Yaskawa USAREM-02AE2K
AC Servomotor

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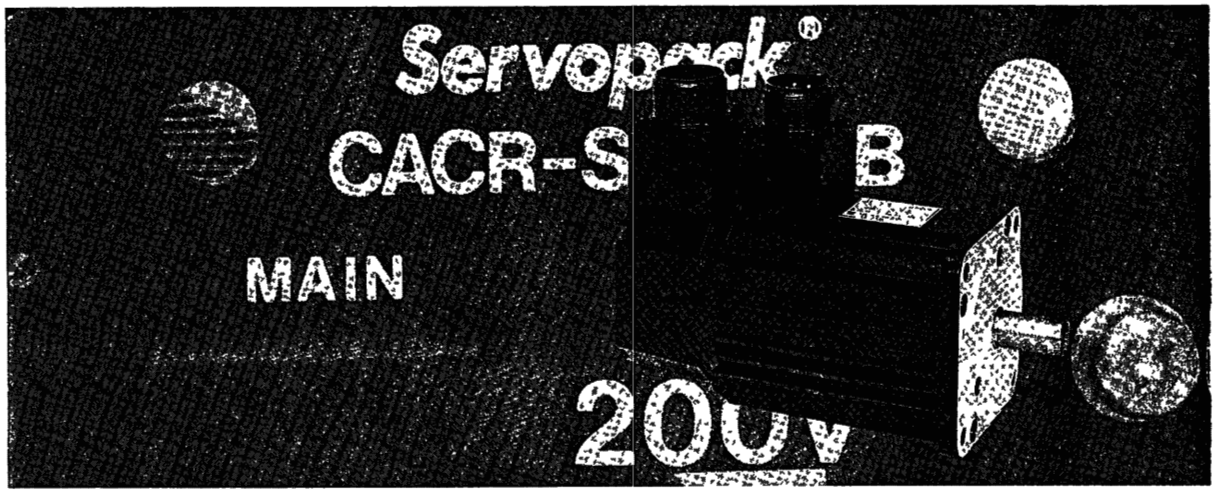
AC SERVO DRIVES

R SERIES FOR SPEED CONTROL

SERVOMOTOR TYPE USAREM (With Optical Encoder)
SERVOPACK TYPE CACR-SR□□R (Rack-Mounted Type)



YASKAWA

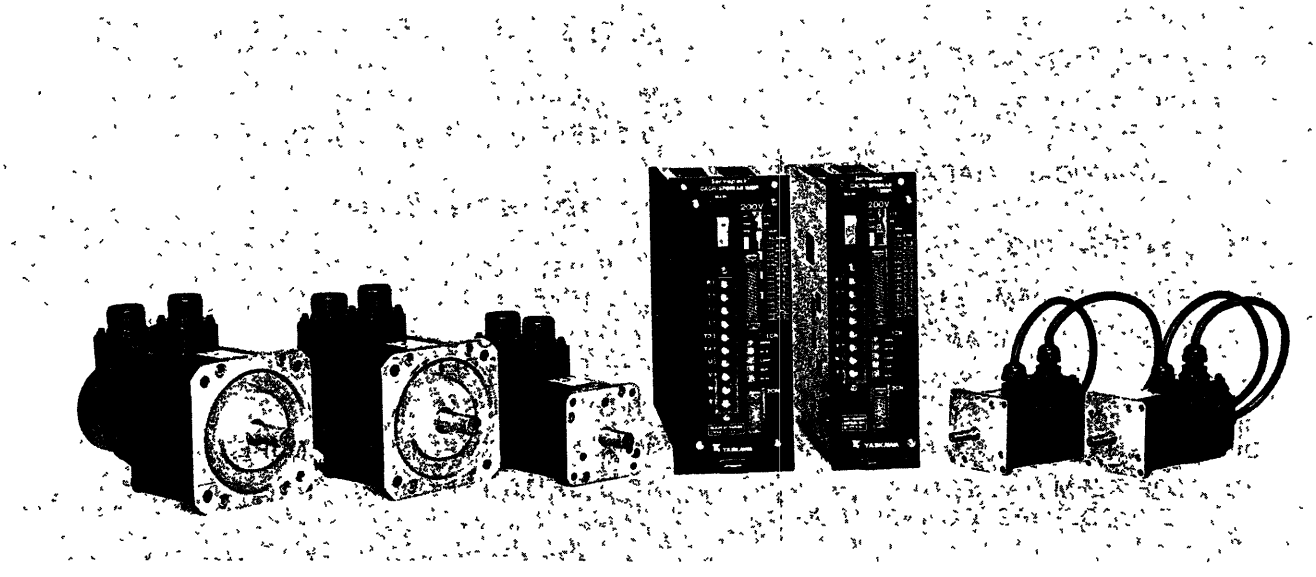
Yaskawa AC Servo Drives have been developed as basic mechatronics drives for the most advanced FA and FMS including robots and machine tools.

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 200V)

Item \ Motor Type USAREM-			-A5A□2	-01A□2	-02A□2	-03A□2	-05A□2	-07A□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)	0 182 (25 9)	0 367 (51 8)	0 733 (103 5)	1 1 (155 3)	1 82 (258.8)	2 56 (363 0)
Instantaneous Max Torque*		N·m (oz·in)	0 476 (67 5)	0 955 (135)	1 91 (270)	2 86 (405)	4 76 (675)	6 68 (948)
Rated Current*		A	0 99	1 36	2 75	3 70	5 29	5 29
Rated Speed*		r/min	3000					
Max Speed*		r/min	4500					
Torque Constant		N·m/A (oz·in/A)	0 17 (24 0)	0 247 (35 0)	0 243 (34 4)	0 271 (38 5)	0 319 (45 3)	0 457 (60 4)
Inertia	J	$kg \cdot m^2 \times 10^{-6}$ ($oz \cdot in \cdot s^2 \times 10^{-3}$)	7 64 (1 08)	12 5 (1 78)	50 7 (7 18)	76 6 (10 9)	272 (38 6)	372 (52 8)
Power Rating*		kW/s	3.30	8.09	8.01	11 9	9 26	13 3
Inertia Time Constant		ms	5 0	3 7	3.6	3 1	3.6	3 4
Inductive Time Constant		ms	1 2	1 5	3 8	4 2	8 7	9.9

* Values when SERVOMOTOR is combined with SERVOPACK and the armature winding temperature is 75°C
Other values at 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 (2) on page 38

3 The table above shows the data when an aluminum plate (heat sink) 250 mm × 250 mm × 6 mm (9 84 in × 9 84 in × 0 24 in) is mounted as a cooling agent

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

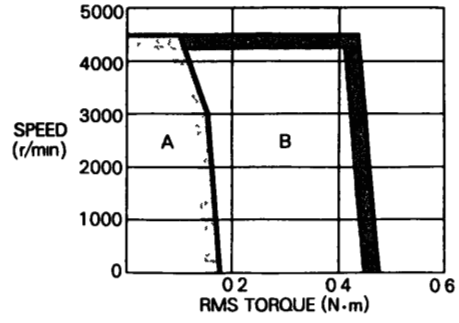
(2) Torque-Speed Characteristics

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

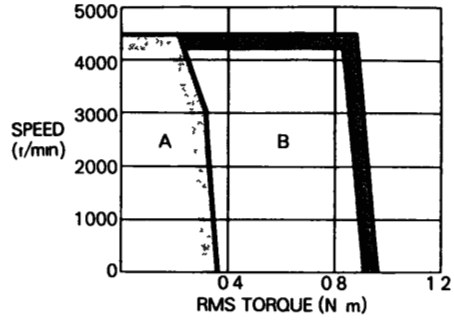
If 200 VAC or below, the output characteristics may be decreased even if the data is within allowable variation.

■ r/min-N·m

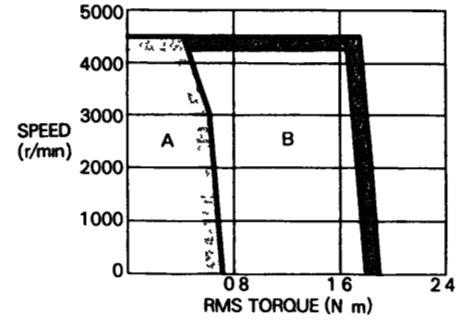
Type USAREM-A5A



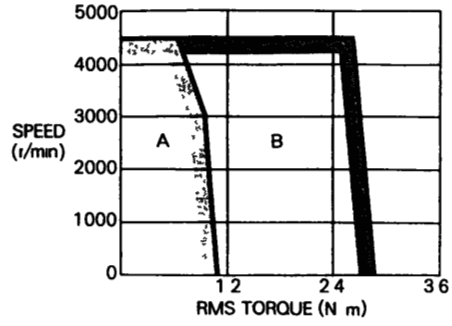
Type USAREM-01A



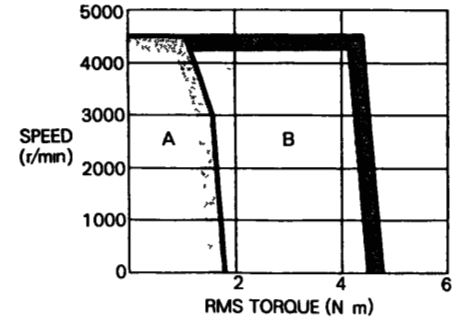
Type USAREM-02A



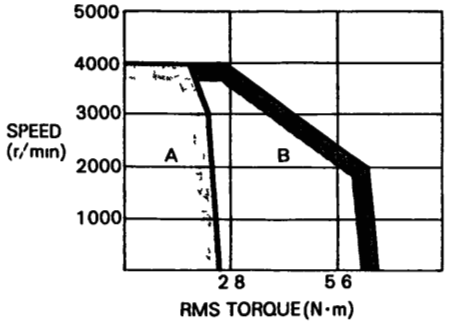
Type USAREM-03A



Type USAREM-05A



Type USAREM-07A

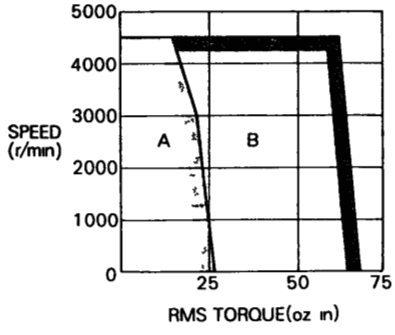


A : Continuous Duty Zone

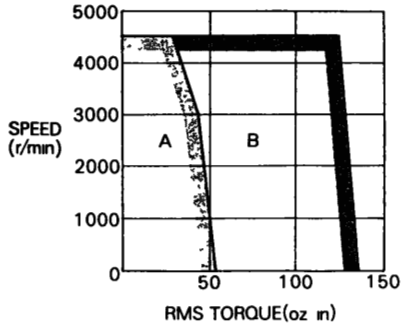
■ : Intermittent Duty Zone

■ r/min-oz·in

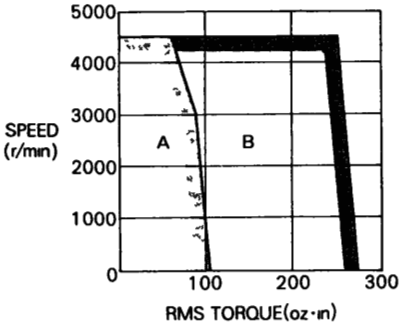
Type USAREM-A5A



Type USAREM-01A



Type USAREM-02A



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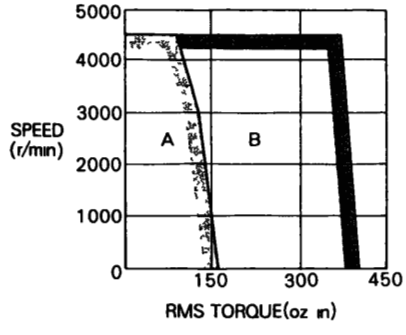

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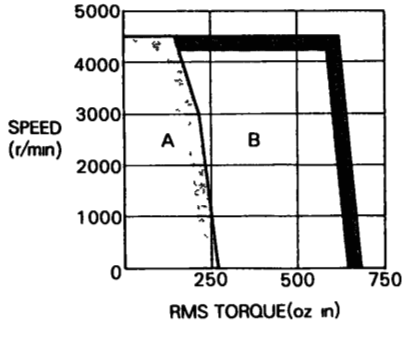
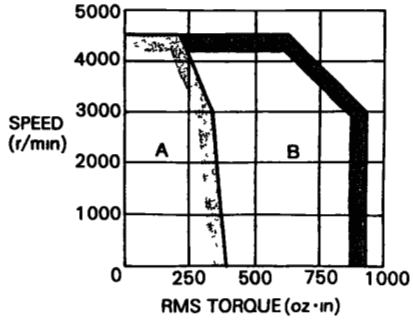


Type USAREM-07A



A : Continuous Duty Zone

■ : Intermittent Duty Zone

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

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 100V)

Item \ Motor Type USAREM-			-A5B□2	-01B□2	-02B□2	-03B□2
Rated Output*		W (HP)	50 (0 07)	100 (0 13)	200 (0 27)	300 (0 40)
Rated Torque*		N·m (oz·in)	0 159 (22 5)	0 318 (45)	0 637 (90)	0 955 (135)
Continuous Max Torque*		N·m (oz·in)	0 182 (25 9)	0 357 (51 8)	0 733 (103 5)	1 1 (155 3)
Instantaneous Max Torque*		N·m (oz·in)	0 476 (67 5)	0 955 (135)	1 91 (270)	2 86 (405)
Rated Current*		A	1 7	2 4	4 1	5 0
Rated Speed*		r/min	3000			
Max Speed*		r/min	4000			
Torque Constant		N·m/A (oz·in/A)	0 10 (14 2)	0 143 (20 3)	0 169 (23 9)	0 205 (29 0)
Inertia	J	$kg \cdot m^2 \times 10^{-6}$ ($oz \cdot in \cdot s^2 \times 10^{-3}$)	7 64 (1 08)	12 5 (1 78)	50 7 (7 18)	76 6 (10 9)
Power Rating*		kW/s	3 30	8 09	8 01	11 9
Inertia Time Constant		ms	4 7	3 6	3 6	3 0
Inductive Time Constant		ms	1 3	1 6	3 9	4 3

*Values when SERVOMOTOR is combined with SERVOPACK and the armature winding temperature is 75°C
Other values at 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 (2) on page 38

3 The table above shows the data when an aluminum plate (heat sink) 250 mm × 250 mm × 6 mm (9 84 in × 9 84 in × 0 24 in) is mounted as a cooling agent

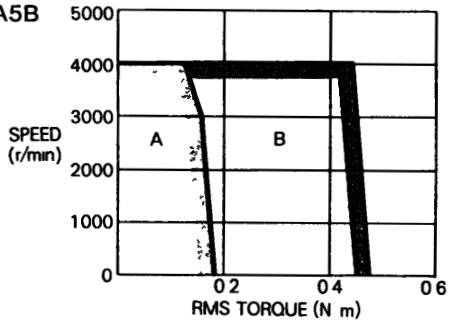
(2) Torque-Speed Characteristics

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

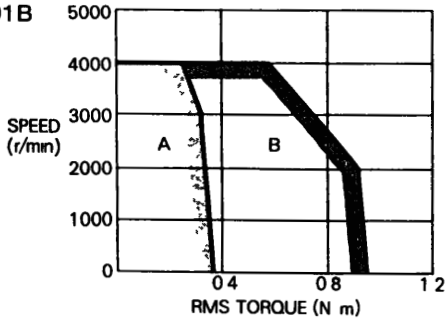
If 100 VAC or below, the output characteristics may be decreased even if the data is within allowable variation.

■ r/min-N·m

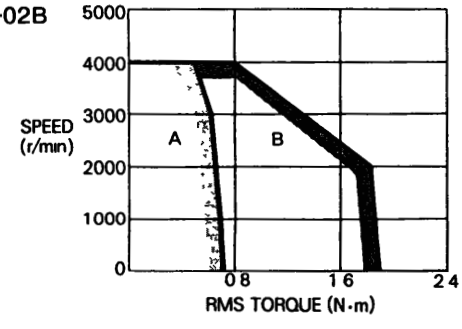
Type USAREM-A5B



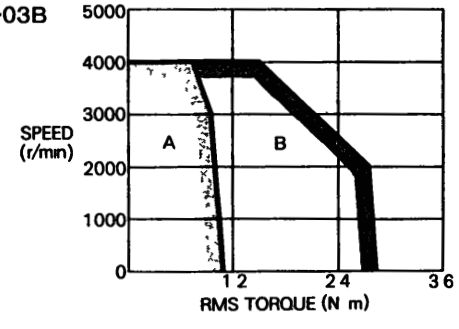
Type USAREM-01B



Type USAREM-02B

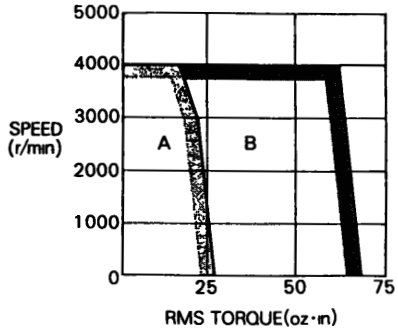


Type USAREM-03B

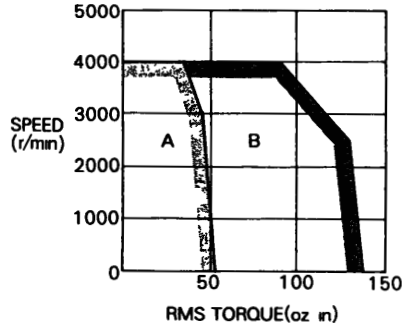


■ r/min-oz·in

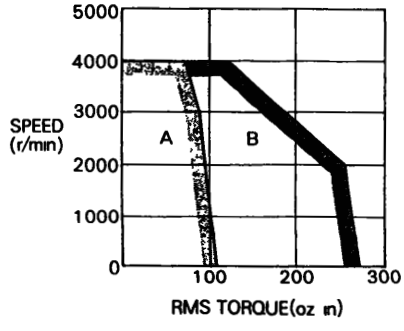
Type USAREM-A5B



Type USAREM-01B



Type USAREM-02B



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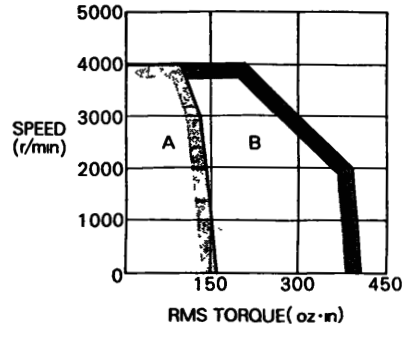


