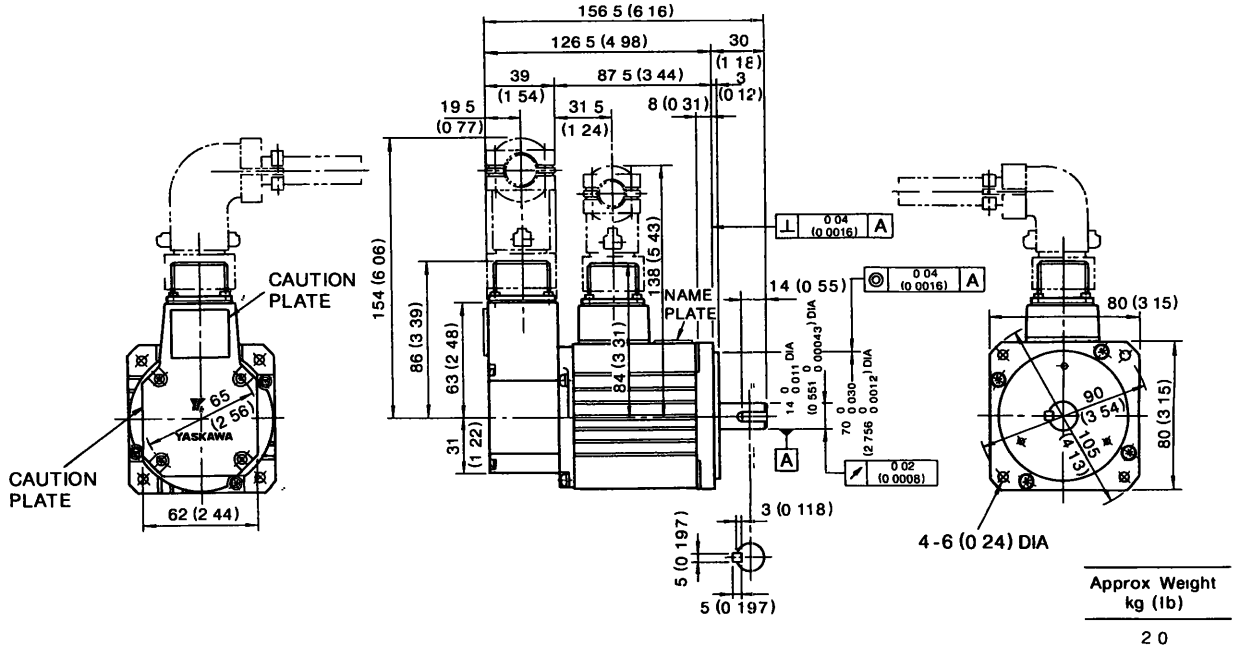
· TYPES USAREM-A5[ ][ ]2K,-01[ ][ ]2K



*Made by Honda Tushin Co Ltd

Type USAREM-	L	LL	LM	Approx Weight kg (lb)
A5[ ][ ]2K	131 5 (5 18)	101 5 (4 00)	62 5 (2 46)	1 0 (2 2)
01[ ][ ]2K	149 (5 87)	119 (4 69)	80 (3 15)	1 3 (2 9)

· TYPE USAREM-02[ ][ ]2K

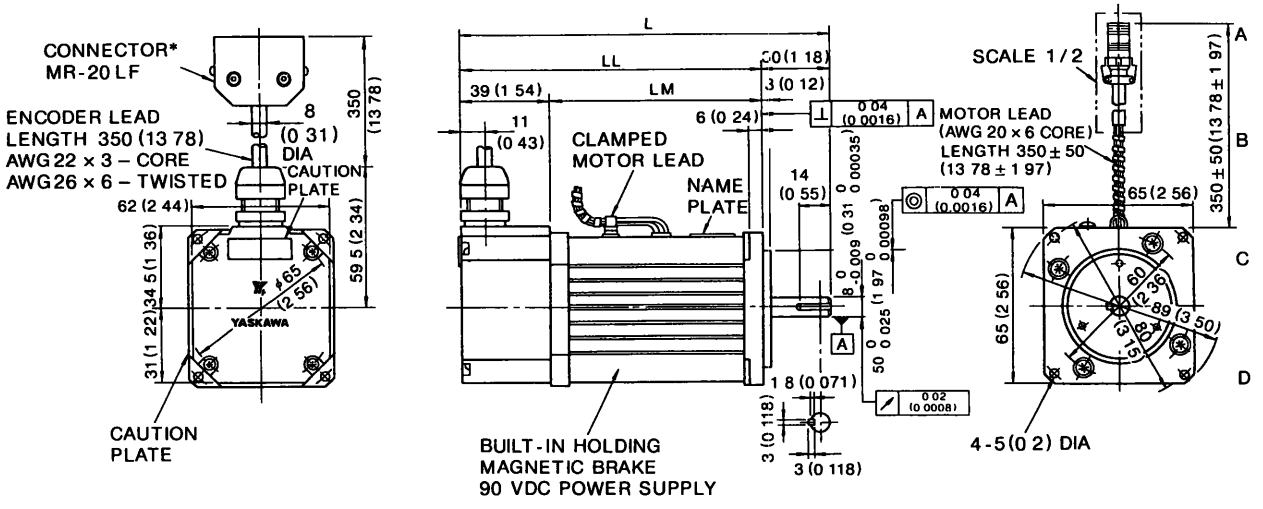


Approx Weight kg (lb)
2 0 (4 4)

(2) With Brake (with key straight shaft)

Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1301 "Sunk keys and their corresponding keyways)." Parallel key has been attached.

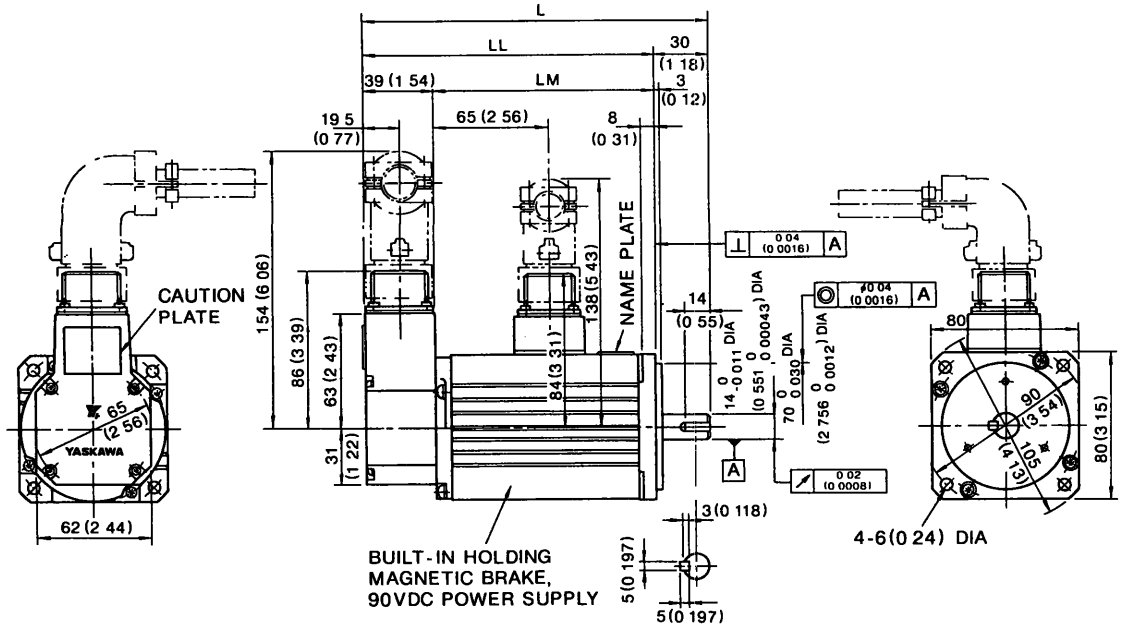
· TYPES USAREM-A5[illegible]2KB,-01[illegible]2KB



*Made by Honda Tushin Co Ltd

Type USAREM	Dimensions L	LL	LM	Magnetic Brake Type	Inertia kg m² x 10⁻⁴ (oz in s² x 10⁻³)	Static Friction Torque N m (oz in)	Voltage VDC	Approx Weight kg (lb)
A5[illegible]2KB	164 5 (6 48)	134 5 (5 30)	95 5 (3 76)	MSB/ 90 6YN	0 98 (0 733)	0 588 (83 3)	90	1 4 (3 09)
01[illegible]2KB	182 (7 17)	152 (5 99)	113 (4 45)					1 7 (3 75)

