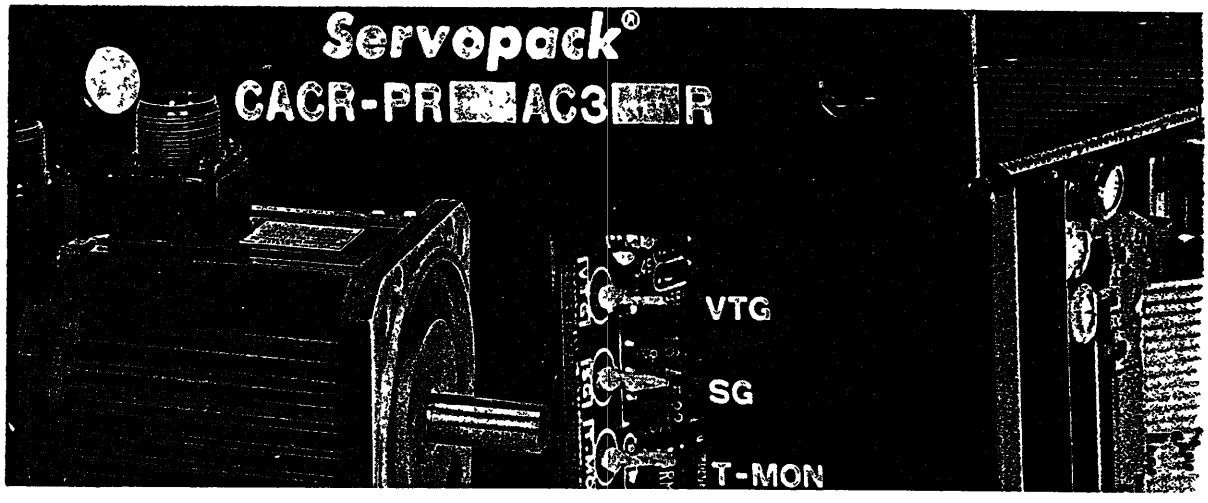
AC Servo Drives

R SERIES FOR POSITIONING CONTROL

SERVOMOTOR: TYPE USAREM (With Optical Encoder)
SERVOPACK: TYPE CACR-PR□R (Rack-mounted Type)



YASKAWA

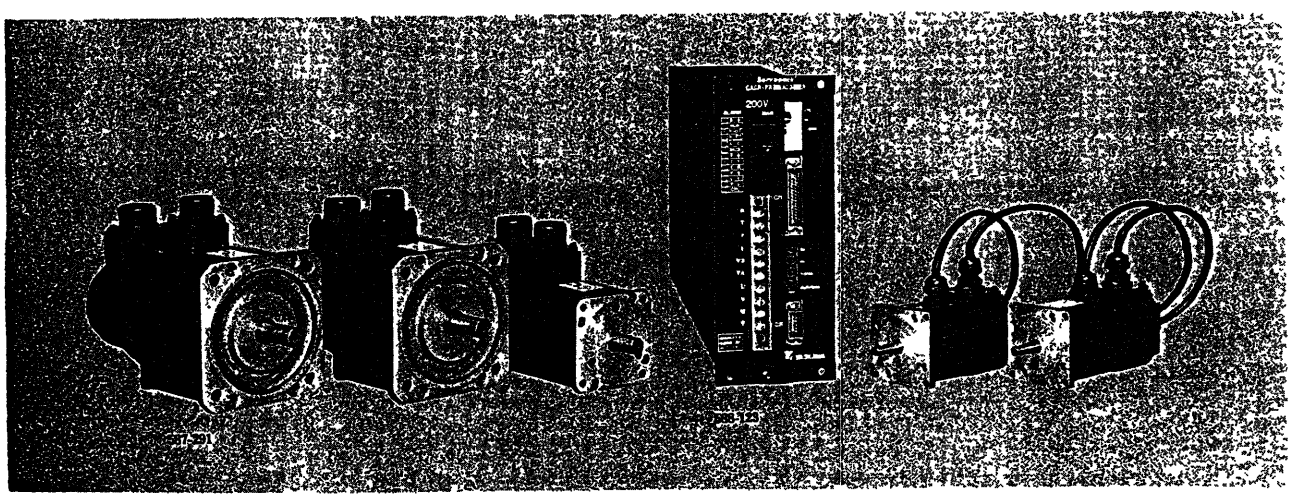
Yaskawa AC Servo Drives have been developed as the basic mechatronics drives for the most advanced FA and FMS including robots and machine tools.

Yaskawa takes great pride in introducing the R series as the latest addition to the M, F, and S series AC Servo Drives which have enjoyed an outstanding reputation among their users.

The R series achieves lower cost and smaller size in spite of high speed operation and high reliability. Originally designed for point-to-point positioning, it has been found in such applications as assembly robots, chip mounters, small-type X-Y tables, coil winding machines, etc.

FEATURES

- High speed operation possible
- High accuracy and quick responce for speed control even under adverse environmental conditions
- Compact design and light weight
- User-friendly protective functions with LED alarm indications



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1. RATINGS AND SPECIFICATIONS

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

(1) Ratings

Time Rating: Continuous
Insulation: Class B
Isolation Voltage: 1000 VAC, one minute
Insulation Resistance: 500 VDC, 10 MΩ 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 200 V)

Item \ Motor Type USAREM-		A5C□2	01C□2	02C□2	03C□2	05C□2	07C□2
Rated Output*	W (HP)	50 (0.07)	100 (0.13)	200 (0.27)	300 (0.40)	500 (0.67)	700 (0.93)
Rated Torque*	N-m (oz·in)	0.159 (22.5)	0.318 (45)	0.637 (90)	0.955 (135)	1.59 (225)	2.23 (316)
Continuous Max. Torque*	N-m (oz·in)	0 19 (26 9)	0 382 (54 2)	0 765 (108 3)	1.15 (162 5)	1 90 (269 4)	2 67 (378)
Peak Torque*	N-m (oz·in)	0.476 (67.5)	0.955 (135)	1.91 (270)	2.86 (405)	4.76 (675)	6.67 (948)
Rated Current*	A	0.71	1.0	2.0	2.7	3.6	5.7
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)	0.378 (53.6)	0.466 (66.0)	0.426 (60.4)
Moment of Motor Inertia J_M (=$GD^2/4$)	kg·m²×10⁻⁶ (oz·in·s²×10⁻³)	7.64 (1.08)	12.5 (1.78)	50.7 (7.18)	76.6 (10.9)	272 (38.6)	372 (52.8)
Power Rate*	kW/s	3.30	8.09	8.01	11.9	9.26	13.3
Inertia Time Constant	ms	4.4	3.4	2.9	2.6	2.8	2.5
Inductive Time Constant	ms	1.3	1.6	4.1	4.5	9.4	10.0

* Values when SERVOMOTOR is combined with SERVOPACK and the armature winding temperature is 75°C. Other values are for temperature of 20°C. Shown are normal (TYP) values above.

Notes.
1. □in type designation is determined by output pulses (pulses/rev) of optical encoder as follows:
   · Standard: E (1500 pulses/rev)
   · Optional: F (1000 pulses/rev)
2. The power supply unit for brake:
   · Input 200 VAC, Output 90 VDC (DP8401002-1)
   For details, see Par. 8.3 on page 46.

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

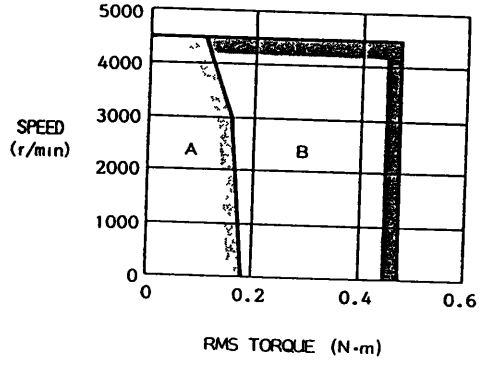
(2) Torque-Speed Characteristics

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

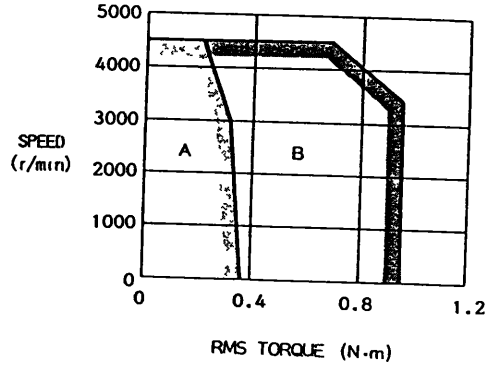
If 200 VAC or below, the output characteristics may be decreased even if the data is within allowable variation.

■ r/min-N · m

Type USAREM-A5C



Type USAREM-01C



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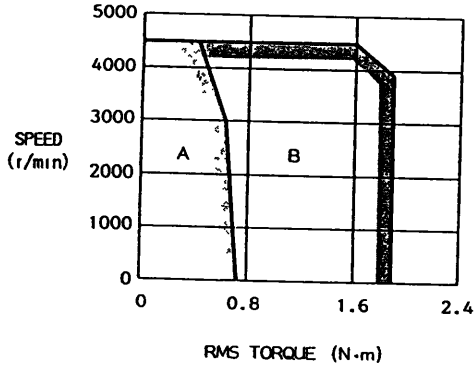
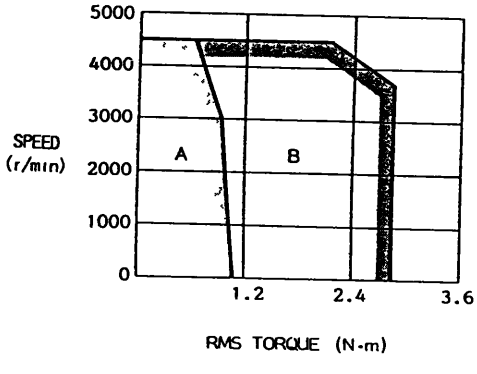


Type USAREM-03C



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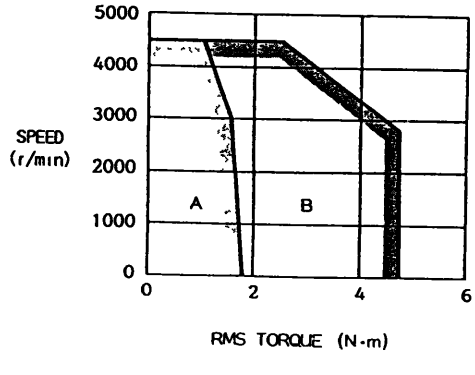
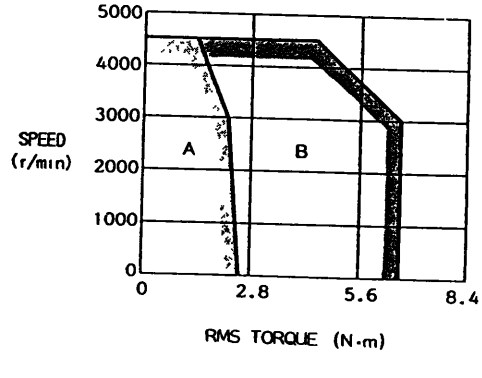


Type USAREM-07C

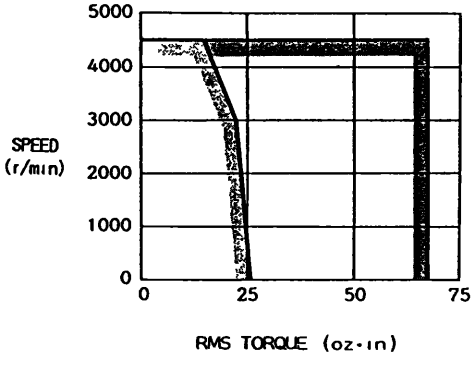


A : Continuous Duty Zone

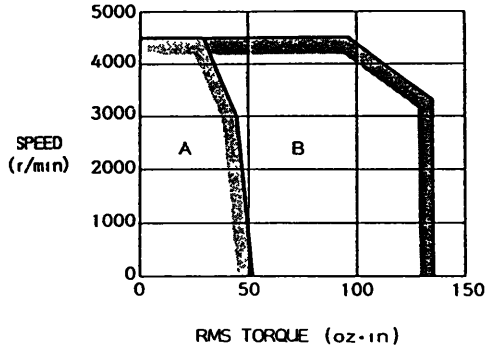
B : Intermittent Duty Zone

■ r/min-oz · in

Type USAREM-A5C



Type USAREM-01C



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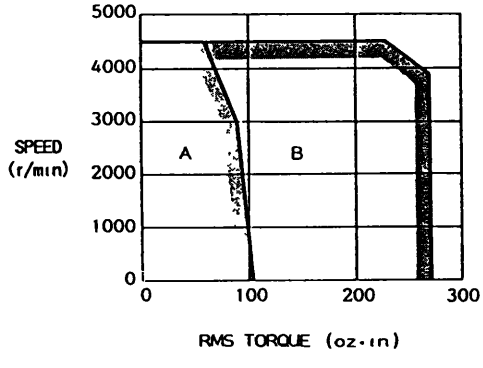

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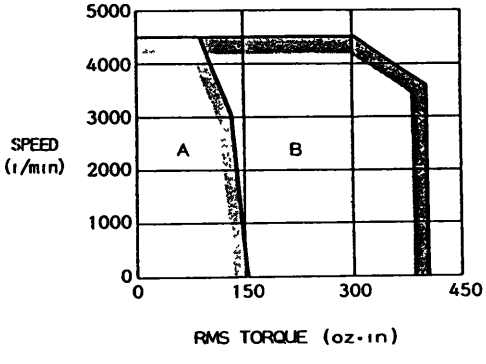
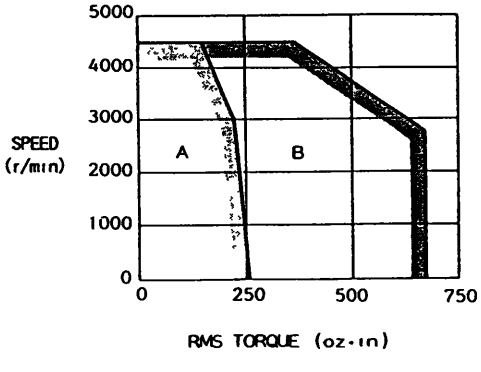
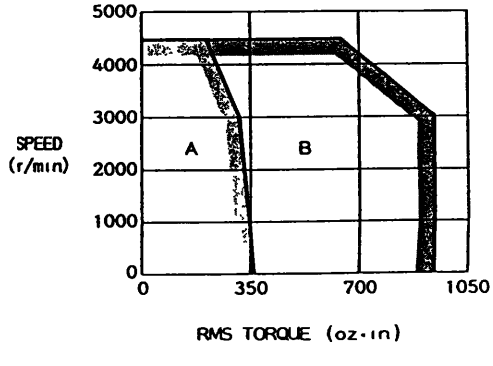


Type USAREM-05C



Type USAREM-07C



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, 10 MΩ 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 100 V)

Item \ Motor Type USAREM-		A5D□2	01D□2	02D□2	03D□2	05D□2
Rated Output*	W (HP)	50 (0.07)	100 (0.13)	200 (0.27)	300 (0.40)	500 (0.67)
Rated Torque*	N-m (oz·in)	0.159 (22.5)	0.318 (45)	0.637 (90)	0.955 (135)	1.59 (225)
Continuous Max. Torque*	N-m (oz·in)	0 19 (26 9)	0 382 (54 2)	0 765 (108 3)	1 15 (162 5)	1 90 (269 4)
Peak Torque*	N-m (oz·in)	0.476 (67.5)	0.955 (135)	1.91 (270)	2.86 (405)	4.76 (675)
Rated Current*	A	1.2	1.7	2.9	3.6	5.5
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)	0.284 (40.3)	0.308 (43.6)
Moment of Motor Inertia J_M (=$GD^2/4$)	kg·m²×10⁻⁶ (oz·in·s²×10³)	7.64 (1.08)	12.5 (1.78)	50 7 (7.18)	76.6 (10.9)	272 (38.6)
Power Rate*	kW/s	3.30	8.09	8.01	11.9	9.26
Inertia Time Constant	ms	4.2	3.2	3.0	2.5	2.7
Inductive Time Constant	ms	1.4	1.7	4.0	4.6	9.6

* Values when SERVOMOTOR is combined with SERVOPACK and the armature winding temperature is 75°C. Other values are for temperature of 20°C. Shown are normal (TYP) values above.

Notes
1. □ in type designation is determined by output pulses (pulses/rev) of optical encoder as follows:
   · Standard: E (1500 pulses/rev)
   · Optional: F (1000 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 46.

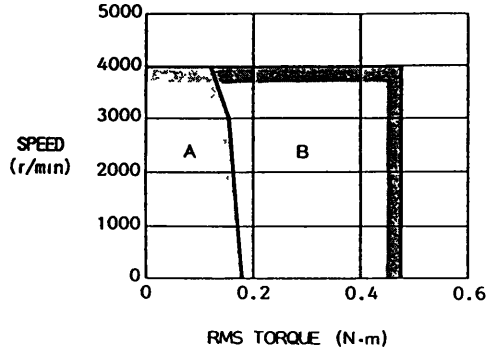
(2) Torque-Speed Characteristics

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

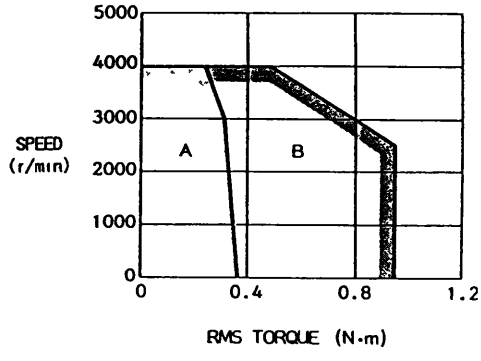
If 100 VAC or below, the output characteristics may be decreased even if the data is within allowable variation.

■ r/min-N · m

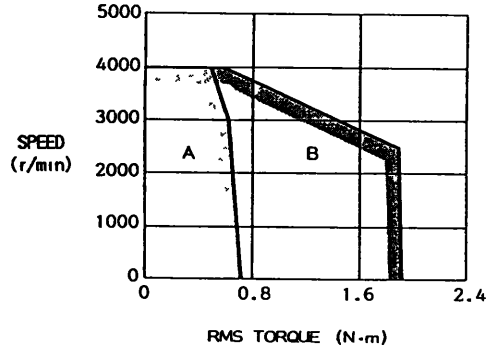
Type USAREM-A5D



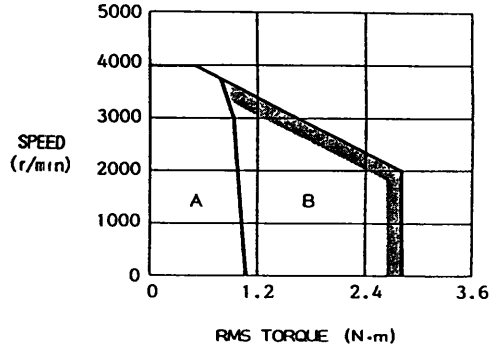
Type USAREM-01D



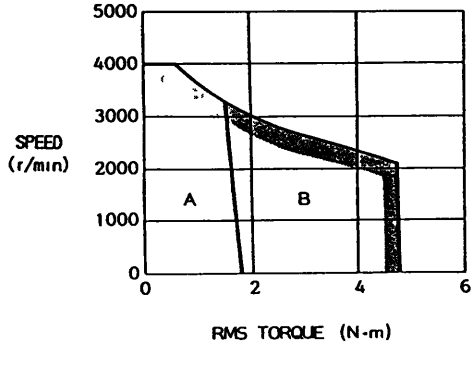
Type USAREM-02D



Type USAREM-03D



Type USAREM-05D



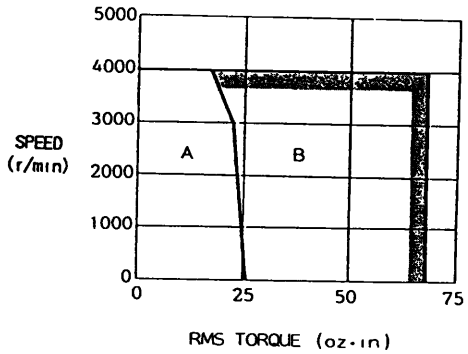
A : Continuous Duty Zone

B : Intermittent Duty Zone

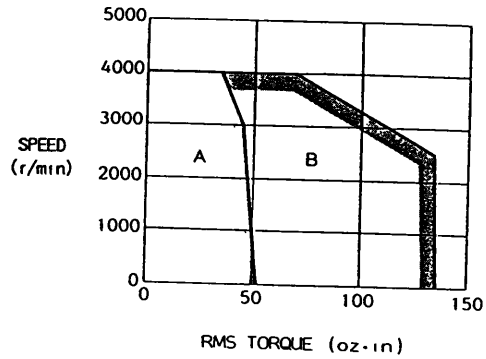
1. 2 RATINGS AND SPECIFICATIONS OF R SERIES AC SERVOMOTORS (FOR 100V) (Cont'd)

■ r/min-oz · in

Type USAREM-A5D



Type USAREM-01D



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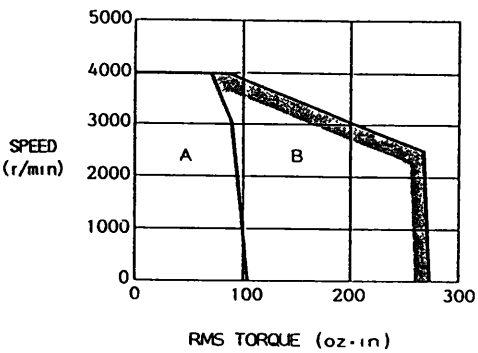
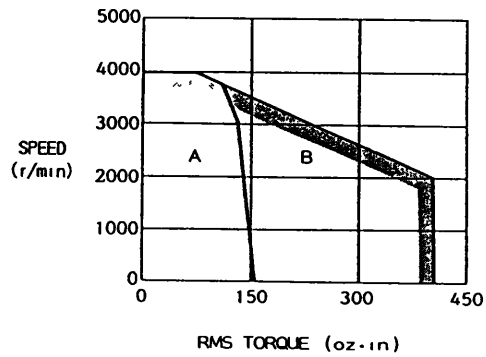
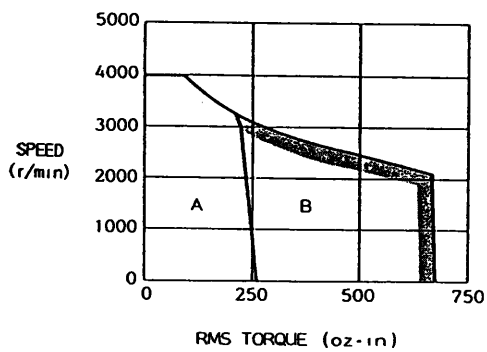


Type USAREM-03D



Type USAREM-05D



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-			PRA5AC3[ ]R	PR01AC3[ ]R	PR02AC[ ]R	PR03AC3[ ]R	PR05AC3[ ]R	PR07AC3[ ].R
Combined Specifications	Applicable AC SERVO MOTOR	Type USAREM-	A5C	01C	02C	03C	05C	07C
		Output W (HP)	50 (0.07)	100 (0.13)	200 (0.27)	300 (0.40)	500 (0.67)	700 (0.93)
		Rated/Max. Speed r/min	3000/4500					
	Continuous Output Current A (rms)		0.7	1.0	2.0	2.7	3.6	5.7
	Max. Output Current A (rms)		2.1	2.8	5.7	7.8	10 6	16.3
	Allowable Load J *1 (=GD²/4) kg·m²X10⁻⁴ (oz·in·s²x10⁻³)		0.764 (10.8)	1.25 (17.8)	5 07 (71 8)	7.66 (109)	27 2 (386)	37.2 (528)
Basic Specifications	Power*2 Supply	Main	1-Phase 200 to 230 VAC +10% -15% 50/60Hz					
		Control						
	Control Method		1-Phase full-wave rectifying, transistorized PWM control					
	Feedback		Optical encoder (1500 or 1000 pulses/rev)					
	Environmental Conditions	Ambient Temp.*3	0 to +55°C					
		Storage Temp.	-20 to +85°C					
		Ambient and Storage Humidity	90% or less (non-condensing)					
		Vibration-/Shock-Resistance	0.5G/2G					
	Mounting Structure		Rack mounted					
	Approx Weight kg (lb)		2.0 (4.4)	2.1 (4.6)	2.6 (5.7)	2 9 (6.4)	3 5 (7.7)	5 4 (11 9)
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)					
	Kf 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					
	Aux Reference Pulse	Reference Pulse Input Type	Effective at inhibit ($\overline{INH}$) signal input					
		Input Pulse Form	Two-phase pulse with 90° phase difference (phase A + B)					
		Pulse Frequency	+12 V open collector					
	Control Signal		0 to 100 kpps (4 multipler internal processing)					
		Input Pulse Form	Clear and inhibit signals					
	PG Pulse Output	Output Form	+5 V level (TTL, line driver) or +12 V open collector					
		Frequency Dividing Ratio	Phases A, B, and C Line driver, Phase C Open collector					
	Sequence Input Signal		1/1, 1/2, 1/3, 1/4, 1/5, 1/6, 1/10, 1/12, 1/15, 1/20, 1/30, 2/3, 2/5 (Hexadecimal rotary switch, SW8)					
	Sequence Output Signal		Servo ON, F run inhibit (P-OT), R run inhibit (N-OT), alarm reset					
	Dynamic Brake		Servo alarm, servo ready, excessive error, positioning completion, alarm code (3-bit)					
	Regeneration		Operated at main power OFF, servo alarm, servo OFF, stop after deceleration at P/N-OT,					
	Applicable Load Inertia		· 50/100 W type Not provided · 200 to 700 W: Provided (containing regenarative resistor)					
	Overtravel Prevention		Up to 10 times motor inertia					
	Protection Function		Stop after deceleration at P/N-OT, Free running stop *4					
	Indication		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)					
	Monitor Output		Power supply (MAIN LED), alarm (7-segment LEDs)					
	Positioning Control		Speed: 2 V ± 5% at 1000 r/min, Torque 3 V ±10%/100% (or speed reference· 2 V ± 10% at 1000 r/min)					
	Others		Input multiplier: ×1, ×2, ×4 (For aux. reference input, phases A and B are fixed at ×4.) Output multiplier. ×1, ×2, ×4 Feedforward compensation. selecting possible Reference pulse logic reverse: L active, H active					
			Reverse run connection possible (Reverse at plus reference) Overflow alarm selecting usage (Warning/servo alarm*4)					

*1 When load J exceeds applicable range, see Par 6 7 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.