A : Continuous Duty Zone
■ : Intermittent Duty Zone

1.3 RATINGS AND SPECIFICATIONS OF SERVOPACK

Table 1.3 Rating and Specifications of SERVOPACK

Voltage Class				200V					
Servopack Type CACR-				SRA5AB1 R	SR01AB1 R	SR02AB1 R	SR03AB1 R	SR05AB1 R	SR05AB1 RY3
Combined Specifications	Applicable AC Servomotor	Type USAREM-		A5A	01A	02A	03A	05A	07A
		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		ADC	±1	±1.4	±2 8	±3 7	±5 3	±5 3
	Max Output Current		ADC	±3	±4	±8	±11	±16	±16
	Allowable Load Inertia $J_L(=GD^2_L/4)$		kg·m^2	$0\ 764\times10^{-4}$	$1\ 25\times10^{-4}$	$5\ 075\times10^{-4}$	$7\ 66\times10^{-4}$	27.25×10^{-4}	37.25×10^{-4}
Basic Specifications	Power Supply	Main		1-Phase 200 to 230 VAC $^{+10\%}_{-15\%}$ 50/60 Hz*1					
		Control							
	Control Maethod			1-Phase full-wave rectifying, transistorized PWM control					
	Feedback			Optical encoder (1500 or 1000 pulses/rev)					
	Environmental Conditions	Ambient Temp *2		0 to + 55℃					
		Storage Temp		−20 to +85℃					
		Ambient and Storage Humidity		90% or less (non-condensing)					
		Vibration-/Shock-Resistance		0 5G/2G					
	Mounting Structure			Rack mounted					
Speed Control	Speed Control Range*3			1 1000					
	Speed Regulation*4	Load		0 to 100% 0 1% or less at 3000 r/min, ±0 05% or less at 3 r/min					
		Voltage		Rating±10% ±0 1% or less at 3000r/min, ±0 05% or less at 3r/min					
		Temperature		25±25℃ ±0 5% or less at 3000r/min, ±0 2% or less at 3r/min					
	Erequency Response			100Hz at J_L (GD^2_L) = J_M (GD^2_M)					
Signal I/O	Speed Reference	Rated Reference Voltage		±6VDC at 3000r/min (forward run at plus reference)					
		Input Impedance		Approx 30kΩ					
		Circuit Time Constant		Approx 35 μs					
	Auxiliary Reference*5	Rated Reference Voltage		±2 to ±10VDC at 3000r/min (forward run at plus reference)					
		Input Impedance		Approx 5kΩ per V					
		Circuit Time Constant		Approx. 22 μs					
	Built-in Reference Power Supply			±12VDC ±5%, ±30mA					
	PG Pulse Output	Types		Aφ, Bφ, Cφ Line driver and 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					
	Sequence Input			Servo ON, P drive, F run inhibit (P-OT), R run inhibit (N-OT), alarm reset					
	Sequence Output			Servo alarm, current limit, TG ON, servo ready, alarm code (3-bit)					
	External Current Limit			20% to max current in each of P and N (3V/100% current)					
Bulit-in Functions	Dynamic Brake			Operated at main power OFF, servo alarm, servo OFF, etc					
	Regeneration			• 50W/100W type Not provided • 200W to 700W type. provided (containing regenerative resistor)					
	Applicable Load Inertia*6			Up to 10 times motor inertia					
	Overtravel Prevention			DB stop at P-OT, N-OT					
	Protection			Overvoltage (OV), overcurrent (OC), overload (OL), overspeed (OS), MCCB trip (MCCB), PG trouble (PG), voltage drop (UV), CPU error (CPU, A/D)					
	Indication			Power supply (MCCB LED), alarm (7-segment LEDs)					
	Monitor Output			Speed 2V±5% at 1000r/min, torque 3V±10% at 100%					
	Others			Reverse run connection possible (Reverse at plus reference)					

*1 In main circuit power supply, voltage should not exceed 230V, +10% (253V) If the voltage should exceed this value, a step down transformer is required

*2 When housed in a panel, the inside temperature must not exceed ambient temperature range

*3 In the speed control range, the lowest speed is defined under the condition in with there is 100% load regulation, but not stopped.

*4 Speed regulation is generally defined as follows

$$\text{Speed regulation} = \frac{\text{No load speed} - \text{Rated speed}}{\text{Rated speed}} \times 100(\%)$$

Motor speed may be changed by voltage variation or operational amplifier drift due to temperature The ratio of this speed change to the rated speed represents the speed regulation due to voltage or temperature change

*5 Used for application at rated reference voltages other than ± 6V

*6 When load inertia (GD^2) exceeds-applicable range, see Par 6 7 2, "Load Inertia (GD^2) "

	100V			
	SRA5AB2□R	SR01AB2□R	SR02AB2□R	SR03AB2□R
	A5B	01B	02B	03B
	50 (0 07)	100 (0 13)	200 (0.27)	300 (0 40)
	3000/4000			
	±17	±23	±43	±60
	±5	±7	±12	±16
	$0\ 764\times10^{-4}$	1.25×10^{-4}	$5\ 075\times10^{-4}$	$7\ 66\times10^{-4}$
	1-Phase 100 to 115 VAC $^{+10\%}_{-15\%}$ 50/60 Hz*1			
	1-Phase full-wave rectifying, transistorized PWM control			
	Optical encoder (1500 or 1000 pulses/rev)			
	0 to + 55℃			
	−20 to +85℃			
	90% or less (non-condensing)			
	0 5G/2G			
	Rack mounted			
	1 1000			
	0 to 100% 0 1% or less at 3000 r/min, ±0 05% or less at 3 r/min			
	Rating±10% ±0 1% or less at 3000r/min, ±0 05% or less at 3r/min			
	25±25℃ ±0 5% or less at 3000r/min, ±0 2% or less at 3r/min			
	100Hz at J_L (GD^2_L) = J_M (GD^2_M)			
	±6VDC at 3000r/min (forward run at plus reference)			
	Approx 30kΩ			
	Approx 35 μs			
	±2 to ±10VDC at 3000r/min (forward run at plus reference)			
	Approx 5kΩ per V			
	Approx 22 μs			
	±12VDC ±5%, ±30mA			
	Aφ, Bφ, Cφ· Line driver and open collector			
	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			
	Servo ON, P drive, F run inhibit (P-OT), R run inhibit (N-OT), alarm reset			
	Servo alarm, current limit, TG ON, servo ready, alarm code (3-bit)			
	20% to max current in each of P and N (3V/100% current)			
	Operated at main power OFF, servo alarm, servo OFF, etc			
	• 50W type Not provided • 100W to 300W type : provided(containing regenerative resistor)			
	Up to 10 times motor inertia			
	DB stop at P-OT, N-OT			
	Overvoltage (OV), overcurrent (OC), overload (OL), overspeed (OS), MCCB trip (MCCB), PG trouble (PG), voltage drop (UV), CPU error (CPU, A/D)			
	Power supply (MCCB LED), alarm (7-segment LEDs)			
	Speed : 2V±5% at 1000r/min, torque 3V±5% at 100%			
	Reverse run connection possible (Reverse at plus reference)			

2. TYPE DESIGNATION

• AC SERVOMOTOR

USAREM-05AE2□□

- USAREM: AC SERVOMOTOR SERIES
  - • AR R Series
- E: ENCLOSURE
  - • E Totally-enclosed Self cooled Type
- M: MAGNET TYPE
  - • M Rare Earth
- 05: MOTOR OUTPUT
  - • A5 50W 0 07HP
  - • 01 100W 0 13HP
  - • 02 200W 0 27HP
  - • 03 300W 0 40HP
  - • 05 500W 0 67HP
  - • 07 700W 0 93 HP
- A: DESIGN REVISION ORDER
  - • A 200V Class
  - • B 100V Class
- E: DETECTOR(Table 2 3)
  - • E 1500 pulses/rev (Standard)
  - • F 1000 pulses/rev
- 2: SHAFT TYPE
  - • 1 Taper
  - • 2 Straight (Standard)
- □: DRIVE END SPECIFICATION
  - • Blank Standard
  - • O Standard (With Brake)
  - • K With Key (Standard)
  - • S With Shaft Seal
  - • T With Key & Shaft Seal
- □: OPPOSITE DRIVE END SPECIFICATION
  - • Blank Standard
  - • B With Brake (Exciting Winding Voltage 90 VDC)

• SERVOPACK

CACR-SR05AB1ER

- CACR: AC SERVOPACK SERIES
- SR: CONTROL TYPE
  - • SR Speed
- 05: MOTOR OUTPUT
  - • A5 50W 0 07HP
  - • 01 100W 0 13HP
  - • 02 200W 0 27HP
  - • 03 300W 0 40HP
  - • 05 500W 0 67HP
- A: APPLICATION
  - • A R Series
- B: DESIGN REVISION ORDER
- 1: INPUT FORM
  - • 1 200V Analog
  - • 2 100V Analog
- E: DETECTOR
  - • E 1500 pulses/rev
  - • F 1000 pulses/rev
- R: APPLICABLE MOTOR SERIES
  - • 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 or Fuse† A	Applicable Noise Filter	Recommended Noise Filter‡ Type	Recommended Noise Filter‡ Specification		Power ON/OFF Switch
200V	50W (0.07HP)	SRA5AB1ER	A5AE2	1500	0 3	5	GOOD	LF-205A	Single-phase, 200VAC class	5A	Yaskawa type HI-16E5 rated 35A or equivalent
		SRA5AB1FR	A5AF2	1000							
	100W (0 13HP)	SR01AB1ER	01AE2	1500	0 5						
		SR01AB1FR	01AF2	1000							
	200W (0.27HP)	SR02AB1ER	02AE2	1500	0 75						
		SR02AB1FR	02AF2	1000							
	300W (0 40HP)	SR03AB1ER	03AE2	1500	1 0	7		LF-210		10A	
		SR03AB1FR	03AF2	1000							
	500W (0 67HP)	SR05AB1ER	05AE2	1500	1 4	11		LF-215		15A	
		SR05AB1FR	05AF2	1000							
	700W (0 93HP)	SR05AB1ERY3	07AE2	1500	1 4	11					
		SR05AB1FRY3	07AF2	1000							
100V	50W (0 07HP)	SRA5AB2ER	A5BE2	1500	0 3	5	POOR	LF-205A	Single-phase, 200VAC class	5A	
		SRA5AB2FR	A5BF2	1000							
	100W (0 13HP)	SR01AB2ER	01BE2	1500	0.5						
		SR01AB2FR	01BF2	1000							
	200W (0 27HP)	SR02AB2ER	02BF2	1500	0 75	8		LF-210		10A	
		SR02AB2FR	02BF2	1000							
	300W (0 40HP)	SR03AB2ER	03BE2	1500	1 0	11		LF-215		15A	
		SR03AB2FR	03BF2	1000							

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

Table 3. 2 Characteristics of AC SERVOMOTOR, Detector and Holding Brake for Standard Combination

Class	SEVOPACK 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
200V	SRA5AB1ER	A5AE2KB	MS3101A 14S-2P	MS3106B* 14S-2S	MS3057 -6A	MS3101A 20-29A	MS3106B 20-29S*	MS3057 -12A	MS3101A 14S-6P	MS3106B 14S-6S*	MS3057 -6A
	SRA5AB1FR	A5AF2KB									
	SR01AB1ER	01AE2KB									
	SR01AB1FR	01AF2KB									
	SR02AB1ER	02AE2KB	MS3102A 18-10P	MS3108B 18S-10S	MS3057 -10A	MS3102A 20-29S	MS3108B 20-29S	MS3057 -12A	MS3102A 18S-12P	MS3108B 18S-12S	MS3057 -10A
	SR02AB1FR	02AF2KB									
	SR03AB1ER	03AE2KB									
	SR03AB1FR	03AF2KB									
	SR05AB1ER	05AE2KB	MS3102A 20-4P	MS3108B 20-4S	MS3057 -12A				MS3102A 20-17P	MS3108B 20-17S	MS3057 -12A
	SR05AB1FR	05AF2KB									
	SR05AB1ERY3	07AE2KB									
	SR05AB1FRY3	07AF2KB									
100V	SRA5AB2ER	A5BE2KB	MS3101A 14S-2P	MS3106B 14S-2S*	MS3057 -6A	MS3101A 20-29P	MS3106B 20-29S*	MS3057 -12A	MS3101A 14S-6P	MS3106B 14S-6S*	MS3057 -6A
	SRA5AB2FR	A5BF2KB									
	SR01AB2ER	01BE2KB									
	SR01AB2FR	01BF2KB									
	SR02AB2ER	02BE2KB	MS3102A 18-10P	MS3108B 18S-10S	MS3057 -10A	MS3102A 20-29P	MS3108B 20-29P		MS3102A 18S-12P	MS3108B 18S-12S	MS3057 -10A
	SR02AB2FR	02BF2KB									
	SR03AB2ER	03BE2KB									
	SR03AB2FR	03BF2KB									

*Straight plug

4. CHARACTERISTICS

4. 1 OVERLOAD CHARACTERISTICS

The overload protective circuit built in SERVOPACK prevents the motor and SERVOPACK from overloading 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

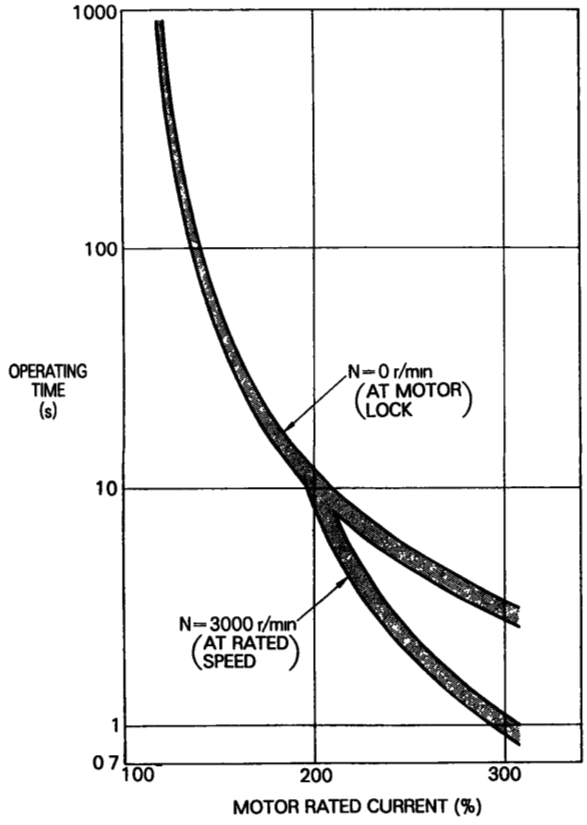


Fig 4 1 Overload Characteristics

4. 2 STARTING AND STOPPING TIME

The starting time and stopping time of SERVOMOTOR under a constant load is shown by the formula below. Viscous or friction torque of the motor is disregarded.

Starting Time:

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

Stopping Time:

$$t_f = 104.7 \times \frac{N_R\ (J_M + J_L)}{Kt\ I_R\ (\alpha + \beta)}\ (\text{ms})$$

Where,

N_R : Rated motor speed (r/min)

J_M : Motor inertia of motor($kg \cdot m^2 \times 10^{-4}$= $lb \cdot in^2$)

J_L : Moment of inertia of motor($kg \cdot m^2 \times 10^{-4}$= $lb \cdot in^2$)

Kt : Torque constant of motor (N·m/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)

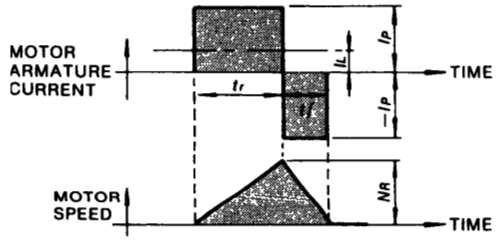


Fig. 4.2 Timing Chart of Motor Armature Current and Speed (Constant Load)

4.3 ALLOWABLE FREQUENCY OF OPERATION

The allowable frequency of operation is restricted by the SERVOMOTOR and SERVOPACK, and the conditions must be considered for satisfactory operation.

- Allowable frequency of operation restricted by the SERVOPACK

  The allowable frequency of operation is restricted by the heat generated in the regenerative resistor in the SERVOPACK, and varies depending on the motor types, capacity, load GD^2, acceleration/deceleration current values, and motor speed. If the frequency of operation exceeds 60 times/min when load inertia J_L (GD^2_L) before the motor becomes rated speed, or if it exceeds $\frac{60}{m+1}$ cycles/min when load inertia J_L (GD^2_L) = motor inertia J_M (GD^2_M) × m, contact your YASKAWA representative.

- Allowable frequency of operation restricted by the SERVOMOTOR

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

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

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

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

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

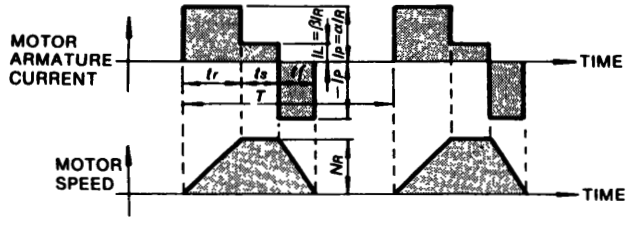


Fig 4.3 Timing Chart of Motor Armature Current and Speed (Restricted by SERVOMOTOR)

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

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

$$n=286.5 \times \frac{Kt \cdot I_R}{N_R\ (J_M+J_L)}\left(\frac{1}{\alpha}-\frac{\beta^2}{\alpha^3}\right)$$

(times/min)

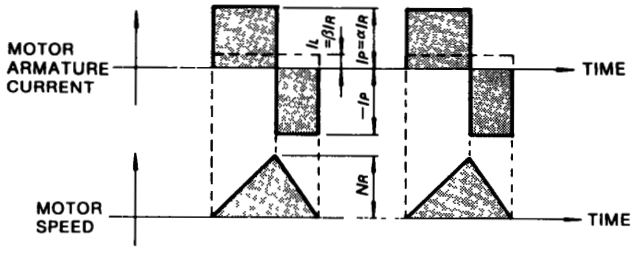


Fig 4.4 Timing Chart of Motor Armature Current and Speed (The motor remains at standstill between cycles of accel/decel without continuous rated speed running)

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

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

$$n=286.5 \times \frac{Kt \cdot I_R}{N_R\ (J_M+J_L)}\left(\frac{1}{\alpha}-\frac{\beta^2}{\alpha}\right)$$

(times/min)

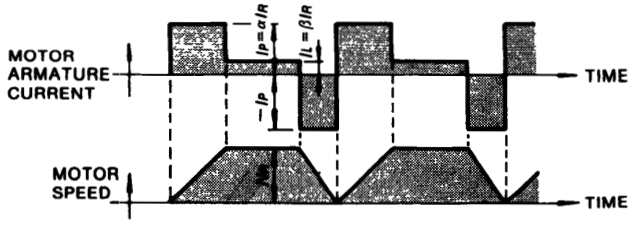


Fig 4.5 Timing Chart of Motor Armature Current and Speed (The motor accelerates, runs at constant speed, and decelerates in a continuing cycle without being at standstill)

4. 4 SERVOMOTOR FREQUENCY

In the servo drive consisting of SERVOPACK and SERVOMOTOR, motor speed amplitude is restricted by the maximum armature current controlled by SERVOPACK.

The relation between motor speed amplitude (N) and frequency(f) is shown by the formula below:

$$N = 1.52 \times \frac{\alpha \times Kt \times I_R}{(J_M + J_L)\ f} \quad (\text{r/min})$$

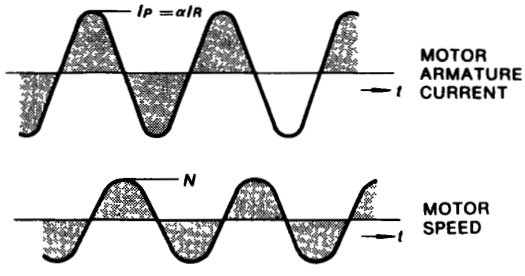


Fig 4 6 Timing Chart of Motor Armature Current and Speed (Restricted by the maximum armature current)

4. 5 MOTOR SPEED-REFERENCE INPUT CHARACTERISTICS

Fig.4.7 shows motor speed and input voltage curve when speed reference input terminals 1CN - ⑫ and ⑬ are used. With auxiliary input terminals, 1CN - ⑭ and ⑮ , motor speed can be set to the rating by adjusting IN-B potentiometer as long as input voltage is within ±2V to ±10V. See Fig. 4.8.

The forward motor rotation (+) means counterclockwise (CCW) rotation when viewed from the drive end.