· TYPE USAREM-02[illegible]2KB



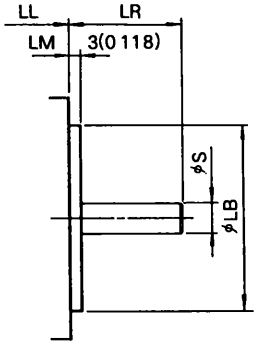
Type USAREM	Dimensions L	LL	LM	Magnetic Brake Type	Inertia kg m² x 10⁻⁴ (oz in s² x 10⁻³)	Static Friction Torque N m (oz in)	Voltage VDC	Approx Weight kg (lb)
02[illegible]2KB	194 (7 64)	164 (6 46)	125 (4 92)	MSB/ 90 20YN	0 19 (2 73)	1 961 (2 78)	90	2 7 (5 95)

8.1 SERVOMOTOR DIMENSIONS in mm (inches) (Cont'd)

(3) Shaft Extension of Straight Shaft

- TYPE USAREM-A5[ ][ ]2 to -02A[ ]2(without brake)
- TYPE USAREM-A5[ ][ ]2B to -02A[ ]2B(with brake)

Servomotor proper is the same dimensions as standard servomotor. See par. 8.1 (1) and (2). Details of shaft extension are shown below:

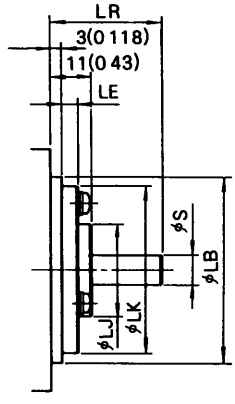


Without Brake Type USAREM-	With Brake Type USAREM-	LR	S	LB
A5[ ][ ]2	A5[ ][ ]2B	30 (1 18)	$8\ ^{0}_{-0.009}$ ($0\ 31\ ^{0}_{-0.00035}$)	$50\ ^{0}_{-0.025}$ ($1\ 97\ ^{0}_{-0.00098}$)
01[ ][ ]2	01[ ][ ]2B			
02[ ][ ]2	02[ ][ ]2B		$14\ ^{0}_{-0.011}$ ($0\ 551\ ^{0}_{-0.00043}$)	$70\ ^{0}_{-0.030}$ ($2\ 756\ ^{0}_{-0.0012}$)

(4) Shaft Extension of Straight Shaft with Oilseal

- TYPE USAREM-A5[ ][ ]2S to -02A[ ]2S (without brake)
- TYPE USAREM-A5[ ][ ]2SB to -02A[ ]2SB (with brake)

Servomotor proper is the same dimensions as standard servomotor. See par. 8.1 (1) and (2). Details of shaft extension are shown below.



Without Brake Type USAREM	With Brake Type USAREM	LR	LE	LJ	LK	S	LB	Oilseal*
A5[ ][ ]2S	A5[ ][ ]2SB	30 (1 18)	45 (0 18)	25 (0 98)	45 (1 77)	$8\ ^{0}_{-0.009}$ ($0\ 31\ ^{0}_{-0.00035}$)	$50\ ^{0}_{-0.025}$ ($1\ 97\ ^{0}_{-0.00098}$)	SB08187
01[ ][ ]2S	01[ ][ ]2SB							
02[ ][ ]2S	02[ ][ ]2SB			36 (1 42)	60 (2 36)	$14\ ^{0}_{-0.011}$ ($0\ 551\ ^{0}_{-0.00043}$)	$70\ ^{0}_{-0.030}$ ($2\ 756\ ^{0}_{-0.0012}$)	SB14287

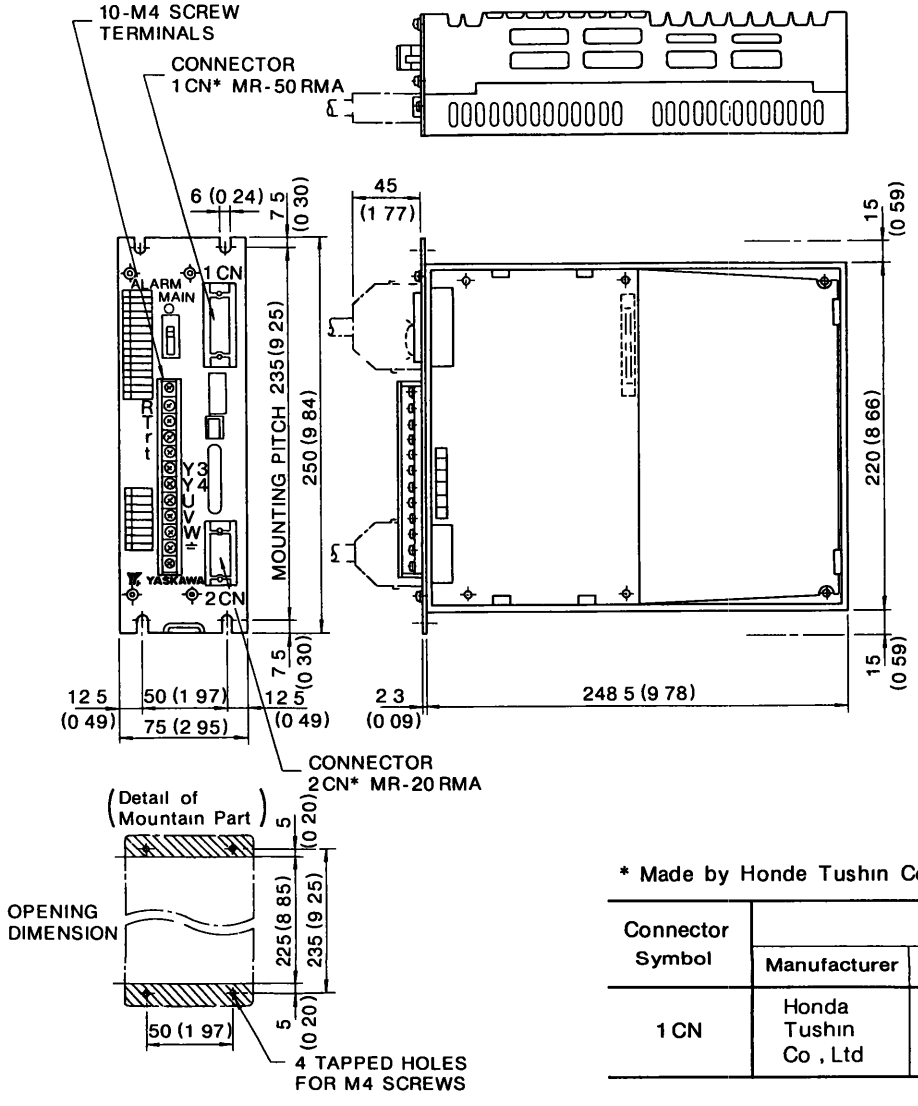
* Nippon Oil Seal Industry Co Ltd

(5) Shaft Extension of Straight Shaft with Keyway and Oilseal

Servomotor proper and shaft extension are same dimensions as standard Servomotor. See Par. 8.1 (1) and (2). Oilseal is same dimensions as shown in par. 8.1 (4).

8.2 *Servopack* DIMENSIONS in mm (inches)

- CACR-PRA5AD3[ ]R to -PR02AD3[ ]R (200 V)
- CACR-PRA5AD4[ ]R to -PR02AD4[ ]R (100 V)



* Made by Honde Tushin Co , Ltd

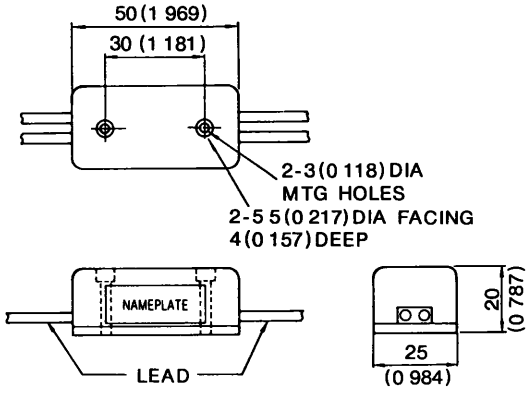
Connector Symbol	Attachments		
	Manufacturer	Receptacle Type	Case Type
1 CN	Honda Tushin Co , Ltd	MR-34 F	MR-34 L

8.3 PERIPHERAL EQUIPMENT in mm (inches)

■ Power Supply for Brake

According to the motor, select 100V/200V power supply for brake.