1.3 RATINGS AND SPECIFICATIONS OF SERVOPACK (Cont'd)

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

Voltage Class			100V				
SERVOPACK Type CACR-			PR5AC4[ ]R	PR01AC4[ ]R	PR02AC4[ ]R	PR03AC4[ ]R	PR05AC4[ ]R
Combined Specifications	Applicable AC SERVO MOTOR	Type USAREM-	A5D	01D	02D	03D	05D
		Output W (HP)	50 (0.07)	100 (0.13)	200 (0.27)	300 (0.40)	500 (0.67)
		Rated/Max. Speed r/min	3000/4000				
	Continuous Output Current A (rms)		1.2	1.7	2.9	3.6	5.5
	Max Output Current A (rms)		3.6	5.0	8.5	10.6	16 3
	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)	7 66 (109)	27.2 (386)
Basic Specifications	Power*2 Supply	Main	1-Phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60Hz*2				
		Control					
	Control Method		1-Phase full-wave rectifying, transistorized PWM control				
	Feedback		Optical encoder (1500 or 1000 pulses/rev)				
	Environmental Conditions	Ambient Temp. *3	0 to +55°C				
		Storage Temp.	-20 to +85°C				
		Ambient and Storage Humidity	90% or less (non-condensing)				
		Vibration-/Shock-Resistance	0.5G/2G				
	Mounting Structure		Rack mounted				
	Approx Weight kg (lb)		2.1 (4.6)	2.6 (5.7)	2 9 (6 4)	3 5 (7.7)	5.4 (11.9)
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				
	Aux Reference Pulse	Reference Pulse	Effective at inhibit (INH) signal input				
		Input Type	Two-phase pulse with 90° phase difference (phase A + B)				
		Input Pulse Form	+12 V open collector				
		Pulse Frequency	0 to 100 kpps (4 multipler internal processing)				
	Control Signal		Clear and inhibit signals				
		Input Pulse Form	+5 V level (TTL, line driver) or +12 V open collector				
	PG Pulse Output	Output Form	Phases A, B, and C Line driver, Phase C. Open collector				
		Frequency Dividing Ratio	1/1, 1/2, 1/3, 1/4, 1/5, 1/6, 1/10, 1/12, 1/15, 1/20, 1/30, 2/3, 2/5 (Hexadecimal rotary switch, SW8)				
	Sequence Input Signal		Servo ON, F run inhibit (P-OT), F 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 W type: Not provided · 100 to 500 W: Provided (containing regenarative 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% (or speed reference 2 V ± 10% at 1000 r/min)				
	Positioning Control		Input multipler: ×1, ×2, ×4 (For aux. reference input, phases A and B are fixed at ×4.) Output multipler ×1, ×2, ×4 Feedforward compensation selecting possible Reference pulse logic reverse· L active, H active				
	Others		Reverse run connection possible (Reverse at plus reference) Overflow alarm selecting usage (Warning/servo alarm*4)				

*1 When load J exceeds applicable range, see Par 6 7 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

USAREM-05CE2□□

AC SERVOMOTOR

SERIES
- AR: R Series

ENCLOSURE
- E: Totally-enclosed Self-cooled Type

MAGNET TYPE
M: Rare Earth

MOTOR OUTPUT
- A5: 50 W, 0.07HP
- 01: 100 W, 0.13HP
- 02: 200 W, 0.27HP
- 03: 300 W, 0.40HP
- 05: 500 W, 0.67HP
- 07: 700 W, 0.93HP

DESIGN REVISION ORDER
- C: 200 V Class, 8-pole
- D: 100 V Class, 8-pole

DETECTOR (Table 2.3)
- E: 1500 pulses/rev (Standard)
- F: 1000 pulses/rev

SHAFT TYPE
- 1: Taper
- 2: Straight (Standard)

DRIVE END SPECIFICATION
- Blank: Standard
- O: Standard (With Brake)
- K: With Key (Standard)
- S: With Oil Seal
- T: With Key & Oil Seal

OPPOSITE DRIVE END SPECIFICATION
- Blank: Standard
- B: With Brake (Excitation Voltage 90 VDC)

• SERVOPACK

CACR-PR05AC3ER

AC SERVOPACK

SERIES CONTROL TYPE
- PR: Positioning control

MOTOR OUTPUT
- A5: 50 W, 0.07HP
- 01: 100 W, 0.13HP
- 02: 200 W, 0.27HP
- 03: 300 W, 0.40HP
- 05: 500 W, 0.67HP
- 07: 700 W, 0.93HP

APPLICATION
- A: R Series

DESIGN REVISION ORDER

INPUT FORM
- 3 : 200 V, Analog
- 4 100 V, Analog

DETECTOR
- E: 1500 pulses/rev
- F: 1000 pulses/rev

APPLICABLE MOTOR SERIES
- R: R Series

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)	PRA5AC3ER	A5CE2	1500	0.3	5	Good	LF-205A	Single-phase, 200 VAC class	5A	Yaskawa type HI-15E$_2$ rated 30 A or equivalent
		PRA5AC3FR	A5CF2	1000							
	100 W (0.13 HP)	PR01AC3ER	01CE2	1500	0.5						
		PR01AC3FR	01CF2	1000							
	200 W (0.27 HP)	PR02AC3ER	02CE2	1500	0.75						
		PR02AC3FR	02CF2	1000							
	300 W (0.40 HP)	PR03AC3ER	03CE2	1500	1.0	7		LF-210		10A	
		PR03AC3FR	03CF2	1000							
	500 W (0.67 HP)	PR05AC3ER	05CE2	1500	1.4	11		LF-215		15A	
		PR05AC3FR	05CF2	1000							
	700 W (0.93 HP)	PR07AC3ER	07CE2	1500	2.0	15		LF-220		20A	
		PR07AC3FR	07CF2	1000							
100 V	50 W (0.07 HP)	PRA5AC4ER	A5DE2	1500	0.3	5	Poor	LF-205A	Single-phase, 200 VAC class	5A	
		PRA5AC4FR	A5DF2	1000							
	100 W (0.13 HP)	PR01AC4ER	01DE2	1500	0.5						
		PR01AC4FR	01DF2	1000							
	200 W (0.27 HP)	PR02AC4ER	02DE2	1500	0.75	8		LF-210		10A	
		PR02AC4FR	02DF2	1000							
	300 W (0.40 HP)	PR03AC4ER	03DE2	1500	1.0	11		LF-215		15A	
		PR03AC4FR	03DF2	1000							
	500 W (0.67 HP)	PR05AC4ER	05DE2	1500	1.4	15		LF-220		20A	
		PR05AC4FR	05DF2	1000							

* 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	PRA5AC3ER	A5CE2KB	MS3101A 14S-2P	MS3106B* 14S-2S	MS3057 -6A	MS3101A 20-29A	MS3106B 20-29S*	MS3057 -12A	MS3101A 14S-6P	MS3106B 14-6S*	MS3057 -6A
	PRA5AC3FR	A5CF2KB									
	PR01AC3ER	01CE2KB									
	PR01AC3FR	01CF2KB									
	PR02AC3ER	02CE2KB	MS3102A 18-10P	MS3108B 18-10S	MS3057 -10A	MS3102A 20-29A	MS3108B 20-29S		MS3102A 18-12P	MS3108B 18-12S	MS3057 -10A
	PR02AC3FR	02CF2KB									
	PR03AC3ER	03CE2KB									
	PR03AC3FR	03CF2KB									
	PR05AC3ER	05CE2KB	MS3102A 20-4P	MS3108B 20-4S	MS3057 -12A				MS3102A 20-17P	MS3108B 20-17S	MS3057 -12A
	PR05AC3FR	05CF2KB									
	PR07AC3ER	07CE2KB									
	PR07AC3FR	07CF2KB									
100 V	PRA5AC4ER	A5DE2KB	MS3101A 14S-2P	MS3106B 14S-2S*	MS3057 -6A	MS3101A 20-29A	MS3106B 20-29S*	MS3057 -12A	MS3101A 14S-6P	MS3106B 14-6S*	MS3057 -6A
	PRA5AC4FR	A5DF2KB									
	PR01AC4ER	01DE2KB									
	PR01AC4FR	01DF2KB									
	PR02AC4ER	02DE2KB	MS3102A 18-10P	MS3108B 18-10S	MS3057 -10A	MS3102A 20-29P	MS3108B 20-29S		MS3102A 18-12P	MS3108B 18-12S	MS3057 -10A
	PR02AC4FR	02DF2KB									
	PR03AC4ER	03DE2KB									
	PR03AC4FR	03DF2KB									
	PR05AC4ER	05DE2KB	MS3102A 20-4P	MS3108B 20-4S	MS3057 12A				MS3102A 20-17P	MS3108B 20-17S	MS3057 -12A
	PR05AC4FR	05DF2KB									

* Straight plug.

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.

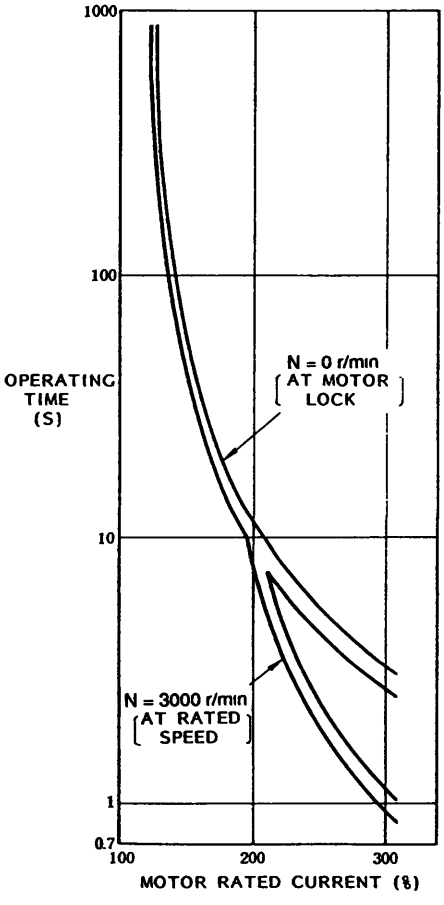


Fig 4 1 Overload Characteristics

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:

$$tr = 104\ 7 \times \frac{N_R\ (J_M + J_L)}{K_t \cdot I_R\ (\alpha - \beta)} \quad (ms)$$

Stopping Time:

$$tf = 104\ 7 \times \frac{N_R\ (J_M + J_L)}{K_t \cdot I_R\ (\alpha + \beta)} \quad (ms)$$

Where,

N_R . Rated motor speed (r/min)

J_M (= $GD^2_M/4$). Moment of motor inertia J
($kg \cdot m^2 \times 10^{-4}$ = lb · in · $s^2 \times 10^{-3}$)

J_L (= $GD^2_L/4$). Moment of load inertia
($kg \cdot m^2 \times 10^{-4}$ = lb · in · $s^2 \times 10^{-1}$)

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)

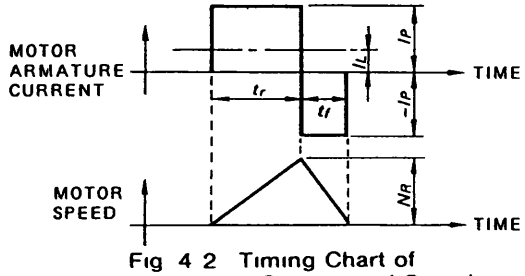


Fig 4 2 Timing Chart of Motor Armature Current and Speed

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 regeneative 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 x m, contact your YASKAWA representative.

5. CONFIGURATION

5.1 CONNECTION DIAGRAM

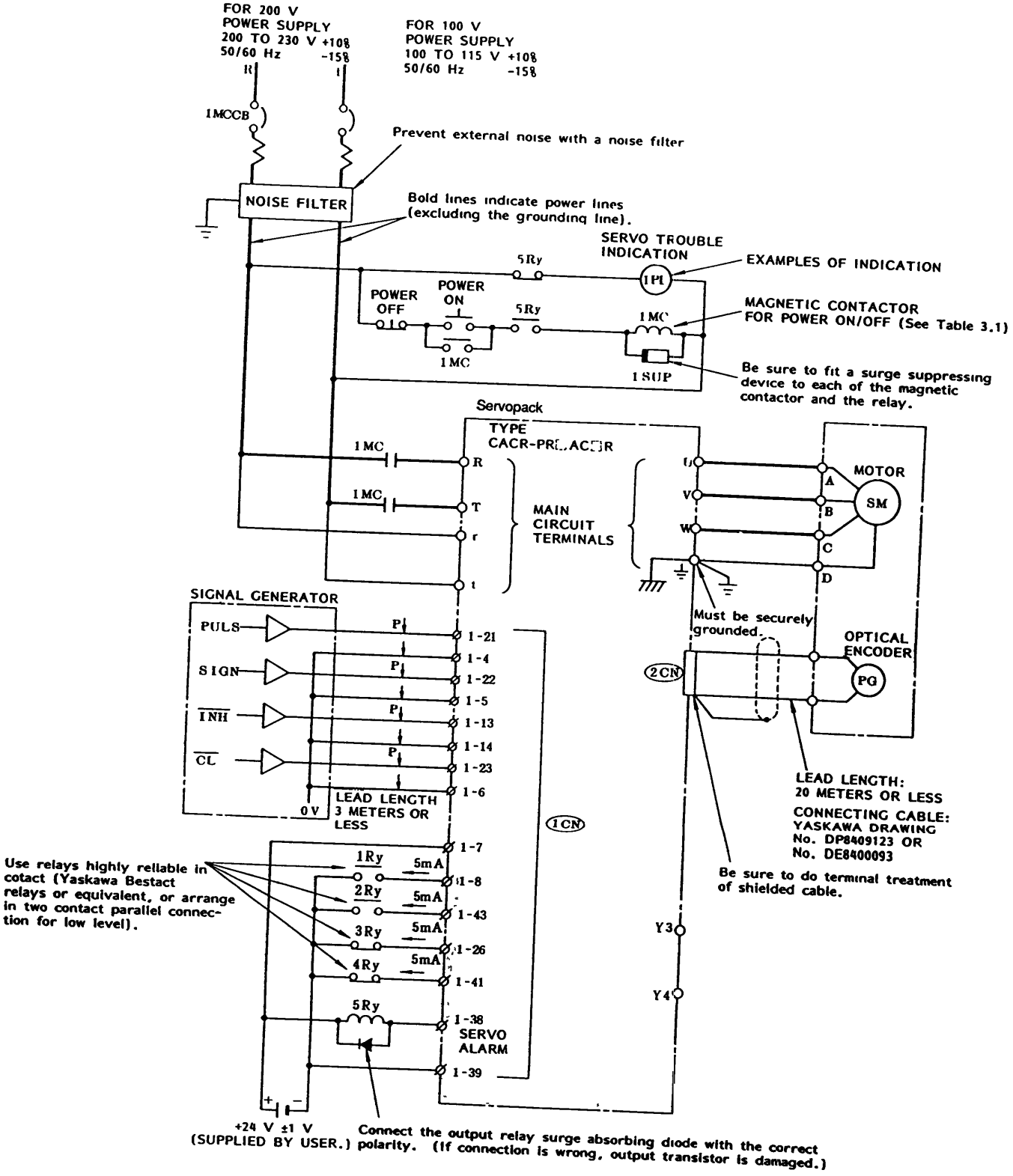


Fig 5.1 Example of Connection Diagram of SERVOPACK with a Servomotor and Peripherals

5. 2 INTERNAL BLOCK DIAGRAM

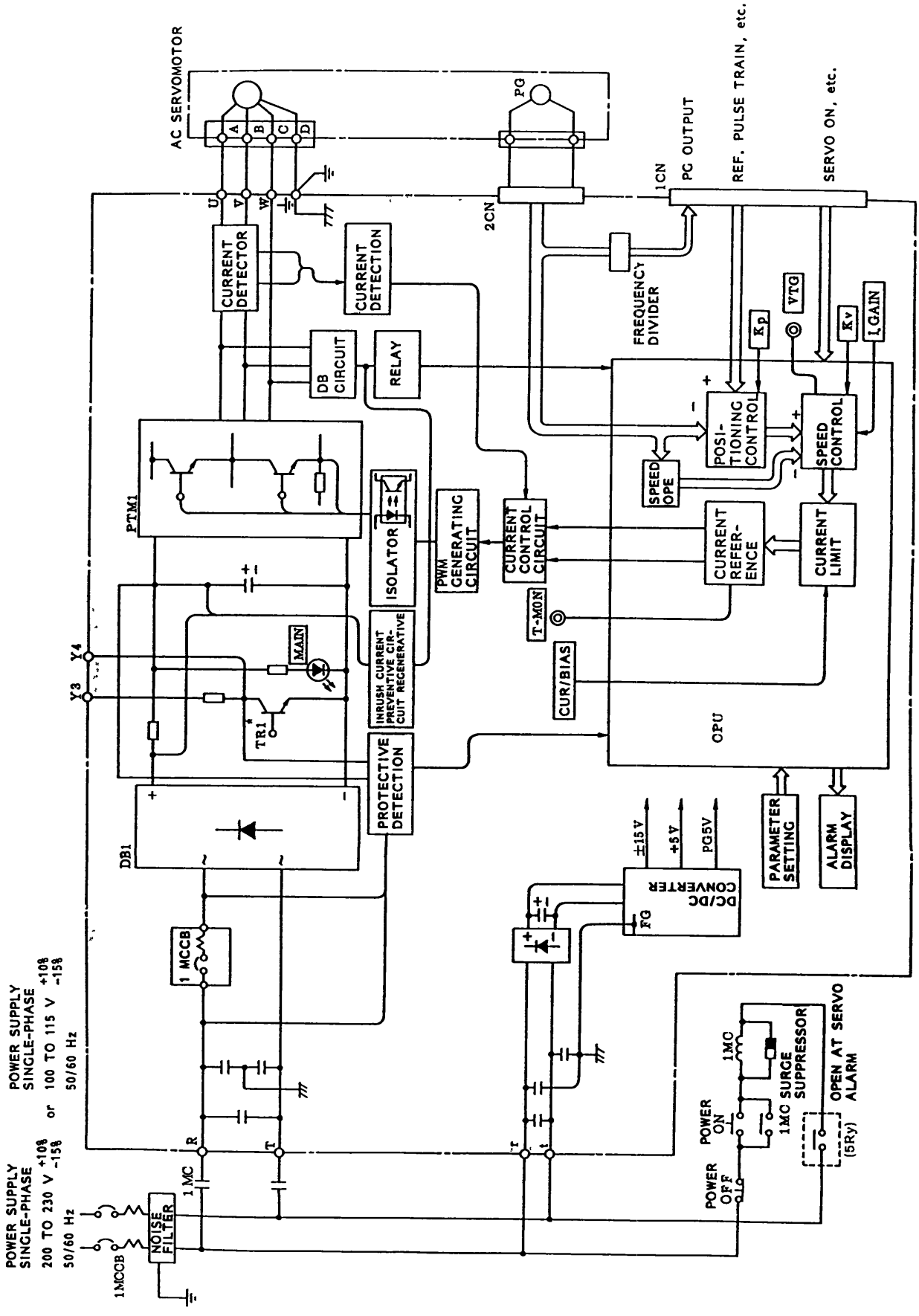


Fig 5.2 Internal Block Diagram of SERVOPACK Type CACR-PR[illegible]AC[illegible]R

* Not provided in SERVOPACK for 200 V 50 W, 200 V 100 W and 100 V 50 W

5. 3 MAIN-CIRCUIT TERMINALS

Table 5 1 Main-Circuit Terminals for SERVOPACK

Terminal Symbol	Name	Description
(R) (T)	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
(U) (V) (W)	Motor connection	Connects terminal (U) to motor terminal A (V) to B and (W) to C
(r) (t)	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
(Y3) (Y4)	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-50RMA (Right angle 50 P)	Honda Tsushin Co, Ltd	MR-50F†	MRP-50F01	MR-50L†

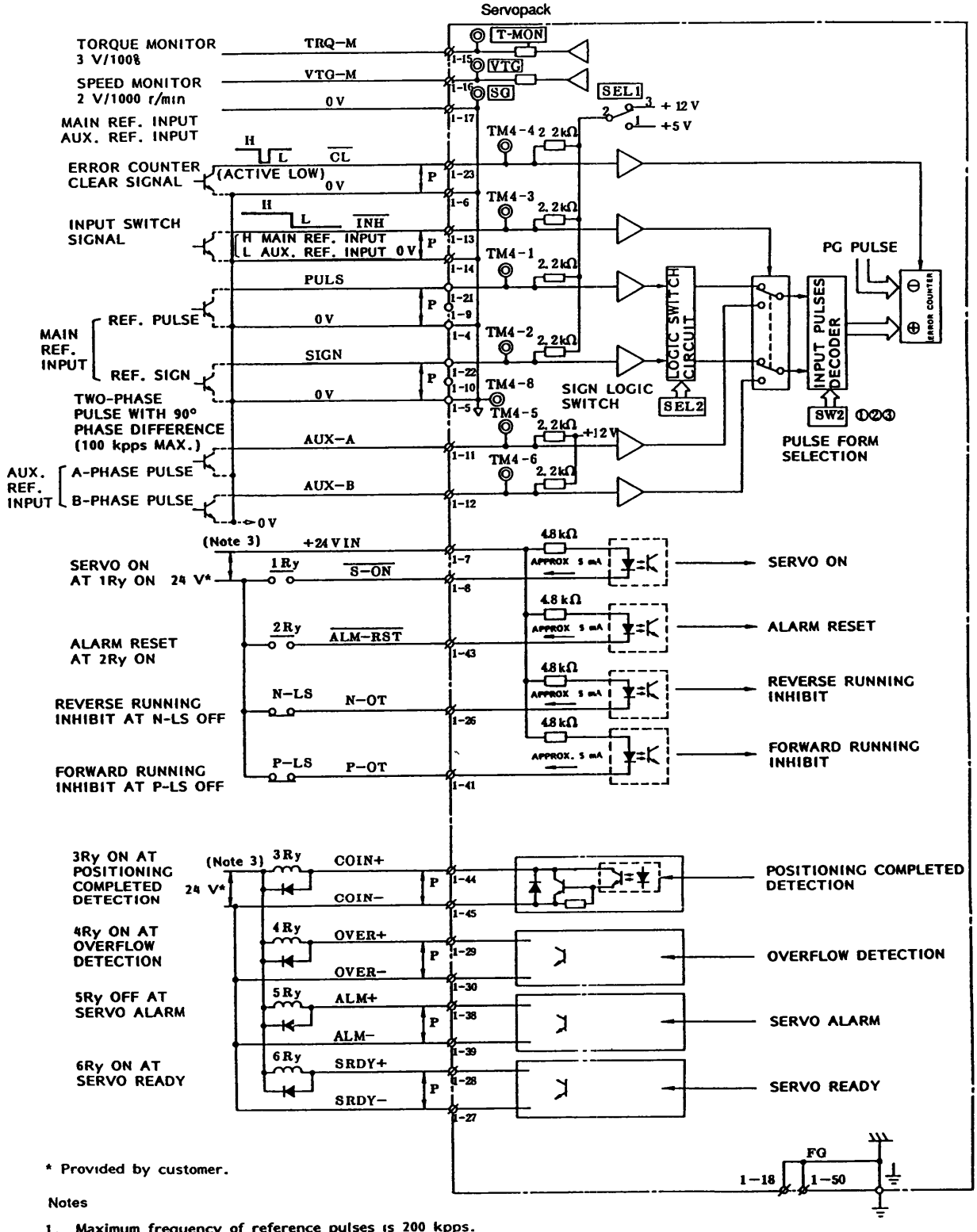
*The connectors for I/O signals used are type MR-50RMA made by Honda Tsushin Co Ltd
†Attached to SERVOPACK when shipping

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.5.4.