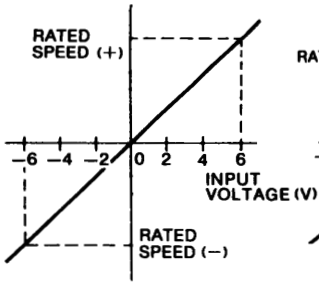


Fig 4 7 Speed-Input Voltage Characteristics

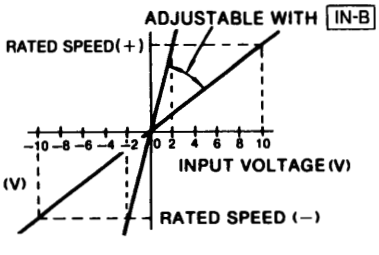


Fig 4 8 Speed-Input Voltage Characteristics when Auxiliary Input Terminals 1CN-⑭ and ⑮ are used

4. 6 MOTOR MECHANICAL CHARACTERISTICS

4 6 1 Mechanical Strength

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

4 6 2 Allowable Radial Load and Thrust Load

Table 4.1 shows allowable loads according to AC SERVOMOTOR types.

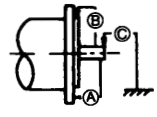
Table 4. 1 R Series Allowable Radial Load and Thrust Load

Motor Type USAREM–	Allowable Radial Load* N (lb)	Allowable Thrust Load N (lb)
A5AE2K	78 4 (18)	39 2 (9)
01AE2K		
02AE2K	245 (55)	98 (22)
03AE2K		
05AE2K	392 (88)	147 (33)
07AE2K		

*Maximu values of the load applying to the shaft extension

4 6 3 Mechanical Specifications

Table 4 2 Mechanical Specifications in mm

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

†T I R (Total Indicator Reading)

4 6 4 Direction of Rotation

AC SERVOMOTORS rotate counterclockwise (CCW) when viewed from the drive end when motor and detector leads are connected as shown below.

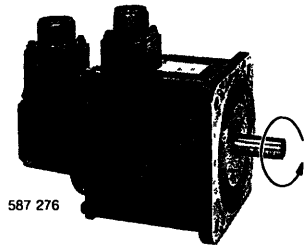
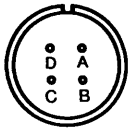


Fig 4.9 AC SERVOMOTOR

(1) Connector Specifications

(a) Motor receptacle

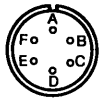
• Standard



A	Phase U
B	Phase V
C	Phase W
D	Frame Ground

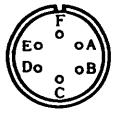
• With brake

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



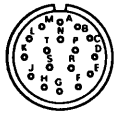
A	Phase U
B	Phase V
C	Phase W
D	Brake terminal
E	
F	Frame Ground

(200W, 0 27HP / 300W 0 40HP)



(500W 0 67HP / 700W 0 93HP)

(b) Detector receptacle



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

4 6 5 Impact Resistance

When mounted horizontally and exposed to vertical shock impulses, the motor can withstand up to two impacts with impact acceleration of 50 G (490 m/s²) (Fig 4 10)

NOTE

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

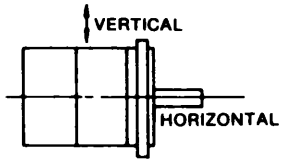


Fig 4 10 Impact Resistance

4 6 6 Vibration Resistance

When mounted horizontally, the motor can withstand vibration (vertical, lateral, axial) of 2 5 G (24 5 m/s²) (Fig 4 11)

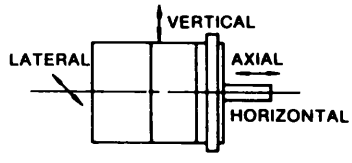


Fig 4 11 Vibration Resistance

4 6 7 Vibration Class

Vibration of the motor running at rated speed is 15μm or below (Fig.4.12).

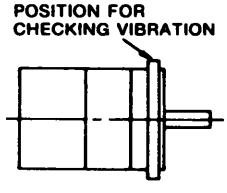


Fig. 4 12 Vibration Checking

5. CONFIGURATION

5. 1 CONNECTION DIAGRAM

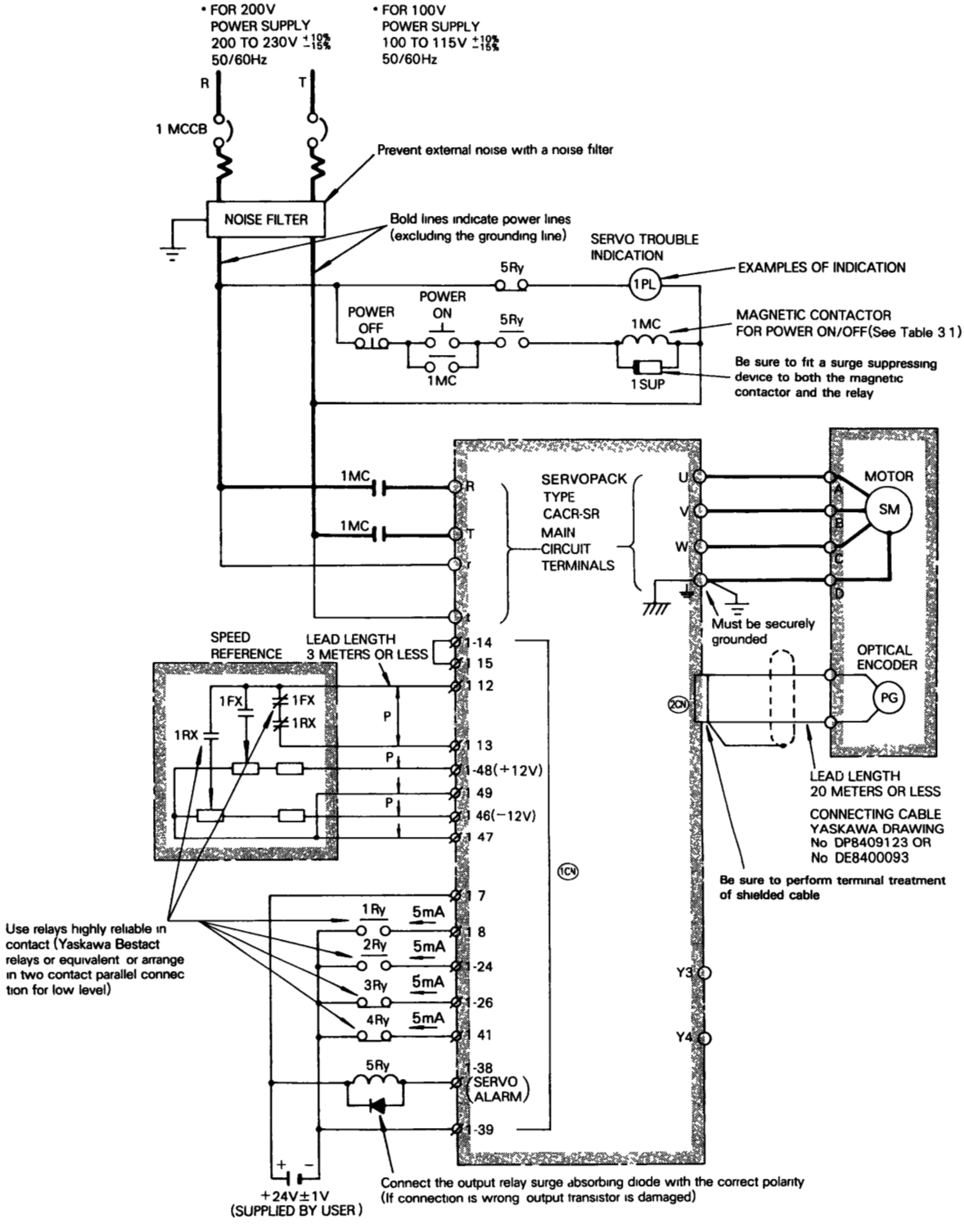


Fig 5 1 Example of Connection Diagram of SERVOPACK with a SERVOMOTOR and Peripherals

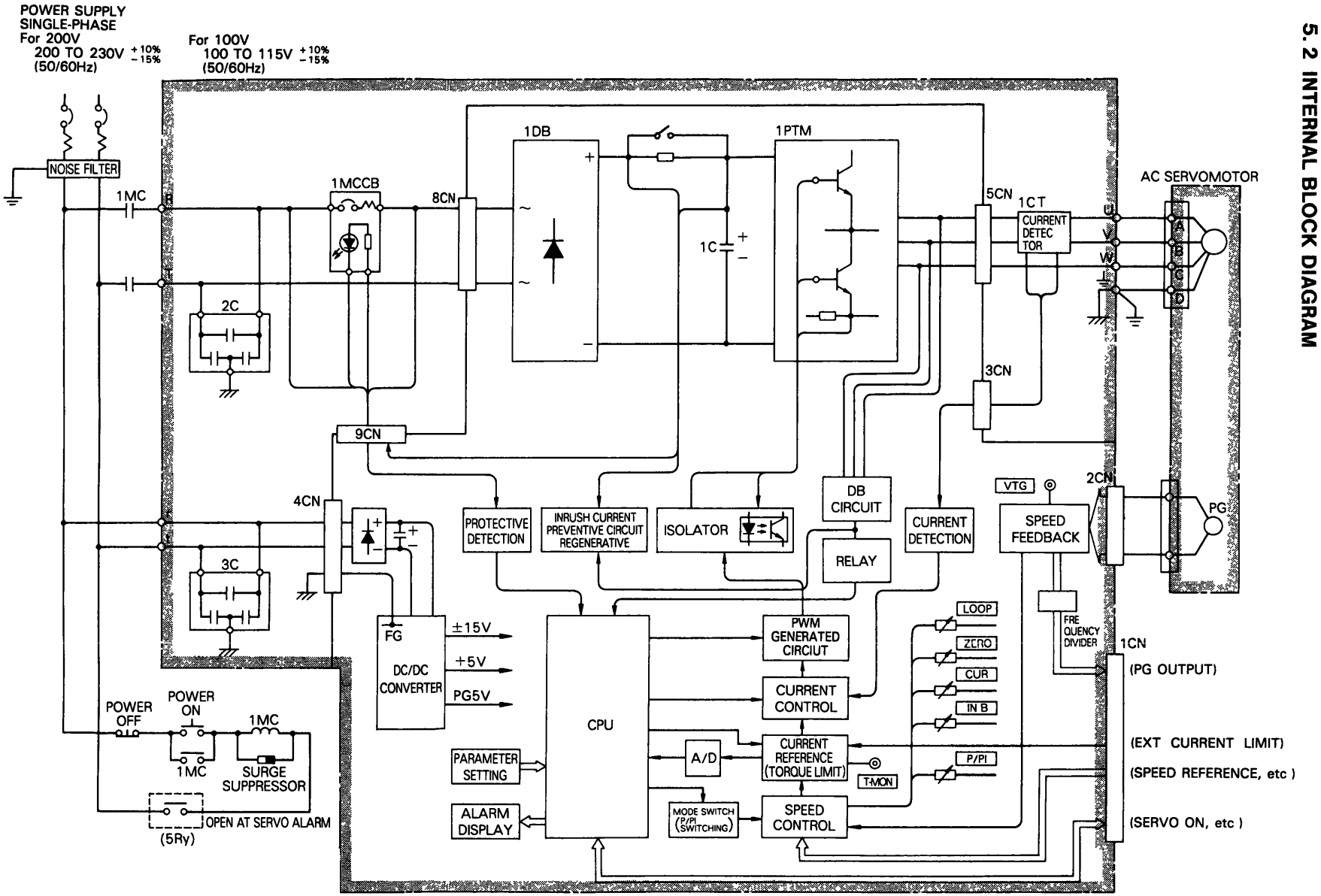


Fig. 5.2 Internal Block Diagram of SERVOPACK Type CACR-SR□□AB□□R
(For 200V, 50 to 100W, 0 07 to 0 13HP)
(For 100V, 50W, 0 07HP)

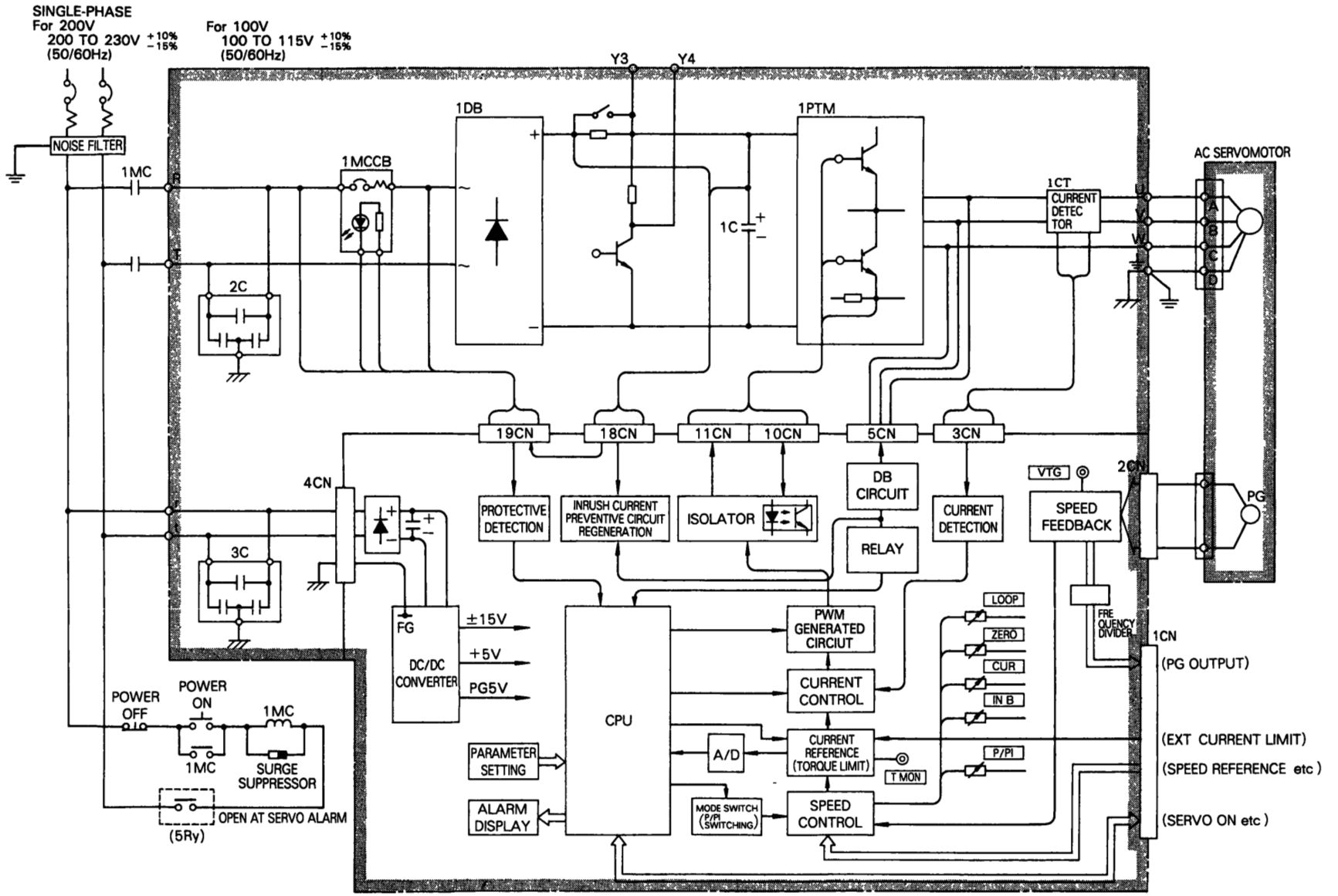


Fig 5.3 Internal Block Diagram of SERVOPACK Type CACR-SR□□□AB□□□R
(For 200V, 200 to 500W, 0 07 to 0 67HP)
(For 100V, 100 to 300W, 0 13 to 0 4HP)

5. 3 MAIN-CIRCUIT TERMINALS

Table 5. 1 Main-Circuit Terminals for SERVOPACK

Terminal Symbol	Name	Description
Ⓡ Ⓣ	Main-circuit AC input	• For 200V Single-phase 200 to 230V $^{+10\%}_{-15\%}$ 50/60Hz • For 100V Single-phase 100 to 115V $^{+10\%}_{-15\%}$ 50/60Hz
ⓊⓋⓌ	Motor connection	Connects terminal Ⓤ to motor terminal A Ⓥ to B and Ⓦ to C
ⓡ ⓣ	Control power input	• For 200V Single-phase 200 to 230V $^{+10\%}_{-15\%}$ 50/60Hz • For 100V Single-phase 100 to 115V $^{+10\%}_{-15\%}$ 50/60Hz
⏚	Ground	Connects to motor terminal D Must be securely grounded
Ⓨ3 Ⓨ4	Regenerative register	External connection not normally 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 Connrction 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 on page17.