- Input 100 VAC, 90 VDC (DP8401002-2)
- Input 200 VAC, 90 VDC (DP8401002-1)

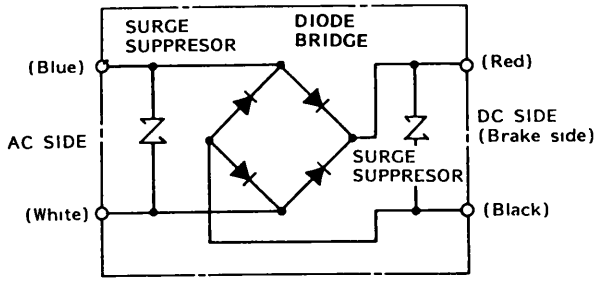


- Lead length: each 500 mm (19.69 inches)
- Lead color:

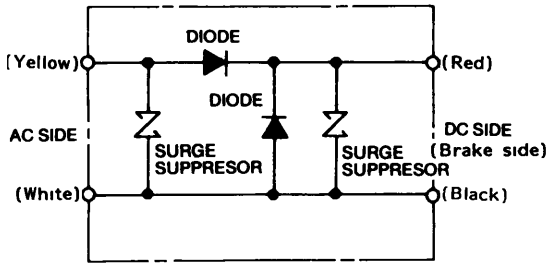
AC Input Side		Brake Side
100V	200V	
Blue White	Yellow White	Red Black

- Maximum ambient temperature: 60°C

- Internal circuit for 100 VAC



- Internal circuit for 200 VAC



Note Close or open the brake power supply circuit on either AC or DC side. Normally, operate on AC side (safer than DC side). If it is operated on DC side, be sure to mount the surge suppressor near the brake coil, because the brake coil may be damaged by surge voltage

9. TEST RUN

Before test run, check the following. Correct any deficiency.

9.1 CHECK ITEMS BEFORE TEST RUN

9 1 1 Servomotor

Before test run, check the following. If the test run is performed after long storage, see par.11 "Inspection and Maintenance".

- Connection to machines or devices, wiring, fuse connection, and grounding are correct.
- Bolts and nuts are not loose.
- For motors with oil seals, the seals are not damaged and oil is properly lubricated.

9 1 2 *Servopack*

- Setting switches are correctly set to satisfy the specifications for the applicable servomotor and optical encoder.
- Connection and wiring leads are firmly connected to terminals or inserted into the connectors.
- The power supply is turned off if servo alarm outputs.
- Voltage supplied to Servopack is 200 to 230V $^{+10}_{-15}$ % or 100 to 115 V $^{+10}_{-15}$ %.
- The speed reference should be 0 V.
- MCCB of Servopack should be ON. (It may be OFF during transit or mounting.)

9.2 TEST RUN PROCEDURES

9 2 1 Preparation of Opertion

During test run, loads should not be applied to the servomotor. If it is necessary to start with the driven machine connected to the motor, confirm that the driven system has been ready for emergency stop at any time.

- Power ON

  After checking items in par. 6.1, turn on the power supply. When the power on sequence is correct, according to par. 6.1, the power is turned on by depressing the POWER pushbutton.

- When the power is correctly supplied, the following green [LED]s light: [-.] and [MAIN] .
- When a Servo ON signal is input (contact is on), the power circuit in the Servopack operates and the motor is ready to run.

9 2 2 Operation

The operation is possible only while Servo ON signal is on.

- **The motor speed is proportional to the reference pulse frequency and the motor rotation angle is proportional to the number of input reference pulses.**
- **Run the motor at a low speed, by continuously inputting low-frequency reference pulses.**

  Check that the motor rotates in the correct direction according to the forward or reverse reference (depending on the input form of the reference pulses).

  The forward rotation of motor is counterclockwise viewed from drive end (output shaft). See Fig. 9.1.

- **The motor is stopped by cutting the reference pulse.**

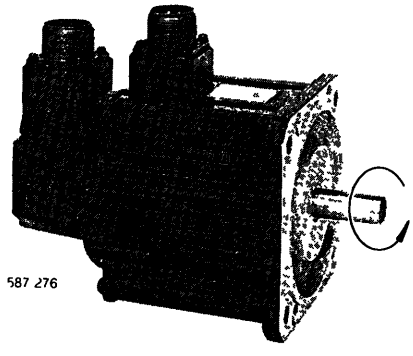


Fig 9 1 Motor Forward Running

9 2 3 Inspection during Test Run

The following items should be checked during the test run.

- Unusual vibration
- Abnormal noise
- Excessive temperature rise

If any abnormality is found, take corrective actions according to par. 12. At a test operation, the load and machine may not fit well at first and result in overload.

10. ADJUSTMENT

10.1 SETTINGS AT THE TIME OF DELIVERY

The Servopack has been factory-adjusted as follows:

Table 10 1 Standard Adjustment and Set ing Specifications

Servopack Type CACR-	Applicable Servomotor				Servopack Adjusting Specifications					
	Type USAREM-	Optical Encoder pulses/ rev	Rated * Current A	Reference Mode	Reference Pulse Frequency kpps	Speed Setting r/min	PG Multi-plier	Pulse Resolution per Motor Revolution	f/V Output r/min	Start Current Setting A (Arms)
PRA5AD3NR	A5CN2	1000	0 7	Sign + pulse train, (Voltage level +5 V)	50	3000	× 1	1000	2 V/1000	3 0 (2 1)
PRA5AD3QR	A5CQ2	2000			100			2000		
PR01AD3NR	01CN2	1000	1 0		50			1000		4 0 (2 8)
PR01AD3QR	01CQ2	2000			100			2000		
PR02AD3NR	02CN2	1000	2 0		50			1000		8 1 (5 7)
PR02AD3QR	02CQ2	2000			100			2000		
PRA5AD4NR	A5DN2	1000	1 2		50			1000		5 1 (3 6)
PRA5AD4QR	A5DQ2	2000			100			2000		
PR01AD4NR	01DN2	1000	1 7		50			1000		7 1 (5 0)
PR01AD4QR	01DQ2	2000			100			2000		
PR02AD4NR	02DN2	1000	2 9		50			1000		12 0 (8 5)
PR02AD4QR	02DQ2	2000			100			2000		

* Effective value

Note:

1. At the factory, the Servopacks are preset and adjusted as shown in [ ].
2. The pulse resolution per rotation of the motor shaft processed in the Servopack is calculated as follows:

$$\text{Pulse resolution} = \frac{P \times M}{N}$$

P: Number of optical encoder pulses/rev
N: Dividing ratio
M: Multiplication factor (1, 2, or 4)

The following relation is also observed.

Reference pulse frequency (pps)

$$= \frac{\text{Motor speed (r/min)}}{60} \times \text{pulse resolution}$$

3. The PG pulse output from the Servopack is the number of pulses generated from the optical encoder multiplied by the PG dividing ratio.

Servopack PG output pulses = P/N
(per rotation of motor)

10.2 READJUSTMENT

The Servopack has been adjusted at the factory to obtain optimum characteristics, and no further adjustment is required. If adjustment is required depending on the use, readjust the Servopack referring to par. 10.3.

10.3 ADJUSTMENT PROCEDURES

10 3 1 Check Terminals

Fig. 10.1 shows the arrangement of rotary switches, potentiometers, and terminals for checking waveforms; and Table 10.2 lists check terminals and functions.

Adjust the potentiometers, observing the waveform of the check terminals. (Do not tamper with them unnecessarily.)