Table 5 3 Connector 1CN Layout of SERVOPACK

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0 V	0 V	0 V	0 V	0 V	0 V	+24V IN	$\overline{\text{S-ON}}$	*PULS	*SIGN	AUX-A	AUX-B	$\overline{\text{INH}}$	0 V	TRQ-M	VTG-M	SG	FG
0 V for PG Output Signal			0 V for PULS	0 V for SIGN	0 V for $\overline{\text{CL}}$	Ext. Power Input	Servo ON Power	For line driver input, input from reverse side		Phase A / Aux. Reference Input	Phase B	Inhibit Input	0 V for $\overline{\text{INH}}$	Torque Monitor	Speed Monitor	VTG TRQ VREF	Frame Ground
		19	20	21	22	23	24	25	26	27	28	29	30	31	32		
		PCO	*PCO	PULS	SIGN	$\overline{\text{CL}}$	-	-	N-OT	S-RDY −	S-RDY +	OVER +	OVER −	-	SG		
		Line Driver Output Phase C		Ref. Pulse Input	Ref. Sign Input	Clear Input	-	-	Reverse Prohibit Input	Servo Ready Output		Overflow Output		-	AL01 AL02 AL03		
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
PAO	*PAO	PBO	*PBO	PCOT	ALM +	ALM −	-	P-OT	-	$\overline{\text{ALM RST}}$	COIN +	COIN −	-	AL01	AL02	AL03	FG*
Line Driver Output Phase A		Line Driver Output Phase B		Phase C Open Collector	Servo Alarm Output		-	Fwd. Prohibit Input	-	Alarm Reset Input	Positioning Completion Output		-	Output 1	Output 2	Output 3	Frame Ground



* Provided by customer.

Notes

1. Maximum frequency of reference pulses is 200 kpps.
   The motor speed is clamped at approx. 4720 r/min
   If reference pulse frequency exceeding these data are added, alarm will activate by overflow detecting signal ($\overline{OVER}$).
2. Capacity of each output circuit is 30 VDC, 50 mA or less.
3. Symbol ⌶ p shows twisted cable. Special cable for 1CN must be provided by the user.

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
$\overline{\text{S-ON}}$	8	Servo ON		Inputting this signal makes the SERVOPACK ready to receive pulse reference input. Base block is cleared.
$\overline{\text{ALM-RST}}$	43	Alarm reset		This signal resets the alarm.
N-OT	26	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	41	Forward running inhibit		
+24 VIN	7	+24 V		External power supply to 1CN-8, 24, 41 and 43. Prepare a 24 VDC (20 mA min.) power supply.
PULS	21 (4)	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	22 (5)	Reference sign input		(For positive logic) Forward rotation command: H-level Reverse rotation command: L-level
*PULS	9	(Reference pulse input)		When reference pulse signal is line driver output, use PULS signal in pairs.
*SIGN	10	(Reference sign input)		When reference sign signal is line driver output, use SIGN signal in pairs.
$\overline{\text{CL}}$	23 (6)	Error counter signal		Blocks reference and feedback pulses. Clears the error counter at L-level.
$\overline{\text{INH}}$	13 (14)	Input change signal		Changes the main reference input and auxiliary reference input. · H-level: Main reference input effective. · L-level: Auxiliary reference input effective.
AUX-A	11	Aux. reference pulse input	Phase-A signal	Aux. reference pulse is effective when INH signal is in L-level. Inputs two-phase pulse with 90° phase difference, and processed by number of four multipliered pulses. · Phase-B leading: forward running reference · Phase-A leading: reverse running reference
AUX-B	12		Phase-B signal	

Table 5 5 Output Signals of Connector 1CN

Signal Name	Connector 1CN No.	Function		Description
ALM	38 (39)	Servo alarm		Turns OFF if malfunction is detected. For details, refer to Par 6.10.
$\overline{\text{S-RDY}}$	28 (27)	Servo ready		Turns ON when main power supply ON, and no servo alarm.
$\overline{\text{COIN}}$	44 (45)	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.
$\overline{\text{OVER}}$	29 (30)	Overflow detection signal		Outputs when No. of lag pulses of the error counter exceeds the specified value. No. of lag pulses = $\frac{4}{Kp} \times \frac{\text{Motor speed (r/min)}}{60} \times$ (Frequency dividing ratio) × No. of pulses (pulse/rev) × M ≤ 2^{20} pulses (M: PG multiplication factor ... 1, 2, 4)
TRQ-M	15	Torque monitor		±3.0 V/rated torque ±10%, ±9 V max., load 1 mA or below.
VTG-M	16	Speed monitor		±2.0 V/1000 r/min ±5%, load 1 mA below.
PAO	33	Positioning signal output-1	Phase A	Encoder output signal after frequency division is output at line driver (T1 MC3487). To be received by line receiver (T1 MC3486).
*PAO	34		Phase $\overline{\text{A}}$	
PBO	35		Phase B	
*PBO	36		Phase $\overline{\text{B}}$	
PCO	19		Phase C	
*PCO	20		Phase $\overline{\text{C}}$	
PCOT	37	Positioning signal output-2 Phase C		Open collector output Max. operating voltage: 30 VDC Max. input current: 20 mADC
AL01 AL02 AL03	47 (1) 48 (2) 49 (3)	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

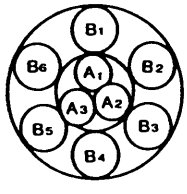
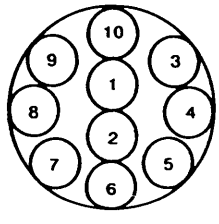
5. 5 1 Specifications of Applicable Receptacles and Cables (Table 5 6)

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†	DP8409123 or DE8400093

*Made by Honda Tsushin Co., Ltd
†Attached to each applicable receptacle (soldered and caulking types)
‡Attached to SERVOPACK when shipping
#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	Caulking Type
Yaskawa Drawing No	DP 8409123	DE 8400093
Manufacturer	Fujikura Cable Co	
General Specifications	Double, KQVV-SW' AWG 22 × 3 C AWG 26 × 6 P	KQVV-SB AWG 26 × 10 P
Internal Composition and Lead Color	For Soldered Type 	For Caulking Type 
	A1 Red A2 Black A3 Green yellow B1 Blue White/blue B2 Yellow White/yellow B3 Green White/green B4 orange White/orange B5 Purple White/purple B6 Grey White/grey Twisted cable	1 Blue-White- 2 Yellow-White 3 Green-White 4 Red-White 5 Purple White 6 Blue Brown 7 Yellow-Brown 8 Green-Brown 9 Red-Brown 10 Purple Brown Twisted Cable
Yaskawa Standard Specifications	Standard length 5 m, 10 m, 20 m 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 Figs. 5.4 and 5.5.

Table 5 8 Connector 2 CN Layout of SERVOPACK

1	2	3	4	5	6	7
PGOV	PGOV	PGOV	PG5V	PG5V	PG5V	DIR
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.

Notes
1 When applicable cables listed in Table 5 7 are used, allowable wiring distance between SERVOPACK and motor is a maximum of 20 meters
2 The cable applied for 50 m wiring distance is available on order (Yaskawa drawing No DP8409179) If wiring distance is 20 m or more, contact your Yaskawa representative

5 5 2 SERVOPACK Connector (2CN) Terminal Layout and Connection (Cont'd)

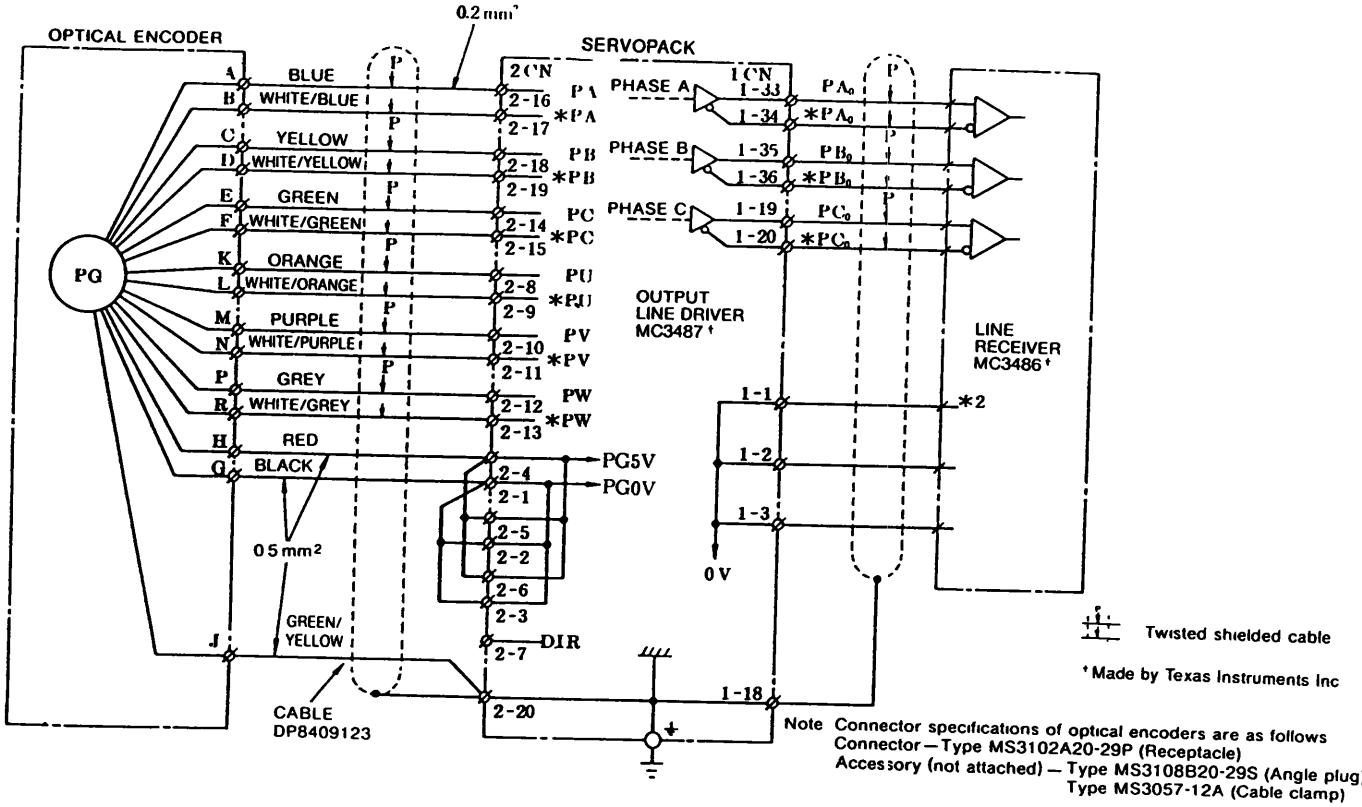


Fig 5 4 Soldered Type Connector 2CN Connection and 1CN Output Processing
(When using Connection Cable DP8401923)

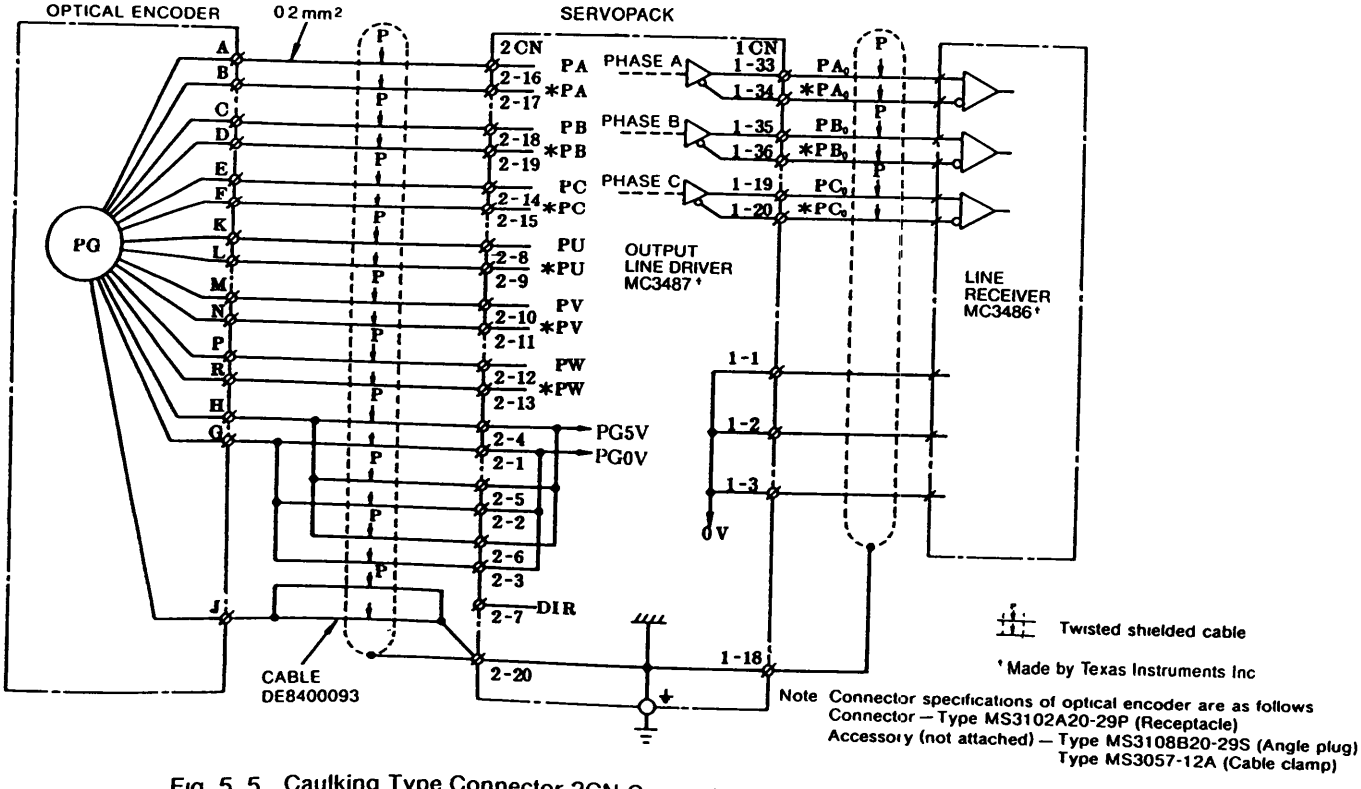


Fig 5 5 Caulking Type Connector 2CN Connection and 1CN Output Processing
(When using Connection Cable DE8400093)

6. OPERATION

6.1 POWER ON AND OFF

Arrange the sequence so that the power 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).

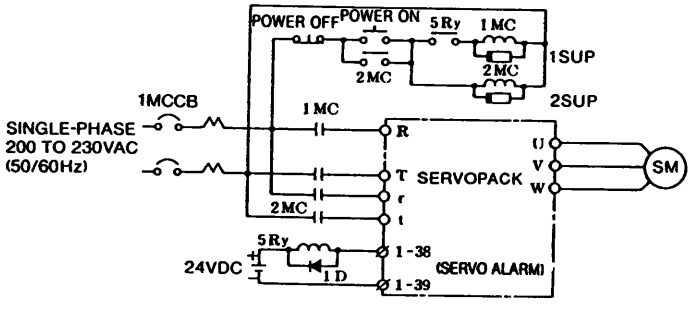
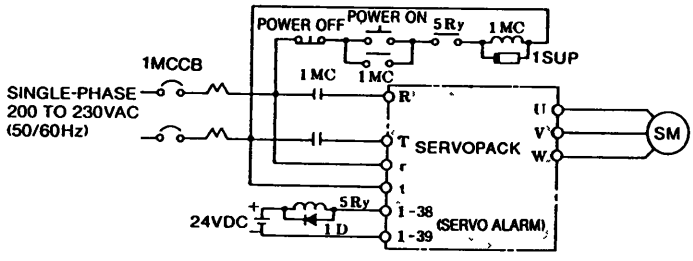


Fig 6 1 Connection Example for Simultaneous Control Power ON/OFF
(When using AC SERVOMOTOR for 200V)



1SUP, 2SUP Surge suppressor CR50500BA or equivalent (made by Okaya Electric Industries Co., Ltd.)
1D Flywheel diode (to prevent spike of 5Ry)

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

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.

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

6. 2 POSITIONING REFERENCE

6 2. 1 Input Reference Pulse

"H" level is effective for input $\overline{\text{INH}}$ ($\overline{\text{INHIBIT}}$) and $\overline{\text{CL}}$ ($\overline{\text{CLEAR}}$) signals.

(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 [SEL2]. See Table 6.1.

(2) Reference pulse mode

Three types of signals can be input as reference pulses. Set switches SW3-①, -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

[SEL2] Setting	1 2 3 ○○○	1 2 3 * ○○○
Effective Logic	negative (active L)	positive (active H)

[○]. Short-circuited [○] Open

* Standard factory-adjusted switch setting

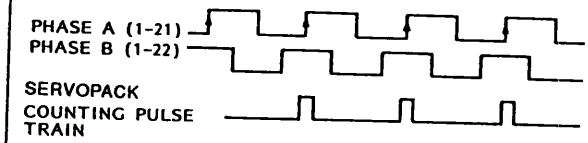
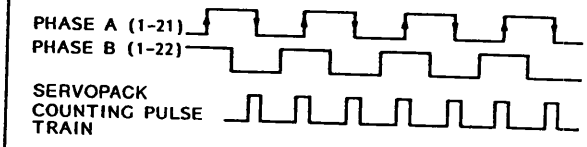
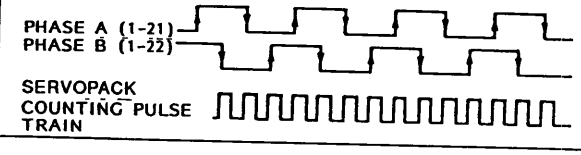
Table 6 2 Reference Pulse Mode

	Reference Pulse Mode	Input Pin No.	Forward Running Reference of Motor	Reverse Running Reference of Motor	Input Multiplier*	SW2† ①	②	③
Positive Logic Setting	Sign + Pulse Train	1CN- ㉑ 1CN- ㉒	"H"	"L"	—		○	○
	Two-Phase Pulse Train with 90° Phase Difference (1, 2 or 4 Times)	1CN- ㉑ 1CN- ㉒	90°	90°	× 1	○	○	○
					× 2	○	○	
					× 4	○		○
	CW Pulse Train + CCW Pulse Train	1CN- ㉑ 1CN- ㉒	"L"	"L"	—		○	
	Reference Pulse Mode	Input Pin No.	Forward Running Reference of Motor	Reverse Running Reference of Motor	Input Multiplier*	SW2† ①	②	③
Negative Logic Setting	Sign + Pulse Train	1CN- ㉑ 1CN- ㉒	"L"	"H"	—		○	○
	Two-Phase Pulse Train with 90° Phase Difference (1, 2 or 4 Times)	1CN- ㉑ 1CN- ㉒	90°	90°	× 1	○	○	○
					× 2	○	○	
					× 4	○		○
	CW Pulse Train + CCW Pulse Train	1CN- ㉑ 1CN- ㉒	"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- ㉑). 	f(pps) (Nr/min*)
× 2	Counts the leading and trailing edges of phase-A pulse input (1CN- ㉑). 	2 × f(pps) (2 × Nr/min)
× 4	Counts the leading and trailing edges of phase-A pulse input (1CN- ㉑) and phase-B pulse input (1CN- ㉒). 	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 . See Table 6.4.

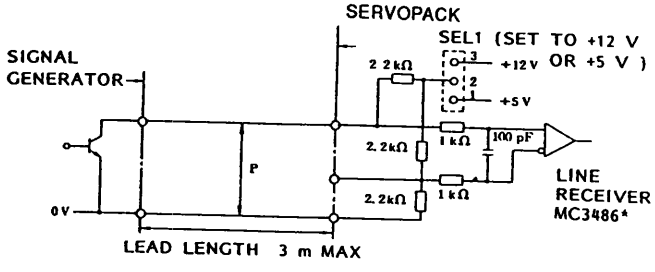
Table 6 4 Voltage Level Setting of Reference Pulse

SEL1 Setting*	1 2 3	1 2 3 †
Voltage level of reference pulse	+12 V	+5 V

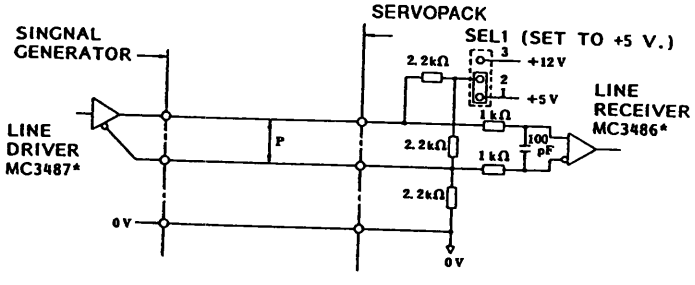
* The voltage level set by SEL1 can also operate $\overline{CL}$ and $\overline{INH}$.
† Line driver is set the setting plugs to this position.