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
0V	0V	0V	AL01	CLT +	CLT −	+24V IN	$\overline{\text{S-ON}}$	TRQ-M	VTG-M	SG	IN-A	SG-A	IN-B	SG-B	+12V	SG	FG
0V for PG Output Signal			Output 1	Current Limit Detection Output		Ext Power Input	Servo ON Power	Torque Monitor	Speed Monitor		Speed Reference Input		Auxiliary Input		+12V Output		Frame Ground
		19	20	21	22	23	24	25	26	27	28	29	30	31	32		
		PCO	*PCO	AL02	TG ON +	TG ON −	$\overline{\text{P-CON}}$	PHC	N-OT	S-RDY −	S-RDY +	N-CL	SG-NCL	−12V	SG		
		Line Driver Output Phase C		Output 2	TG ON Output Signal		P Drive Input	Open Collector Output Phase C	Reverse Prohibit Input	Servo Ready Output		Reverse Current Limit Input		−12V Output			
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
PAO	*PAO	PBO	*PBO	AL03	ALM +	ALM −	PHB	P-OT	PHA	$\overline{\text{ALM-RST}}$	P-CL	SG-PCL	−12V	SG	+12V	SG	FG
Line Driver Output Phase A		Line Driver Output Phase B		Output 3	Servo Alarm Output		Open Collector Output Phase B	Fwd Prohibit Input	Open Collector Output Phase A	Alarm Reset Input	Fwd Current Limit Input		−12V Output		+12V Output		Frame Ground

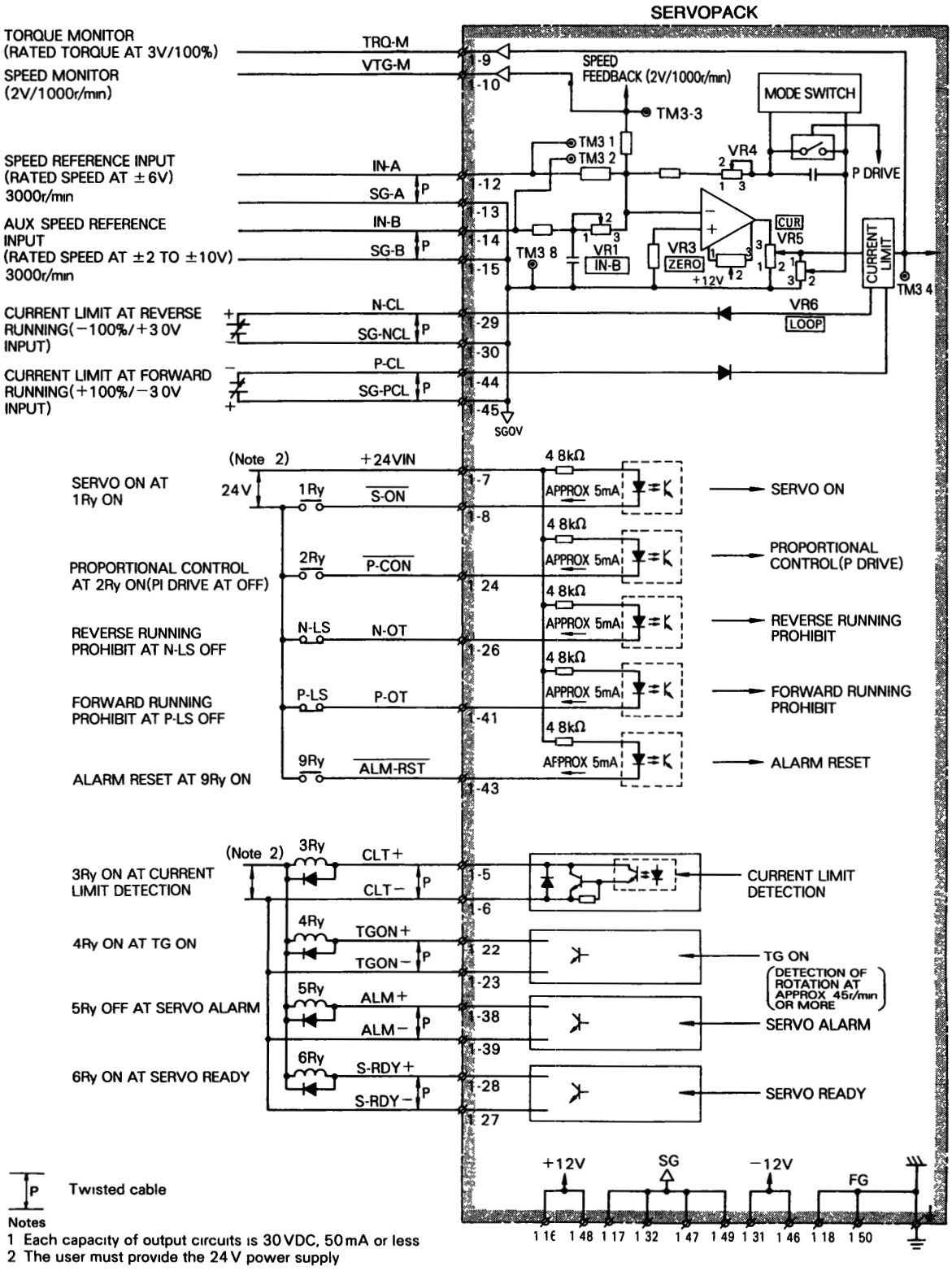


Fig 5 4 1CN I/O Signal Connection and External Signal Processing

5 4 2 Connector 1CN Layout and Connection of SERVOPACK (Cont'd)

Table 5 4 Input Signals of Connector 1CN

Signal Name	Connector 1CN No	Function	Descrption
$\overline{\text{SV-ON}}$	8	Servo ON	Inputting this signal makes the SERVOPACK ready to receive speed reference input Base block and dynamic brake are cleared
$\overline{\text{P-CON}}$	24	Proportional drive reference	Proportional control reference applies friction torque to the motor to prevent drifting when the motor is left motionless without reference input while the main circuit is kept energizec
N-OT	26	Reverse running prohibit	In the case of linear drive etc , connect limit switch signal according to the run direction This signal is "closed" during normal run When limit switch is tripped, it becomes "open "
P-OT	41	Forward running prohibit	
24V	7	24V	External power supply to 1CN-8, 24 26, 41 and 43 Prepare a 24VDC(25mA min) power supply
IN-A*	12(13)	Speed reference input	At ±6 0V, ± rated speed is obtained
IN-B*	14(15)	Aux reference input	At ±2 0 to ±10 0V, ±rated speed is obtained For adjustment potentiometer [IN-B] is used
N-CL	29(30)	Current limit reference at reverse running	+3 0V ± 10%/100% torque +9V max
P-CL	44(45)	Current limit reference at forward running	−3 0V ±10%/100% troque −9V max
$\overline{\text{ALM-RST}}$	43	Alarm reset	This signal resets the alarm

*When either IN-A or IN-B is used, be sure to short the unused input

Table 5 5 Output Signals of Connector 1CN

Signal Name	Connector 1CN No	Function		Description
ALM	38(39)	Servo alarm		Turns OFF when fault is detected For details refer to Table 6 2, "Fault Detection Function "
$\overline{\text{TGON}}$	22(23)	Motor run detection		Turns ON when motor speed exceeds approx 45 r/min or 450 r/min The motor speed can be changed by using SW1-3 • 45 r/min ··· Short-circuit SW1-3 • 450 r/min ·· Open SW1-3
$\overline{\text{CLT}}$	5(6)	Current limit detection		• N-CL or P-CL used Turns ON when output torque reaches the level set by N-CL or P-CL • N-CL or P-CL not used Turns ON when output torque reaches the level set by potentiometer [CUR]
$\overline{\text{S-RDY}}$	28(27)	Servo ready		Turns ON when main power supply ON, and no servo alarm
+12V	16, 48	±12V output power supply		+12V ±5% max output current 30mA Used with speed reference oi current limit input
0V	17, 32, 47, 49			
−12V	31, 46			
TRQ-M	9	Torque monitor		(±3 0V/rated torque) ±10%, ±9V max, load 1mA max
VTG-M	10	Speed monitor		(±2 0V/1000rpm)±5%, load 1mA max
PAO	33	Positioning Signal Output 1	Phase A	Encoder output signal after frequency division is output at PG pulse line driver (TI MC3487) To be received by line receiver (TI MC 3486)
*PAO	34		Phase $\overline{\text{A}}$	
PBO	35		Phase B	
*PBO	36		Phase $\overline{\text{B}}$	
PCO	19		Phase C	
*PCO	20		Phase $\overline{\text{C}}$	
PHA	42(1)	Positioning Signal Output 2	Phase A	Open collector output, encoder output signal after frequency division Max operating voltage 30VDC Max output current 20mADC
PHB	40(2)		Phase B	
PHC	25(3)		Phase C	
AL01	4(1)	Alarm output code (BCD code)		Open collector output Max operating voltage 30VDC Max output current 20mADC
AL02	21(2)			
AL03	37(3)			

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

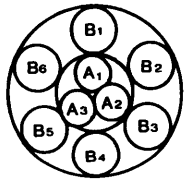
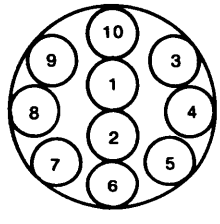
5 5.1 Specifications of Applicable Receptacles and Cables (Table 5 6)

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 being shipped
#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 lengths 5 m, 10 m, 20 m Terminal ends are not provided (without connectors)	

NOTE

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

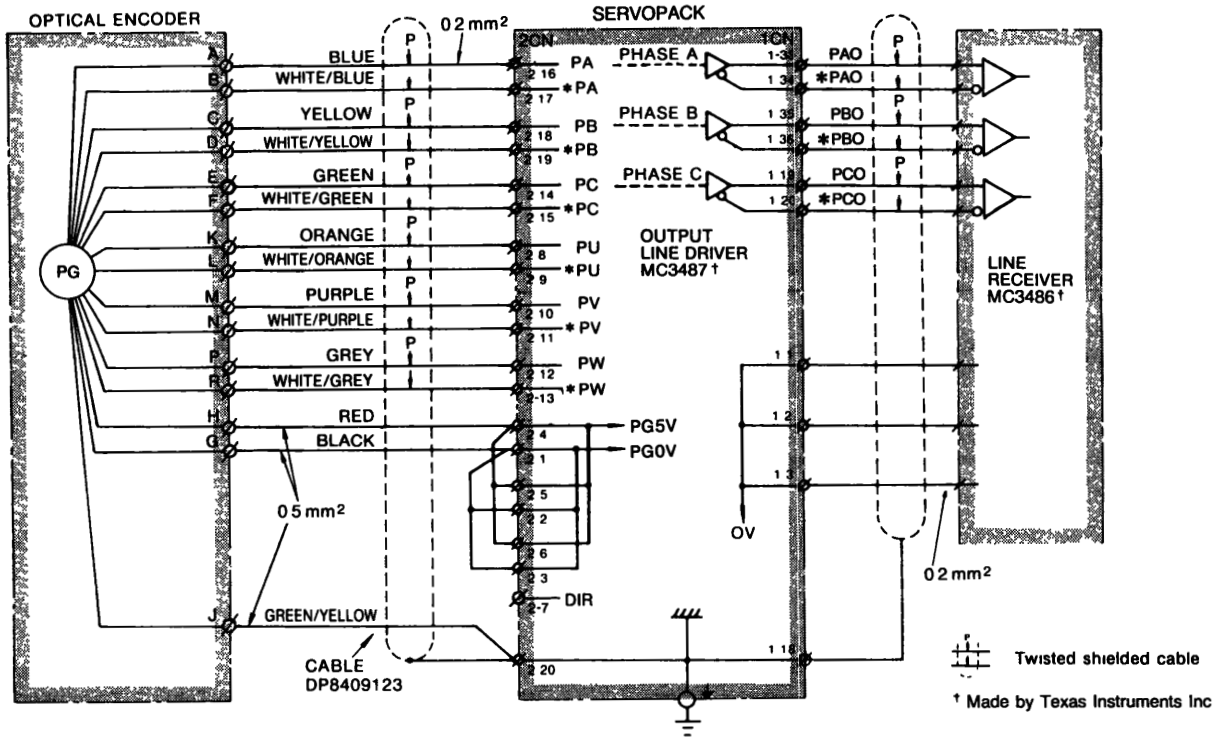
5.5 2 SERVOPACK Connector (2CN) Terminal Layout and Connection

The terminal layout for the SERVOPACK connectors (2CN) for connecting the optical encoder is shown in Table 5.8, and the connection method of 2CN and the optical encoder, in Figs. 5.5 and 5.6.

Table 5 8 Connector 2CN Layout of SERVOPACK

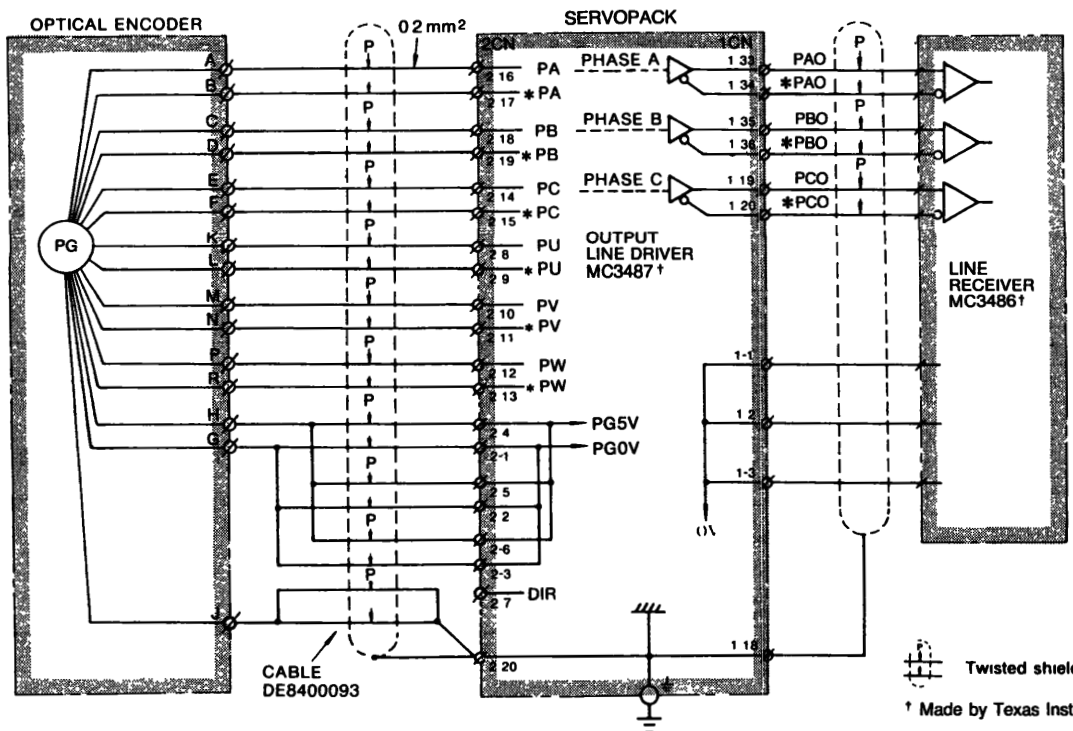
1	2	3	4	5	6	7
PG0V	PG0V	PG0V	PG5V	PG5V	PG5V	DIR
8	9	10	11	12	13	
PU	*PU	PV	*PV	PW	*PW	
14	15	16	17	18	19	20
PC	*PC	PA	*PA	PB	*PB	FG

Note For DIR, See Par 6 9 1



Note Connector specifications of optical encoders are as follows
Connector — Type MS3102A20-29P (Receptacle)
Accessory (not attached) — Type MS3108B20-29S (Angle plug)
Type MS3057-12A (Cable clamp)

Fig 5 5 Soldered Type Connector 2CN Connection and 1CN Output Processing
(When using Connection Cable DP8409123)



Note Connector specifications of optical encoder are as follows
Connector — Type MS3102A20-29P (Receptacle)
Accessory (not attached) — Type MS3108B20-29S (Angle plug)
Type MS3057-12A (Cable clamp)

Fig 5 6 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).

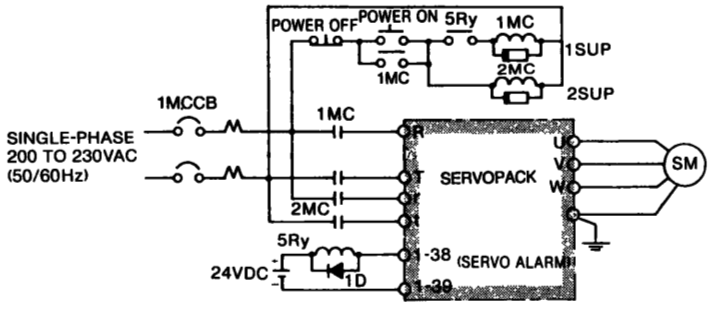
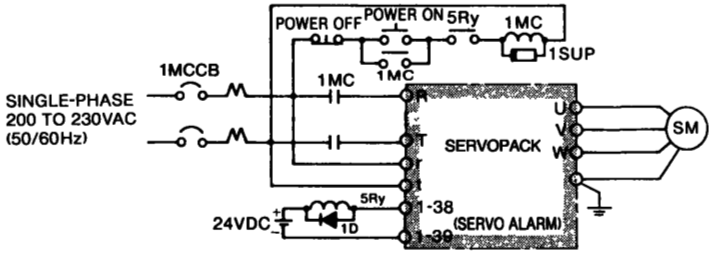


Fig 6 1 Connection Example for Simultaneous Control Power ON/OFF (When using AC Servomotor for 200V)



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.

- When power is supplied to the power ON/OFF sequence shown in Fig.6.1, the normal signal is set (5Ry is turned ON) in the control circuit after a maximum delay of 1 second.

  When the power is turned ON, a servo alarm signal continues for approximately 1 second (normally 200 to 300 ms) to initialize the SERVOPACK.

  Hold the main-circuit power ON signal for approximately 1 second. However, this is unnecessary in the sequence in Fig.6.2, because the control power is always turned ON.

- 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 speed reference 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.**

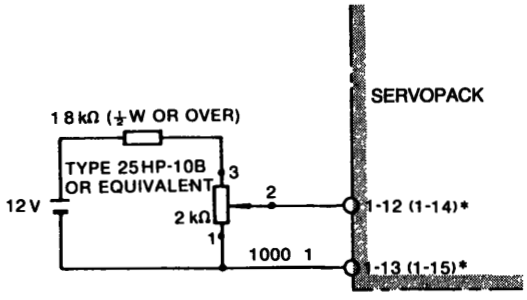
6.2 SPEED REFERENCE

6 2 1 Speed Reference Circuit

From the SERVOPACK built-in control power(1CN-⑯, ㊽: +12V, 1CN-⑰, ㉜, ㊼, ㊾: 0V, 1CN-㉛, ㊻: -12V) or the external power, the speed reference voltage is given to 1CN-⑫ and ⑬ or to 1CN-⑭ and ⑮. When the SERVOPACK built-in control power is used, the motor speed fluctuates in the range of ±2% of the speed set value.

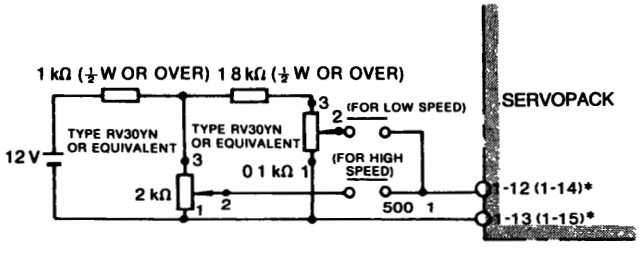
The method for giving speed reference voltage is described below.

(1) For accurate(inching) speed setting



25HP-10B type Multiple-rotation type, wire wound variable resistor (with dial MD10-30B4) made by Sakae Tsushin Inc

(a) When Multiple-rotation Type, Wire Wound Variable Resistor is used



RV30YN type Carbon-film variable resistor made by Tokyo Cosmos Electric

Low-and high-speed relays Reed relay (SRF-B, SRG-B) made by Nippon Electric or equivalent, or low-level relay (G2A-432) made by OMRON or equivalent

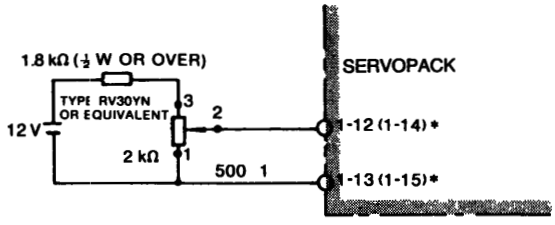
Note When a carbon resistor is used, a great residual resistance remains, and so the speed control range becomes approximately 500 1

(b) When Carbon Variable Resistor is used

*Parentheses are for auxiliary input

Fig 6 3 Method for Giving Speed Reference Voltage (for Accurate Speed Setting)

(2) For relatively rough speed setting

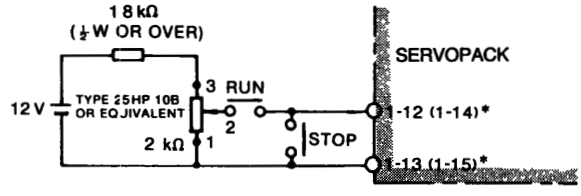


* Parentheses are for auxiliary input
Note When a carbon resistor is used, a great residual resistance remains, and so the speed control range becomes about 500 1

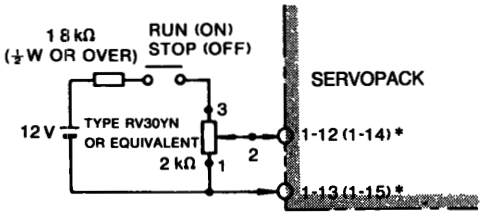
Fig 6 4 Method for Giving Speed Reference Voltage (for relatively Rough Speed Setting as compared with Fig 6 3)

6 2 2 Stop Reference Circuit

When commanding a stop, do not open the speed reference circuit (1CN-⑫ or 1CN-⑭), but set to 0 V.



(a) When Multiple-rotation Type, Wire Wound Variable Resistor is used



(b) When Carbon Variable Resistor is used

* Parentheses are for auxiliary input

Fig 6 5 Method for Giving Stop Reference

6 2 3 Handling of Speed Reference Input Terminal

The unused terminals, out of the speed reference terminals 1CN-⑫, ⑬ and the auxiliary input terminals 1CN-⑭, ⑮ must be short-circuited.