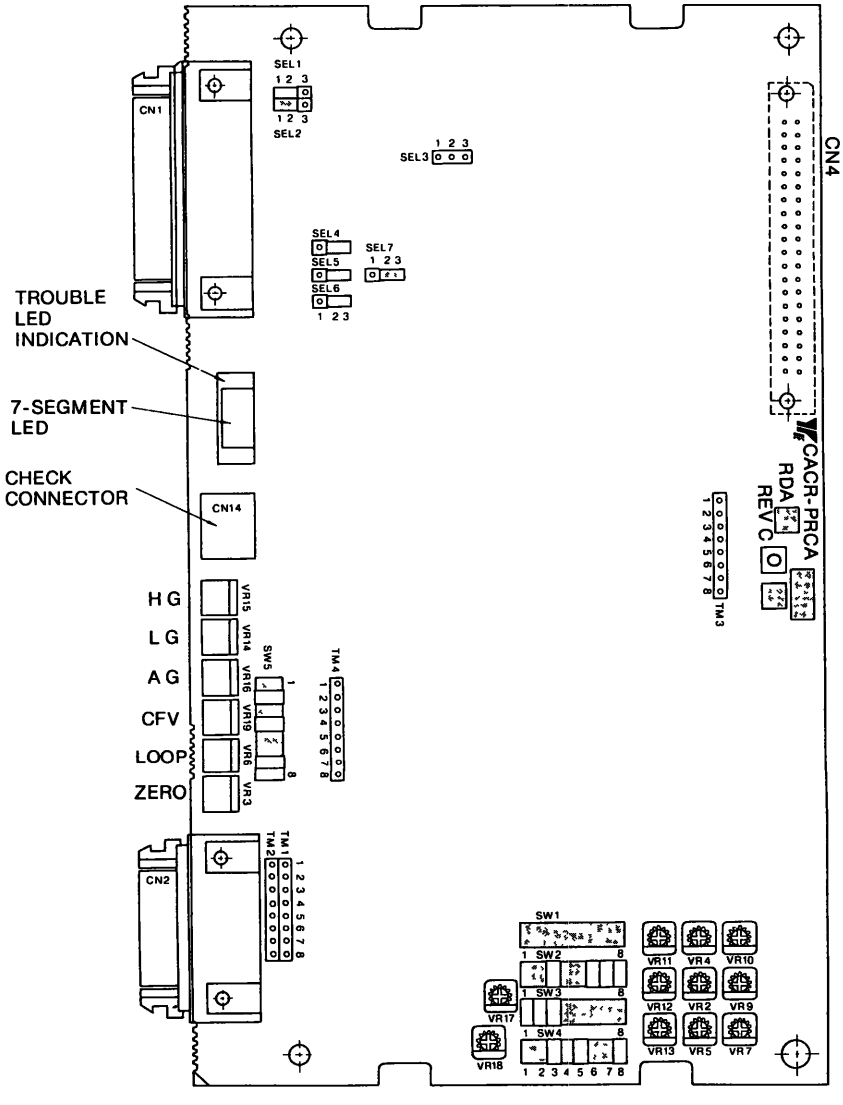
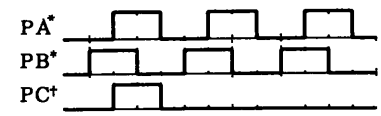
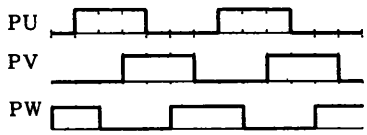


Fig 10 1 Printed Circuit Board Type CACR-PRCA□RDA

Table 10.2 Check Terminal Functions

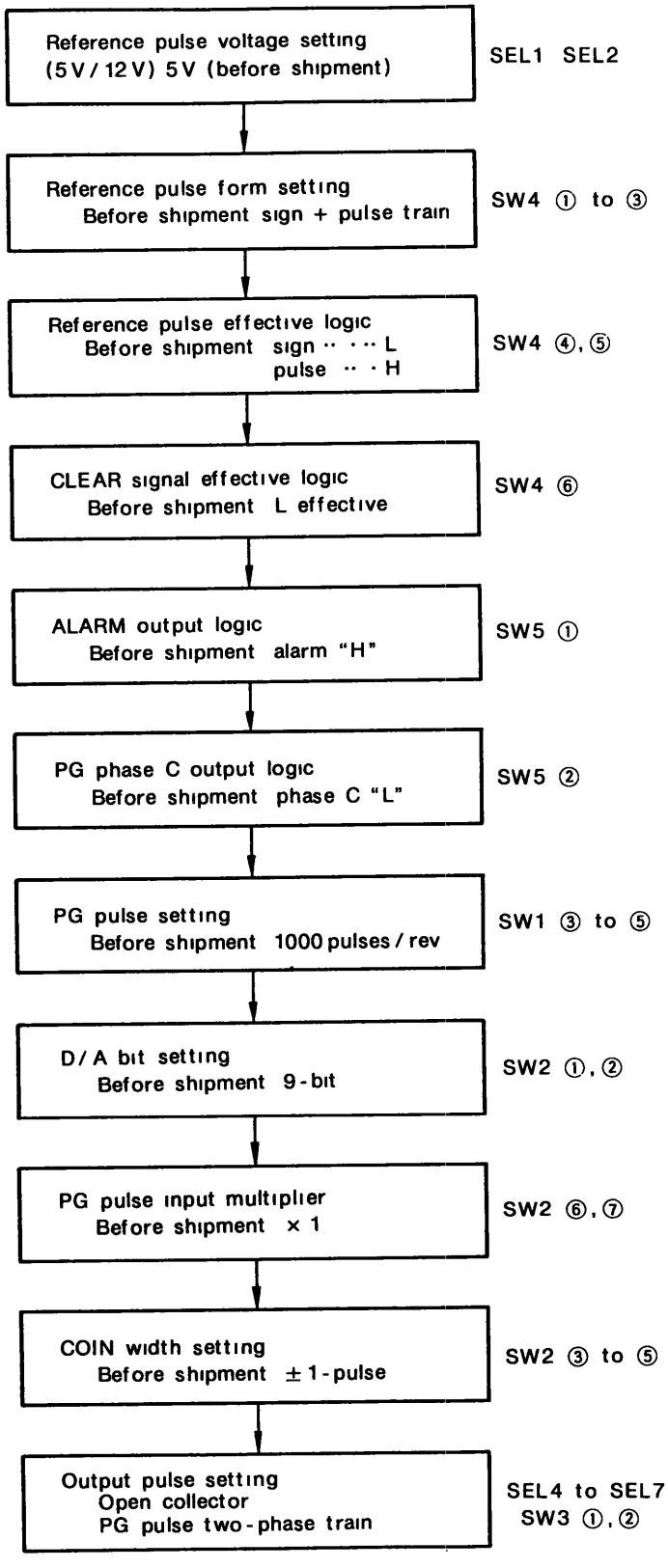
Equipment Symbol		Signal Name	Description		
TM1	1	PA	PG input signal	Phase A pulse input.	* Waveform at motor forward running.  * Two-phase pulse with 90° phase difference. † One generation per motor turning. Synchronizing with PA
	2	*PA		Phase A reverse input.	
	3	PB		Phase B pulse input.	
	4	*PB		Phase B reverse input.	
	5	PC		Phase C pulse input.	
	6	*PC		Phase C reverse input.	
	7	-	Not used.		
	8	PG5V	Optical encoder (PG) power supply voltage: +5V.		
TM2	1	PU	Phase U pulse input from pole sensor.		* Waveform at motor forward running. 
	2	*PU	Phase U reverse input.		
	3	PV	Phase V pulse input from pole sensor.		
	4	*PV	Phase V reverse input.		
	5	PW	Phase W pulse input from pole sensor.		
	6	*PW	Phase W reverse input.		
	7	-	Not used.		
	8	PG0V	Optical encoder (PG) power supply voltage: 0V (PG, common terminal of signal from pole sensor)		
TM3	1	Uref	Phase U current reference		
	2	Vref	Phase V current reference		
	3	VTG	Motor speed monitoring: ±2.0VDC ±10%/100r/min		
	4	Vref	Motor torque monitoring: ±3.0VDC ±10%/100% torque		
	5	Iu	Phase U current monitor	Servopack type: 200V class A5 / 01 / 02; 100V class A5 / 01 / 02	
	6	Iv	Phase V current monitor	Monitor Voltage (V/A): 0.8 / 0.4 / 0.8 / 0.4 / 0.2	
	7	OSC1	Carrier frequency (Triangle pulse)		
	8	SG	Signal 0V		
TM4	1	PULS	Reference pulse input "PULS" monitoring*		
	2	SIGN	Reference pulse input "SIGN" monitoring*		
	3	CFV	Reference pulse F/V output		
	4	D/A	D/A output (speed reference)		
	5	SIN	PG-Phase B analog signal		
	6	-	—		
	7	COIN	Positioning completion signal		
	8	SG	Signal 0V		

See the next page for the notes of this table.

* "PULSE" and "SIGN" differs from the setting of reference pulse form.
(1) sign + pulse (2) Two-phase difference (3) CW/CCW pulse.
† Two-phase pulse with 90 phase difference.

Note:
1. The check terminals allow oscilloscope connection for measurment.
2. The waveform of TM3 and TM4 are measured normally by TM3 ⑧ and TM4 ⑧ (signal 0 V) are connected with respectively. TM2 ⑧ (PG power supply: 0 V) and TM3, ⑧ , TM4 ⑧ (signal 0 V) are connected with impedance.
3. During measument, do not connect the adjacent two check terminals. If connected, the electronic parts may be damaged.