(4) Input circuit

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



(a) For open collector



(b) For line driver

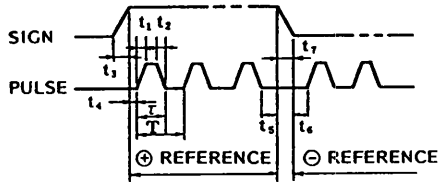
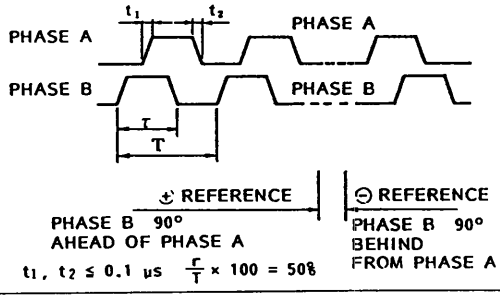
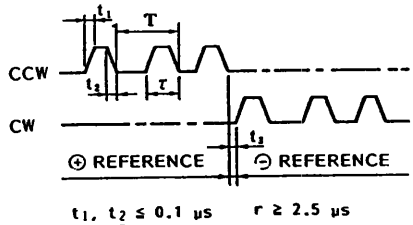
* Made by Texas Instruments Inc

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

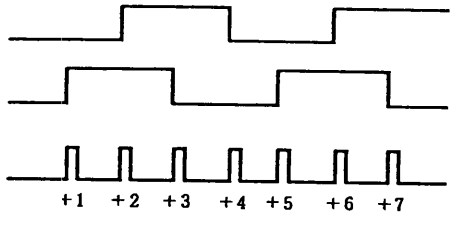
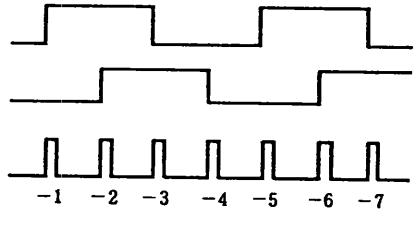
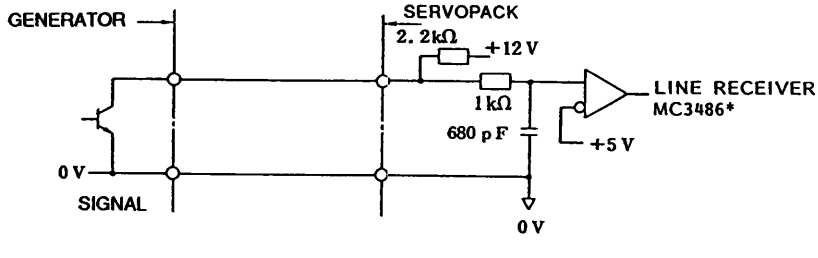
Item			Electrical Specifications		Remarks
Voltage Level of Signal		+12 V Level	H Level	+10.8 V to +12 V	+5 V level or +12 V level is set by internal switch SEL1.
			L Level	0 V to +1.2 V	
		+5 V Level	H Level	+4.2 V to +5 V	
			L Level	0 V to +0.8 V	
			Line driver	(H level-L level) > 2.0 V	
Reference Pulse Signal Mode	Sign + Pulse Train Input (SIGN + PULSE Signal)		 $t_1, t_2 \le 0.1\ \mu s$ $t_3, t_7 \le 0.1\ \mu s$ $t_4, t_5, t_6 > 3\ \mu s$ $r \ge 2.5\ \mu s$ $\frac{r}{T} \times 100 \le 50\%$	SIGN: H - ⊕ Reference L - ⊖ Reference
	2-phase Pulse with 90° Phase Difference (Phase A + Phase B)		 $t_1, t_2 \le 0.1\ \mu s$ $\frac{r}{T} \times 100 = 50\%$	Multipher mode is set by the internal switch SW2- ① to - ③ .
	CCW Pulses + CW Pulses		 $t_1, t_2 \le 0.1\ \mu s$ $t_3 > 3\ \mu s$ $r \ge 2.5\ \mu s$ $\frac{r}{T} \times 100 \le 50\%$	—

Note Maximum reference frequency is 200 kpps

6.2.2 Auxiliary Reference Pulse Signal

When $\overline{INH}$ signal is L level, reference pulse signal input is blocked and auxiliary reference pulse signal input becomes effective. Table 6.6 shows the specifications of auxiliary reference pulse.

Table 6 6 Specifications of Auxiliary Reference Pulse

Voltage Level	+12 V open collector, positive logic
Signal Mode	Two-phase pulse train with 90° phase difference (Phase A and B)
Multiplier	Fixed at ×4. (Counts the leading and trailing edges of phase A / phase B pulse input.)
Maximum Reference Frequency	100 kpps (Reference frequency in SERVOPACK is 400 kpps.)
Forward Running Reference of Motor	AUX-A (CN1- ⑪) AUX-B (CN1- ⑫) COUNTER PULSE TRAIN IN SERVOPACK 
Reverse Running Reference of Motor	AUX-A (CN1- ⑪) AUX-B (CN1- ⑫) COUNTER PULSE TRAIN IN SERVOPACK 
Input Circuit	

* Made by Texas Instruments Inc

6 2 3 Other Input Signals

Other input signals are $\overline{CL}$ and $\overline{INH}$. The voltage level of these signals are the same as that of the reference pulse (the voltage level set by [SEL1] can operate $\overline{CL}$ and $\overline{INH}$).

(1) $\overline{CL}$ ($\overline{CLEAR}$) signal

This signal is usually held at H level during operation. When $\overline{CL}$ signal goes "L," the contents of the positioning error counter returns to 0, and positioning loop does not function.

(2) $\overline{INH}$ ($\overline{INHIBIT}$) signal

- Where the auxiliary reference pulse signal is not used, this signal usually held at H level during operation. When $\overline{INH}$ signal goes "L," reference pulse input gate closes, and the error counter does not count. However, the servo is clamped because the positioning error counter is not cleared.
- Where the auxiliary reference pulse signal and reference pulse signal are used by switching alternately, set $\overline{INH}$ signal to "L." Then the error counter can be counted at auxiliary pulse input. See Fig. 6.4 for the timing.

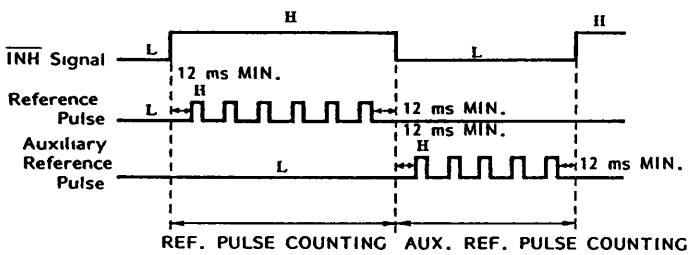


Fig 6 4 Timing of $\overline{INH}$, Reference Pulse and Auxiliary Reference Pulse Signals

6. 2. 4 Other Output Signals

See Par. 6.4.2, "Output circuit," for the output circuit configuration.

(1) $\overline{OVER}$ (overflow detection signal)

This signal is output when No. of lag pulses in error counter becomes abnormally large. $\overline{OVER}$ output is set to "L" when the number of error counter lag pulses is a value δ or more, calclulated following formula.

$$\delta = \frac{4}{Kp} \times \frac{\text{Motor max speed (r/min)}}{60} \times \frac{P \times M}{N}$$

P : Number of PG pulses (pulse/rev)
M . PG output multiplier ratio
N · Dividing frequency ratio

According to SW3-⑥ setting, the servo alarm is output when lag pulse is δ or exceeds $2^{18} \times \frac{M}{N}$. See Fig. 6.5. At this time, Servopack shows [3] on alarm display LED, and stops at alarm status.

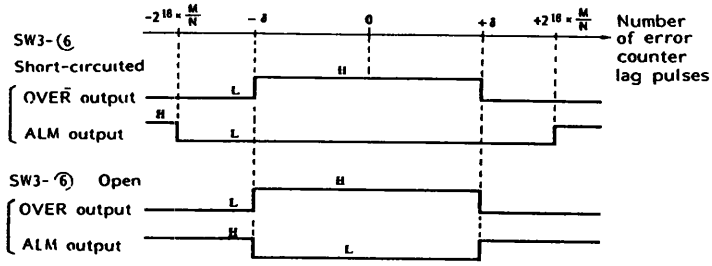


Fig 6 5 Relationship of $\overline{OVER}$ and $\overline{ALM}$ Outputs

(2) $\overline{COIN}$ (positioning completion) signal

This signal is output when the lag pulses in error counter fall within the set values. The lag pulses in error counter (position completion width) are set by switch SW2-⑤ to -⑧. See Table 6.7.

Table 6. 7 Setting of Lag Pulses

Item	SW2 ⑤	SW2 ⑥	SW2 ⑦	SW2 ⑧	Remarks
Data	D_0	D_1	D_2	D_3	
With Short-circuit Pin	1	1	2	4	Setting of lag pulses
Without Short-circuit Pin	5	0	0	0	

Note: SW2-⑥, -⑦, and -⑧ are without short-circuit pin, number of lag pulses is "±1 pulse."

$$\text{No of lag pulses} = \left(\sum_{N=1}^{3} D_N \right) \times Do$$

No. of lag pulses is converted to angle of rotation.

$$\frac{N}{P \times M} \times \left(\sum_{N=1}^{3} D_N \right) \times Do \text{ (rev)}$$

P : No. of pulses from optical encoder (pulse/rev)
N : Pulse frequency dividing ratio
M : Multiplier ratio

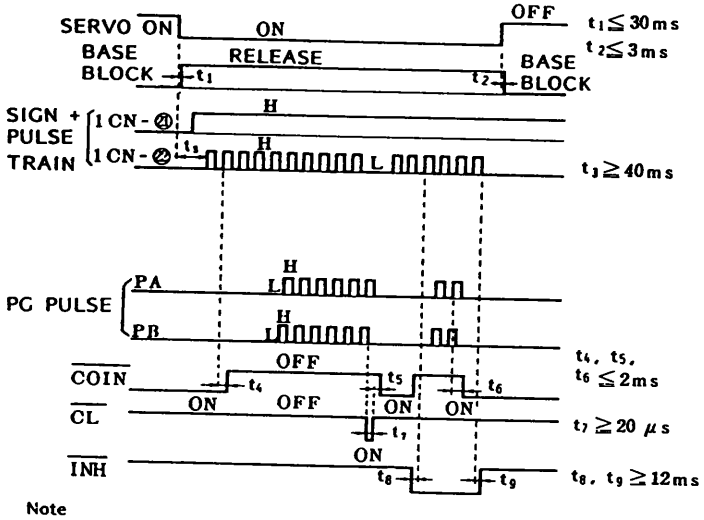
6.3 I/O SIGNAL TIMING

An example of the timing of the I/O signal is shown in Fig. 6.6.

: PG pulse frequency dividing ratio = 1

: Output multiplier = 1

: Width of positioning completion = ±1 pulse



Note

1. It takes 40 ms or more after turning "ON" the servo-on signal until the reference pulse is input. If the reference pulse is input within less than 40 ms the reference pulse may not be correctly input
2. The clear signal must be kept on for at least 20 μs. It may not be input if it is less than 20 μs.

Fig 6 6 Timing Chart of I/O Signal

6.4 CONFIGURATION OF I/O CIRCUIT

For overtravel, servo ON, alarm reset, servo alarm output, OVER output, COIN output, servo ready output, etc., each I/O circuit is a noncontact circuit insulated with optical couplers. The external circuit, therefore, must be constructed with the specified voltage and current.

6.4 1 Input Circuit

There are four input signals: Servo ON, forward/reverse overtravel protection, alarm reset. Construct the input circuit using 24 V power supply (Fig. 6.7). Typical circuits are shown in Fig. 5.3.

NOTE

The user must provide the 24 V power supply: 24 VDC ±1 V, 20 mA or more (approx. 5 mA/circuit)

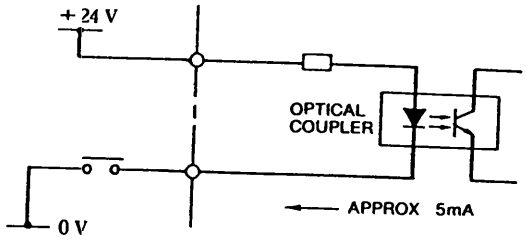


Fig 6 7 Configuration of I/O Circuit

(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-㉖ and ㊶ to the 0 V terminal of the external 24 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.

6 4 2 Output Circuit

There are four output signals: Overflow, 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) ≦ 50 mA

NOTE

The output circuit requires a separate power supply. It is recommended to use the same 24 V power supply used for the input circuit (Fig. 6.8).

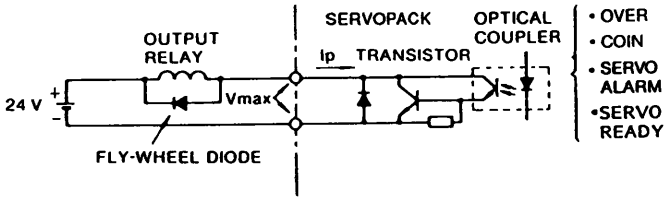


Fig 6.8 Output Circuit

6 4.3 Optical Encoder (PG) Output Circuit [PAo, *PAo, PBo, *PBo, PCo, *PCo]

Phases A, B, and C (original point) signals for the optical encoder, PG are output.

Use these signals as positioning signals. The output signal specifications are as follows:

(1) Signal form

- Two-phase pulse with 90° pulse difference (phases A and B)
- Original point pulse(phase C)

(2) Output circuit and receiver circuit

Two types of output circuits are provided: line driver output and open collector output. Fig. 6.9 shows an example of line driver output. However, open collector output has only phase-C signal.

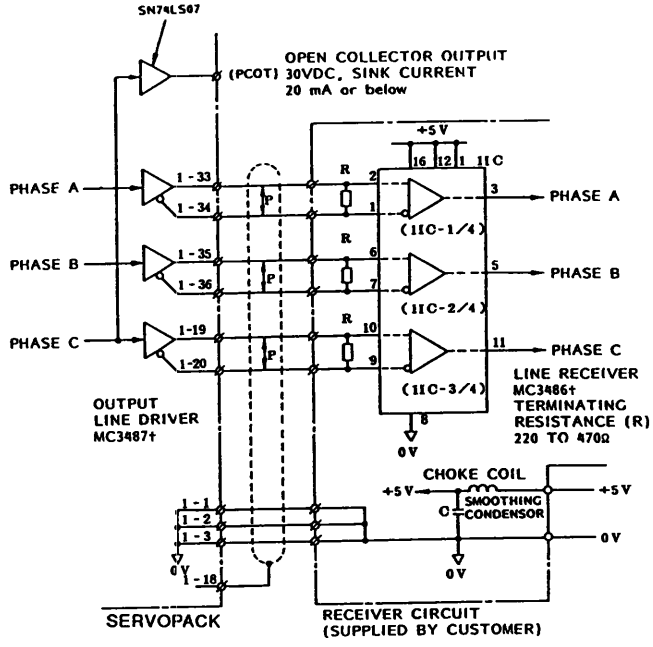
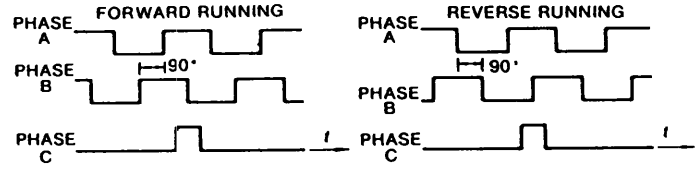


Fig 6 9 Output Circuit and Receiver Circuit

(3) Output phase



Note Phase C (original point pulse) is synchronized with phase A

Fig 6. 10 Output Phase

(4) Pulse resolution

The pulse frequency of the PG can be further divided by using the divider in the SERVOPACK. The phase relation is the same as in (3), above. Set the pulse frequency dividing ratio according to Table 6.8. Fig. 6.11 shows the optical encoder output waveform under the dividing pulse frequency.

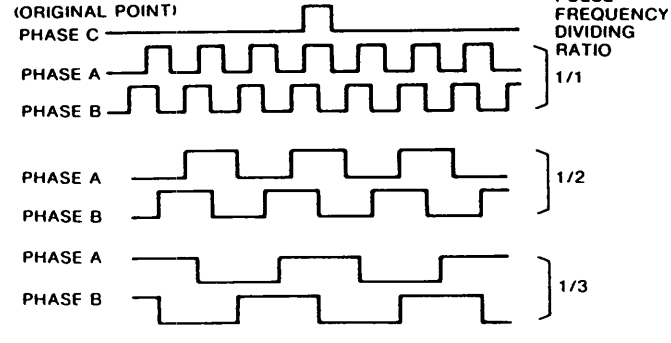


Fig 6 11 Output Waveform of Optical Encoder

Table 6 8 Setting of PG Pulse Frequency Dividing Ratio

SW8*	0†	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Pulse Frequency Dividing Ratio	1/1	1/2	1/3	1/4	1/5	1/6	1/10	1/12	1/15	1/20	1/30	2/3	2/5	–	–	–

* Hexadecimal digital switch
† Initial setting

(5) Output multiplier circuit

According to the combination of switch SW1-① and -② in the SERVOPACK, the number of optical encoder frequency (output) can be multiplied by the user. See Table 6.9.

Four multiplier should be set when all edges of 2 phases of the PG output are used; 2-multiplier when all edges of 1 phase are used; and 1-multiplier when one edge of 1 phase is used.

Table 6 9 Setting of Output Multiplier Circut

SW1		Multiplier
①	②	
○	○	× 1
	○	× 1
○		× 2
		× 4

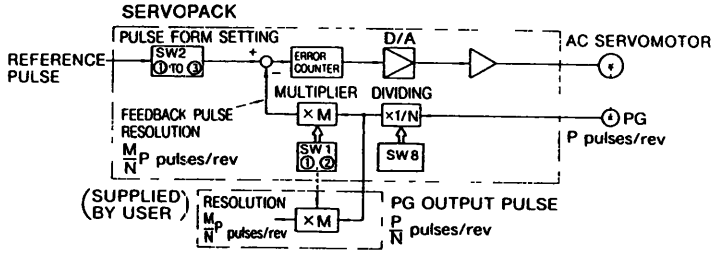
Note
1 Circles indicate the positions of short-circuit pins
2 The relationship of pulse frequency dividing ratio(N), multiplier (M) and rotation angle per pulse are as follows

$$\text{Rotation angle per pulse} = \frac{N}{P \times M} \text{ (rev)}$$

N Pulse frequency dividing ratio
M Multiplier
P Number of PG pulses (pulses/rev)

6 4.4 I/O Pulses

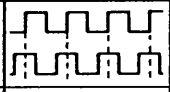
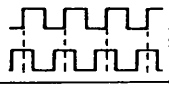
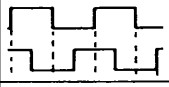
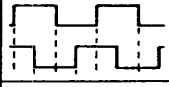
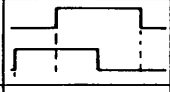
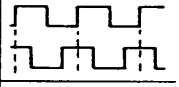
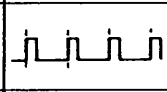
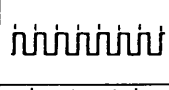
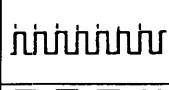
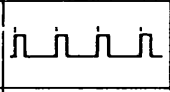
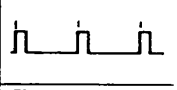
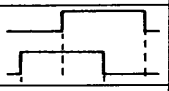
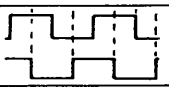
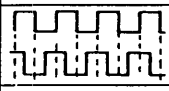
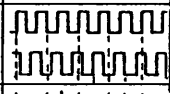
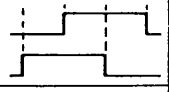
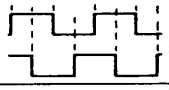
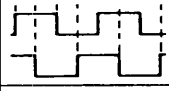
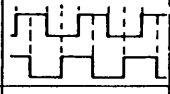
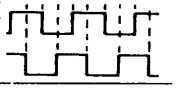
SERVOPACK multiplies the reference input pulses, and divides and multiplies the PG output. Table 6.10 shows a typical relationship between these functions when the reference input pulses and PG output pulses are combined.



Note When the same number of pulses obtained from feedback pulse resolution is required, multiply the PG output pulses by the number (M) set by switches SW1-① and -② in the SERVOPACK

Fig.6 12 Block Diagram of Pulse Setting in Type CACR-PR

Table 6 10 I/O Pulses

Input Multiplier (SW2- ① , -② , -③)		1	1	4	4	4	1
PG Pulse Frequency Dividing (SW8)		1	1	1	2	3	3
Output Multiplier (SW1- ① , -②)		1	4	4	4	1	1
Reference Pulse Train	For 2-phase Pulse Train Input						
	For Sign + Pulse Train Input						
PG, FB Pulse	PA PB						
PG Output	PAo PBo						
Pulse Resolution		1500	6000	6000	3000	500	500

Note:
1. When the input multiplier is 4, 2-phase pulse train can be input. Inputting the sign and pulse train indicates that the condition is the same as when four times of reference frequency is input.
2. The pulse resolution is calculated from PG 1500 pulses/rev.

6.4.5 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 (SW3- ③) 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: 1500 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 Tables 10.2 and 10.7.

6.5 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 6.11 Trouble Detecting Functions

Trouble	Detection
Overcurrent (OC)	Overcurrent flow in the main circuit (at 1.2 times min. inst max. current)
Circuit Protector Trip (MCCB)	Circuit protector tripped
Regeneration Trouble (RG)	Regenerative circuit not activated in SERVOPACK • For 200 V: only 200 to 700 W • For 100 V: only 200 to 500 W
Overflow (OF)	Excessively large number of lag pulses of error counter
Overvoltage (OV)	Excessively high DC voltage in the main circuit (detected at approx. 420 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 (150 V or less.)
Overload (OL)	Overload condition of motor and SERVOPACK
CPU Error (CPU)	Any error of CPU

(3) Overload (OL) detection level

Fig.6.13 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 responce to the same overload.

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

If any trouble detection circuits in Table 6.11 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 6.12.

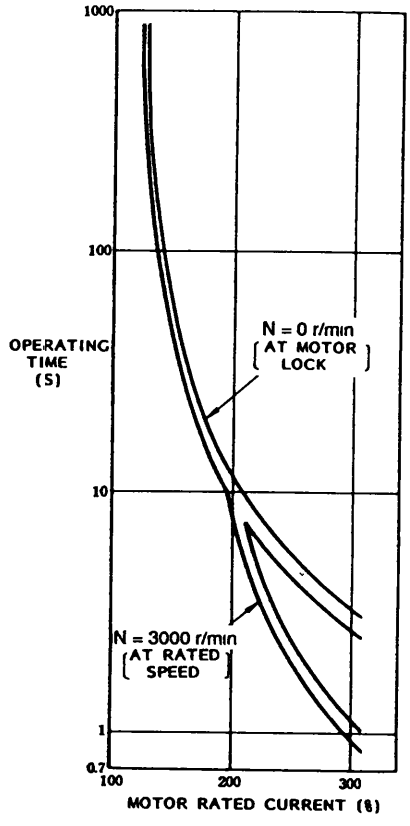


Fig 6.13 Overload Characteristics

Table 6.12 Alarm Display and Alarm Output Code (SVALM and 3-bit Output)

Specifications	Display (LED)	Code No.	Output 1	Output 2	Output 3	SVALM	OVER
Normal	[-]	8	×	×	×	○	*
OC	[1]	1	○	×	×	×	×
MCCB	[2]	2	×	○	×	×	×
RG	[3]	3	○	○	×	×	×
OF							○
OV	[4]	4	×	×	○	×	×
OS	[5]	5	○	×	○	×	×
PG	[C]						
UV	[6]	6	×	○	○	×	×
OL	[7]	7	○	○	○	×	×
CPU	[-]	0	×	×	×	×	×

○ . Output transistor is turned ON

× Output transistor is turned OFF

* When lag pulses of error counter is δ or more, output transistor is turned ON.
When it is δ or below, output transistor is turned OFF.
See Par 6.2.4 (1) for value of δ .

(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.

6.6 LED INDICATION

Table 6 13 LED Status Indications (Green)

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

6.7 PRECAUTIONS FOR APPLICATION

6 7 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), for application to a minus load, contact your YASKAWA representative.

6 7 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. If this occurs, take the following actions:

- Reduce the current limit.
- Slow down the deceleration curve.
- Decrease the maximum speed.

For details, contact your YASKAWA representative

6.7 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 6.15 shows the transformer selection. Connection should be made so that the power is supplied and cut through the primary (or secondary) side of the transformer.

6.8 PRECAUTIONS OF OPERATION

6 8 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. 6.14.