6.2 4 Auxiliary Input Circuit (± 2 to ± 10 V)

Auxiliary input circuit is used for application at rated reference voltage other than ±6V.

- Adjustment procedures

  Between 1CN-⑭ and ⑮ (⑮ is 0V), input the voltage to be used to set the rated speed, and adjust the potentiometer IN-B so that the rated speed is achieved.

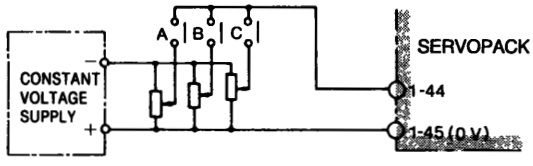
  When combined with Yaskawa Positionpack in positioning system drive, auxiliary input terminals are normally used as speed reference input. In this case, positioning loop gain is adjusted with the potentiometer 1VR IN-B. For adjustment, be sure to refer to Positionpack instruction manuals.

6.3 EXTERNAL CURRENT LIMIT REFERENCE CIRCUIT [P-CL, N-CL]

Current can be limited from the outside as well as within SERVOPACK. The external current limit is used for the following cases:

- To protect the motor from overload current when an abnormal load lock occurs in the load.
- To change the current limit value according to the external sequence.

The current can be limited by multi-stage setting by the use of relays (Fig.6.6). The same effect can be obtained by giving voltage signals making analog change.



Relay Low-level relay type G2A-432A made by OMRON

Fig 6 6 Multi-stage Switching of Current Value at Forward Side

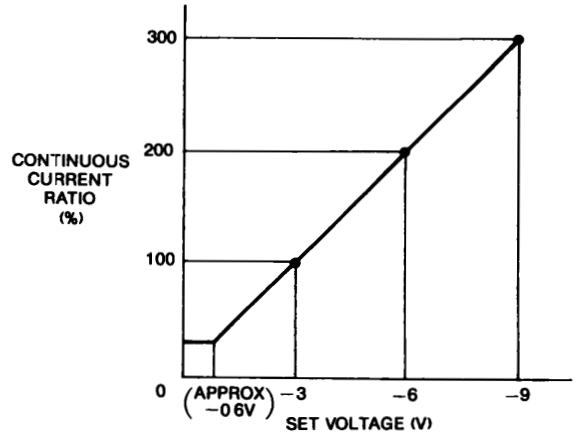
6 3 1 Method for Giving External Current Limit Reference

Forward current and reverse current can be controlled independently. The forward current can be controlled by giving a reverse voltage (0 to -9.0 V) between SERVOPACK terminals 1CN-㊹ and ㊺ ; the reverse current can be controlled by a forward voltage (0 to +9.0 V) between terminals 1CN-㉙ and ㉚ .

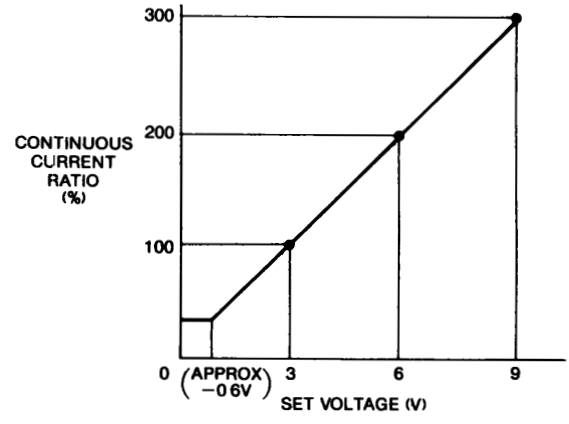
The relation between the rated current of the motor and current limit values is rated current at 3.0 V for applicable motor. The power supply must use an internal resistance less than 2kΩ. The input resistance at SERVOPACK side must be greater than 5kΩ. When external current is not restricted, contacts between terminals 1CN-㊹ and ㊺ and between 1CN-㉙ and ㉚ are opened.

6 3.2 Set Voltage and Current Limit Values

The relationship between set voltages of 0 to ±9.0 V and current limit values are shown in Fig. 6.7.



(a) Current Limit at Forward Side



(b) Current Limit at Reverse Side

Note If setting value exceeds max output current value of Servopack, max output current value becomes saturation value

Fig 6 7 Set Voltage and Current Limit Values

6 3 3 Current Limit when Motor is Locked

When locking a motor by applying a current limit, determine a current limit value less than the rated current of the motor. If the load condition requires a current limit exceeding the rated motor, current, refer to Par. 6.5(3), "Overload detection level" and make sure to unlock the motor before reaching the trip level.

Note that when the speed reference voltage is less than tens or so millivolts (affected by setting of GAIN [LOOP]), the motor lock current sometimes pulsates. If this is not desirable, the current pulsation can be removed by increasing the speed reference voltage.

6.4 CONFIGURATION OF I/O CIRCUIT

For proportional drive, overtravel, servo ON, alarm reset, servo alarm output, current limit detection output, TG ON, 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 five input signals: Servo ON, proportional drive reference, forward/reverse overtravel protection, alarm reset. Construct the input circuit using 24 V power supply (Fig.6.8). Typical circuits are shown in Fig.5.4.

NOTE

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

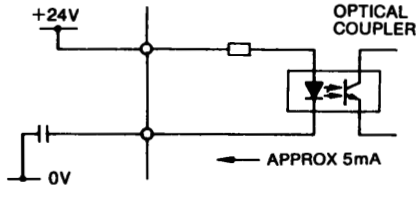


Fig 6 8 Configuration of I/O Circuit

(1) Proportional Drive Reference [$\overline{\text{P-CON}}$]

If a position loop is not set for positioning, and after completion of positioning, has been left for quite a long time, the positioned point may have moved due to preamplifier drift. To avoid this, switch the speed amplifier from PI drive to P drive after the positioning and the loop gain in the control systems drops and the drift decreases. With several percent of friction load, the motor stops completely.

(2) 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 instruction to operate to the OT 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

(3) 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

(4) Alarm reset [$\overline{\text{ALM-RST}}$]

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

Turn OFF control power temporarily to reset the servo alarm if an overcurrent alarm ([1.]) occurs.

6 4 2 Output Circuit

There are four output signals: Current limit detection, TG ON, Servo alarm, Servo ready.

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

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. 9)

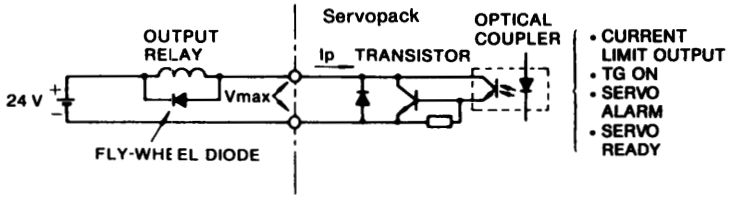


Fig 6 9 Output Circuit

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.

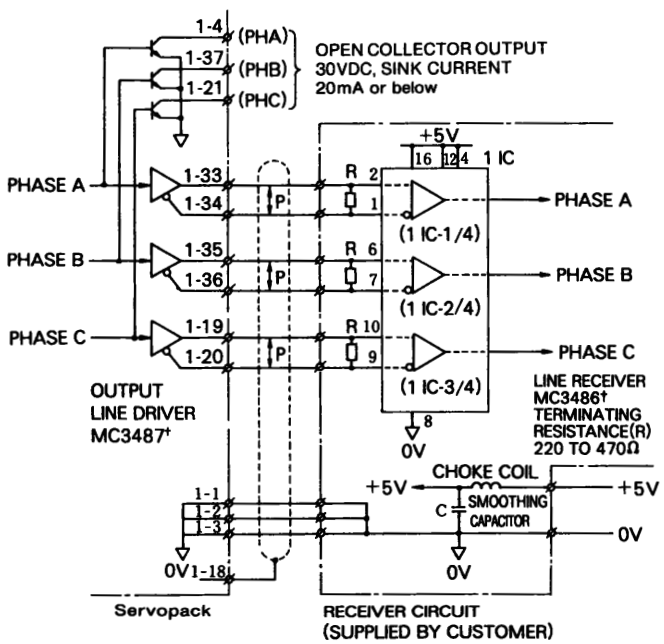
Use these signals as positioning signals. The output signal specifications are as follows:

(1) Signal form

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

(2) Ouput circuit and receiver circuit

Two types of output circuits are provided: line driver output and open collector output. Fig.6.10 shows an example of line driver output.

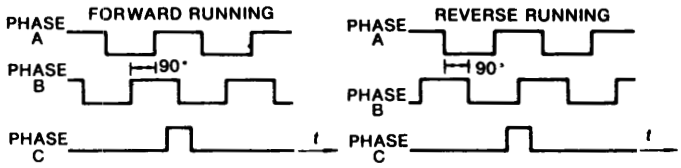


Twisted cable

†Made by Texas Instruments Inc

Fig 6 10 Output Circuit and Receiver Circuit

(3) Output phase



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

Fig 6 11 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 6.1. Fig. 6.12 shows the optical encoder output waveform under the dividing pulse frequency.

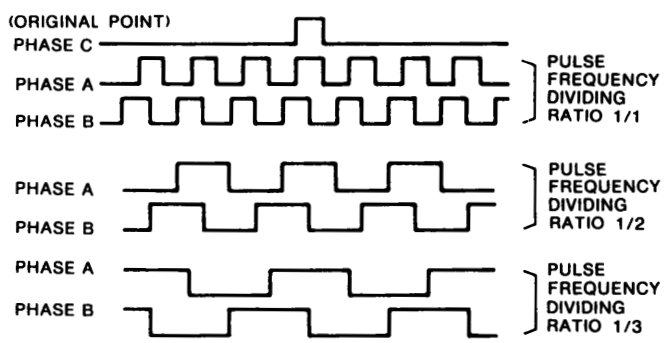


Fig 6 12 Output Waveform of Optical Encoder

Table 6 1 Setting of PG Pulse Frequency Dividing Ratio

SW2*	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

6.5 PROTECTIVE CIRCUIT

SERVOPACK provides funtions 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 2 Trouble Detecting Functions

Trouble	Detection
Overcurrent	Overcurrent flow in the main circuit (at 1 2 times min inst max current)
Circuit Protector Trip	Circuit protector tripped
Regeneration Trouble	Regenerative circuit not activated in SERVOPACK • For 200V only 200 to 700W • For 100V only 100 to 300W
Overvoltage	Excessively high DC volatge in the main circuit • For 200V approx 420V • For 100V approx 220V
Overspeed	Excessively large speed reference input
Voltage Drop	Low DC voltage in the main circuit after power ON • For 200V approx 150V • For 100V approx 75V
Overload	Overload condition of motor and SERVOPACK
A/D Error	Element error on the printed circuit board of SERVOPACK
Overrun Prevention	Wrong wiring of motor circuit or PG signal line
CPU Error	Any error of CPU

(3) Overload (OL) detection level

Fig. 6.13 shows the setting of overload detection level at 100% rated motor current. For rated current 200% or more, the higher the motor speed is, the quicker the motor responce to the same overload.

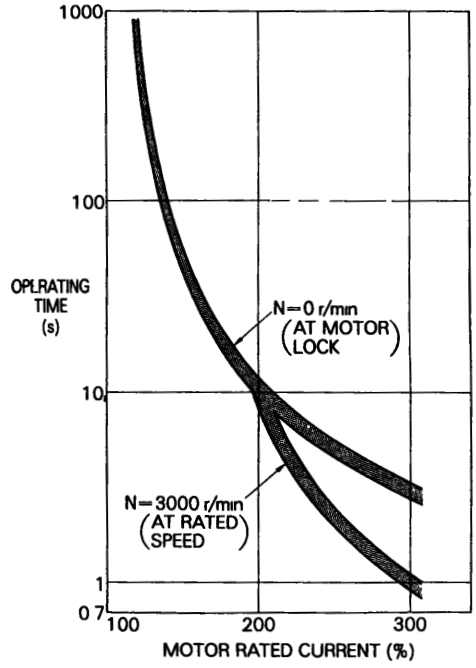


Fig 6 13 Overloard Characteristics

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

If any trouble detection circuits in Table 6.2 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 6.4.

(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, set the speed reference to 0 V 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 1. or 7. is on (SERVOPACK is over loaded), the reset alarm is not immediate and occurs a few minutes later.

6. 6 LED INDICATION

LED [MAIN] incorporated circuit protector and 7-segment LED show status of SERVOPACK and alarm.

Table 6 3 LED Status Indications

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

Table 6 4 Alarm Display and Alarm Output Code (SVALM and 3-bit Output)

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

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

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_L (GD_L^2)

The allowable load inertia J_L (GD_L^2) converted to the motor shaft must be within ten times the inertia of the applicable AC SERVOMOTOR. If the allowable inertia is exceeded, an 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 400/440V to single-phase 200 V or 100 V by using a power transformer. Table 6.6 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 Control

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.

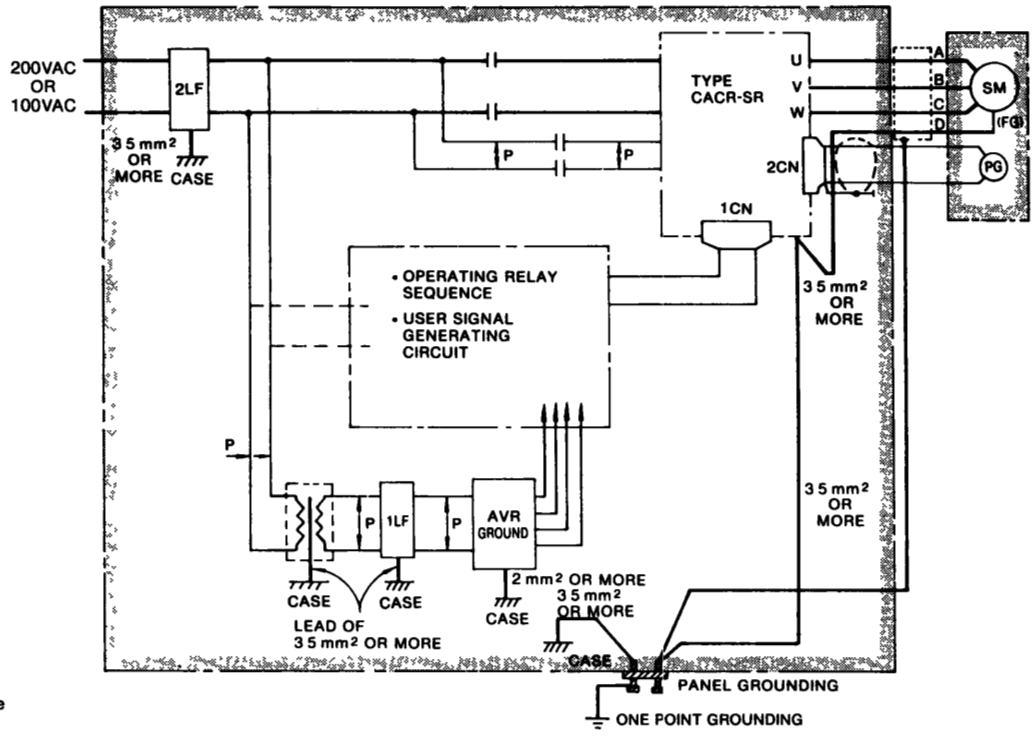
(1) Grounding method (Fig. 6.14)

- Motor frame grounding

  When the motor is at the machine side and grounded through the frame, Cf $\frac{dv}{dt}$ current flows from the PWM power through the floating capacity of the motor. To prevent this effect of current, motor ground terminal Ⓓ (motor frame) should be connected to terminal ⏚ of SREVOPACK. (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 6.5. 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. 5 Recommended Noise Filter

Class	SERVOPACK Type CACR-		Applicable Noise Filter	Recommended Noise Filter* Type	Specifications
200V	50W (0 07HP)	SRA5AB1 R	GOOD	LF-205A	Single-phase 200VAC class, 5A
	100W (0 13HP)	SR01AB1 R			
	200W (0 27HP)	SR02AB1 R			
	300W (0.40HP)	SR03AB1 R		LF-210A	Single-phase 200VAC class, 10A
	500W (0.67HP)	SR05AB1 R		LF-215A	Single-phase 200VAC class, 15A
	700W (0 93HP)	SR05AB1 .RY3			
100V	50W (0 07HP)	SRA5AB2 R	POOR	LF-205A	Single-phase 200VAC class, 5A
	100W (0 13HP)	SR01AB2 R			
	200W (0 27HP)	SR02AB2 R		LF-210A	Single-phase 200VAC class, 10A
	300W (0 40HP)	SR03AB2 R		LF-215A	Single-phase 200VAC class, 15A

*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.

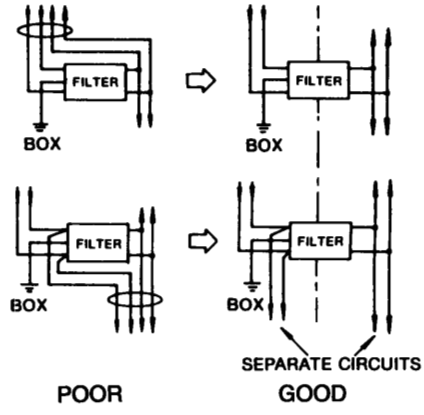


Fig 6 15

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

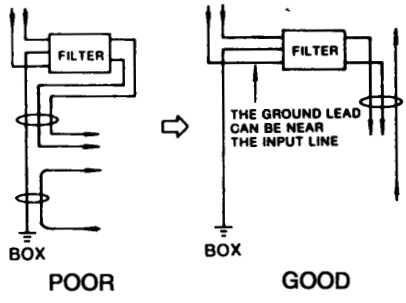


Fig 6 16

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

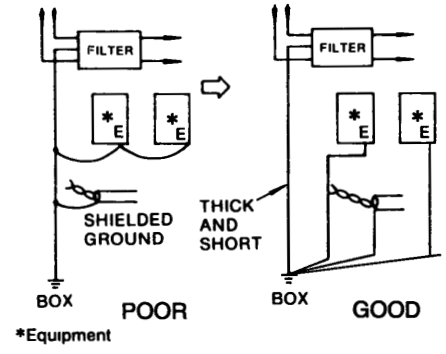


Fig 6 17

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

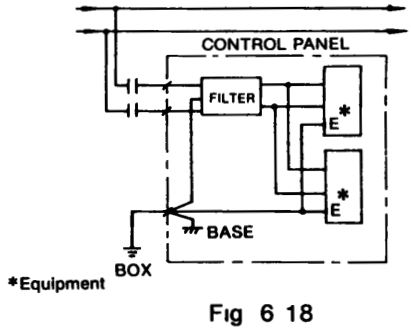


Fig 6 18

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 6.6).

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 6 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)	SRA5AB1. :R	0 3	5
	100 (0 13)	SR01AB1. :R	0 5	5
	200 (0 27)	SR02AB1. :R	0 75	5
	300 (0 40)	SR03AB1. :R	1 0	10
	500 (0 67)	SR05AB1. :R	1.4	15
	700 (0 93)	SR05AB1. :RY3	1 4	15
100V	50 (0.07)	SRA5AB2. :R	0 3	5
	100 (0 13)	SR01AB2. :R	0.5	5
	200 (0 27)	SR02AB2. :R	0.75	10
	300 (0 40)	SR03AB2. :R	1 0	15

*Values at rated load
† Interruption characteristics at 25°C 200% 2s or more
700% 0 01s or more
Note For short-circuit breaker, specify the high-speed type The time delay type is not applied

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 circuit 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.