10.3.2 Switch Setting



10 3 2 Switch Setting (Cont'd)

Table 10 3 Switch Setting and Functions (1)

Switch Name	Pin No	Function	Short Circuited (○)	Open (×)	Standard Setting
SW1	1	Motor setting	○ 8P-SIN	No use the other settings by user	○
	2		○ 3000 r/min		○
	3	PG pulse	○ 1000 pulses/rev	○ 2000 pulses/rev	No use the other settings by user	○
	4		○	○		○
	5		○	×		○
	6	OT mode (1)	○ DB operation	× DB not operate		○
	7	OT mode (2)	○ Nomal usually operation	× Servo alarm		○
	8	Test mode	○ Usually operation	× (No use the other settings by user)		○
SW2	1	D/A conversion bit setting	○ 9-bit	× 10-bit	○ 11-bit	× 12-bit	○
	2		○	×	×	×	○
	3	Positioning completion width setting	○ ± 0 pulse	× ± 1 pulse	○ ± 2 pulse	× ± 3 pulse	○ ± 4 pulse	× ± 5 pulse	○ ± 6 pulse	× ± 7 pulse	×
	4		○	○	×	×	○	○	×	×	○
	5		○	○	×	×	×	×	×	×	○
	6	PG pulses input multiplied setting	×	× 1	○	× 2	○	× 4	×	No use	×
	7		×		×		○		○		×
	8	—	—		—		×
SW3	1	Output pulse setting	○ Reference pulse SIGN + PULSE	○ PG pulse CW/CCW	× PG pulse SIGN - PULSE	× PG pulse Two-phase pulse	×
	2		○	×	○	×	×
	3						×
	4						○
	5						○
	6						○
	7						○
	8						○
SW4	1	Reference pulse form ○ SIGN + × PULSE	× CCW + CW	○ A ϕ + B ϕ × 1	× A ϕ + B ϕ × 2	○ A ϕ + B ϕ × 4	○
	2		○	○	○	×	○
	3		×	○	○	○	×
	4	Reference pulse input logic	○ "L" active operation	× "H" active operation			○
	5		○	×			×
	6	CL signal input logic	○ "L" active operation	× "H" active operation			○
	7	GAIN signal input logic	○ "L" active operation	× "H" active operation			○
	8	Clear operation setting	○ Differential operation	× Better operation			×
SW5	1	ALM signal output logic	○ "H" active	× "L" active			○
	2	Phase PG-C signal output logic	○ "H" active	× "L" active			×
	3		○	×			○
	4		○	×			×
	5		○	×			○
	6		○	×			○
	7		○	×			×
	8		○	×			×

Notes

1 Do not touch the switches that have no explanations in the table

2 SW4 No 4 Sign or CCW pulse input logic
SW4 No 5 Pulse or CW pulse input logic

3 If the reference pulse form is CCW + CW, set SW4 No 4 and No 5 the same input logic

Table 10 4 Switch Setting and Functions (2)

Switch Name	Function	1-2 Short	2-3 Short	Open	Standard Setting
SEL 1	Reference pulse input Voltage level setting	+5 V level open collector	+12 V level open collector	+5 V external power supply (Set line driver in the same way)	1-2 short
SEL 2					1-2 short
SEL 3	Test mode	Test mode		Usually operation	Open
SEL 4	Output pulse form setting	Line driver	Open collector	—	2-3 short
SEL 5		Line driver	Open collector	—	2-3 short
SEL 6		Line driver	Open collector	—	2-3 short
SEL 7		Line driver	Open collector	—	2-3 short

Table 10 5 Servo Gain Adjustment (at Potentiometer on the Panel)

Volume Name	VR15 [H·G]	VR14 [L·G]	VR16 [A·G]	VR19 [CFV]	VR6 [LOOP]	VR3 [ZERO]
Function	Position loop high gain	Position loop low gain	Analog loop gain	Speed reference feedforward compensation	Speed loop gain	Speed amplifier zero adjustment
How to Adjust	Adjusts the position loop gain at H-gain Turn [H·G] CW to increase the gain	Adjusts the position loop gain at L-gain Turn [L·G] CW to increase the gain	Adjusts the motor not to vibrate at stop	Forward feed compensation will be added to increase the apparent kp value and improve response Compensation will be applied when turned clockwise	Turn [Loop] CW to increase the gain	If output of the positioning-complete signal becomes unbalanced with forward and reverse rotation, correct with zero adjustment
Remark				Too high compensation puts the motor into disorder	Turn CCW to suppress the gain	

Adjust the gain depends on the specifications and how to use the motor.
Do not touch the other potentiometers. (for adjustment by Yaskawa)

VR2, VR9, VR10 ·····for Speed feedback adjustment

VR5 ·····for Starting current adjustment

VR7 ·····for Motor maximum current adjustment

VR11, VR12, VR13 ·····for Current offset adjustment

VR4 ·····for Proportional gain adjustment

VR17, VR18 ·····for Speed reference feedforward adjustment

10.3 3 Adjustment Procedures

(1) Check terminal waveform (at normal)

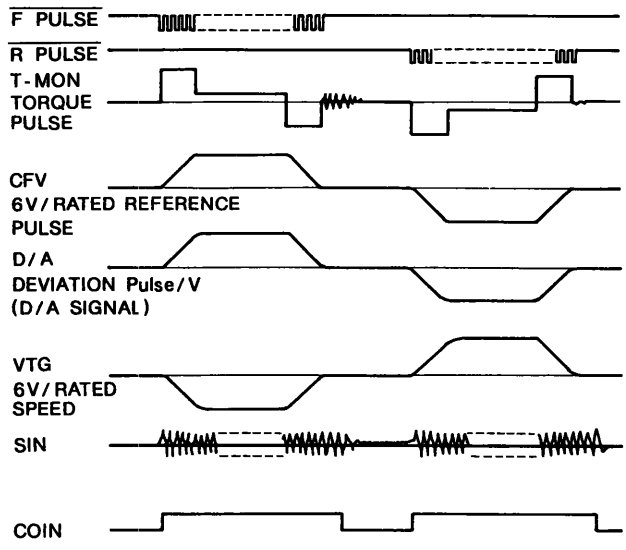


Fig. 10 2 Check Terminal Waveform (at normal)