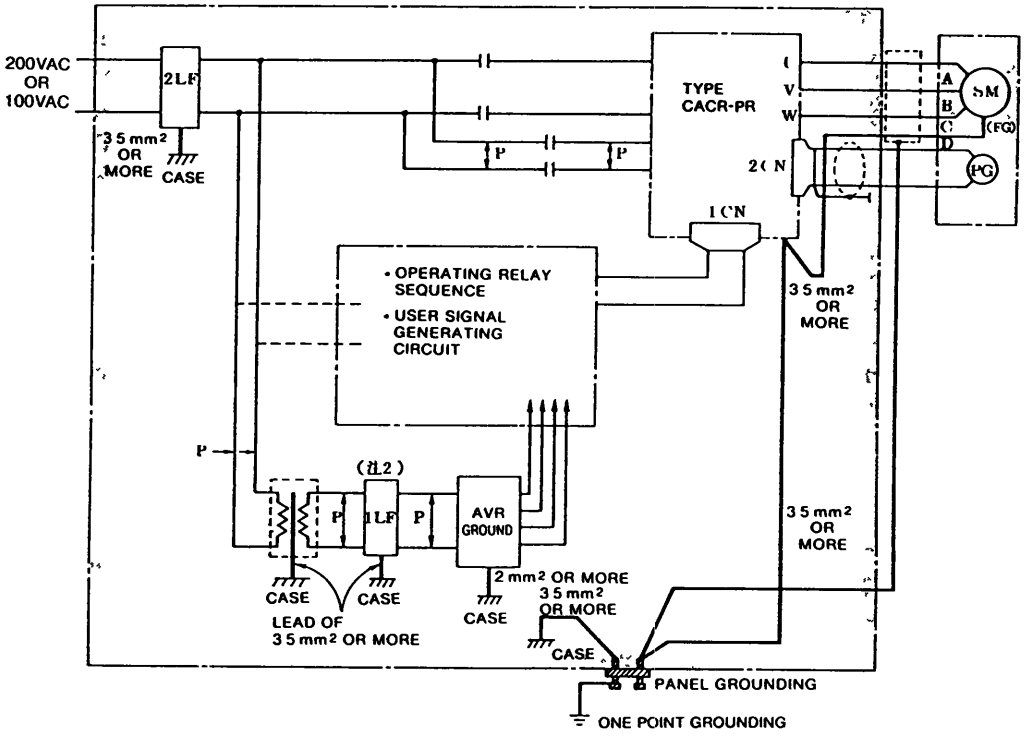
(1) Grounding method (Fig. 6.14)

• Motor frame grounding

When the motor is at the machine side and grounded through the frame, Cf $\frac{di}{dt}$ 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

Notes
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 6.14 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 6.14. 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. 6.15 to 6.18.

Table 6 14 Recommended Noise Filter

Class	SERVOPACK Type CACR-		Applicable Noise Filter	Recommended Noise Filter*	
				Type	Specifications
200V	50W (0.07HP)	PRA5AC3□R	Good	LF-205A	Single-phase 200VAC class, 5A
	100W (0.13HP)	PR01AC3□R			
	200W (0.27HP)	PR02AC3□R			
	300W (0.40HP)	PR03AC3□R		LF-210	Single-phase 200VAC class, 10A
	500W (0.67HP)	PR05AC3□R		LF-215	Single-phase 200VAC class, 15A
	700W (0.93HP)	PR07AC3□R		LF-220	Single-phase 200VAC class, 20A
100V	50W (0.07HP)	PRA5AC4□R	Poor	LF-205A	Single-phase 200VAC class, 5A
	100W (0.13HP)	PR01AC4□R			
	200W (0.27HP)	PR02AC4□R		LF-210	Single-phase 200VAC class, 10A
	300W (0.40HP)	PR03AC4□R		LF-215	Single-phase 200VAC class, 15A
	500W (0.67HP)	PR05AC4□R		LF-220	Single-phase 200VAC class, 20A

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

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

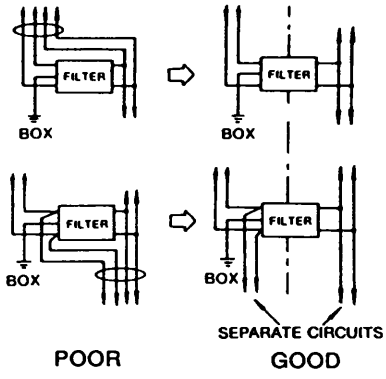


Fig 6.15

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

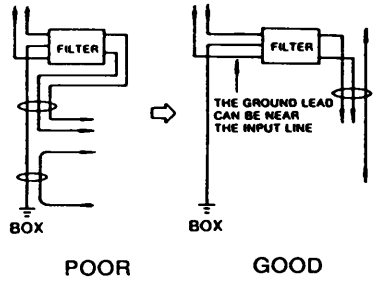


Fig 6 16

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

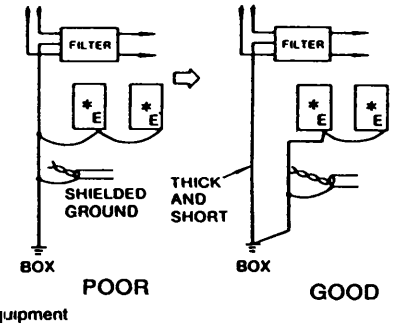


Fig 6.17

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

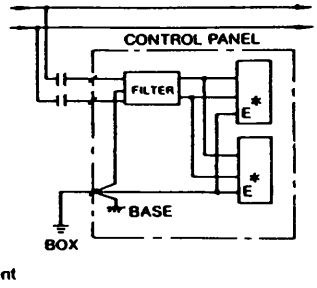


Fig 6 18

6 8 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 6.15).

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 15 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
200V	50(0.07)	PRA5AC3[ ]R	0.3	5
	100(0.13)	PR01AC3[ ]R	0.5	5
	200(0.27)	PR02AC3[ ]R	0.75	5
	300(0.40)	PR03AC3[ ]R	1.0	7
	500(0.67)	PR05AC3[ ]R	1.4	11
	700(0.93)	PR07AC3[ ]R	2.0	15
100V	50(0.07)	PRA5AC4[ ]R	0.3	5
	100(0.13)	PR01AC4[ ]R	0.5	5
	200(0.27)	PR02AC4[ ]R	0.75	8
	300(0.40)	PR03AC4[ ]R	1.0	11
	500(0.67)	PR05AC4[ ]R	1.4	15

* Values at rated load.
† Interruption characteristics at 25°C · 200% 2 s or more.
700% 0.01 s or more.

6.9 APPLICATION

6 9 1 Connection for Reverse Motor Running

If the machine construction requires that the normal forward reference is used for reverse motor running and the normal reverse reference for forward running, short across 2CN-1 and 2CN-7 of connector 2CN for the PG. In this case, change of motor and PG connection is not required. For forward reference, frequency dividing output from SERVOPACK forwards B-phase.

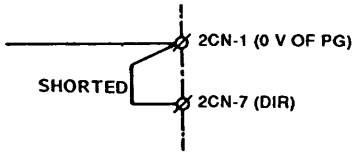


Fig 6 19

6 9 2 Speed and Torque Measurement

When an instrument is connected to measure speed and torque, make the connection as shown in Fig. 6.20, using a DC ammeter of ±1mA (both swing) load at full-scale voltage.

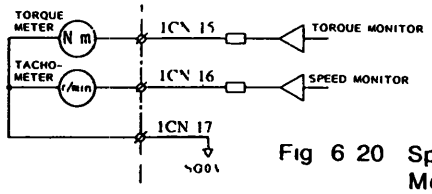
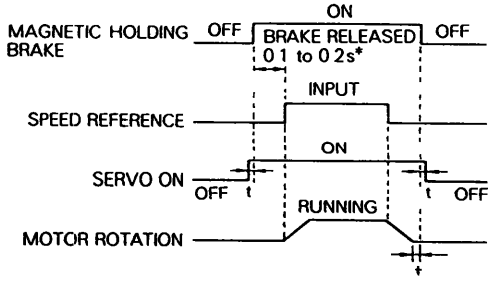


Fig 6 20 Speed and Torque Measurement

- Torque monitor output (1CN-9): ±3.0V ±10%/100% torque
- Speed monitor output (1CN-10): ±2.0V ±5%/1000 r/min
- Instrument: Ammeter of ±1 mA (both swing) load at full-scale voltage. Use ammeter of DCF-6 or DCF-12N by Toyo Instrument or equivalent.
- Example: When an R Series motor (rated speed: 3000 r/min) is used, and speeds are to be measured up to the maximum speed (4500 r/min) in both directions, use ±9V (both swing) DC voltmeter.

6 9 3 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 21 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.

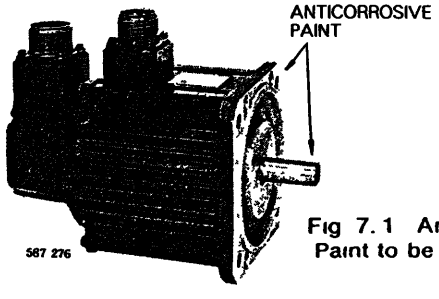


Fig 7.1 Anticorrosive Paint to be Removed

(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

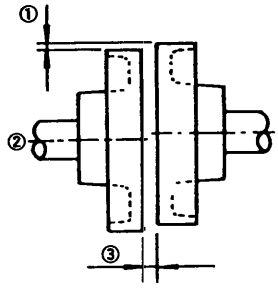
Humidity: 20% to 80% RH (non-condensing)

(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 equidistant 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. (50G max.)

7 2.2 SERVOPACK

(1) Installation

The SERVOPACK type CACR-PR☐☐AC 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.

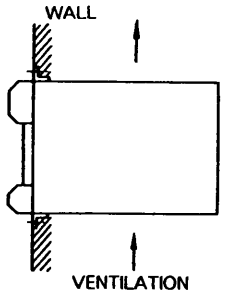


Fig 7 5 Mounting Direction

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				
			PRA5AC3	PR01AC3	PR02AC3	PR03AC3	PR05AC3	PR07AC3	PRA5AC4	PR01AC4	PR02AC4	PR03AC4	PR05AC4
On Line	Main Circuit Power Input	® Ⓣ	1.3	2.5	4.4	6.5	10.4	15.0	2.6	4.5	8.0	11.0	15.0
	Motor Connection	Ⓤ Ⓥ Ⓦ	0.7	1.0	2.0	2.7	3.6	5.7	1.2	1.7	2.9	3.6	5.5
	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* mm^2										
			200 V Class						100 V Class				
			PRA5AC3	PR01AC3	PR02AC3	PR03AC3	PR05AC3	PR07AC3	PRA5AC4	PR01AC4	PR02AC4	PR03AC4	PR05AC4
On Line	Main Circuit Power Input	® Ⓣ	HIV 1.25 or more			HIV 2.0 or more			HIV 1.25		HIV 2.0 or more		
	Motor Connection	Ⓤ Ⓥ Ⓦ	HIV 1.25 or more										HIV 2.0 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 mm^2 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 emviromental 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

Notes
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 and PG feedback lines, use twisted cables or multi-core shielded twisted-pair cables (Yaskawa Drawing No. DP8409123 or DE8400093).

Cable length is a maximum of 3 m for reference input lines and a maximum of 20 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) Corrective Action 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 mm²). 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. The values are calculated under the following conditions.

- $J_l = 10 \times J_M$
- Repetitive duty of N = 0 ⟷ 4000 r/min is 5%.

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
200V	50 (0.07)	A5AC3□R	0.7	20	-	30	50
	100 (0.13)	01AC3□R	1.0	25	-		55
	200 (0.27)	02AC3□R	2.0	30	6		66
	300 (0.40)	03AC3□R	2.7	35	6		71
	500 (0.67)	05AC3□R	3.6	55	6		91
	700 (0.93)	07AC3□R	5.7	50	15		95
100V	50 (0.07)	A5AC4□R	1.2	20	-		50
	100 (0.13)	01AC4□R	1.7	25	6		61
	200 (0.27)	02AC4□R	2.9	40	6		76
	300 (0.40)	03AC4□R	3.6	50	6		86
	500 (0.67)	05AC4□R	5.5	45	15		90

* 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 exeeding these values, the regenerative resistor should be installed separately from SERVOPACK

8. DIMENSIONS

8. 1 SERVOMOTOR DIMENSIONS in mm (inches)

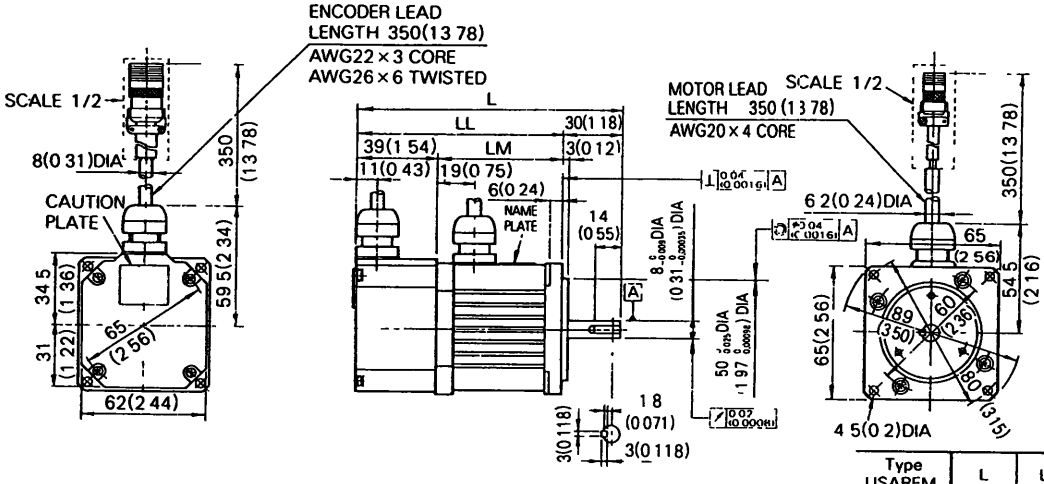
If the capacity is the same, the dimensions are the same even if the voltage or pulse specifications differ (100 V, 200 V, 1500 pulses or 1000 pulses).

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)

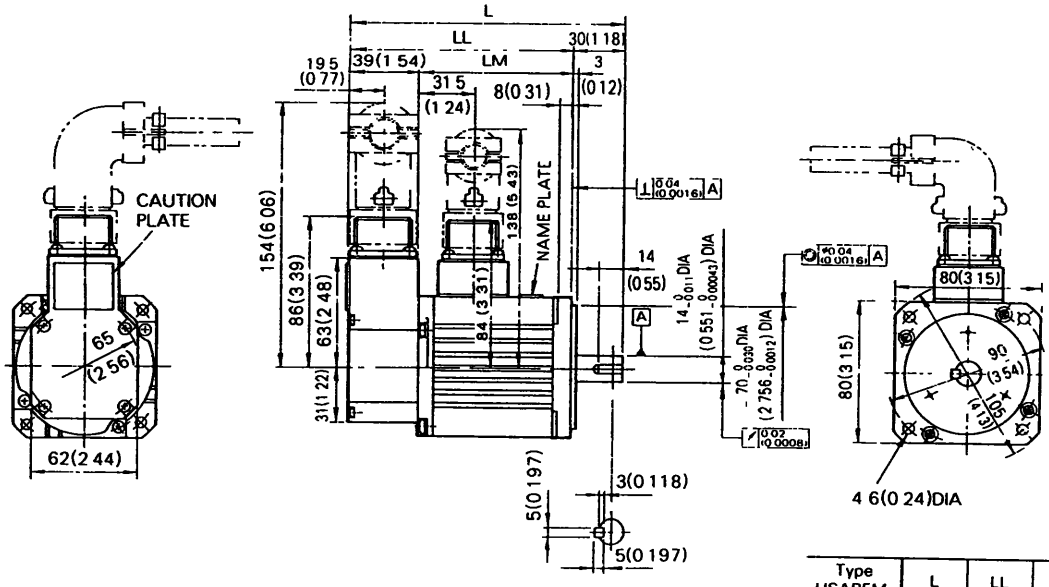
Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1031 "Sunk keys and their corresponding keyways)." Parallel key has been attached.

• TYPES USAREM-A5[ ][ ]2K,-01[ ][ ]2K



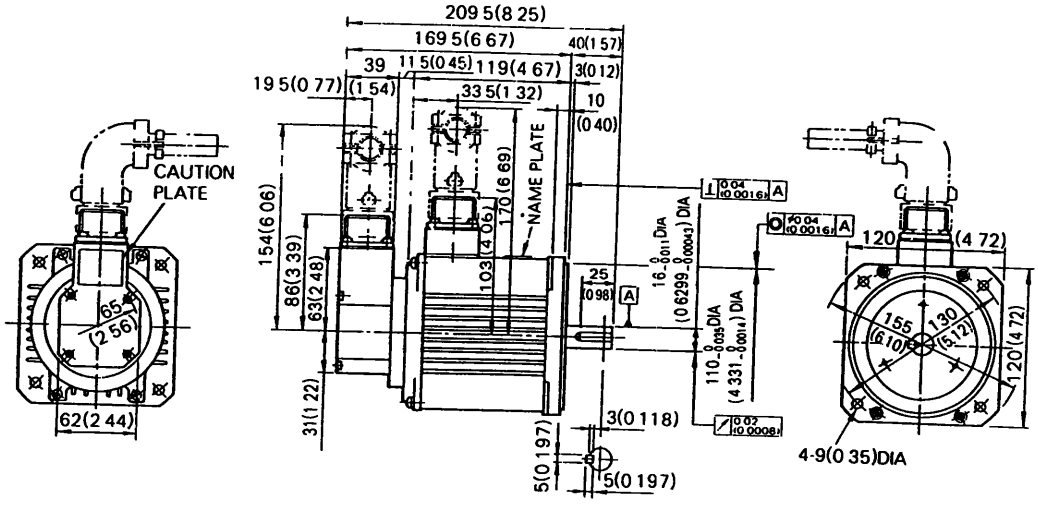
Type USAREM	L	LL	LM	Approx Mass kg (lb)
A5[ ]2K	131 5 (5 18)	101 5 (4 00)	62 5 (2 46)	1 0 (2 2)
01[ ]2K	149 (5 87)	119 (4 69)	80 (3 15)	1 3 (2 9)

• TYPES USAREM-02[ ][ ]2K, -03[ ][ ]2K



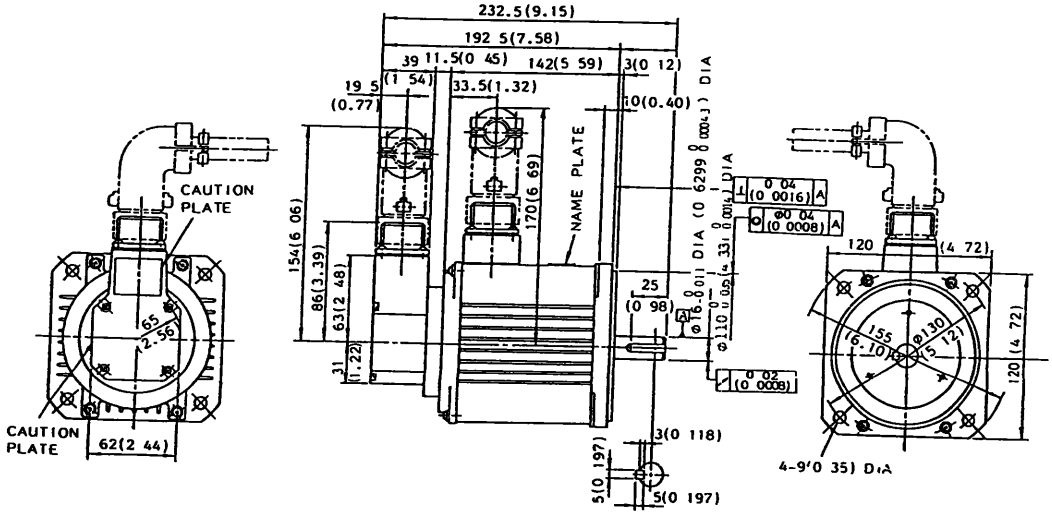
Type USAREM	L	LL	LM	Approx Mass kg (lb)
02[ ]2K	156 5 (6 16)	126 5 (4 98)	87 5 (3 44)	2 0 (4 4)
03[ ]2K	180 5 (7 11)	150 5 (5 93)	111 5 (4 39)	2 6 (5 7)

• TYPE USAREM-05A□2K



Approx Mass 4.4 kg (9.7 lb)

• TYPE USAEM-07C□2K

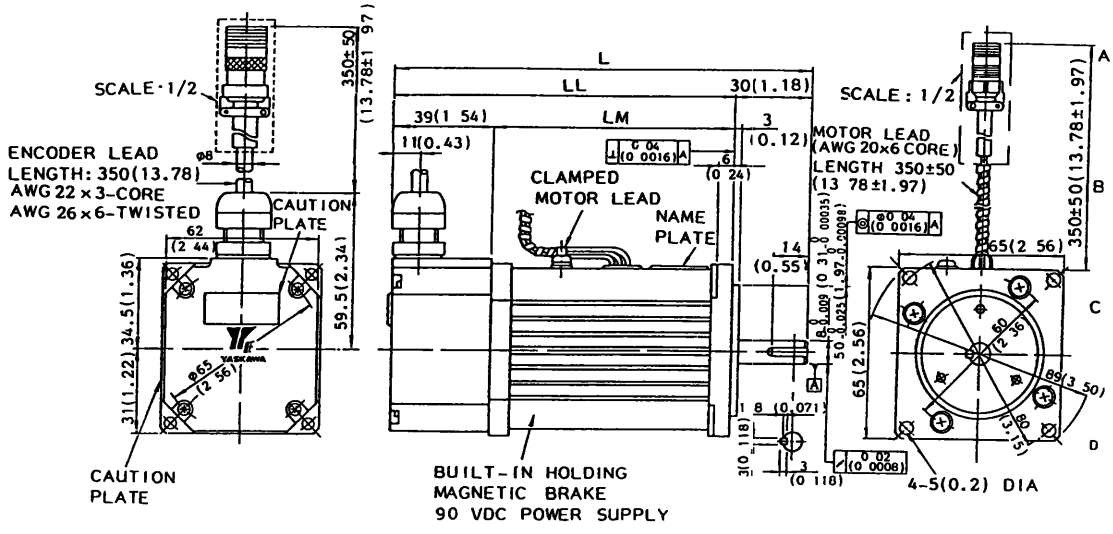


(2) With Brake (with key, straight shaft)

Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1031 "Sunk keys and their corresponding keyways)." Parallel key has been attached.