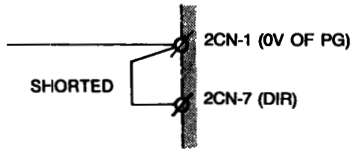


Fig 6 19

Note The connection between 2CN—1 and 2CN—7 should be made in cable side connector (MR-20F or MRP-20F01) as short as possible If this is not done an error may be occur due to noise

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 load at fullscale voltage (both swing).

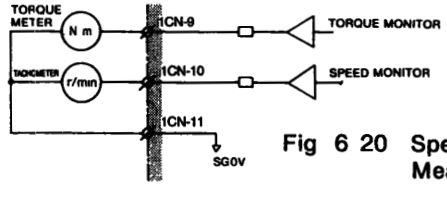


Fig 6 20 Speed and Torque Measurement

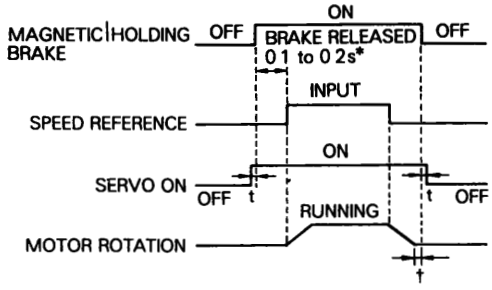
- Torque monitor output(1CN-9): ±3.0V ±10%/100% torque
- Speed monitor output(1CN-10): ±2.0V ±5%/1000 r/min
- Instrument: ±1 mA(both swing) ammeter. Use ammeter of DCF-6 or DCF-12N by Toyo Instrument or equivalent.

6 9 2 Speed and Torque Measurement (Cont'd)

- 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 50 ms

Fig 6 21 Magnetic Holding Brake ON-OFF Timing

7. INSTALLATION AND WIRING

7.1 RECEIVING

This motor has been put through stringent tests at the factory before shipment. After unpacking, however, check for the following.

- Its nameplate ratings meet your requirements.
- It has sustained no damage while in transit.
- The output shaft can be hand-rotated freely. However, the brake-mounted motor does not rotate since 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 contact your YASKAWA representative 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 off anticorrosive paint on shaft extension and flange surface with thinner before connecting the motor to the driven machine. See Fig. 7.1.

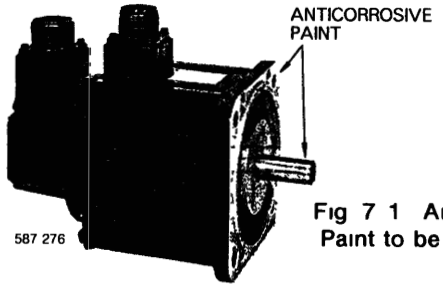


Fig 7 1 Anticorrosive Paint to be Removed

(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 maintenance 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° to +80°C

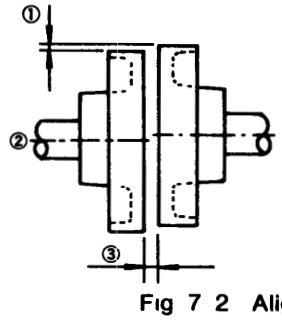
Humidity: 20% to 80% RH(non-condensing)

(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. 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 a staight-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 a thickness gage The maximum variation between any two readings should not exceed 0 03 mm

Fig 7 2 Alignment of Coupling

(5) Allowable bearing load

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

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

7 2.2 SERVOPACK

(1) Installation

The SERVOPACK type CACR-SR□□AB is rack-mounted type.

(2) Location

- When installed in a panel:

  Keep the ambient temperature around SERVOPACK at 55°C or below.

- When installed near a heat source:

  Keep the ambient temperature around SERVOPACK below 55°C.

- If subjected to vibration:

  Mount the unit on shock absorbing material.

- If corrosive gases are present:

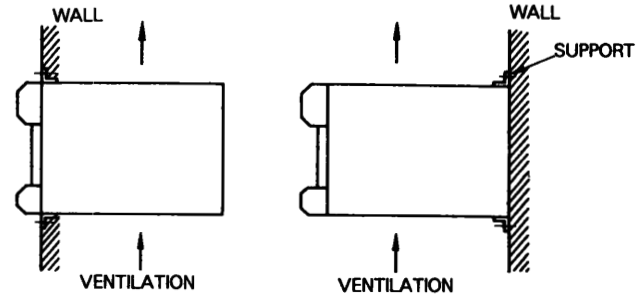
  Avoid locations where corrosive gases exist since it may cause extensive damage over long use. Especially vulnerable are switching operation of contactors and relays.

- 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. (See Fig. 7.5(a).) Install it with setscrews tightened at four mounting holes in the unit base. To change to base-mounted type, change the support position as shown in Fig. 7.5(b). Mounting screws of base support are attached to the SERVOPACK.



(a) Rack-mounted Type (b) Base-mounted Type

Fig 7 5 Mounting of SERVOPACK

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)									
			200V Class						100V Class			
			SRA5AB1	SR01AB1	SR02AB1	SR03AB1	SR05AB1	SR05AB1, RY3	SRA5AB2	SR01AB2	SR02AB2	SR03AB2
On Line	Main Circuit Power Input	ⓇⓉ	1 3	2 5	4 5	6 5	10 4		2 6	4 5	8 0	11 0
	Motor Connection*	ⓊⓋⓌ	1	1 4	2 8	3 7	5 3		1 7	2 3	4 3	6 0
	Control Power Input	ⓡⓣ	0 5									
Off Line	Control I/O Signal Connector	1CN	100mA DC max									
	PG Signal Connector	2CN	100mA DC max (500mA DC for power line only)									
	Ground	⏚	—									

*The unit of current is ±□ DC

Table 7.2 Recommended Cable Size of SERVOPACK

External Terminal		Type CACR- / Symbol	Cable Size mm²									
			200V Class						100V Class			
			SRA5AB1	SR01AB1	SR02AB1	SR03AB1	SR05AB1	SR05AB1, RY3	SRA5AB2	SR01AB2	SR02AB2	SR03AB2
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									
	Control Power Input	ⓡⓣ	HIV 1 25 or more									
Off Line	Control I/O Signal Connector	1CN	• Two-core twisted shielded cable • Core must be 0 2 mm² or more • Tin-plated soft-copper twisted cable • Finished cable dimension 16 dia or less for 1CN 11 dia or less for 2CN									
	PG Signal Connector	2CN										
	Ground	⏚	HIV 1 25 or more									

7.3.1 Rated Current and Cable Size (Cont'd)

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

SERVOPACK is a device for speed control of 1000:1, and signal level of several milli-volts or less. The following precautions should be taken when 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 noise filters, SERVOPACK and I/O reference as near as possible to each other.
- Make sure to mount a surge suppressing circuit into the relay, electromagnetic contact, and solenoid coils.
- Make sure to mount a surge absorbing circuit into the relay, electromagnetic contact, and solenoid coils.
- Run the power line and signal line, keeping the distance to 30 cm or more; do not run them in the same duct or in a bundle.
- When the same power is used for SERVOPACK, as for an electric welder or electrical discharge machine or when a high-frequency noise source is present in the vicinity, use filters in the power and input circuits.
- The SERVOPACK uses a switching amplifier, and spurious noise may be present in the signal line. Never leave the termination of the analog input wiring open.

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

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

(5) The signal line uses cables whose cores are 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 (GD^2_L) = 10 × J_M (GM^2_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-SR	Output Current ±ADC	Power Loss			
				Main Circuit W	Regenerative Resistance* W	Control Circuit W	Total W
200V	50 (0.07)	A5AB1 :R	1.0	20	—	30	50
	100 (0.13)	01AB1 :R	1.4	25	—		55
	200 (0.27)	02AB1 :R	2.8	30	6		66
	300 (0.40)	03AB1 :R	3.7	35	6		71
	500 (0.67)	05AB1 :R	5.3	55	6		91
	700 (0.93)	05AB1 :RY3	5.3	55	6		91
100V	50 (0.07)	A5AB2 :R	1.7	20	—		50
	100 (0.13)	01AB2 :R	2.3	25	6		61
	200 (0.27)	02AB2 :R	4.3	40	6		76
	300 (0.40)	03AB2 :R	6.0	50	6		86

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

8. DIMENSIONS

8. 1 SERVOMOTOR **DIMENSIONS** in mm (inches)

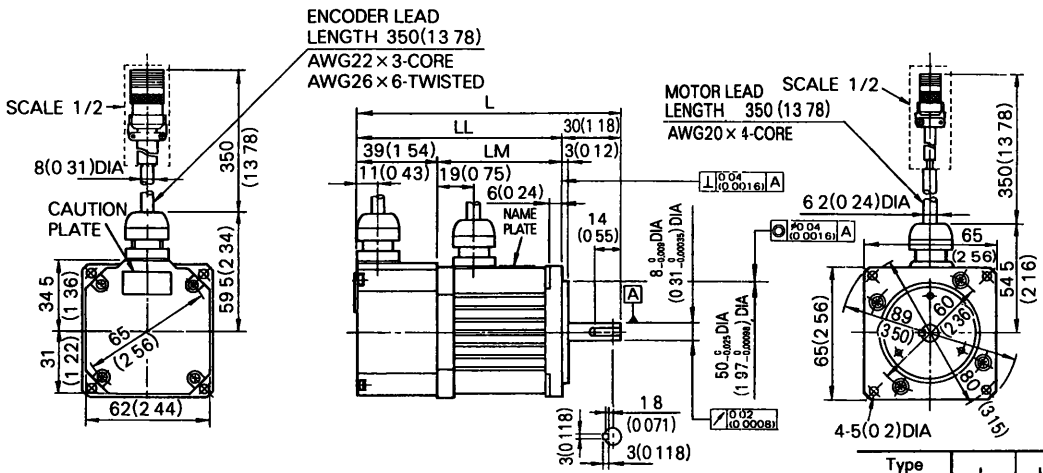
If the capacity is the same, the dimensions are the same even if the voltage or pulse specifications differ (100V, 200V, 1500 pulses or 1000 pulses).

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)

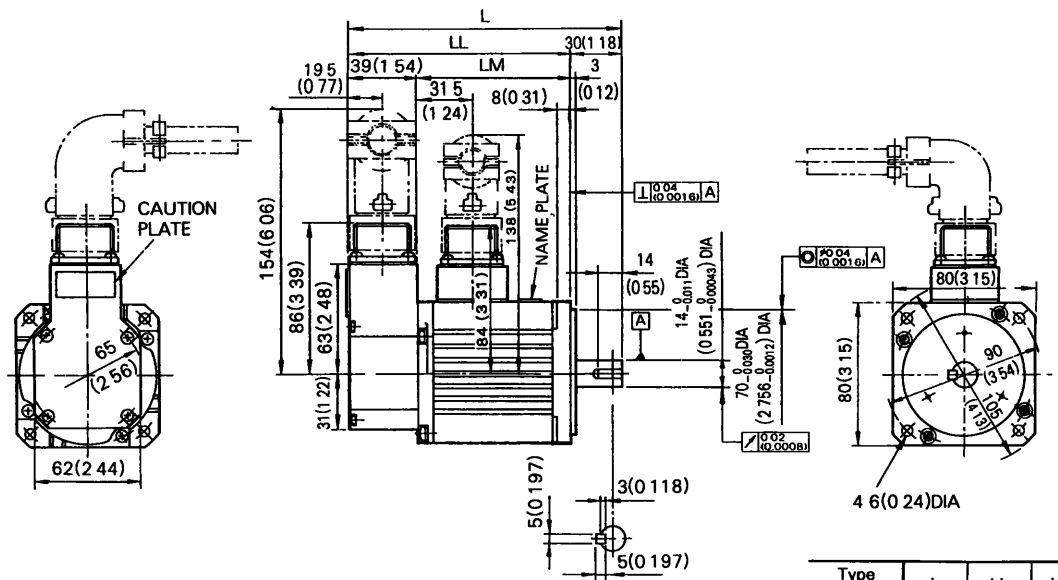
Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1031 "Sunk keys and their corresponding keyways)." Parallel key has been attached.

• 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)

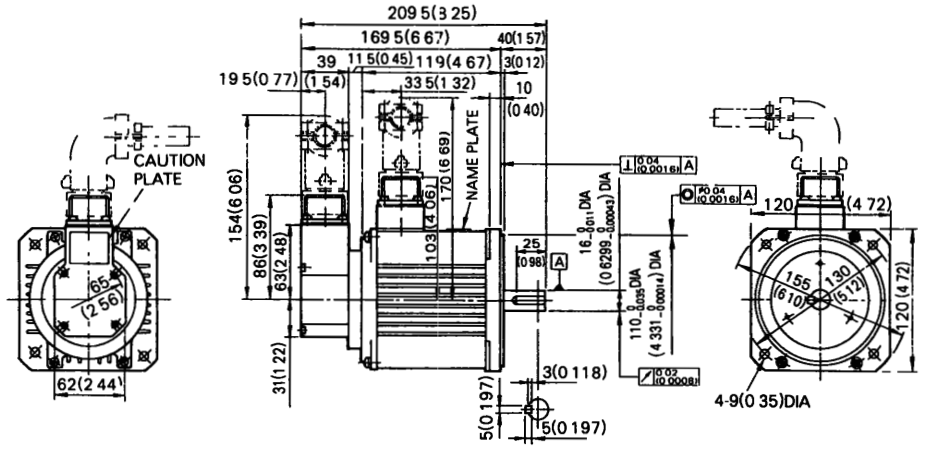
• TYPES USAREM-02□□2K, -03□□2K



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)

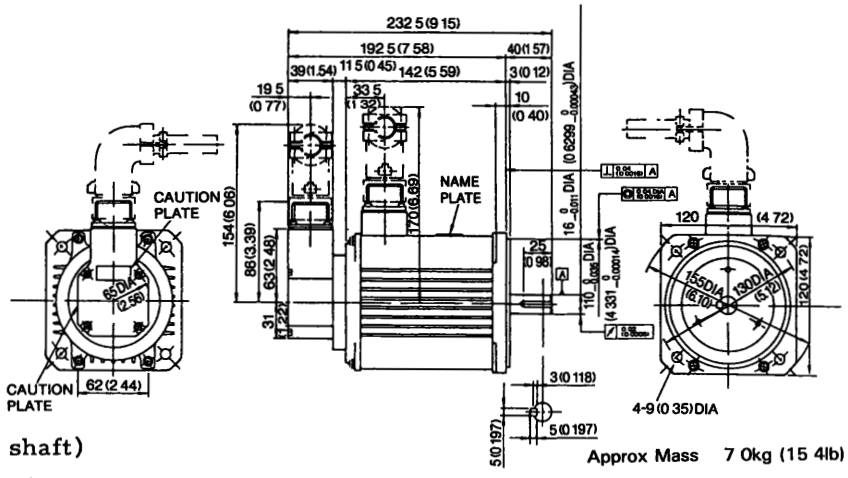
8. 1 SERVOMOTOR DIMENSIONS in mm (inches) (Cont'd)

• TYPE USAREM-05A□2K



Approx Mass 4 4kg (9 7lb)

• TYPE USAREM-07A□2K

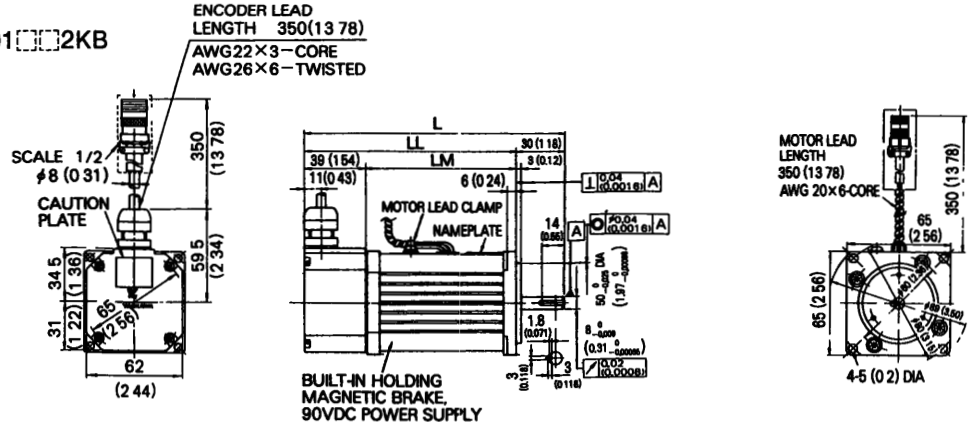


Approx Mass 7 0kg (15 4lb)

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

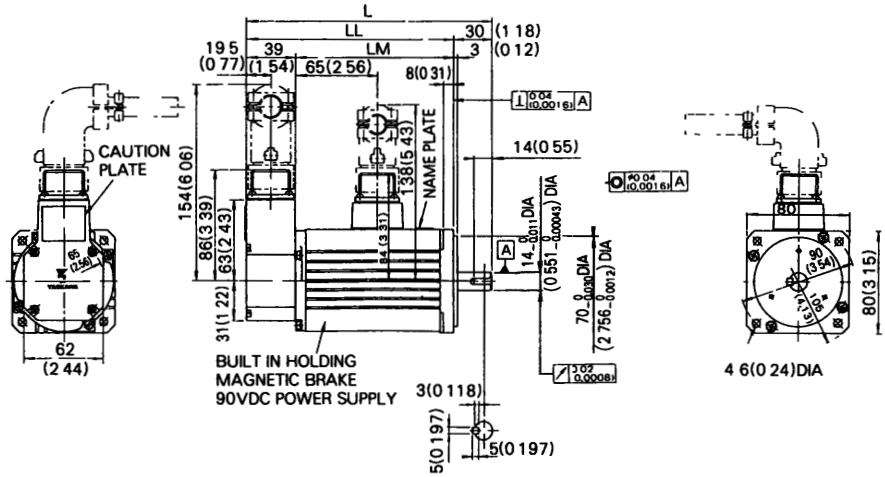
Dimensions of the keyway are based on JIS (Japanese Industrial Standard) B1031 "Sunk keys and their corresponding keyways)." Parallel key has been attached.