(2) H-Gain

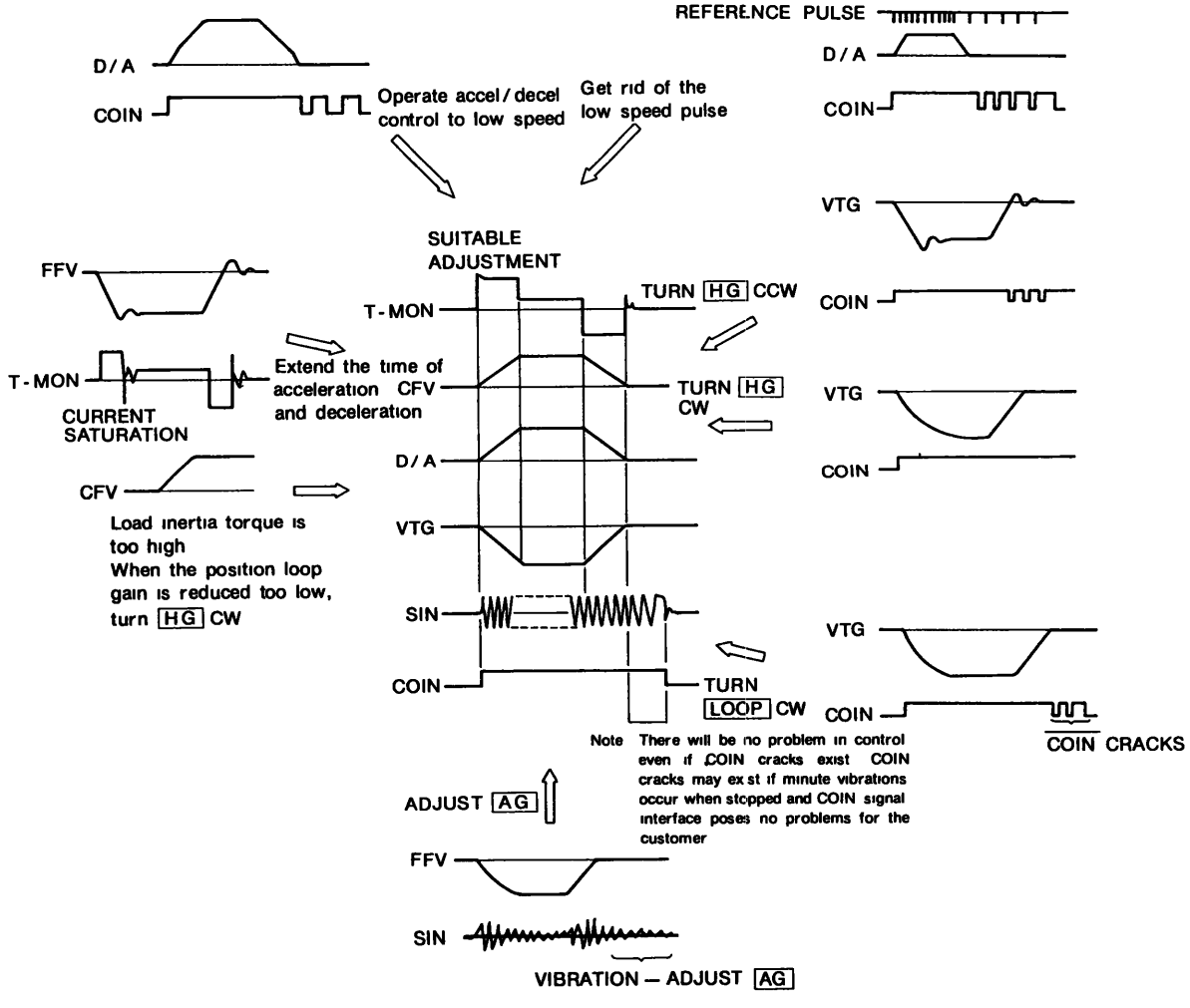
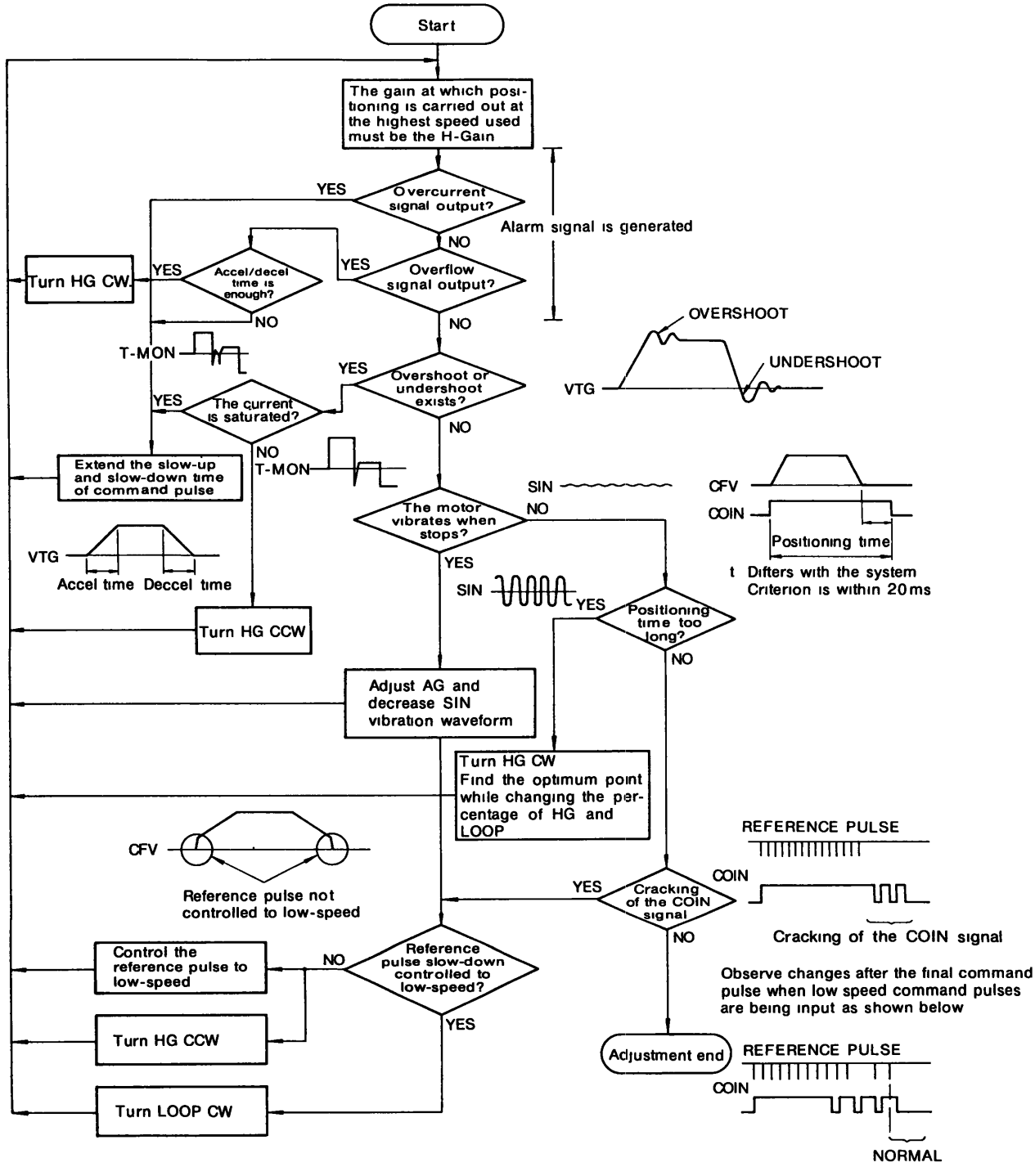


Fig. 10.3 Adjustment Procedures at H-gain

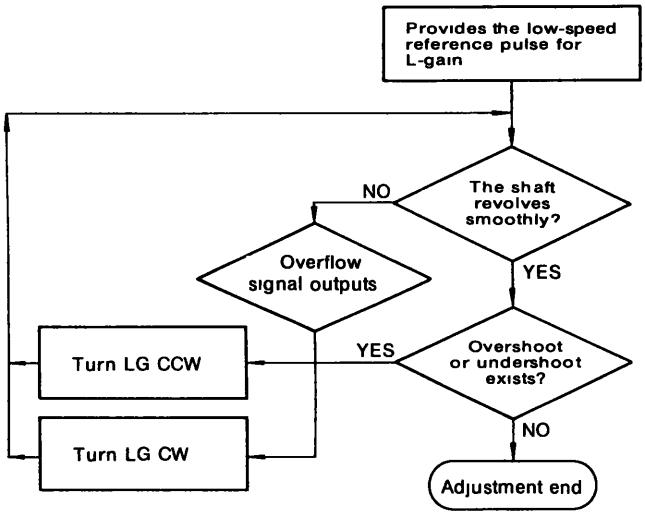
(3) Adjusting Flow Chart When in H-gain

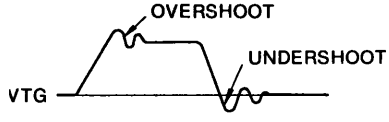


10.3.3 Adjustment Procedures (Cont'd)

(4) Adjusting Flow Chart when in L-gain

Find the optimum value of LG while complying with the following flow.





11. INSPECTION AND MAINTENANCE

11.1 AC SERVOMOTOR

The AC servomotor has no wearing parts (e.g. brushes), so simple daily inspection is sufficient. The inspection schedule for the motor is shown in Table 11.1.

Do not disassemble the motor. If disassembly is necessary, contact your Yaskawa representative.

Table 11 1 Inspection Schedule for Motors

Inspection Item	Frequency	Inspection Operation	
Vibration	Daily	Feel manually	If abnormal vibration or noise is found, contact your Yaskawa representative
Noise		Aurally	
Exterior and Cleaning	As required	Clean with dry cloth or compressed air	
Insulation Resistance	Yearly	Make sure that it is more than 10 MΩ by measuring with a 500 V megger after disconnecting the motor from the controller	
Oil Seal	Every 5000 hours	If worn or damaged, replace after disconnecting the motor from the driven machine	
Total Inspection	Every 20,000 hours or every 5-year	Contact your Yaskawa representative	

11.2 *Servopack*

High reliable semiconductor is used at the Servopack so that no special maintenance is required. Remove dust and tighten screws periodically.

Charging will be in process while LED MAIN is lit even after power is cut off. To prevent shocks, carry out work after the LED goes out.