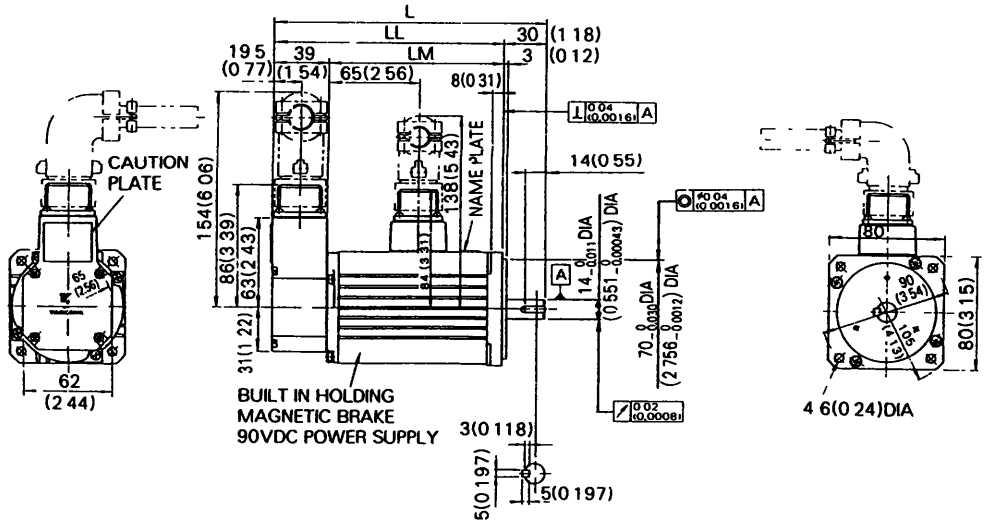
8. 1 SERVOMOTOR DIMENSIONS in mm (inches)
(Cont'd)

• TYPES USAREM-A5[ ]2KB, 01[ ]2KB



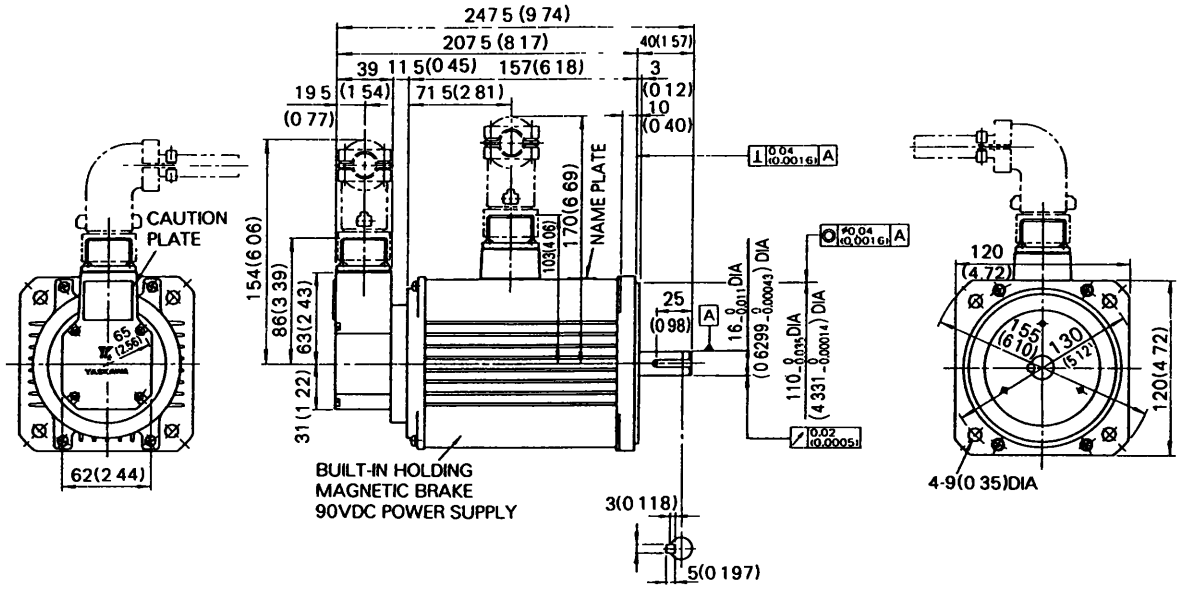
Type USAREM-	Dimensions L	LL	LM	Magnetic Brake Type	Inertia kg·m²×10⁻⁴ (oz·in·s²×10⁻³)	Static Friction Torque N·m (oz·in)	Voltage VDC	Approx Mass kg (lb)
A5[ ]2KB	164 5 (6 48)	134 5 (5 30)	95 5 (3 76)	MSB/ 90-6YN	0 98 (0 733)	0 588 (83 3)	90	1 4 (3 09)
01[ ]2KB	182 (7 17)	152 (5 99)	113 (4 45)					1.7 (3 75)

• TYPES USAREM-02[ ]2KB, -03[ ]2KB



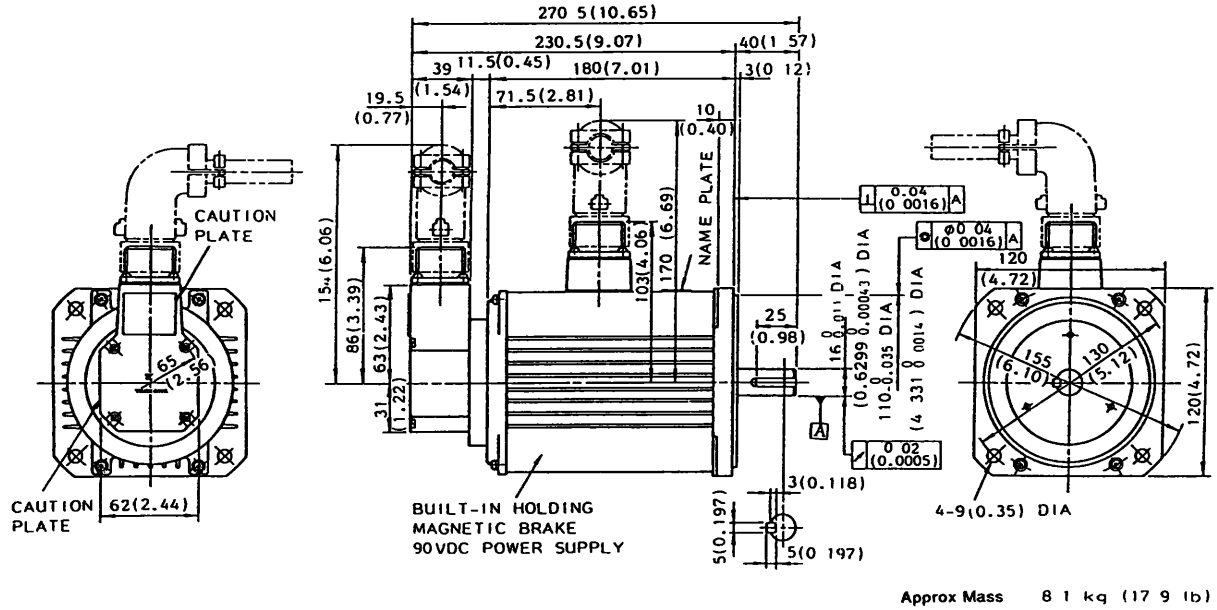
Type USAREM-	Dimensions L	LL	LM	Magnetic Brake Type	Inertia kg·m²×10⁻⁴ (oz·in·s²×10⁻³)	Static Friction Torque N·m (oz·in)	Voltage VDC	Approx Mass kg (lb)
02[ ]2KB	194 (7 64)	164 (6 46)	125 (4 92)	MSB/ 90 20YN	0 19 (2 73)	1 961 (278)	90	2 7 (5 95)
03[ ]2KB	218 (8 58)	188 (7 40)	149 (5 87)					3 3 (7 28)

• TYPES USAREM-05A□2KB



Type USAREM-	Magnetic Brake				Approx Mass kg (lb)
	Type	Inertia kg·m²×10⁻⁴ (oz·in·s²×10⁻⁴)	Static Friction Torque N·m (oz·in)	Voltage VDC	
05A□2KB 07C□2KB	MSB/ 90-30YN	0.48 (6.83)	2.942 (417)	90	5.5 (12.16)

• TYPE USAREM-07C□2KB



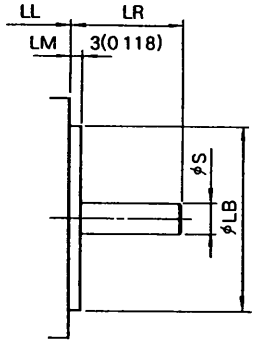
Approx Mass 8.1 kg (17.9 lb)

8. 1 SERVOMOTOR DIMENSIONS in mm (inches) (Cont'd)

(3) Shaft Externsion of Straight Shaft

- TYPE USAREM-A5□□2 to -07C□□2(without brake)
- TYPE USAREM-A5□□2B to -07C□□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:

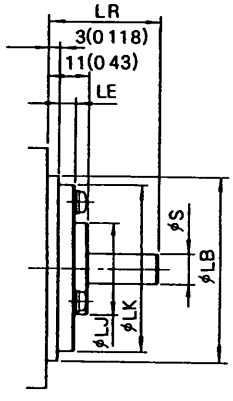


Without Brake Type USAREM	With Brake Type USAREM	LR	S	LB
A5□□2	A5□□2B	30 (1 18)	8 $^{0}_{-0.009}$ (0 31 $^{0}_{-0.00035}$)	50 $^{0}_{-0.025}$ (1 97 $^{0}_{-0.00098}$)
01□□2	01□□2B		14 $^{0}_{-0.011}$ (0 551 $^{0}_{-0.00043}$)	70 $^{0}_{-0.030}$ (2 756 $^{0}_{-0.0012}$)
02□□2	02□□2B			
03□□2	03□□2B			
05A□□2	05A□□2B	40 (1 57)	16 $^{0}_{-0.011}$ (0 6299 $^{0}_{-0.00043}$)	110 $^{0}_{-0.035}$ (4 331 $^{0}_{-0.00014}$)
07C□□2	07C□□2B			

(4) Shaft Extension of Straight Shaft with Oilseal

- TYPE USAREM-A5□□2S to -07C□□2S (without brake)
- TYPE USAREM-A5□□2SB to -07C□□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
03□□2S	03□□2SB							
05A□□2S	05A□□2SB	40 (1 57)	25 (0 10)	50 (1 97)	73 (2 87)	16 $^{0}_{-0.011}$ (0 6299 $^{0}_{-0.00043}$)	110 $^{0}_{-0.035}$ (4 331 $^{0}_{-0.00014}$)	SB16307
07C□□2S	07C□□2SB							

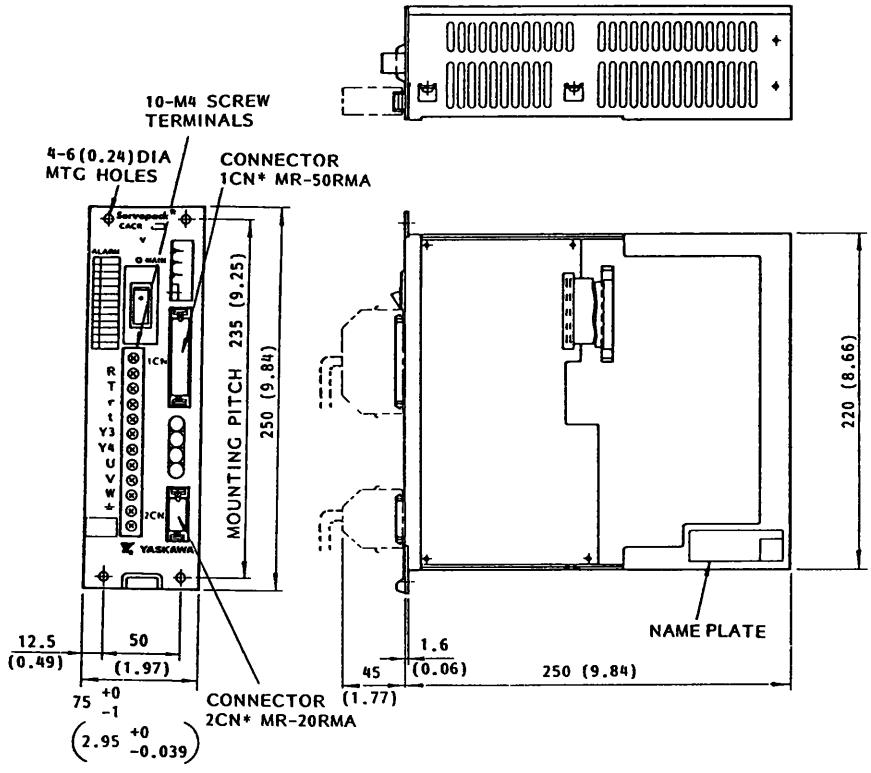
* Nippon Oil Seal Industry Co Ltd

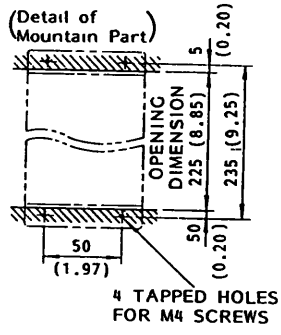
(5) Shaft Extension of Straight Shaft with Keyway and Oilseal

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)

- TYPES CACR-PRA5AC3⬚R, -PR01AC3⬚R (200V)
- TYPE CACR-PRA5AC4⬚R (100V)

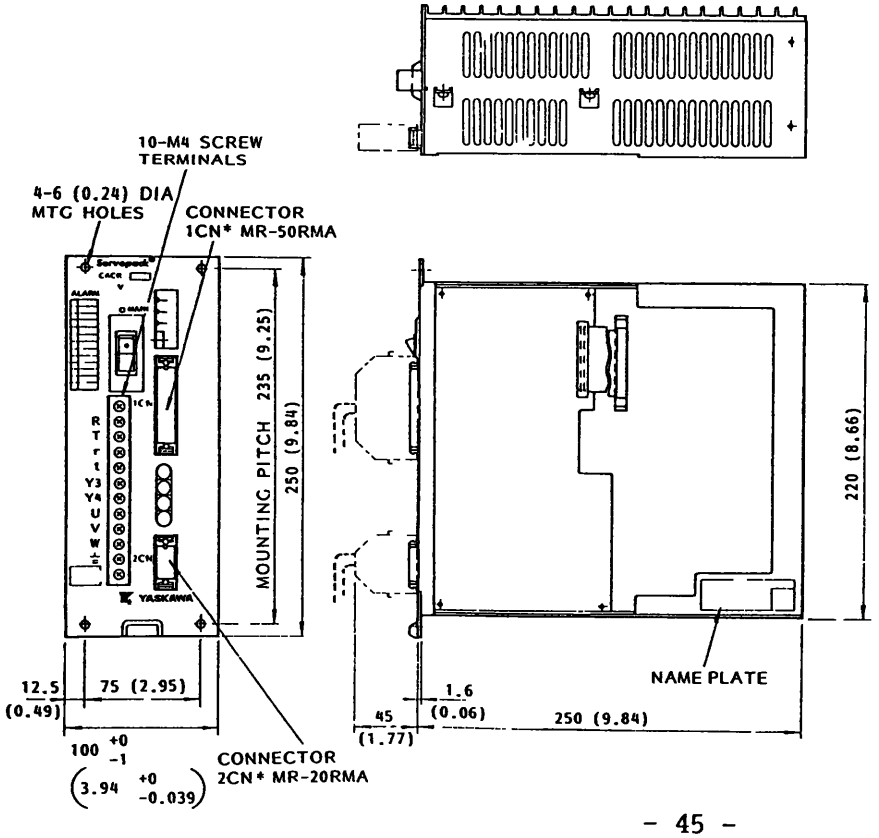


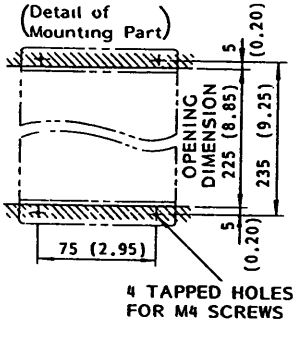


*Made by Honda Tushin Co Ltd

Connector Symbol	Attachments		
	Manufacturer	Receptacle Type	Case Type
1CN	Honda Tsushin Co Ltd	MR 50F	MR 50L
2CN		MR 20F	MR 20L

- TYPES CACR-PR02AC3⬚R, -PR03AC3⬚R (200V)
- TYPES CACR-PR01AC4⬚R, -PR02AC4⬚R (100V)



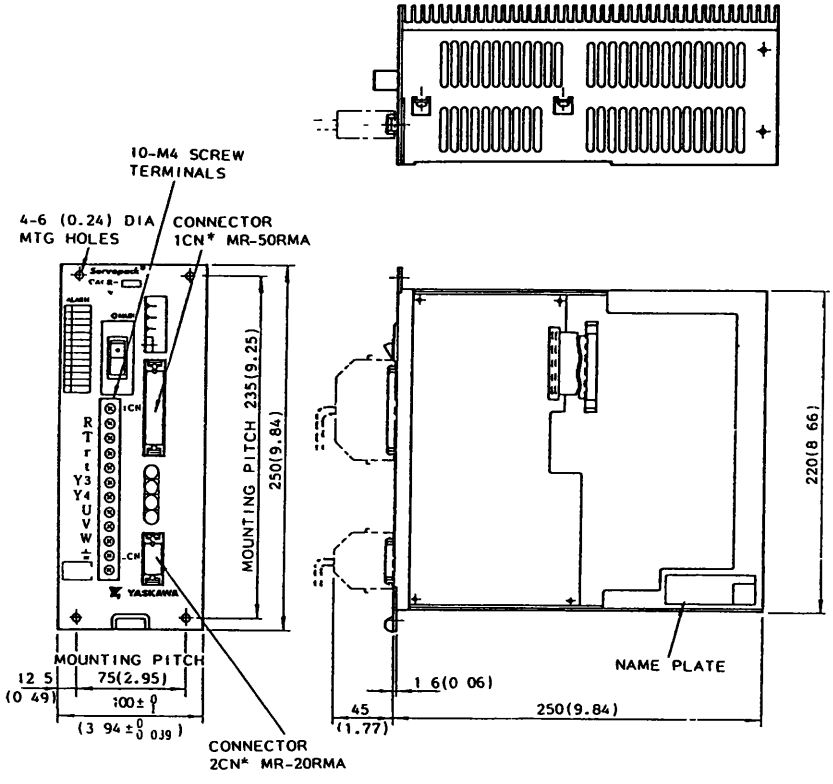


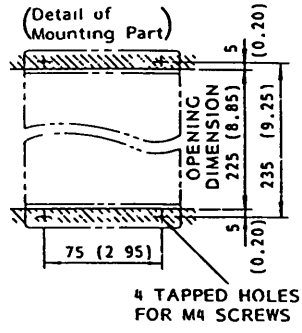
*Made by Honda Tushin Co Ltd

Connector Symbol	Attachments		
	Manufacturer	Receptacle Type	Case Type
1CN	Honda Tsushin Co Ltd	MR 50F	MR 50L
2CN		MR 20F	MR 20L

8.2 SERVOPACK DIMENSIONS in mm (inches)
(Cont'd)

- TYPE CACR-PR05AC3 ⬚ R (200V)
- TYPE CACR-PR03AC4 ⬚ R (100V)

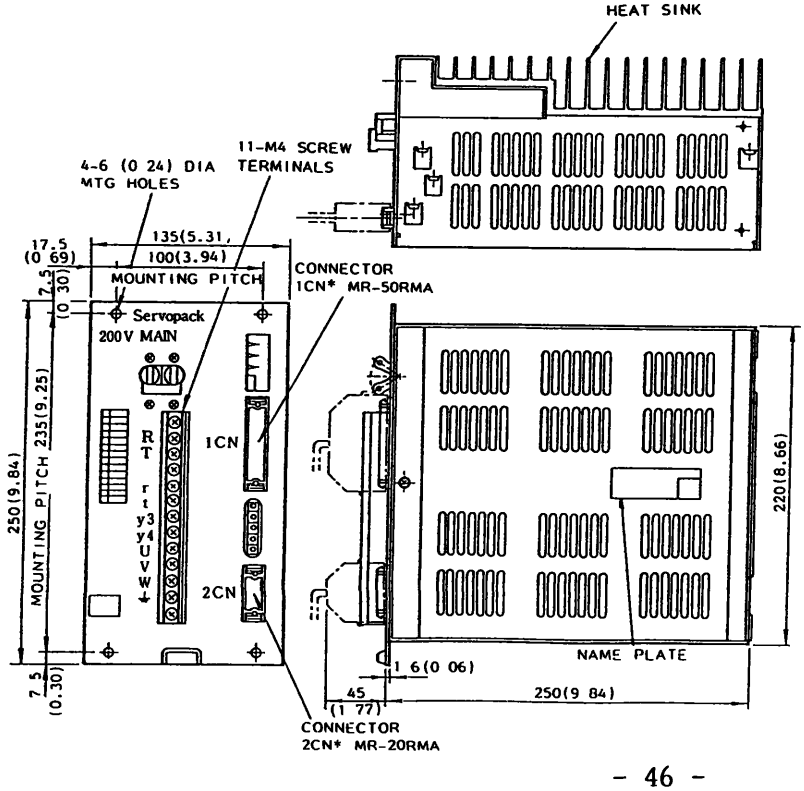


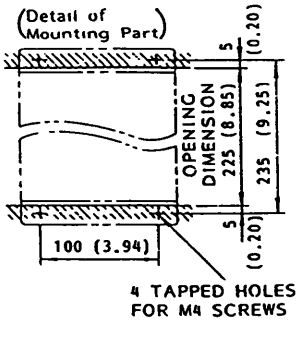


* Made by Honda Tushin Co Ltd

Connector Symbol	Attachments		
	Manufacturer	Receptacle Type	Case Type
1CN	Honda Tsushin Co Ltd	MR 50F	MR 50L
2CN		MR 20F	MR 20L

- TYPE CACR-PR07AC3 ⬚ R (200V)
- TYPE CACR-PR05AC4 ⬚ R (100V)





* Made by Honda Tushin Co Ltd

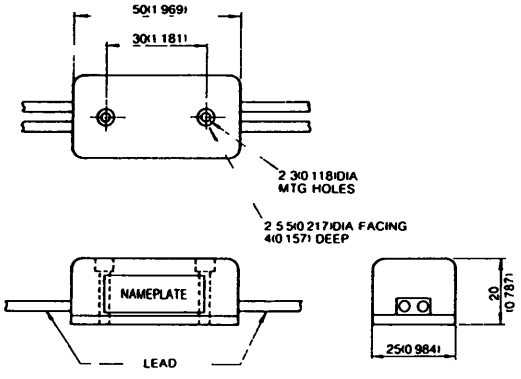
Connector Symbol	Attachments		
	Manufacturer	Receptacle Type	Case Type
1CN	Honda Tsushin Co Ltd	MR 50F	MR 50L
2CN		MR 20F	MR 20L

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)

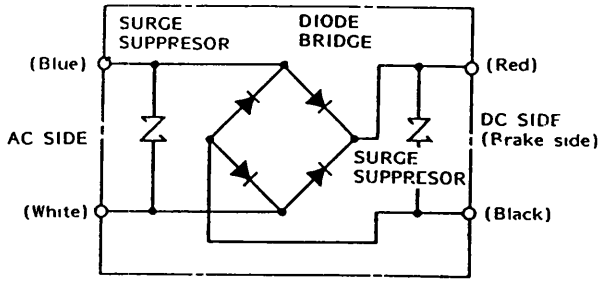


- Lead length: each 500 mm (19.69 inches)
- Lead color:

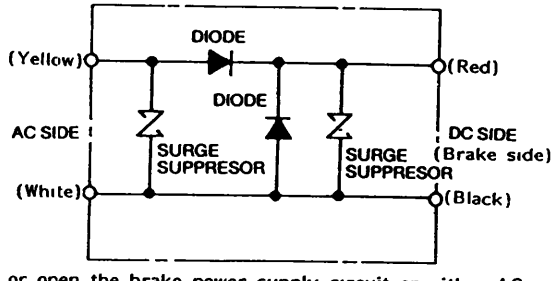
AC Input Side		Brake Side
100V	200V	
Blue White	Yellow White	Red Black

- 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.

9.2 TEST RUN PROCEDURES

9 2 1 Preparation of Operation

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. 9.1, 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.

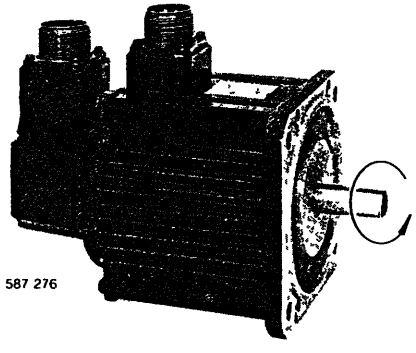


Fig 9 1 Motor Forward Running

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 ovreload

10. ADJUSTMENT

10.1 SETTINGS AT THE TIME OF DELIVERY

The SERVOPACK has been factory-adjusted as follows:

Table 10 1 Standard Adjustment and Setting 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 Pulse Frequency Dividing Ratio	PG Multiplier	Pulse Resolution per Motor Revolution	f/V Output r/min	Start Current Setting A(Arms)
PRA5AC3ER	A5CE2	1500	0.7	Sign + pulse train, (Voltage level +12V)	75	3000	×1	×1	1500	2V/1000	3.0 (2.1)
PRA5AC3FR	A5CF2	1000			60				1000		
PR01AC3ER	01CE2	1500	1.0		75				1500		4.0 (2.8)
PR01AC3FR	01CF2	1000			60				1000		
PR02AC3ER	02CE2	1500	2.0		75				1500		8.1 (5.7)
PR02AC3FR	02CF2	1000			60				1000		
PR03AC3ER	03CE2	1500	2.7		75				1500		11.0 (7.8)
PR03AC3FR	03CF2	1000			60				1000		
PR05AC3ER	05CE2	1500	3.6		75				1500		15.0 (10.6)
PR05AC3FR	05CF2	1000			60				1000		
PR07AC3ER	07CE2	1500	5.7		75				1500		16.3 (23.0)
PR07AC3FR	07CF2	1000			60				1000		
PRA5AC4ER	A5DE2	1500	1.2		75				1500		5.1 (3.6)
PRA5AC4FR	A5DF2	1000			60				1000		
PR01AC4ER	01DE2	1500	1.7		75				1500		7.1 (5.0)
PR01AC4FR	01DF2	1000			60				1000		
PR02AC4ER	02DE2	1500	2.9		75				1500		12.0 (8.5)
PR02AC4FR	02DF2	1000			60				1000		
PR03AC4ER	03DE2	1500	3.6		75				1500		15.0 (10.6)
PR03AC4FR	03DF2	1000			60				1000		
PR05AC4ER	05DE2	1500	5.5		75				1500		16.3 (23.0)
PR05AC4FR	05DF2	1000			60				1000		

* Effective value.