• TYPES USAREM-A5□□2KB, 01□□2KB



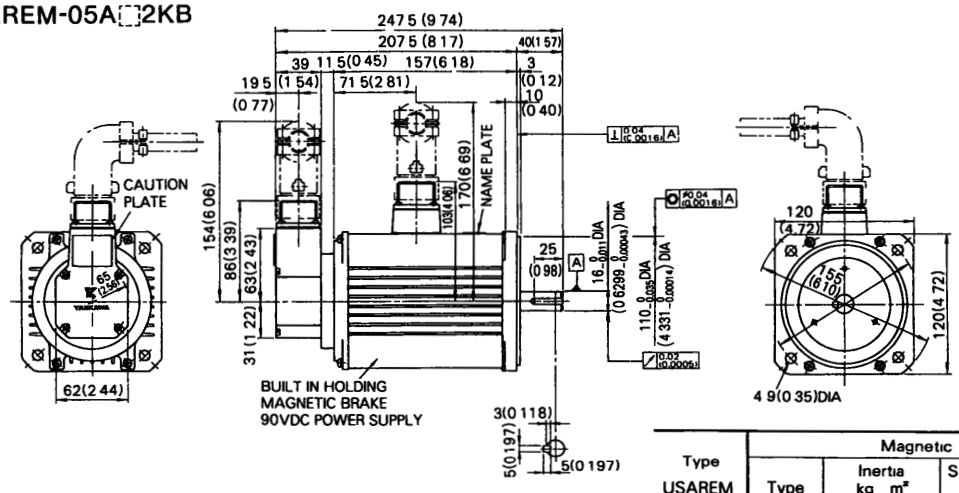
Type USAREM-	Dimensions			Magnetic Brake				Approx Mass kg (lb)
	L	LL	LM	Type	Inertia kg m² (oz in s²×10⁻³)	Static Friction Torque N m (oz in)	Voltage VDC	
A5□□2KB	164 5 (6 48)	134 5 (5 30)	95 5 (3 76)	MSB/ 90-6YN	0 052×10⁻⁴ (0 733)	0 59 (83 3)	90	1 4 (3 09)
01□□2KB	182 (7 17)	152 (5 99)	113 (4 45)					1 7 (3 75)

• TYPES USAREM-02□□2KB, -03□□2KB



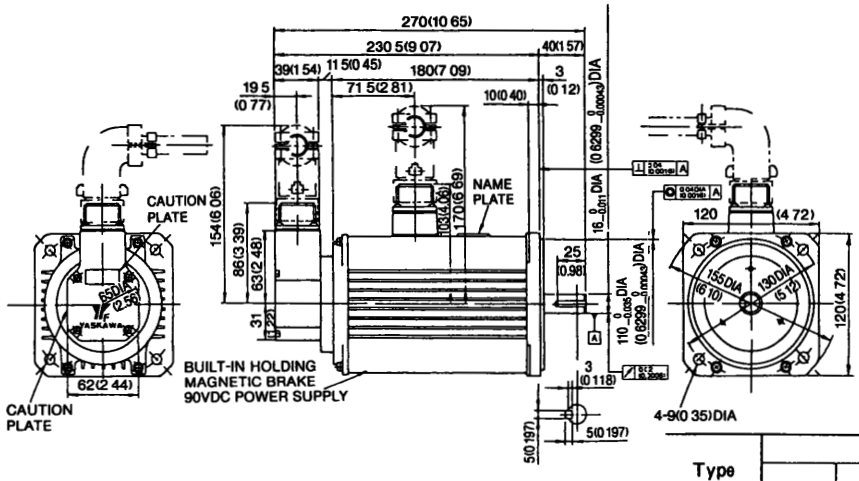
Type USAREM-	Dimensions			Magnetic Brake				Approx Mass kg (lb)
	L	LL	LM	Type	Inertia kg m² (oz in s²×10⁻³)	Static Friction Torque N m (oz in)	Voltage VDC	
02□□2KB	194 (7 64)	164 (6 46)	125 (4 92)	MSB/ 90 20YN	0 1925×10⁻⁴ (2 73)	1 96 (278)	90	2 7 (5 95)
03□□2KB	218 (8 58)	188 (7 40)	149 (5 87)					3 3 (7 28)

• TYPE USAREM-05A□2KB



Type USAREM	Magnetic Brake				Approx Mass kg (lb)
	Type	Inertia kg m² (oz in s²×10⁻³)	Static Friction Torque N m (oz in)	Voltage VDC	
05A□2KB	MSB/ 90-30YN	0 4823×10⁻⁴ (6 83)	2 94 (417)	90	5 5 (12 16)

• TYPE USAREM-07A□2KB



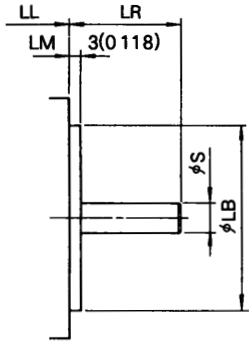
Type USAREM-	Magnetic Brake				Approx Mass kg (lb)
	Type	Inertia kg·m² (oz·in·s²×10⁻³)	Static Friction Torque N·m (oz·in)	Voltage VDC	
07A□2KB	MSB/ 90-30YN	0 4823×10⁻⁴ (6 83)	2 94 (417)	90	8 1 (17 8)

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

(3) Shaft Externsion of Straight Shaft

- TYPE USAREM-A5[ ][ ]2 to -05[ ][ ]2 (without brake)
- TYPE USAREM-A5[ ][ ]2B to -05A[ ]2B (with brake)

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

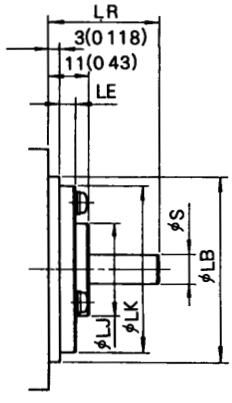


Without Brake Type USAREM-	With Brake Type USAREM-	LR	S	LB
A5[ ][ ]2	A5[ ][ ]2B	30 (1 18)	$8\ ^{0}_{-0009}$ ($0\ 31\ ^{0}_{-0\,00035}$)	$50\ ^{0}_{-0025}$ ($1\ 97\ ^{0}_{-0\,00098}$)
01[ ][ ]2	01[ ][ ]2B			
02[ ][ ]2	02[ ][ ]2B		$14\ ^{0}_{-0011}$ ($0\ 551\ ^{0}_{-0\,00043}$)	$70\ ^{0}_{-0030}$ ($2\ 756\ ^{0}_{-0012}$)
03[ ][ ]2	03[ ][ ]2B			
05A[ ]2	05A[ ]2B	40 (1 57)	$16\ ^{0}_{-0011}$ ($0\ 6299\ ^{0}_{-0\,00043}$)	$110\ ^{0}_{-0035}$ ($4\ 331\ ^{0}_{-0\,00014}$)
07A[ ]2	07A[ ]2B			

(4) Shaft Extension of Straight Shaft with Shaft Seal

- TYPE USAREM-A5[ ][ ]2S to -05A[ ]2S (without brake)
- TYPE USAREM-A5[ ][ ]2SB to -05A[ ]2SB (with brake)

SERVOMOTOR proper is the same dimensions as stanard 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)	$8\ ^{0}_{-0009}$ ($0\ 31\ ^{0}_{-0\,00035}$)	$50\ ^{0}_{-0025}$ ($1\ 97\ ^{0}_{-0\,00098}$)	SB08187
01[ ][ ]2S	01[ ][ ]2SB							
02[ ][ ]2S	02[ ][ ]2SB			36 (1 42)	60 (2 36)	$14\ ^{0}_{-0011}$ ($0\ 551\ ^{0}_{-0\,00043}$)	$70\ ^{0}_{-0030}$ ($2\ 756\ ^{0}_{-0012}$)	SB14287
03[ ][ ]2S	03[ ][ ]2SB							
05A[ ]2S	05A[ ]2SB	40 (1 57)	25 (0 10)	50 (1 97)	73 (2 87)	$16\ ^{0}_{-0011}$ ($0\ 6299\ ^{0}_{-0\,00043}$)	$110\ ^{0}_{-0030}$ ($4\ 331\ ^{0}_{-0\,00014}$)	SB16307
07A[ ]2S	07A[ ]2SB							

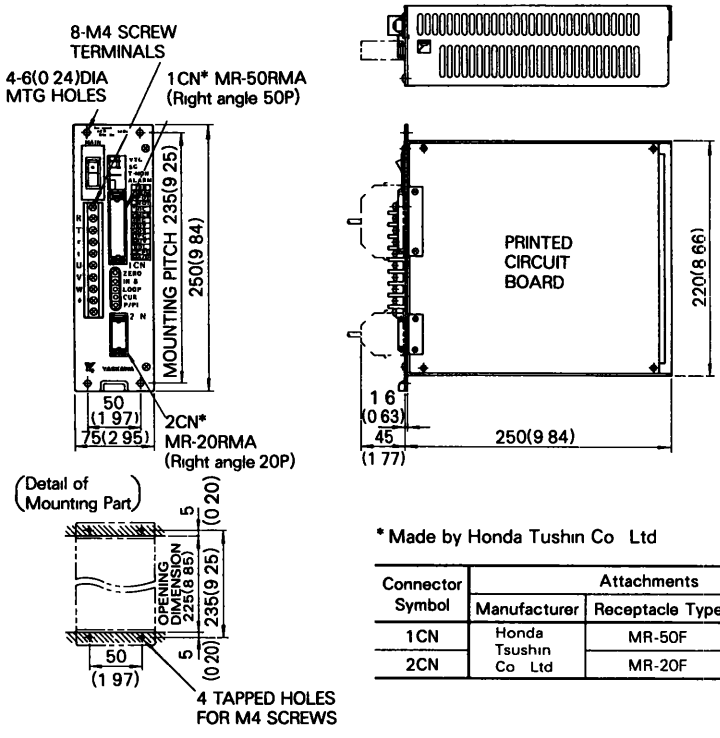
* Nippon Oil Seal Industry Co Ltd

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

SERVOMOTOR proper and shaft extension are same dimensions as standard SERVOMOTOR. See Pars. 8.1 (1) and (2). Shaft seal is same dimensions as shown in Par. 8.1 (4).

8.2 SERVOPACK **DIMENSIONS** in mm (inches)

- TYPES CACR-SRA5AB1□R, -SR01AB1□R (200 V)
- TYPES CACR-SRA5AB2□R (100 V)

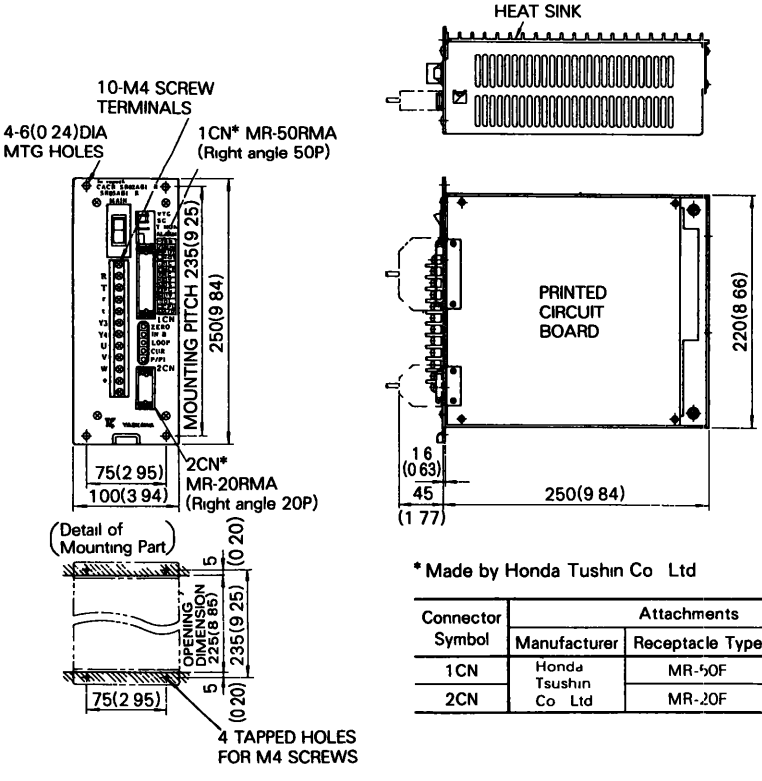


*Made by Honda Tushin Co Ltd

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

Approx Mass 2 8kg (6 16lb)

- TYPES CACR-SR02AB1□R TO -SR05AB1□RY3(200V)
- TYPES CACR-SR01AB2□R TO -SR03AB2□R(100V)



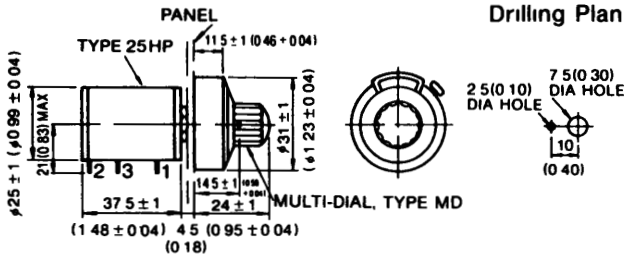
*Made by Honda Tushin Co Ltd

Approx Mass 3 6kg (7 92lb)

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

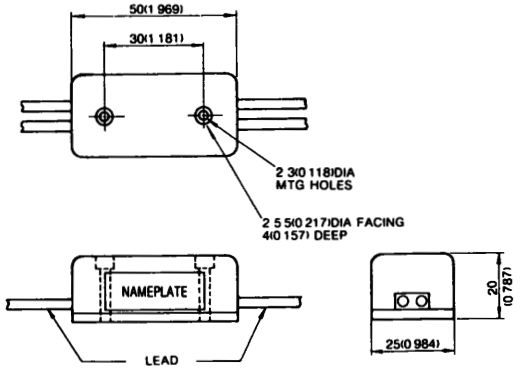
8. 3 PERIPHERAL EQUIPMENT in mm (inches)

(1) Variable Resistor for Speed Setting Type 25HP-10B



(2) Power Supply for Brake

- Input 100 VAC, 90 VDC, Max 1 0 ADC (B 9400876-2) Type LPDE-1H01
- Input 200 VAC, 90 VDC, Max 1 0 ADC (B 9400876-1) Type LPSE-2H01



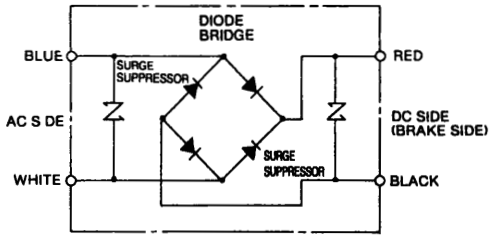
Lead length 500mm (19 69) each

Lead color

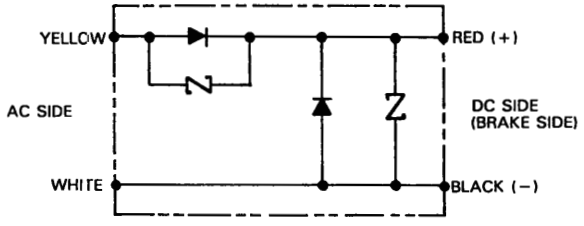
AC input Side		Brake Side
100V	200V	
Blue White	Yellow White	Red Black

Max ambient temperature 60°C

- For 100 VAC (LPDE-1H01)



- For 200 VAC (LPSE-2H01)



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 tightened.
- For motors with shaft seals, the seals are not damaged and motor 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 outputs alarm.
- Voltage supplied to SERVOPACK is 200 to 230V $^{+10}_{-15}$% or 100 to 115 V $^{+10}_{-15}$%.
- The speed reference should be 0 V (speed reference circuit is short-circuited.)

9.2 TEST RUN PROCEDURES

9.2.1 Preparation for 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 itmes 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 for approximately 1 second.

- When the power is correctly supplied, 7-segment LED [-.] and LED in MCCB light.
- When a Servo ON signal is input (correct 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.

- Increase the speed reference voltage gradually from 0 V, then the motor will rotate at a speed proportional to the reference voltage.
- When the reference voltage is positive, the motor rotates forward(counterclockwise viewed from drive end-output shaft) (Fig. 9.1).

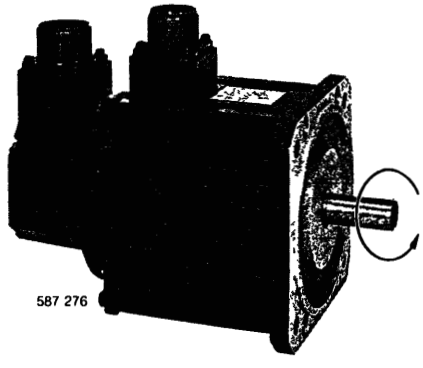


Fig 9 1 Motor Forward Running

9 2 3 Inspection during Test Run

The following items should be checked for during the test run.

- Unusual vibration
- Abnormal noise
- Excessive temperature rise

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

10. ADJUSTMENT

10.1 SETTINGS AT THE TIME OF DELIVERY

The SERVOPACK has been factory-adjusted as follows:

Table 10.1 Standard Adjustment and Setting Specifications

Class V	Rated Output W (HP)	SERVOPACK Type CACR-	Applicable SERVOMOTOR			SERVOPACK Adjustment		
			Type USAREM-	Optical Encoder pulses/rev	Rated Current ± ADC	Speed Setting	Starting Currnet Setting ± A	PG Frequency Dividing Ratio
200	50 (0.07)	SRA5AB1ER SRA5AB1FR	A5AE2 A5AF2	1500 1000	1 0	3000 r/min at rated speed reference	3 0	× 1
	100 (0 13)	SR01AB1ER SR01AB1FR	01AE2 01AF2	1500 1000	1 4		4 0	
	200 (0 27)	SR02AB1ER SR02AB1FR	02AE2 02AF2	1500 1000	2 8		8 0	
	300 (0 40)	SR03AB1ER SR03AB1FR	03AE2 03AF2	1500 1000	3 7		11 0	
	500 (0.67)	SR05AB1ER SR05AB1FR	05AE2 05AF2	1500 1000	5 3		16 0	
	700 (0 93)	SR05AB1ERY3 SR05AB1FRY3	07AE2 07AF2	1500 1000	5 3		16 0	
100	50 (0 07)	SRA5AB2ER SRA5AB2FR	A5BE2 A5BF2	1500 1000	1 7		5 0	
	100 (0 13)	SR01AB2ER SR01AB2FR	01BE2 01BF2	1500 1000	2 3		7 0	
	200 (0.27)	SR02AB2ER SR02AB2FR	02BE2 02BF2	1500 1000	4 3		12 0	
	300 (0 40)	SR03AB2ER SR03AB2FR	03BE2 03BF2	1500 1000	6 0		16 0	

Table 10.2 Standard Factory-adjusted Switch Settings

SERVOPACK				SW1 (16P Setting Switch)	SW2 (Hexadecimal Digital Switch)	SEL1	SEL2	SEL3
						(3P Setting Switch)		
Class		Rated Output W(HP)	Type CACR-	Optical Encoder Pulse Setting	Dividing Ratio Setting	f/V Filter Time Constant Setting	Mode Switch (MS) Level Setting	MS/P-PI Selection
Standard	200V	50 (0 07) 100 (0 13) 200 (0 27) 300 (0 40) 500 (0 67) 700 (0 93)	SRA5AB1ER SR01AB1ER SR02AB1ER SR03AB1ER SR05AB1ER SR05AB1ERY3	1500 pulses/rev 1 2 3 4 5 6 7 8 ●●●●●●○○ ●●●●●●○○	1/1 [0]	0 6ms 1 2 3 ●●○	200 % 1 2 3 ○○○	MS Selection 1 2 3 ●●○
	100V	50 (0 07) 100 (0 13) 200 (0 27) 300 (0 40)	SRA5AB2ER SR01AB2ER SR02AB2ER SR03AB2ER					
Optional	200V	50 (0 07) 100 (0 13) 200 (0 27) 300 (0 40) 500 (0 67) 700 (0 93)	SRA5AB1FR SR01AB1FR SR02AB1FR SR03AB1FR SR05AB1FR SRO5AB1FRY3	1000 pulses/rev 1 2 3 4 5 6 7 8 ●●●●●○○○ ●●●●●○○○				
	100V	50 (0 07) 100 (0 13) 200 (0 27) 300 (0 40)	SRA5AB2FR SR01AB2FR SR02AB2FR SR03AB2FR					

● Short-circuited ○ Open

Table 10. 3 Standard Factory-adjusted Potentiometer Setting

SERVOPACK			VR1 [IN-B]	VR3 [ZERO]	VR5 [CUR]	VR6 [LOOP]	VR8 [P/PI]
Class V	Rated Output W (HP)	SERVOPACK Type CACR-	Auxiliary Input Setting	Zero Drift Setting	Max Current Setting	Loop Gain Setting	P/PI Operation Setting
200	50 (0 07)	SRA5AB1 ⬚ R	(For setting by the user)	4 to 6/10	(For setting by the user)	6/10	(For setting by the user)
	100 (0 13)	SR01AB1 ⬚ R					
	200 (0 27)	SR02AB1 ⬚ R					
	300 (0 40)	SR03AB1 ⬚ R					
	500 (0 67)	SR04AB1 ⬚ R					
	700 (0 93)	SR05AB1 RY3					
100	50 (0 07)	SRA5AB2 ⬚ R	0/10min		10/10max		10/10max
	100 (0 13)	SR01AB2 ⬚ R					
	200 (0 27)	SR02AB2 ⬚ R					
	300 (0 40)	SR03AB2 ⬚ R					

Notes

1 In the Table above, ⬚ shows approximate scale of potentiometer
For example,  indicates 7/10 scale

2 The potentiometers other than listed in the Table above are provided for SERVOPACK Do not tamper with these with these potentiometers except for a special case as they have been preset at the factory

10. 2 CHARACTERISTICS AT THE TIME OF DELIVERY

The SERVOPACK has been factory-adjusted as follows:

(1) Speed reference input-servomotor speed ratio (no load) (Fig. 10.1)

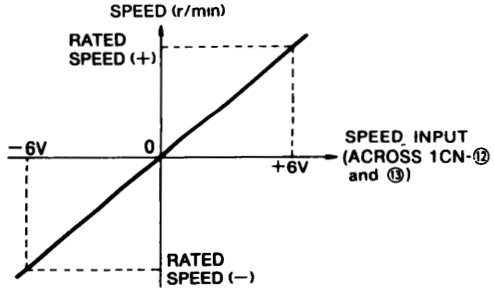


Fig 10 1 Speed Reference Input—SERVOMOTOR Speed Ratio

(2) Speed Variation (Fig. 10.2)

Speed variation ΔN, Δn:

$$\frac{\Delta N}{N_R} \times 100\,\% \leqq 0\ 1\ \%$$

$$\frac{\Delta n}{N_R} \times 100\,\% \leqq 0\ 05\ \%$$

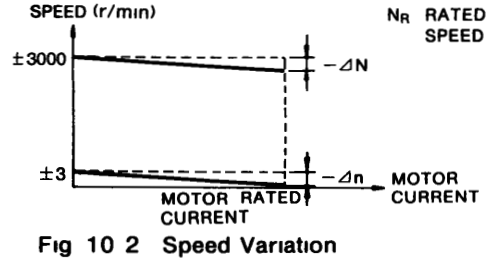


Fig 10 2 Speed Variation

10. 2 CHARACTERISTICS AT THE TIME OF DELIVERY (Cont'd)

(3) Start-stop characteristics (Fig. 10.3)

I_P: Start current set value in Table 10.1. The overshoot (ΔN_{OV}) and undershoot (ΔN_{UD}) when load inertia $J_L(GD^2_L)$ = motor inertia $J_M(GD^2_M)$, are as shown in **Table 10.4** (adjustment level preset at the factory).