12. TROUBLESHOOTING GUIDE

12.1 AC SERVOMOTOR

WARNING

Remedies in ☐ should be practiced after turning off the power

Table 12 1 Troubleshooting Guide for AC Servomotor

Trouble	Cause	Corrective Action
Motor does not start	Voltage below rated	Measure voltage across motor terminals U, V, and W with a tester and correct to rated value
	Loose connection	Tighten connection
	Wrong wiring	Correct
	Overload	Reduce load or use a larger motor
	Motor defective	Measure voltage across motor terminals U, V, and W with a tester When correct, replace motor
Unstable operation	Wrong wiring	Inspect and correct wiring across motor terminals U, V and W, and PG
Motor overheats	Excessive ambient temperature	Reduce below 40 °C
	Motor dirty	Clean motor surface
	Overload	Reduce load or use a larger motor
Unusual noise	Motor loosely mounted	Tighten foundation bolts
	Motor misaligned	Realign
	Coupling out of balance	Balance coupling
	Noisy bearing	Check alignment, loading of bearing, lubrication and contact Yaskawa representative
	Vibration of driven machine	Contact the machine manufacturer

12.2 *Servopack*

Table 12 2 LED Indication (7-segment) for Troubleshooting

LED	Detection	Lighting Condition	Probable Cause	Corrective Action
1.	Over-current	Goes on when power is supplied to the control circuit	• Defective control circuit board (1 PWB)	• Replace the Servopack
		Goes on when power is supplied to the main circuit and servo power is turned on • MCCB does not trip	• Defective current feedback circuit • Defective main circuit transistor module	• Insert the 3CN connector firmly • Replace the Servopack
		Goes on when power is supplied to the main circuit and servo power is turned on • MCCB trips	• Defective motor grounding • Defective main circuit transistor module	• Replace the motor • Replace the Servopack
		Goes on when power is supplied to the main circuit	• Defective main circuit transistor module	• Replace the Servopack
		Goes on when the motor is running	• Faulty internal elements • Defective internal elements	• Replace the Servopack
2.	Circuit protector tripped	Goes on when power is supplied to the control circuit	• Defective control circuit board (1 PWB)	• Replace the Servopack
		Goes on when power is supplied to the main circuit	• Defective main circuit thyristor-diode module	• Replace the Servopack
			• MCCB trips	• Check if there is disconnection in the wiring leads in Servopack • Check the conduction state on connecting parts
3.	Regener-ative trouble	Goes on when power is supplied to the control circuit	• Defective control circuit board (1 PWB)	• Replace the Servopack
		Goes on approximate 0 5 to 1 second after power is supplied to the main circuit	• Defective regenerative transistor	• Replace the Servopack
			• Regenerative resistor disconnection	• Check and replace the regenera-tive resistor (Replace the Servopack)
	Overflow	• The reference pulse is input, but the PG pulse is not returned	• Wrong connection in motor • Wrong connection in optical encoder	• Correct the connection of the motor Check the pulses of phases A, B, C, U, V and W for lead disconnection, short-circuit, no power supply, faulty printed circuit board Correct the con-nections
			• Control board (1 PWB or 2 PWB) faulty	• Replace Servopack
		• High-speed operation resulting in overflow	• Wrong connection in motor • Wrong connection in optical encoder	• Correct the motor connection Check the pulses of phases A, B, C, U, V, W for lead disconnection, short-circuit, no power supply, faulty PC board Correct the connections
			• Control board (1 PWB) faulty	• Replace the Servopack
		• The operation is normal, but it overflows if long reference are given	• Faulty adjustment of the Servopack	• Increase the speed loop gain
			• Load capacity too large	• Check and correct the load (over-load, load inertia too high)
			• Reference pulse frequency too high	• Speed-up or slow-down the command pulse
4.	Over-voltage	Goes on when the motor starts or slows down	• Load inertia (GD^2) too large	• Check the inertia of the machine with the value converted to the motor shaft
			• Defective regenerative circuit	• Replace the Servopack
5.	Over-speed	When the reference is input, the motor runs fast and 5. goes on	• Motor connection error • Optical encoder connection error	• Correct the motor connection • Check and correct pulses in phases A, B, C, U, V and W with 2CN
			• The reference input voltage too large	• Decrease the reference input voltage

Table 12 2 LED Indication (7-segment) for Troubleshooting (Cont'd)

LED	Detection	Lighting Condition	Probable Cause	Corrective Action
6.	Voltage drop	Goes on when power is supplied to the main circuit	• Defective main circuit thyristor-diode module	• Replace the Servopack
7.	Overload	Goes on when power is supplied to the control circuit	• Defective control circuit board (1 PWB)	• Replace the Servopack
		Goes on during operation • When power to the control circuit is turned off and then turned on again, the operation starts	• Operation with 105% to 130% or more of the rated load	• Check and correct the load (may be overload)
		The motor rotates, but the torque is unavailable When power to the control circuit is turned off and then turned on again, the operation starts, but the torque is still unavailable	• Motor circuit error connection, such as U → V, V → W, W → U or single-phase connection	• Correct the connection
-	CPU error	Goes on during operation	• Faulty internal elements	• Resume after reset operation
			• Defective internal elements	• Replace the Servopack
C.	Overrun prevention	Goes on when power is supplied to the control circuit	• Defective control circuit board (1 PWB)	• Replace the Servopack
		The motor starts momentarily, then C. goes on	• Motor connection error	• Correct the motor connection
			• Optical encoder connection error	• Check and correct pulses in phases A, B, C, U, V and W with 2CN

12.3 TROUBLESHOOTING

If a malfunction occurs, checking must be started with the assumption that the failure was caused by either erroneous operation or faulty equipment. Condition of the digital control unit is easily checked using LEDs provided on the panel and I/O terminals. The following charts show typical examples for troubleshooting.

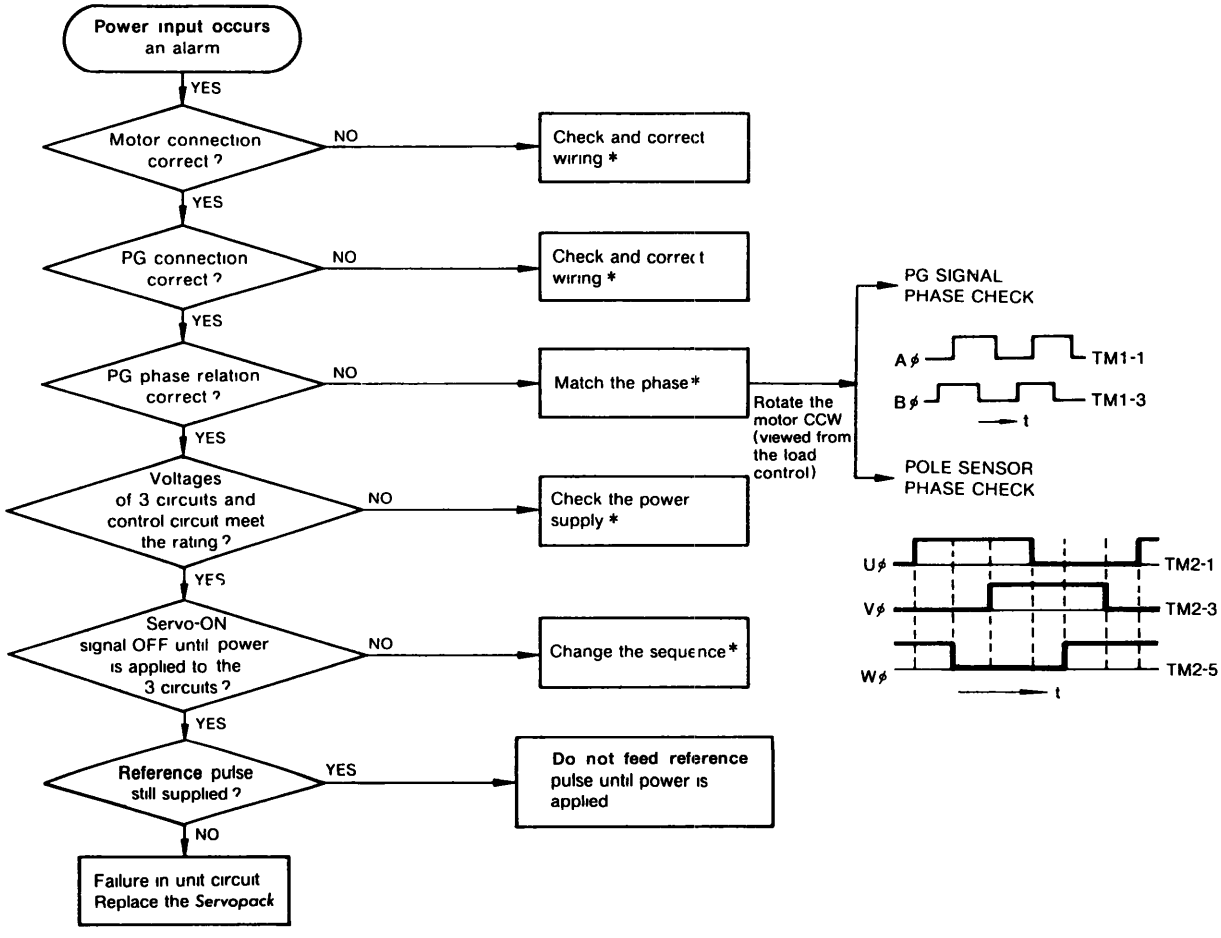
12 3.1 DC Power Supply

Faulty of control power voltage exceeding following limits may cause overrunning of the motor or inaccurate control. Voltage measured at the following terminals in Servopack should not exceed the limits given below.