Notes.

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.

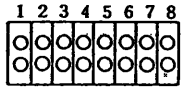
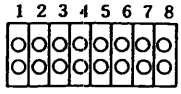
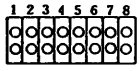
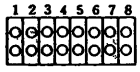
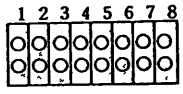
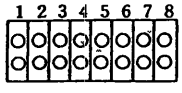
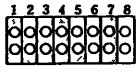
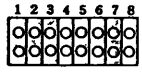
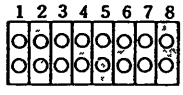
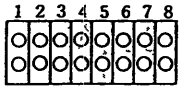
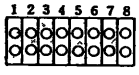
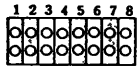
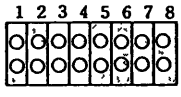
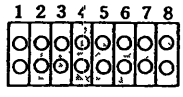
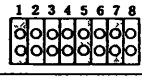
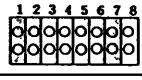
$$\text{Reference pulse frequency (pps)} = \frac{\text{Motor speed (r/min)}}{60} \times \text{pulse resolution}$$

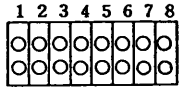
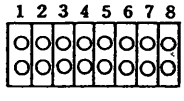
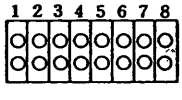
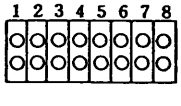
3. The PG pulse output from the SERVOPACK is the number of pulses generated from the optical encoder multiplied by the PG dividing ratio.

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

10.1 SETTINGS AT THE TIME OF DELIVERY (Cont'd)

Table 10 2 Standard Factory-adjusted Switch Settings

SERVOPACK Class V	SERVOPACK Rated Output W (HP)	SERVOPACK Type CACR-	SW1	SW2	SW3
200	50 (0.07)	PRA5AC3ER			
	100 (0.13)	PR01AC3ER			
	500 (0.67)	PR05AC3ER			
	700 (0.93)	PR07AC3ER			
	200 (0.27)	PR02AC3ER			
	300 (0.40)	PR03AC3ER			
100	50 (0.07)	PRA5AC4ER			
	300 (0.40)	PR03AC4ER			
	500 (0.67)	PR05AC4ER			
	100 (0.13)	PR01AC4ER			
	200 (0.27)	PR02AC4ER			
200	50 (0.07)	PRA5AC3FR			
	100 (0.13)	PR01AC3FR			
	500 (0.67)	PR05AC3FR			
	700 (0.93)	PR07AC3FR			
	200 (0.27)	PR02AC3FR			
	300 (0.40)	PR03AC3FR			
100	50 (0.07)	PRA5AC4FR			
	300 (0.40)	PR03AC4FR			
	500 (0.67)	PR05AC4FR			
	100 (0.13)	PR01AC4FR			
	200 (0.27)	PR02AC4FR			

SERVOPACK Class V	SERVOPACK Rated Output W (HP)	SERVOPACK Type CACR-	SW9	SEL1	SEL2
200	50 (0.07)	PRA5AC3ER			
	100 (0.13)	PR01AC3ER			
	200 (0.27)	PR02AC3ER			
	300 (0.40)	PR03AC3ER			
	500 (0.67)	PR05AC3ER			
	700 (0.93)	PR07AC3ER			
100	50 (0.07)	PRA5AC4ER			
	100 (0.13)	PR01AC4ER			
	200 (0.27)	PR02AC4ER			
	300 (0.40)	PR03AC4ER			
	500 (0.67)	PR05AC4ER			
200	50 (0.07)	PRA5AC3FR			
	100 (0.13)	PR01AC3FR			
	200 (0.27)	PR02AC3FR			
	300 (0.40)	PR03AC3FR			
	500 (0.67)	PR05AC3FR			
	700 (0.93)	PR07AC3FR			
100	50 (0.07)	PRA5AC4FR			
	100 (0.13)	PR01AC4FR			
	200 (0.27)	PR02AC4FR			
	300 (0.40)	PR03AC4FR			
	500 (0.67)	PR05AC4FR			

[oo]: Short-circuited [oo]: Open

Note: See Table 10.7 for other functions.

Table 10 3 Standard Factory-adjusted Setting of Rotary Switch

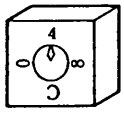
SERVOPACK			SW5 Kp	SW4 Kv	SW7 I-GAIN	SW6 CUR/BIAS	SW8
Class V	Rated Output W (HP)	Type CACR-	Position Loop Gain	Speed Loop Gain	Integration Constant	Current Limit	–
200	50 (0.07)	PRA5AC3[ ]R	6	4	4	F	0 (Frequency dividing ratio = 1/1)
	100 (0.13)	PR01AC3[ ]R					
	200 (0.27)	PR02AC3[ ]R	2	3	8		
	300 (0.40)	PR03AC3[ ]R					
	500 (0.67)	PR05AC3[ ]R					
	700 (0.93)	PR07AC3[ ]R					
100	50 (0.07)	PRA5AC4[ ]R	6	4	4		
	100 (0.13)	PR01AC4[ ]R	2	3	8		
	200 (0.27)	PR02AC4[ ]R					
	300 (0.40)	PR03AC4[ ]R					
	500 (0.67)	PR05AC4[ ]R					

Notes

1. The table above shows approximate scale of rotary switch.

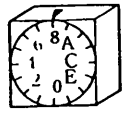
〈Example〉

· SW4 to SW7



indicates scale 4.

· SW8



indicates scale 8.

2. The digital switches other than listed in the table above are provided for the SERVOPACK Do not tamper with these digital switches except in exceptional cases as they have been preset at the factory.

10. 2 CHARACTERISTICS AT THE TIME OF DELIVERY

The SERVOPACK has been adjusted prior to shipping as follows.

(a) Speed reference input and servomotor speed ratio (Fig. 10.1)

· No load
· Continuous pulses

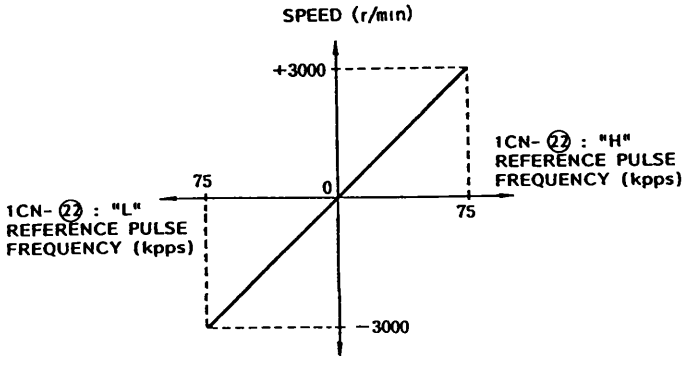


Fig 10. 1 Reference Input Frequency and Motor Speed Characteristics

(b) Start-stop response characteristics

• Load $J_L = J_M$

• No load $t_2 \fallingdotseq 3 \times t_1$

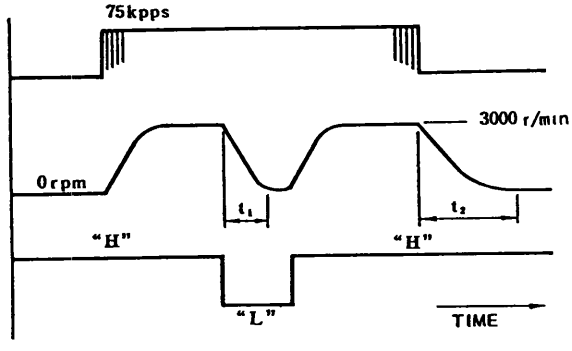


Fig 10 2 Start-stop Response Characteristics

10. 3 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.10.4.

10. 4 ADJUSTMENT PROCEDURES

Fig. 10.3 shows the arrangement of rotary switches, potentiometers, and terminals for checking waveforms; Table 10.4 shows potentiometer adjustment; and Table 10.5 lists check terminals and functions.

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

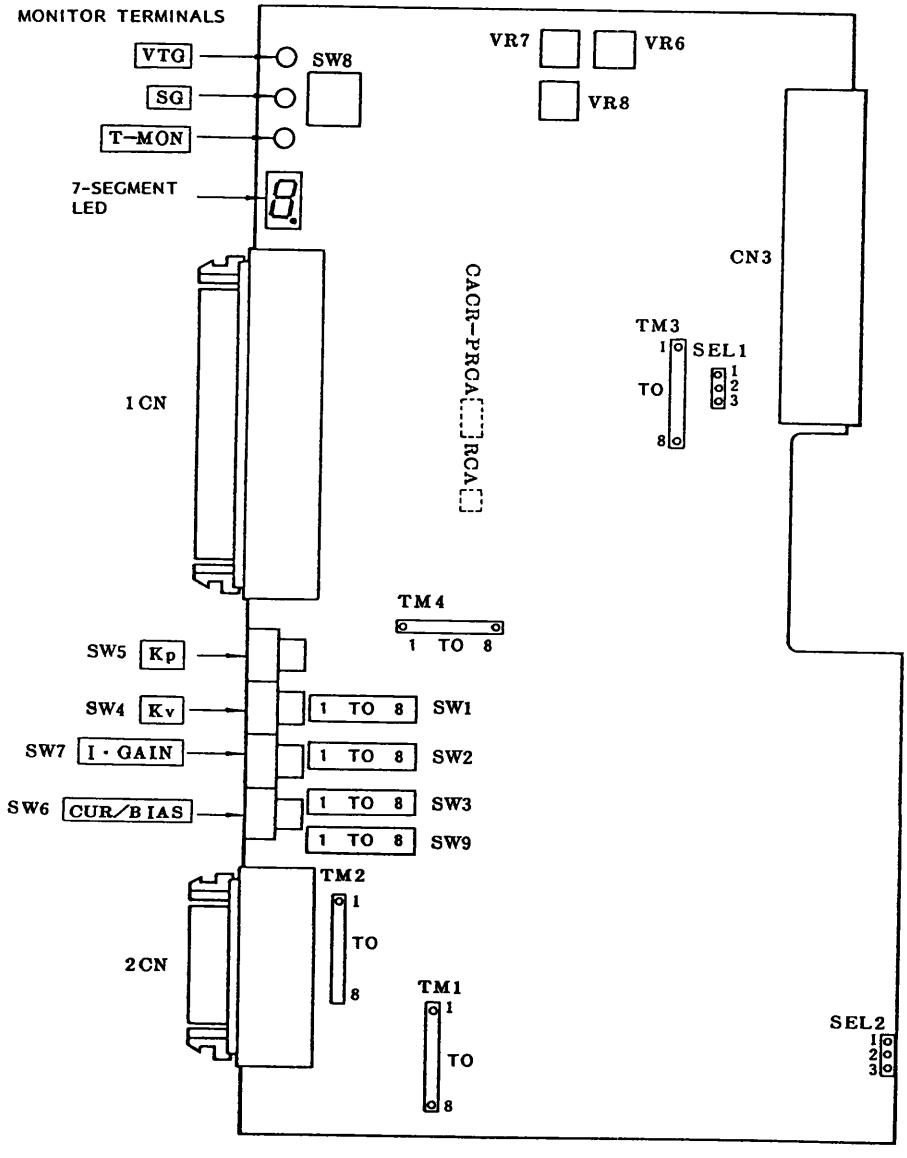


Fig 10 3 Printed Circuit Board Type CACR-PRCA RCA

Table 10.4 Contents of Setting Rotary Switch (Normal Mode Setting)

Digital Switch	Scale	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	Remarks
Kp Position loop Gain	×1	40	48	56	64	72	80	88	96	104	112	120	128	144	160	176	200	The selection of ×1 to ×1/8 depends on the setting of SW1-⑦ and -⑧.
	×1/2	20	24	28	32	36	40	44	48	52	56	60	64	72	80	88	100	
	×1/4	10	12	14	16	18	20	22	24	26	28	30	32	36	40	44	50	
	×1/8	5	6	7	8	9	10	11	12	13	14	15	16	18	20	22	25	
Kv Speed loop Gain	×1	1.0	1.5	2.0	2.5	3.0	3.5	4.5	5.5	6.5	8.0	10.0	12.5	15.5	19.5	24	30	
	×4	4.0	6.0	8.0	10	12	14	18	22	26	32	40	50	62	78	96	120	
I·GAIN	Integration Constant	∞	256	171	128	85.3	64	46.5	32	22.3	16	11.4	8	5.7	4	2.8	2	(ms)
CUR/BIAS (Current limit) for 200V	CACR-PRA3AC3[ ]R	1.0A 99%	1.1A 112%	1.3A 125%	1.4A 138%	1.5A 152%	1.7A 165%	1.8A 178%	1.9A 191%	2.0A 204%	2.2A 218%	2.3A 231%	2.4A 244%	2.6A 257%	2.7A 271%	2.8A 284%	3.0A 296%	• The selection of Current limit, Bias and Feedforward depends on the setting of SW1-④ and -⑤
	CACR-PR01AC3[ ]R	1.3A 94%	1.5A 106%	1.7A 119%	1.9A 131%	2.0A 143%	2.2A 156%	2.4A 168%	2.6A 181%	2.7A 193%	2.9A 205%	3.1A 218%	3.3A 230%	3.4A 243%	3.6A 255%	3.8A 267%	4.0A 280%	
	CACR-PR02AC3[ ]R	2.7A 95%	3.0A 107%	3.4A 120%	3.8A 133%	4.1A 145%	4.5A 158%	4.8A 171%	5.2A 183%	5.6A 196%	5.9A 209%	6.3A 221%	6.6A 234%	7.0A 247%	7.3A 260%	7.7A 272%	8.1A 285%	
	CACR-PR03AC3[ ]R	3.7A 96%	4.2A 109%	4.7A 122%	5.2A 134%	5.6A 147%	6.1A 160%	6.6A 173%	7.1A 186%	7.6A 199%	8.1A 212%	8.6A 225%	9.1A 237%	9.6A 250%	10.1A 263%	10.5A 276%	11.0A 289%	
	CACR-PR05AC3[ ]R	5.0A 98%	5.7A 111%	6.3A 124%	7.0A 137%	7.7A 150%	8.3A 163%	9.0A 176%	9.7A 189%	10.3A 203%	11.0A 216%	11.7A 229%	12.3A 242%	13.0A 255%	13.7A 268%	14.3A 281%	15.0A 294%	
	CACR-PR07AC3[ ]R	7.7A 96%	8.7A 108%	9.7A 120%	10.7A 133%	11.8A 146%	12.8A 159%	13.8A 171%	14.8A 184%	15.8A 196%	16.9A 210%	17.9A 222%	18.9A 234%	19.9A 247%	21.0A 261%	22.0A 273%	23.0A 285%	
CUR/BIAS (Current limit) for 100V	CACR-PRA5AC4[ ]R	1.7A 100%	1.9A 113%	2.2A 126%	2.4A 140%	2.6A 153%	2.8A 167%	3.1A 180%	3.3A 193%	3.5A 207%	3.7A 220%	4.0A 233%	4.2A 247%	4.4A 260%	4.7A 273%	4.9A 287%	5.1A 300%	
	CACR-PR01AC4[ ]R	2.4A 98%	2.7A 111%	3.0A 124%	3.3A 137%	3.6A 150%	3.9A 163%	4.2A 176%	4.6A 189%	4.9A 202%	5.2A 216%	5.5A 229%	5.8A 242%	6.1A 255%	6.4A 268%	6.8A 281%	7.1A 294%	• Percent indicates values when the rated current of the motor used is 100%. The current value in the table is Ao-p value
	CACR-PR02AC4[ ]R	4.0A 97%	4.5A 110%	5.1A 123%	5.6A 136%	6.1A 149%	6.7A 162%	7.2A 175%	7.7A 188%	8.3A 202%	8.8A 215%	9.4A 228%	9.9A 241%	10.4A 254%	11.0A 267%	11.5A 280%	12.0A 293%	
	CACR-PR03AC4[ ]R	5.0A 98%	5.7A 111%	6.3A 124%	7.0A 137%	7.7A 150%	8.3A 163%	9.0A 176%	9.7A 189%	10.3A 203%	11.0A 216%	11.7A 229%	12.3A 242%	13.0A 255%	13.7A 268%	14.3A 281%	15.0A 294%	
	CACR-PR05AC4[ ]R	7.7A 99%	8.7A 112%	9.7A 125%	10.7A 138%	11.8A 152%	12.8A 165%	13.8A 177%	14.8A 190%	15.8A 203%	16.9A 217%	17.9A 230%	18.9A 243%	19.9A 256%	21.0A 270%	22.0A 283%	23.0A 296%	
	BIAS*	0	10	15	20	30	40	60	80	100	150	200	250	300	350	400	450	(rpm)
	Feedforward*	0	10	20	30	40	50	55	60	65	70	75	80	85	90	95	100	(%)

Remarks – Kp:

SW1	×1	×1/2	×1/4	×1/8
⑦	○	×	○	×
⑧	○	○	×	×

○: Short-circuited × Open

Remarks – Kv:

	×1	×4
SW1-⑥	○	×

○: Short-circuited × Open

Remarks – CUR/BIAS:

SW1	Current Limit		Bias	Feed-forward
④	○	×	×	○
⑤	○	×	○	×

○: Short-circuited × Open

* If CUR/BIAS switch is set to Bias or Feedforward, current limit value is fixed at scale "F"

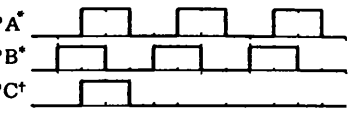
[shaded box] : Standard factory-adjusted switch setting

10.4 ADJUSTMENT PROCEDURES (Cont'd)

Table 10 5 Check Terminal Functions

Equipment Symbol		Signal Name	Description
TM1	1	PA	PG input signal: Phase A pulse input.
	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.

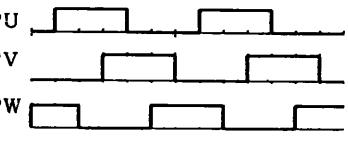
* Waveform at motor forward running.



* Two-phase pulse with 90° phase difference.
† One generation per motor turning. Synchronizing with PA.

Equipment Symbol		Signal Name	Description
TM2	1	PU	Phase U pulse input from pole sensor.
	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	DIR	Monitoring of setting for motor running direction switching.
	8	PG0V	Optical encoder (PG) power supply voltage: 0V (PG, common terminal of signal from pole sensor)

* Waveform at motor forward running.



Equipment Symbol		Signal Name	Description									
TM3	1	Uref	Phase U current reference	Servopack type	200V class					100V class			
	2	Vref	Phase V current reference		A5	01	02	03	05	A5	01	02	03
				Monitor Voltage (V/A)	0.39	0.52	1.05	1.44	1.96	0.67	0.92	1.57	1.96
	3	VTG	Motor speed monitoring: ±2.0VDC ±10%/100 r/min										
	4	Vref	Motor torque monitoring: ±3.0VDC ±10%/100% torque										
	5	Iu	Phase U current monitor	Servopack type	200V class						100V class				
	6	Iv	Phase V current monitor		A5	01	02	03	05	07	A5	01	02	03	05
				Monitor Voltage (V/A)	0.8		0.4	0.2			0.8	0.4	0.2		
	7	-	-												
	8	SG	Signal 0V												

Equipment Symbol		Signal Name	Description
TM4	1	PULS	Reference pulse input "PULS" (Connector 1CN-21) monitoring*
	2	SIGN	Reference pulse input "SIGN" (Connector 1CN-22) monitoring*
	3	INH	Reference pulse inhibit input "INH" (Connector 1CN-13) monitoring
	4	CL	Error counter clear signal "CL" (Connector 1CN-23) monitoring
	5	AUXA	Auxiliary reference pulse input "AUX-A" (1CN-11) monitoring †
	6	AUXB	Auxiliary reference pulse input "Aux-B" (1CN-12) monitoring†
	7	-	-
	8	SG	Signal 0V

Equipment Symbol		Signal Name	Description
TM101	1	+16V	Control power ±16V (16.1 V ± 0.1 V)
	2	-	-
	3	+15V	Control power +15V (±5%)
	4	PG5V	Optical encoder (PG) power +5V (5.25V ± 50mV)
	5	+5V	Control power +5V (±5%)
	6	-15V	Control power -15V (±5%)
	7	-	-
	8	SG	Signal 0V

Equipment Symbol		Signal Name	Description
TM102	1	Valm	Alarm detection voltage (6.385V ± 10mV)
	2	-	-
	3	Oalm	For observation of TM102-1.

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.
† Two-phase pulse with 90° phase difference.

Notes

1. The check terminals allow oscilloscope connection for measurment.
2. The waveform of TM3, TM4 and TM101 are measured normally by TM3 ⑧, TM4 ⑧, and TM101 ⑧ (signal 0V) are connected with respectively. TM2 ⑧ (PG power supply: 0 V) and TM3 ⑧, TM4 ⑧ and TM101 ⑧ (signal 0 V) are connected with impedance.
3. During measurment, do not connect the adjacent two check terminals. If connected, the electronic parts may be damaged.
4. TM102 check terminal is for use only by the manufacturer. Do not make any measurment with it.

· Estimation of position loop gain (Kp)

For stepping input of reference pulses, the approximate value is obtained from the following formula. Motor, controller and machine specifications are shown in Table 10.6.

Table 10 6 Specifications of Motor, SERVOPACK and Machine

Motor		SERVOPACK		Machine	
Rated Speed (N)	r/min	Starting Current (Ip)	A	Torque at Motor Shaft (T_L)	N · m (lb · in)
Rated Motor Torque (T_R)	N·m (lb·in)	Adjust Ip according to machine specifications.		Load Ineatia at Motor Shaft (GD^2_L)	kg · m² (lb · m²)
Rotor Inertia (GD^2_R)	kg·m² (lb·in²)			—	
Rated Motor Current (Ia)	A				

(a) Motor starting time

$$ta = 10.48 \times \frac{(J_M + J_I) \times N}{I_P / I_a \times T_M - T_L} \quad (s)$$

(b) Position loop gain

$$K_P \approx \frac{1.4}{ta} \quad [s^{-1}]$$

(c) No. of lag pulses in error counter

$$\varepsilon = \frac{fin}{K_P} \quad (Pulses)$$

fin . Reference pulse frequency (pps)

10. 5 ROTARY SWITCH ADJUSTMENT

Digital switches should be adjusted with servomotor and driven machine combined.

(1) CUR/BIAS

By setting of SW1- ④ and ⑤, either Current limit, Bias or Feedforward compensation is selected.

		Current Limit		Bias	Feedforward Compensation
SW1	④	○	×	×	○
	⑤	○	×	○	×

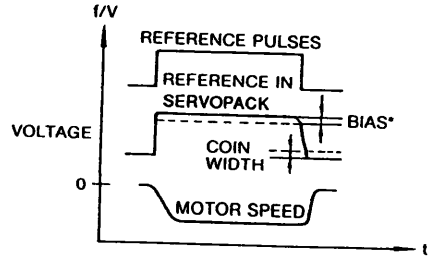
○: Short-circuited ×: Open

(a) Current limit .... Check terminal: TM3-5 and -6

The maximum current of the Servopack is adjusted.