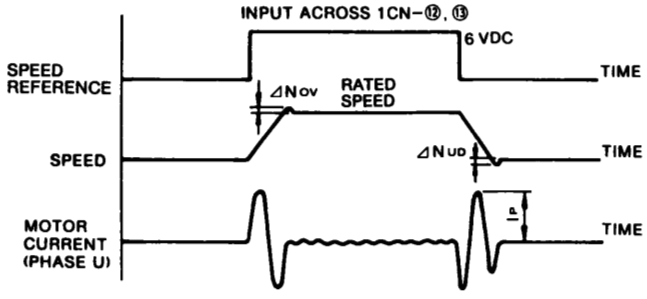


Fig 10 3 Start–Stop Characteristics

Table 10 4 Overshoot and Undershoot at Step Response

Type CACR-	$\Delta N_{OV} \times 100$	$\Delta N_{UD} \times 100$
SRA5AB	5% max	5% max
SR01AB		
SR02AB		
SR03AB		
SR05AB		
SR05AB1[ ]RY3		

10. 3 READJUSTMENT

The SERVOPACK has been adjusted at the factory to obtain optimum characteristics, and readjustment is normally unnecessary. If adjustment is required depending on the use, readjust the SERVOPACK referring to Table 10.5. (Do not tamper with potentiometers.)

10. 4 ADJUSTMENT PROCEDURES

Fig. 10.4 shows the arrangement of potentiometers, and terminals for checking waveforms; Table 10.5 shows potentiometer adjustment; and Table 10.6 lists check terminals and functions.

Adjust the potentiometers, observing the specified check locations. (Potentiometers should not be tampered with.) Fig. 10.5 shows waveforms at the respective check terminals for step responses at no load.

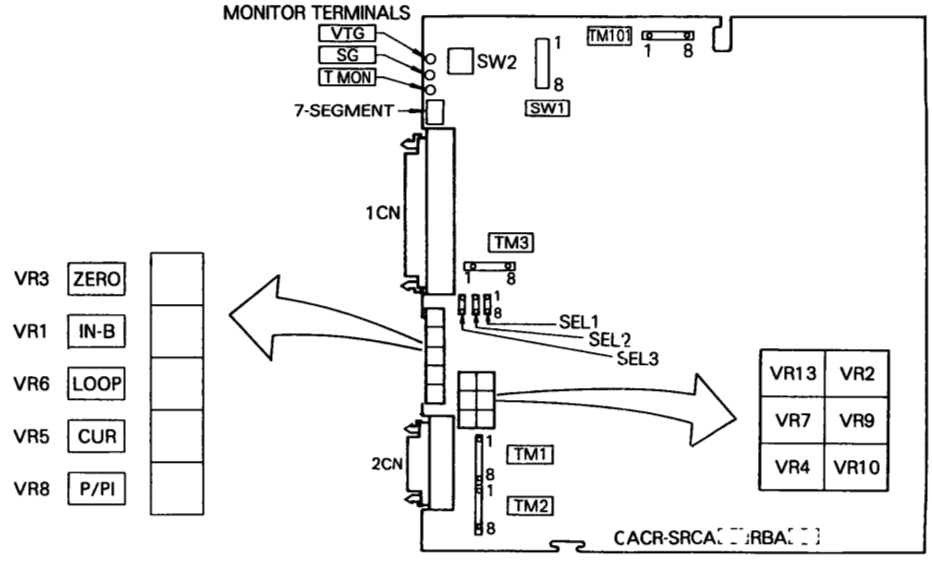
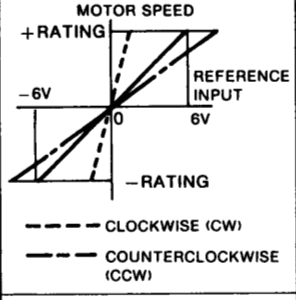
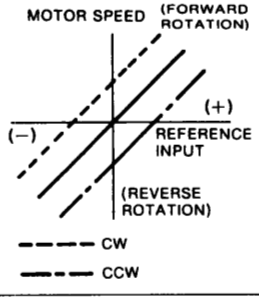


Fig 10 4 Printed Circuit Board for SERVOPACK Type CACR-SRCA[ ]RBA

Table 10 5 Potentiometer Adjustment

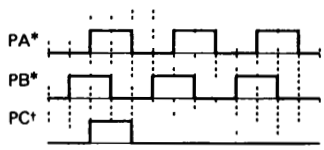
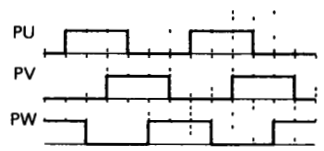
Potentiometer	VR1 [IN-B]	VR4	VR3 [ZERO]	VR5 [CUR]
Functions	Auxiliary input adjustment	Proportional gain adjustment	Zero drift adjustment	Starting current adjustment
How to Adjust	To be adjusted only when the rated reference voltage (±2 to ±10V) is other than ±6V Turn only to get the rated speed and do not operate other VRs	Turning CW increases proportional gain Start/ stop by the motor step input Adjust so that the overshoot and undershoot decreases	To adjust so that the motor does not turn at the speed reference voltage 0V Turning CW allows the motor to be finely adjusted in forward rotation and CCW in reverse rotation	Turning CW increases the starting current This has been adjusted to full scale CCW at the factory
Characteristics		• If the proportional gain is too high, overshoot or undershoot increases • If the proportional gain is too low, rise or fall time is unstable		–
Adjustment	○	△	○	△

Potentiometer	VR6 [LOOP]	VR8 [P/PI]	VR21
Functions	Speed loop gain adjustment	P/PI Selection adjustment	PG 5V voltage adjustment
How to Adjust	To increase gain, turn CW	For special purpose	Turning CW increases voltage It is set at factory
Characteristics	Turn CCW to prevent hunting	–	If wiring to optical encoder is long causing voltage drop, increase voltage (6V or below)
Adjustment	○	△	△

Adjustment Directions
Mark ○ Potentiometer should be adjusted in accordance with specifications and applications
Mark △ Potentiometer should not be adjusted except in special cases

Do not tamper with following potentiometers as they have been set at the factory
- VR2 VR9 VR10 (For speed feedback adjustment)
- VR7 (For max motor current adjustment)
- VR13 (For current offset adjustment)

Table 10 6 Check Terminal Functions

Equipment Symbol		Signal Name	Description		
TM1	1	PA	PG input signal	Phase A pulse input	• Waveform at motor forward running  *Two phase pulse with 90° phase difference †One generation per motor turning Synchronizing with PA
	2	*PA		Phase A reverse input	
	3	PB		Phase B pulse input	
	4	*PB		Phase B reverse input	
	5	PC		Phase C pulse input	
	6	*PC		Phase C reverse input	
	7	–	Not used		
	8	PG5V	Optical encoder (PG) power supply volatge +5 25V ±50mV		
TM2	1	PU	Phase U pulse input from pole sensor		• Waveform at motor forward running 
	2	*PU	Phase U reverse input		
	3	PV	Phase V pulse input from pole sensor		
	4	*PV	Phase V reverse input		
	5	PW	Phase W pulse input from pole sensor		
	6	*PW	Phase W reverse input		
	7	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)		
TM3	1	IN-A	For monitoring of speed reference input (connector 1CN between ⑫ and ⑬)		
	2	IN-B	For monitoring of speed reference aux input (connector 1CN between ⑭ and ⑮)		
	3	VTG	Motor speed monitoring ±2 0 VDC ±5%/1000 r/m n		
	4	T-MON	Motor torque monitoring ±3 0VDC ±10%/100% torque		
	5	Iu	Current monitoring	Phase U	
	6	Iv		Phase V	
	7	Iw		Phase W (synthesis of Iu and Iv)	
	8	SG	Signal 0V		

	200 V					100 V			
Type	A5	01	02	03	05	A5	01	02	03
V/A	0 8		0 4		0 2	0 8		0 4	

TM101	1	+16V	Control power +16V (16 1 ±0 1V)
	2	–	–
	3	+15V	Control power +15V(±5%)
	4	+5VP	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
TM102	1	Valm	Alarm detection voltage(6 385V ±10mV)
	2	–	–
	3	0alm	For observation of TM102-1

CH1	VTG	±2 0VDC ±5%/1000 r/min	Check terminal on front panel (For user s monitor)
CH2	T-MON	±3 0VDC ±10%/100% torque	
CH3	SG	Signal 0V	

Notes
1 Do not attempt to adjust except check terminal (with buffer amplifier) on front panel
2 The check terminal on front panel is measured by oscilloscope For other check terminal measurements do not connect the adjacent two check terminals If connected the electrical parts may be damaged

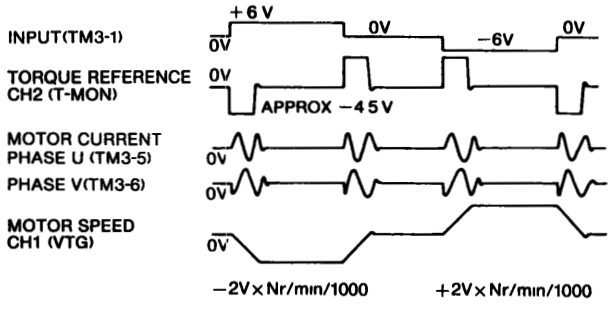


Fig 10 5 Waveforms at the Respective Check Terminals for Step Responses (No Load)

10. 5 SWITCH SETTING

The four switches(SW1 , SEL1 , SEL2 , SEL3) and hexadecimal digital switch SW2 , have the following functions:

Table 10 7 SW1 Setting and Functions

Setting Switch	No	Contents	With Short-circuited	With Open
SW1	1	Motor setting	6P, 3000 r/min*	2P, 8000 r/min
	2	Phase compensation	20°*	0°
	3	TG ON level	1 % (approx 45 r/min)*	10 % (approx 450 r/min)
	4	OT mode	DB operation*	NO DB operation
	5	PWM phase shift	0μs*	20 μs
	6	PG pulse	1500 pulses/rev*	1000 pulses/rev
	7	Test mode	Test mode (User disable)	Normal operation*
	8			

* Standard factory-adjusted switch setting

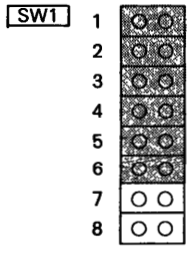


Table 10 8 SW2 (digital switch) Setting and Functions

SW2 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	–	–	–

* Standard factory-adjusted switch setting

10. 5 SWITCH SETTING (Cont'd)

Table 10 9 SEL Setting and Functions

SEL	Setting	Functions
SEL1	* 1 2 3 ○ ● ● ○	0 6 ms
	1 2 3 ○ ● ● ●	1 1 ms
	1 2 3 ○ ○ ○ ○	0 6 ms
SEL2	1 2 3 ● ● ○	No MS
	1 2 3 ○ ● ● ●	Variable MS level
	* 1 2 3 ○ ○ ○ ○	MS level 200 %
SEL3	* 1 2 3 ● ● ○ ○	MS operation
	1 2 3 ○ ● ● ●	IN-B input P/PI control
	1 2 3 ○ ○ ○ ○	Normally MS ON (P operation)

* Standard factory-adjusted 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	Annually	Make sure that it is more than 10MΩ by measuring with a 500V megger after disconnecting the motor from the controller	
Shaft Seal	Every 5,000 hours	Replace shaft seal	
Overhaul	Every 20,000 hours or 5 years	If worn or damaged, replace after disconnecting the motor form the driven machine Contact your YASKAWA representative	

· Parts Replacement Schedule

The following parts should be replaced periodically since they may become worn mechanically

Table 11 2 Parts Replacement Schedule

Part Name	Interval	Remarks
Bearing	20,000 hours	Disassemble the motor to replace with new one
Shaft Seal	5,000 hours	Replace with new one

11. 2 SERVOPACK

SERVOPACK does not require daily maintenance However, it is advisable to perform the following maintenance at least once a year

However, when the SERVOPACK is overhauled by YASKAWA, check the user constants before running since they are reset to the standard setting

Table 11 3 Inspection Schedule for SERVOPACK

Inspection Item	Frequency	Operation	Corrective Action
Cleaning of SERVOPACK and board	Every 1 year	Visually check for dust or oil on parts	Clean with dry cloth or compressed air
Loose screws		Check for loose screws of terminals and connectors of 1CN and 2CN of SERVOPACK	Retighten
Deterioration of SERVOPACK and/or parts on board		Visually check for discoloration, brakage or disconnection resulting from heat, bumping, etc	Conatct your YASKAWA representative
Cooling fan		Check if the fan rotates normally	

· Parts Replacement Schedule

The following parts should be replaced periodically since they may become worn mechanically or deteriorated with age

Table 11 4 Parts Replacement Schedule

Part Name	Interval	Remarks
Smoothing capacitor	7 to 8 years	Replace with new one (Decided after inspection)
Circuit protector or relays	—	Upon inspecton, decided whether they should be replaced
Aluminum electrolytic capacitor on PC board	5 years	Replace with new one (Decided after inspection)

Note Optimum operating environment is as follows
Ambient temperature 30°C on average
Load factor 80% or less
Operating rate 20 hours or less per day

12. TROUBLESHOOTING GUIDE

12.1 AC SERVOMOTOR

WARNING

Corrective actions in ▭ should be performed after turning OFF the power

Table 12.1 Troublesooting Guide for AC SERVOMOTOR

Trouble	Cause	Corrective Action
Motor does not start	Loose connection	Tighten connection
	Wrong wiring	Correct wiring
	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 with driven machine
	Coupling out of balance	Balance coupling
	Noisy bearings	Check alignment, loading of bearing, lubrication and contact Yaskawa representative
	Vibration of driven machine	Contact the machine manufacturer

12. 2 SERVOPACK

12 2 1 LED Indication (7-segment) for Troubleshooting

Table 12 2 LED Indication 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 (1PWB)	• Replace the SERVOPACK
		Goes ON when power is supplied to the main circuit	• Defective main circuit 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 ransistor	• Replace the SERVOPACK
			• Regenerative resistor disconnection	• Check and replace the regenerative resistor (Replace the SERVOPACK)
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
6.	Voltage drop	Goes ON when power is supplied to the main circuit	• Defective main circuit doide 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

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

LED	Detection	Lighting Condition	Probable Cause	Corrective Action
b.	A/D error	Goes ON when power is supplied to the control circuit	• Defective control circuit board (1 PWB)	• Replace the SERVOPACK
-	CPU error	Goes ON during operation	• Faulty internal elements	• Resume after reset operation
			• Defective internal elements	• Replace the SERVOPACK
C.* 1.	Overrun prevention	The motor does not rotate, and C and 1 blink alternately when the servo power is turned ON	• Encoder cables are broken • Contact fault of connector or defective encoder	• Replace the cable • Check the signal in phases U, V, and W
C.* 2.		Blink alternately after the motor rotates momentarily at starting or during operation	• Wrong combination of motor and Servopack • Disconnection, contact fault, connection error, defective encoder	• Check and correct the combination • Check and correct pulses in phases A, B, U, V, and W • Correct the connection
4.		• Blink alternately after the motor rotates momentarily at starting • Blink alternately during operation	• Wiring error —	• Correct the wiring • Contact your YASKAWA representative

*The LED C displays one of three type indications according to the trouble conditions
These displays will blink alternately between C and 1, 2 or 4

12 2 2 Examples of Troubleshooting for Defective Wiring or Parts

Table 12 3 Example of Troubleshooting for Defective Wiring or Parts

Trouble	Check Items	Corrective Action
MCCB trips immediately after Power ON and Servo ON	• Main circuit wiring (such as motor grounding)	• Correct the wiring
The reference is input, but the motor does not run	• Voltage across ®, and Ⓣ	• Check the AC power supply circuit
	• Trouble LED OFF	• If LEDs are ON, check the cause
	• Speed reference voltage • P-CON, N-OT, P-OT, S-ON signal	• Adjust the speed setting potentiometer (supplied by the user)

12 2 3 Examples of Troubleshooting for Incomplete Adjustment

Table 12 4 Examples of Troubleshooting for Incomplete Adjustment

Trouble	Cause	Corrective Action
Motor rotates even if the speed reference voltage is 0 V	Incomplete ZERO potentiometer adjustment	Adjust VR3 ZERO correctly
Motor vibrates or vibration frequency is too high, approx 200 to 300 Hz (When vibration frequency equals commercial frequency)	Speed loop gain too high • Excessively long lead of SERVOPACK input circuit • Noise interference due to bundling of signal line and power line	Turn VR6 LOOP CW to increase the speed loop gain • Decrease length of lead • Separate input circuit line from power line or connect input circuit to low impedance less than several 100 ohms
Motor speed overshoot is too large at starting or stopping	• Speed loop gain too high	• Turn VR6 LOOP CW to increase the speed loop gain

AC SERVO DRIVES

R SERIES FOR SPEED CONTROL

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

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