Main circuit voltage
(Power transformer primary side):
- For 200 VAC: 200 to 230 VAC, +10%, -15%
- For 100 VAC: 100 to 115 VAC, +10%, -15%

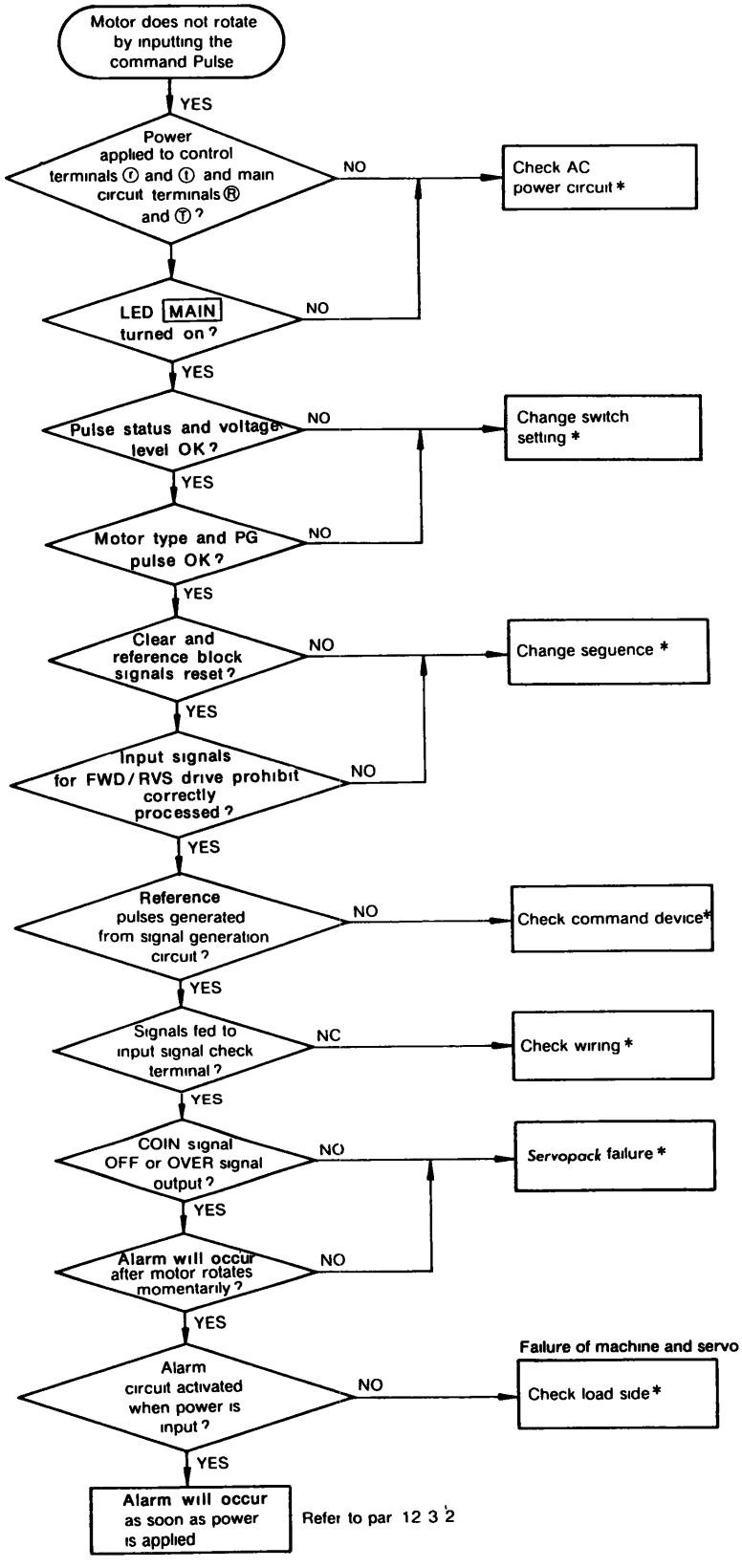
Control power voltage:
- For 200 VAC: 200 to 230 VAC, +10%, -15%
- For 100 VAC: 100 to 115 VAC, +10%, -15%

12 3.2 Alarm Occurance at Power Input



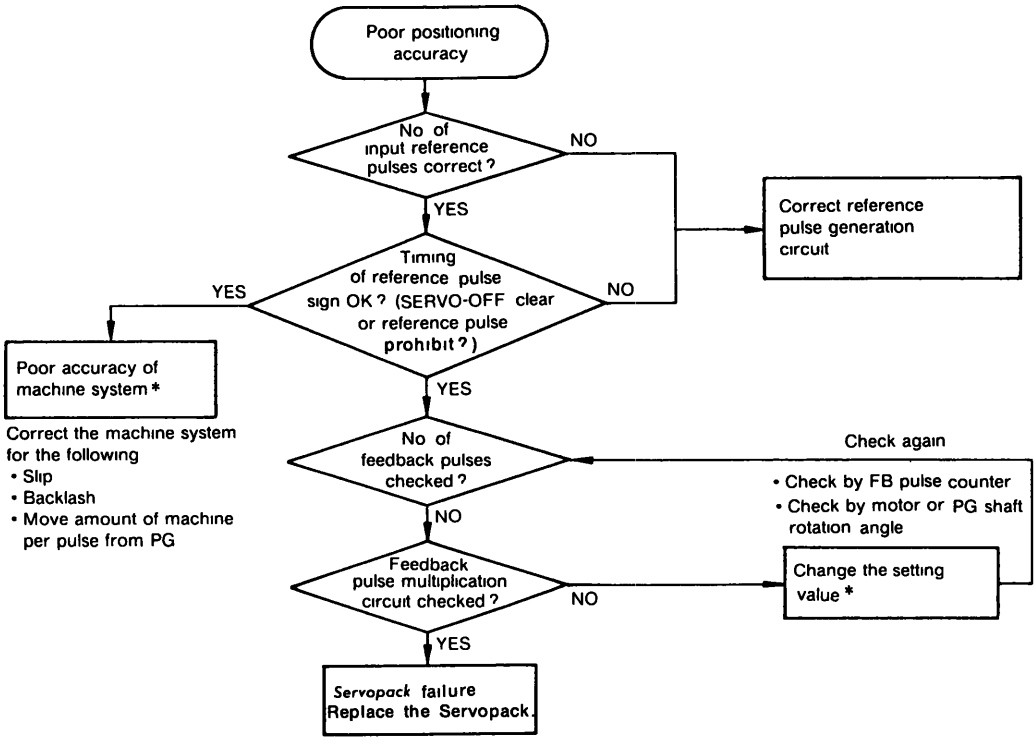
*If alarm does not go off, continue sequence

12 3 3 No Motor Rotates by Inputting Reference Pulse



*If alarm does not go off, continue sequence

12 3 4 Poor Positioning Accuracy



*If alarm does not go off, continue sequence

12 3 5 Examples of Troubleshooting for Defective Wiring or Parts

Table 12.3 Example of Troubleshooting for Defective Wiring or Parts

Trouble	Check Items	What to do
• Fuse blows immediately after the power is turned on or Servo ON	• Fuse capacity • Main circuit wiring (such as the ground of motor)	• Replace the fuse, if defective • Correct wiring, if wrong
• The motor runs but does not stop (or overruns)	• PG feedback signal of A, B and C • PG feedback signal phases	• Correct the wiring
• An overflow signal instantly appears	• Reference pulse frequency • Motor lock • Load inertia • PG feedback signal of phases A B and C	• Check that fin = $\frac{\text{Motor speed}}{60}$ × number of PG pulses • Release the motor lock • Recheck the inertia converted to the motor shaft • Correct the wiring

12.3.6 Examples of Troubleshooting for Incomplete Adjustment

Table 12.4 Examples of Troubleshootings for Incomplete Adjustment

Trouble	Check Items	What to do
Servo performance is improper	Positioning loop gain too low	Increase positioning loop gain [HG] If hunting, increase the speed loopgain [LOOP] (Even if hunting occurs by increasing the speed loop gain, positioning loop gain cannot be increased This is a limit of Servo performance)

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