(b) Bias setting .... Check terminal: Monitor VTG

The motor must not vibrate or oscillate. The bias is used according to the load conditions to shorten the positioning time. This is used to shorten the positioning time when Kp cannot be increased (Fig. 10.4).



* Amount for 0 to 450 r/min can be set. When the frequency dividing ratio is 1/1 and multiplication factor is 1, 450 r/min is 11.25 kpps equivalent at PG = 1500 pulses/rev. (setting value: Table 10.4)

Fig 10 4 Bias Setting

10. 5 ROTARY SWITCH ADJUSTMENT (Cont'd)

(c) Feedforward compensation

The positioning time is shortened by differential calculation of the reference pulse and adding it to the reference pulse. The variable feedforward compensation is 0 to 100%.

If the load is small, it may cause overshoot or undershoot. Do not use this setting if overshoot and undershoot are to be avoided.

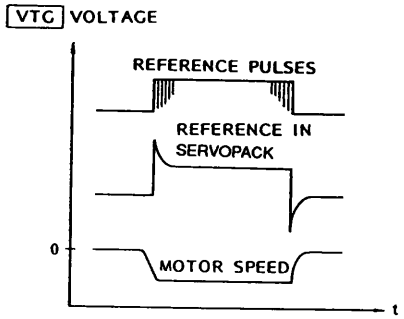


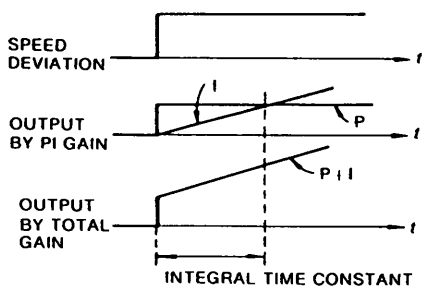
Fig 10 5 Feed Forward Compensation

(2) I-GAIN (Integral time constant):

Check locations — Motor movement (the motor should not cause vibration or oscillation.)

Adjust I-GAIN of the speed loop. When speed deviations are applied in steps, the proportional gain becomes equal to the integral gain after this integral time constant.

The sum of the proportional gain and the integral gain is the total gain. The output by the total gain is proportional to the current reference.



Note If the integral time is shortened oscillation occurs It is recommended not to change the condition (10 ms or more) preset at the factory

Fig 10 6 Integral Gain

(3) Kv (Speed loop gain):

Check terminal — Monitor VTG (the motor should not cause vibration or oscillation.)

Adjust the loop gain of the speed loop. Assuming the speed deviation to be ε , the relationship between the speed loop gain and the integral gain is defined by the following formula which becomes proportional to the current reference:

$$Kv\left[\varepsilon_v + \int \frac{\varepsilon_v}{Ti}\, dt\right]$$

Ti: Integral time constant

NOTE

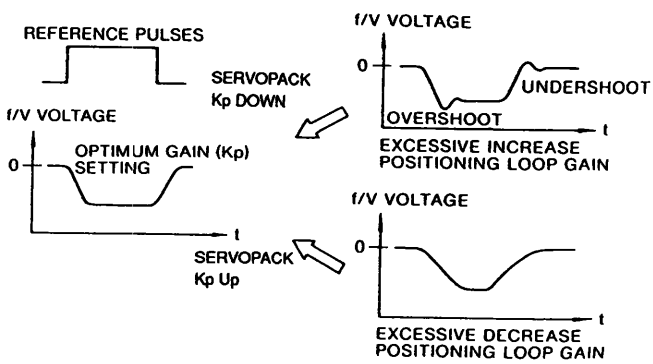
If the rigidity of the mechanical system is poor, Kv cannot be increased. If Kv is increased, oscillation occurs. Adjust the Kv when the $\overline{CL}$ is turned on and the position error counter is cleared to 0, then the effect of the position loop gain Kp can be removed.

(4) Kp (Position loop gain):

Check terminal — Monitor VTG (the motor should not cause overshoot, undershoot, or oscillation.)

Adjust the loop gain of the position loop, after the speed loop has been adjusted. Input the maximum pulse frequency while observing the speed monitoring f/V output with an oscilloscope. The optimum Kp value is at the point and undershoot disappear.

If a relatively high Kp value is needed while overshoot and undershoot are undesirable, then gradually speed up and slow down the pulse frequency (Fig. 10.8).

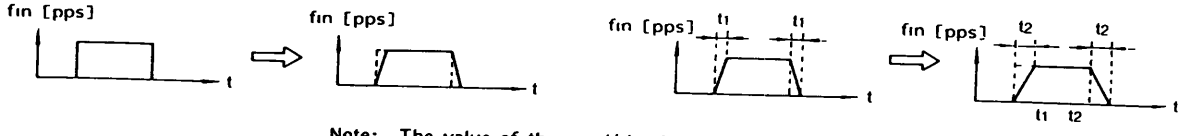


Note If Kp is increased too much the overshoot and/or undershoot becomes too large It may even oscillate without commands

Fig 10 7 Positioning Loop Gain Adjustment

① Accel/decel speed control is performed on the reference pulse train input, and the mode is set at lamp input.

② When it is currently lamp input, prolong the accel/decel time.



Note: The value of the accel/decel time t_{SL} must exceed the value of t_a calculated in Table 10.6 (a).
$t_{SL} \geq t_a$

Fig 10 8 Speed Up and Slow Down of Reference Pulse

10.6 SWITCH SETTING

The six switches (SW1 , SW2 , SW3 , SW9 , SEL1 , SEL2) and hexadecimal digital switch SW8 , have the following functions:

Table 10 7 Switch Setting and Functions

□: Standard factory-adjusted switch setting
○: Short-circuited
×: Open

(a) SW1 Setting and Functions

Switch Name	Pin No.	Functions								
SW1	1	Output Multiplier setting	○	×1	×	×1	○	×2	×	×4
	2		○		○		×		×	
	3	OT(in 1CN) mode	○	DB operation			×	No DB operation		
	4	Function of digital switch CUR/BIAS	○	Current limit	×	Current limit	×	Bias setting	○	Feedforward compensation
	5		○		×		○		×	
	6	Kv setting	○	Standard value			×	Standard value ×4		
	7	Kp setting	○	×1.0	×	×0.5	○	×0.25	×	×0.125
	8		○		○		×		×	

(b) SW2 Setting and Functions

Switch Name	Pin No.	Functions									
SW2	1	Reference pulse form	×	SIGN + PULS	○	Phase A + B, ×1	○	Phase A + B, ×2	○	Phase A + B, ×4	×	CCW + CW
	2		○		○		○		×		○	
	3		○		○		×		○		×	
	4	Spare pin	○	-			×	-				
	5	Data D_0	Positioning completion width setting $= \left(\sum_{N=1}^{3} D_N\right) \times D_0$						○	$D_0 = 1$	×	$D_0 = 5$
	6	Data D_1							○	$D_1 = 1$	×	$D_1 = 0$
	7	Data D_2							○	$D_2 = 2$	×	$D_2 = 0$
	8	Data D_3							○	$D_3 = 4$	×	$D_3 = 0$

10.6 SWITCH SETTING (Cont'd)

(c) SW3 Setting and Functions

Switch Name	Pin No.	Functions				
SW3	1	Motor setting	○	8P-SIN 3000 r/min	User disable	
	2		○			
	3	PG pulse	○	1500 pulses/rev	×	1000 pulses/rev
	4*	Phase compensation	○	20°	×	10°
	5	Mode switch	○	Provided (200%)	×	Not provided
	6	Overflow alarm processing switch	○	Alarm	×	Servo alarm
	7	Monitor switching	○	TRQ-M	×	User disable
	8	CL operation time setting	○	Special (1.5 ms or more)	×	Normal (20 μs or more)

* Standard factory-adjusted switch setting varies according to the motor type.
○: 200 V (Type USAREM-A5, -01,-05,-07)·100 V (Type USAREM-A5, -03,-05)
×: 200 V (Type USAREM-02, -03)·100 V (Type USAREM-01, -2)

(d) SW9 Setting and Functions

Switch Name	Pin No.	Functions				
SW9	1	Test mode 1	○	Test mode (User use prohibit)	×	Normal operation
	2		○		×	
	3	EMF compensation	○	20%	×	5%
	4	Test mode 2	○	Speed control operation*	×	Normal operation
	5	Not used	×			
	6	Not used	×			
	7	Not used	×			
	8	Reserved	○			

* Used for checking of motor speed without position loop at test run. Operates at speed set by SW7 I·GAIN .

Motor Speed Setting with Short-circuited SW9-④																
I·GAIN Scalling	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Motor Speed (r/min)	0	64	32	16	8	4	2	0	0	2	4	8	16	32	64	0
Motor Running Direction	Stop	CW						Stop		CCW						Stop

(e) SEL Setting and Functions

[o]: Short-circuited [o]: Open
* Standard factory-adjusted switch setting

Switch Name	Contents	Setting	Function
SEL1	Reference pulse input and voltage level setting	1 2 3 [o][o][o]	+5V level TTL, Line driver
		1 2 3 [o][o][o] *	+12V, Open collector
SEL2	Logic of reference pulse input and positive/negative logic selection	1 2 3 [o][o][o]	"L" active
		1 2 3 [o][o][o]	"H" active

(f) SW8 (digital switch) Setting and Functions

□: Standard factory adjusted switch setting

SW8 Setting	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Frequency Dividing Ratio	1/1	1/2	1/3	1/4	1/5	1/6	1/10	1/12	1/15	1/20	1/30	2/3	2/5	–	–	–

10.7 ALTERATION OF INTERNAL SWITCHES

The setting of the internal switches of systems where Model CACR-PR□AC□R is applied must be changed.

Change the setting of the switches according to the order shown in Fig. 10.9.

<Switch setting order>

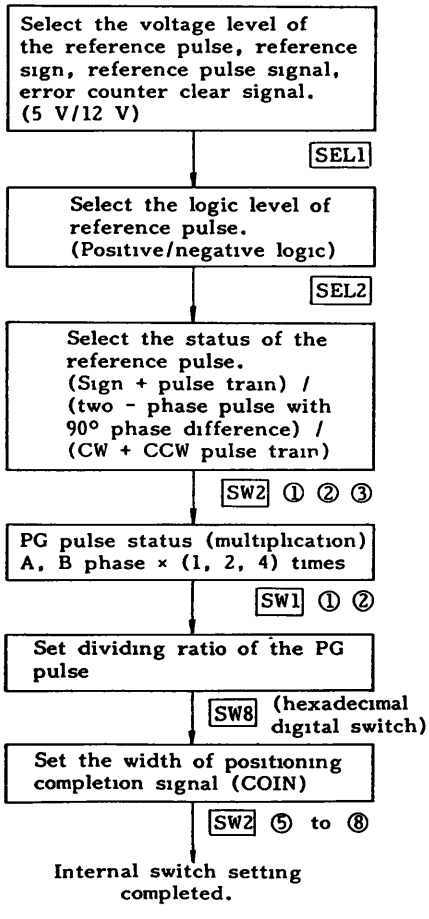


Fig 10 9 Order of Switch Setting

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 10MΩ by measuring with a 500V 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.

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 your 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 circu t 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 check panel and I/O terminals. The following charts show typical examples for trouble-shooting.

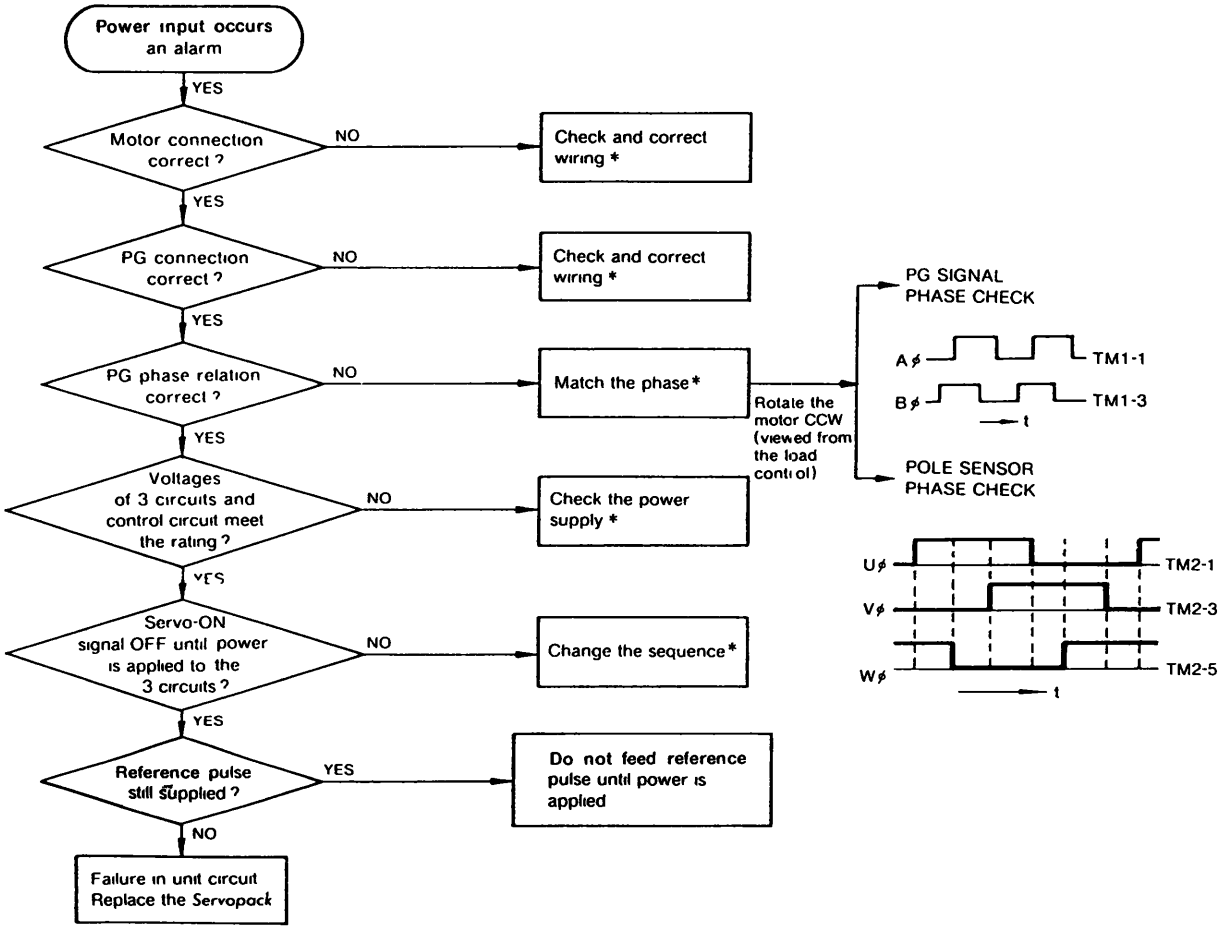
12 3 1 DC Power Supply

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%

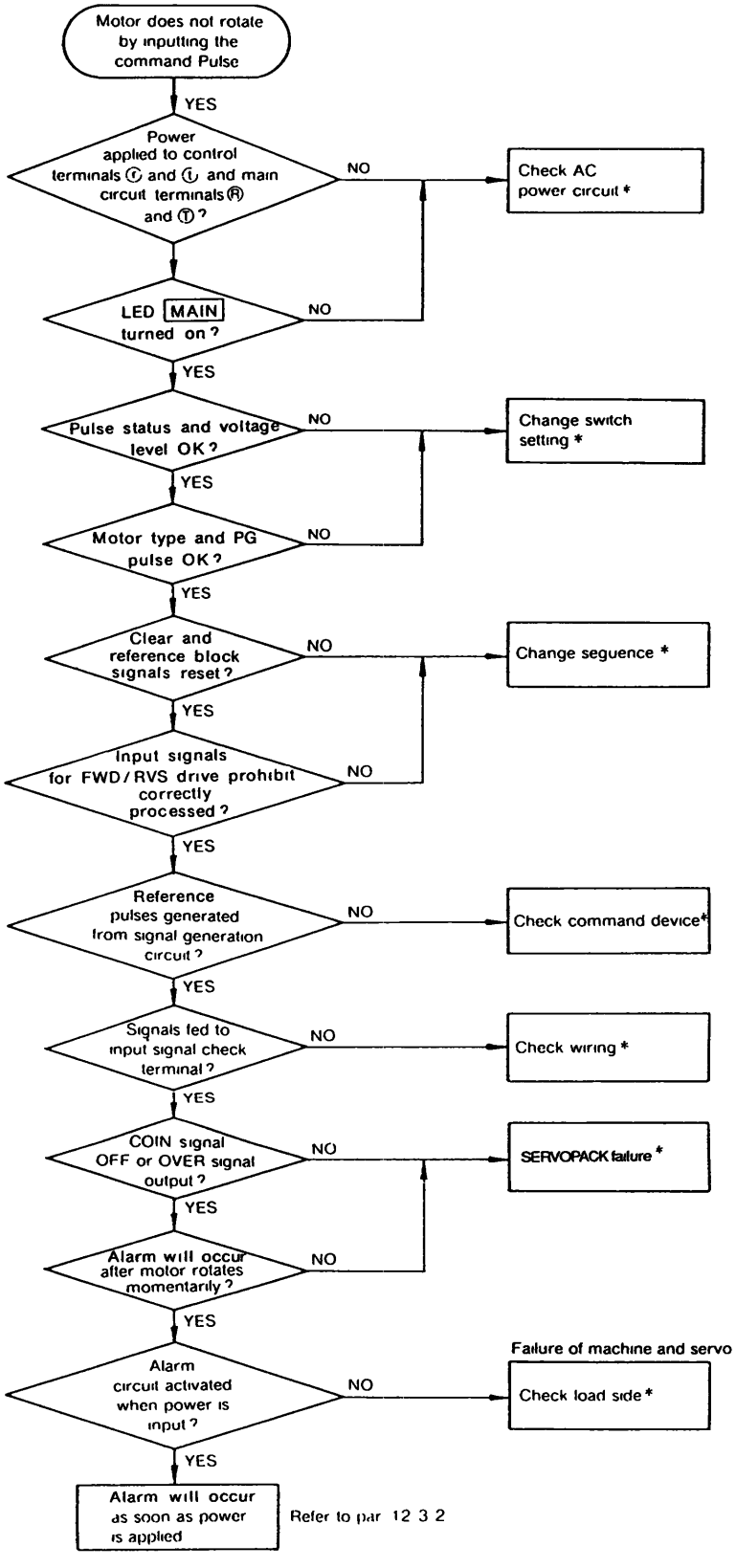
Control power voltage:
- For 200 VAC: 200 to 230 VAC, +10%, -15%
- For 100 VAC: 100 to 115 VAC, +10%, -15%

12. 3 2 Alarm Occurance at Power Input



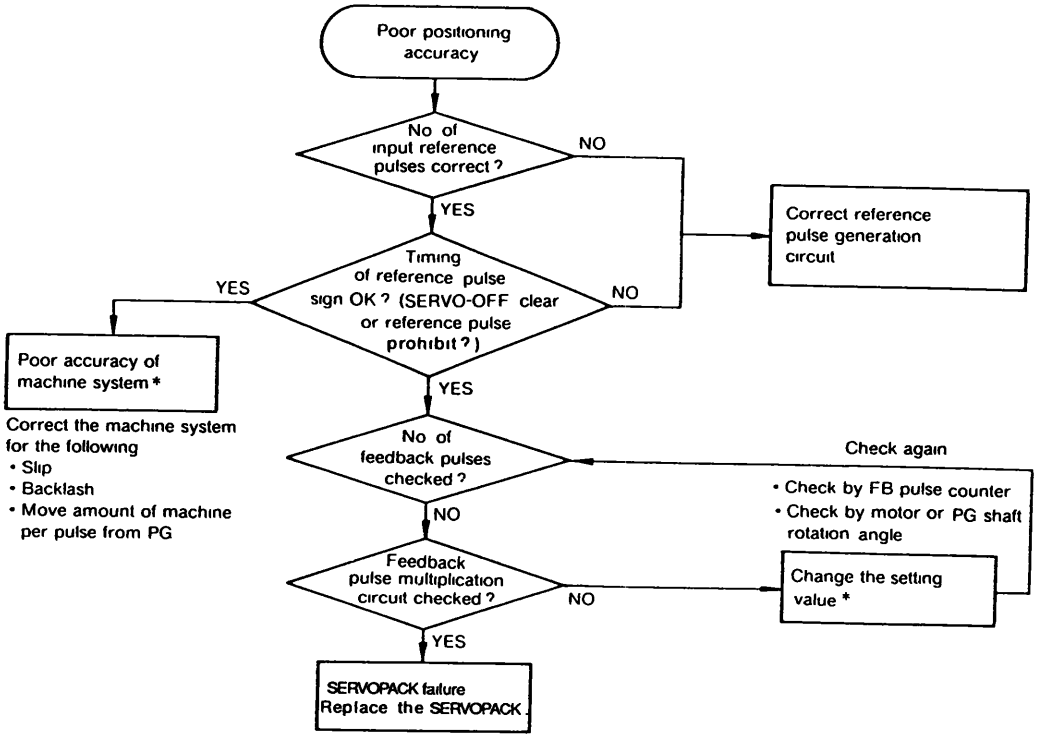
*If alarm does not go off, continue sequence

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 $= \frac{\text{Motor speed}}{60} \times$ 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 [Kp] If hunting, increase the speed loop gain [Kv] (Even if hunting occurs by increasing the speed loop gain positioning loop gain cannot be increased This is a limit of Servo performance)

AC Servo Drives

R SERIES FOR POSITIONING CONTROL

SERVOMOTOR : TYPE USAREM (With Optical Encoder)
SERVOPACK : TYPE CACR-PR□R (Rack-mounted Type)

TOKYO OFFICE Ohtemachi Bldg 1-6-1 Ohtemachi Chiyoda-ku, Tokyo, 100 Japan
Phone (03) 3284-9111 Telex YASKAWA J33530 Fax (03) 3284-9034
SEOUL OFFICE Seoul Center Bldg, 91-1, So Kong-Dong Chung-ku, Seoul, Korea
Phone (02) 776-7844 Fax (02) 753-2639
TAIPEI OFFICE Shen Hsiang Tang Sung Chiang Building 10F 146 Sung Chiang Road, Taipei, Taiwan
Phone (02) 563-0010, -7732 Fax (02) 567-4677
YASKAWA ELECTRIC AMERICA, INC SUBSIDIARY
Chicago-Corporate Headquarters 2942 MacArthur Blvd Northbrook, Illinois 60062-2028, U S A
Phone (708) 291-2340 Fax (708) 498-2430
Chicago-Technical Center 3160 MacArthur Blvd Northbrook, Illinois 60062-1917, U S A
Phone (708) 291-0411 Fax (708) 291-1028
Los Angeles Office 5626 Corporate Avenue Cypress, CA 90630, U S A
Phone (714) 828-9692 Telex (230) 678396 YASKAWAUS TSTN Fax (714) 828-1165
New Jersey Office Riverdale One, 44 Route 23 North, Suite 5 Riverdale, NJ 07457-1619
Phone (201) 835-9512 Fax (201) 835-9511
YASKAWA ELECTRIC EUROPE GmbH SUBSIDIARY
Niederhochstadter Straße 73, 61476 Kronberg-Oberhochstadt, Germany
Phone (06173) 938-0 Telex 415660 YASE D Fax (06173) 68421
YASKAWA ELÉTRICO DO BRASIL COMÉRCIO LTDA. SUBSIDIARY
Rua Conde Do Pinhal 8-5°, Andar Sala 51 CEP 01501-São Paulo-SP, Brasil
Phone (011) 35-1911 Fax (011) 37-7375
YASKAWA ELECTRIC (SINGAPORE) PTE LTD
CPF Bldg, 79 Robinson Road No 13-05, Singapore 0106
Phone 2217530 Telex (87) 24890 YASKAWA RS Fax (65) 224-5854

YASKAWA ELECTRIC CORPORATION

YASKAWA

TSE-S800-2 7F

588-123 587-276